

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



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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)

This manual is applicable for the following R&S®FSV models with firmware 1.71 and higher:

- R&S®FSV3 (1307.9002K03)
- R&S®FSV7 (1307.9002K07)
- R&S®FSV13 (1307.9002K13)
- R&S®FSV30 (1307.9002K30)
- R&S®FSV40 (1307.9002K40)

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

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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 WCDMA-based 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).

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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. Cost-effective 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.

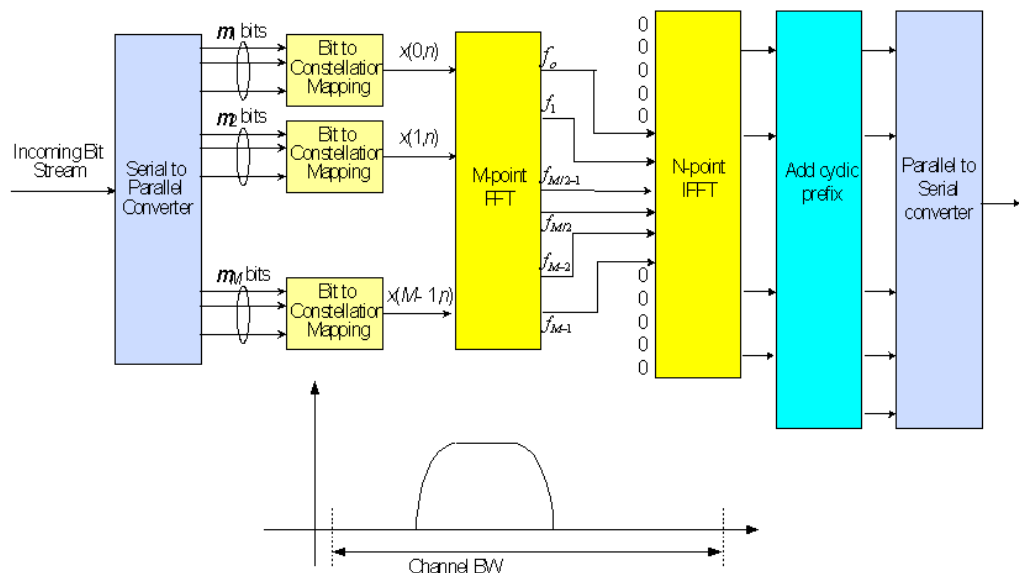


Fig. 1-1: Block Diagram of DFT-s-OFDM (Localized Transmission)

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 $N_{\text{symbol}}^{\text{UL}}$ SC-FDMA symbols, where $N_{\text{symbol}}^{\text{UL}} = 7$ for the normal cyclic prefix and $N_{\text{symbol}}^{\text{UL}} = 6$ 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.

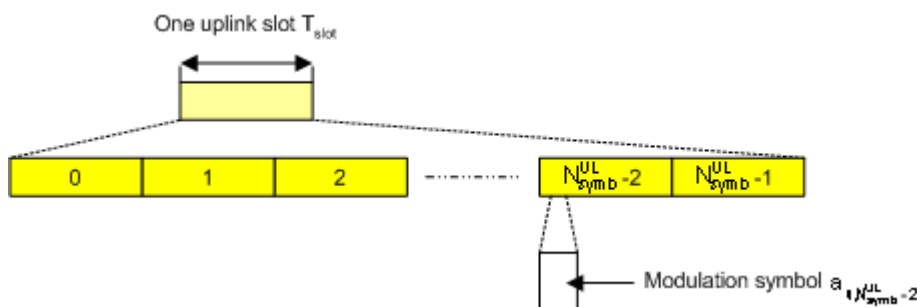


Fig. 1-2: Uplink Slot Structure

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 $N_{\text{symbol}}^{\text{UL}}$	Cyclic prefix length in samples	Cyclic prefix length in μs
Normal cyclic prefix $\Delta f=15\text{kHz}$	7	160 for first symbol 144 for other symbols	5.2 μs for first symbol 4.7 μs for other symbols
Extended cyclic prefix $\Delta f=15\text{kHz}$	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 N_{Tx} and the frequency hopping pattern k_0 .

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 transitioning from idle to connected, or to re-establish uplink synchronization. The structure is shown in figure 1-3.

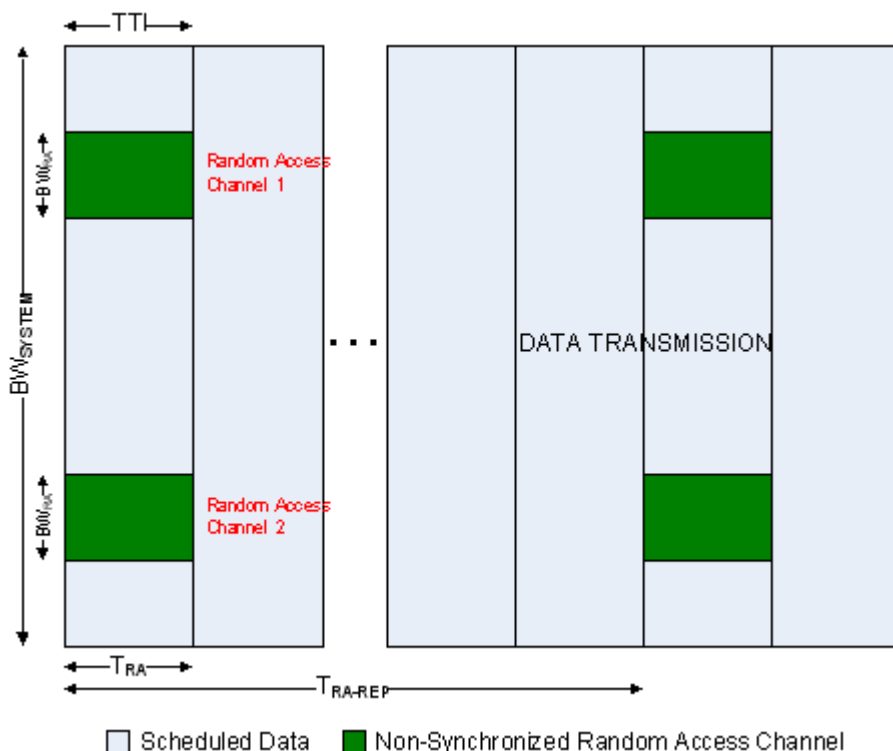


Fig. 1-3: Random Access Structure, principle

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.

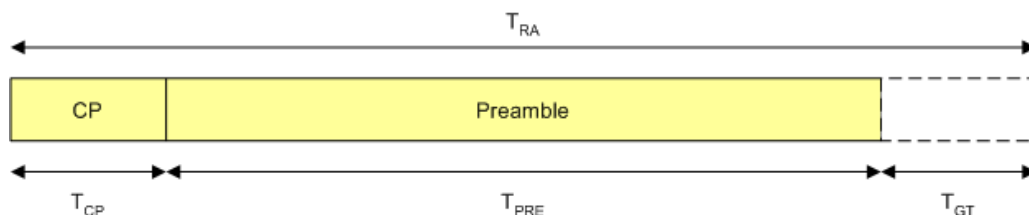


Fig. 1-4: Random Access Preamble

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 software 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 FSV

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

- [Installing the Software](#).....14
- [Application Overview](#).....14
- [Support](#).....16

2.1 Installing the Software

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

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.

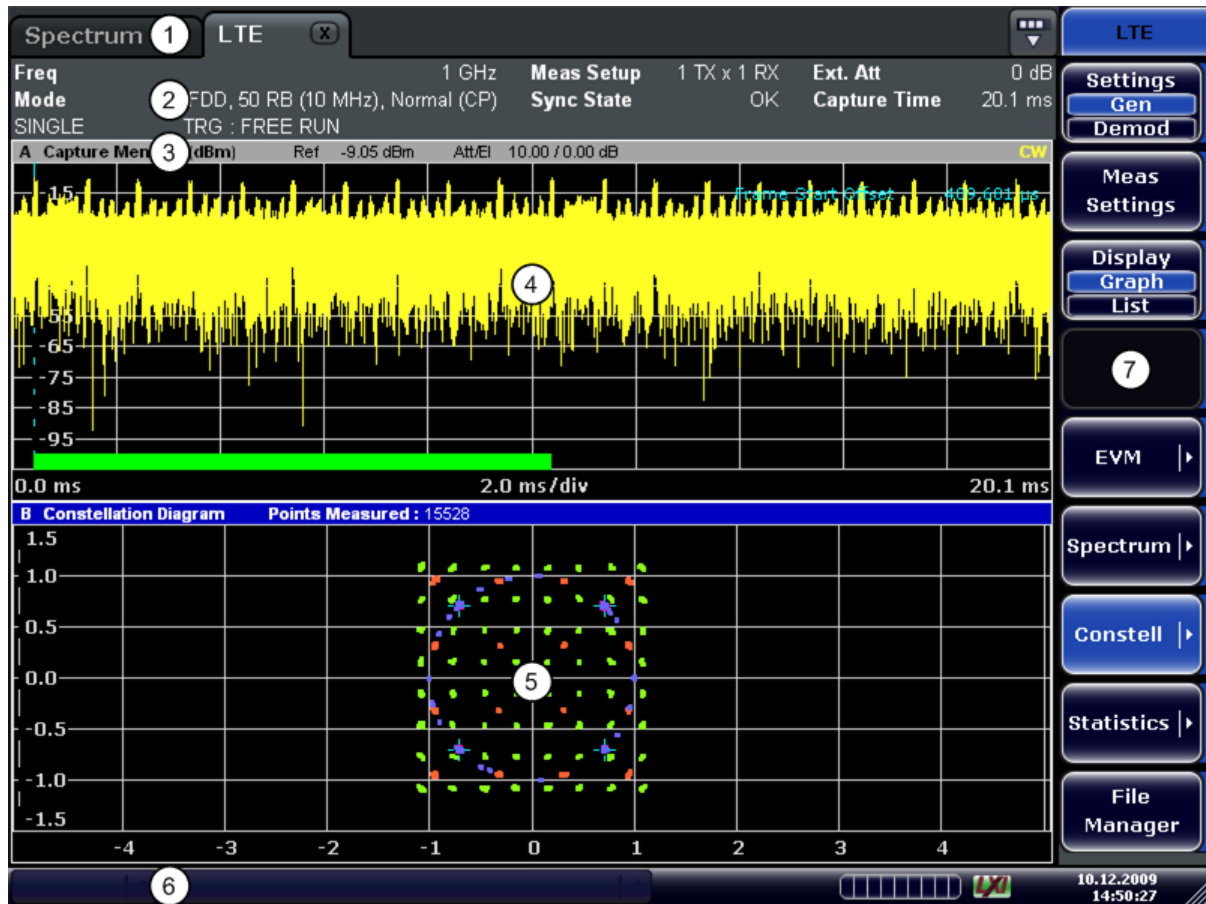
Presetting the software

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 126

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.

LTE					
Freq	1 GHz	Meas Setup	1 TX x 1 RX	Ext. Att	0 dB
Mode	DL FDD, 50 RB (10 MHz), Normal (CP)	Sync State	OK	Capture Time	20.1 ms
SINGLE	TRG : FREE RUN				

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 80
- **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 FSV stores the information in a number of files that are located in the R&S FSV 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

This chapter provides background information on the measurements and result displays available with the LTE Analysis Software.

- [Symbols and Variables](#)..... 17
- [Overview](#)..... 18
- [The LTE Uplink Analysis Measurement Application](#)..... 18

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.

$a_{i,k}, \hat{a}_{i,k}$	data symbol (actual, decided)
$A_{i,k}$	data symbol after DFT-precoding
$\Delta f, \Delta \hat{f}_{\text{coarse}}$	carrier frequency offset between transmitter and receiver (actual, coarse estimate)
Δf_{res}	residual carrier frequency offset
ζ	relative sampling frequency offset
$H_{i,k}, \hat{H}_{i,k}$	channel transfer function (actual, estimate)
i	time index
$\hat{t}_{\text{coarse}}, \hat{t}_{\text{fine}}$	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 precoding
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 structured 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 $\hat{a}_{n,l}$ 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.

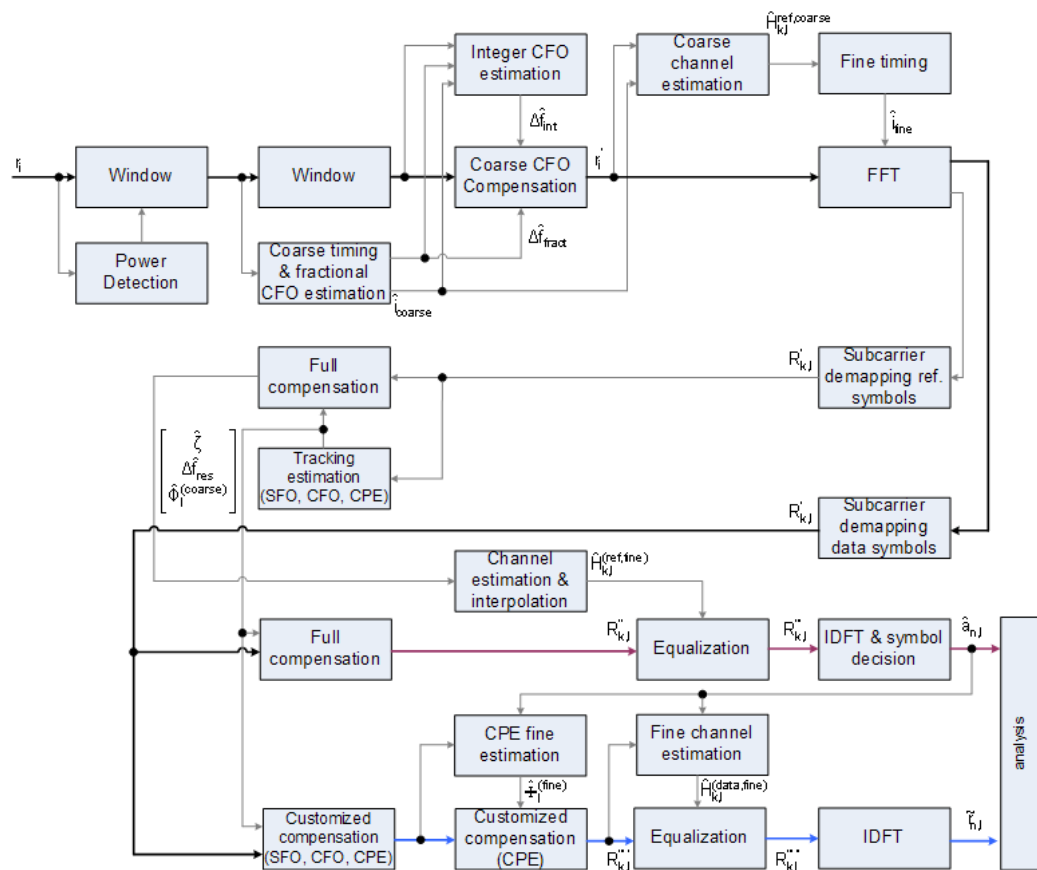


Fig. 3-1: Block diagram for the LTE UL measurement application

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_1

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

$$R'_{k,l} = A_{k,l} \cdot H_{k,l} \cdot \underbrace{e^{j\Phi_l}}_{\leftarrow CPE} \cdot \underbrace{e^{j2\pi \cdot N_S / N_{FFT} \cdot \zeta \cdot k \cdot l}}_{\leftarrow SFO} \cdot \underbrace{e^{j2\pi \cdot N_S / N_{FFT} \cdot \Delta f_{res} \cdot T \cdot l}}_{\leftarrow res.CFO} + N_{k,l} \quad (3 - 1)$$

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

$$EVM_{l,k} = \frac{|\tilde{r}_{n,l} - \hat{a}_{n,l}|}{\sqrt{E\{|a_{n,l}|^2\}}} \quad (3 - 2)$$

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

$$EVM_{n,l} = |\tilde{r}_{n,l} - \hat{a}_{n,l}| \quad (3 - 3)$$

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 $Q:=1+\Delta Q$.

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. $\Delta_{RB}=1$ or $\Delta_{RB}=-1$ 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

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 48.

- Numerical Results.....23
- Measuring the Power Over Time.....25
- Measuring the Error Vector Magnitude (EVM).....26
- Measuring the Spectrum.....28
- Measuring the Symbol Constellation.....34
- Measuring Statistics.....35

4.1 Numerical Results

- Result Summary.....23

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.

SCPI command:

DISPlay[:WINDow<n>]:TABLE on page 77

Contents of the result summary

Result Summary						
Frame Results	Min	Mean	Limit	Max	Limit	Unit
EVM PUSCH QPSK		0.31	17.50			%
EVM PUSCH 16QAM			12.50			%
EVM PUSCH 64QAM						%
Results for Selection	Subframe(s)	ALL	Slot(s)	ALL	Symbols meas.	140
EVM All	0.26	0.30		0.33		%
EVM Phys. Channel	0.27	0.30		0.34		%
EVM Phys. Signal	0.23	0.28		0.33		%
Frequency Error	-40.89	-39.51		-38.27		Hz
Sampling Error	-0.06	-0.03		-0.01		ppm
IQ Offset	-79.56	-77.57		-75.40		dB
IQ Gain Imbalance	-0.00	0.00		0.00		dB
IQ Quadrature Error	0.03	0.03		0.04		°
Power	-30.87	-30.87		-30.87		dBm
Crest Factor		5.87				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.

- **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 85
- **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 85
- **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 84
- **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 84

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 specific 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 83
- **EVM Phys Channel**
Shows the EVM for all physical channel resource elements in the analyzed frame.
[FETCh:SUMMary:EVM:PCHannel\[:AVERage\]?](#) on page 83
- **EVM Phys Signal**
Shows the EVM for all physical signal resource elements in the analyzed frame.
[FETCh:SUMMary:EVM:PSIGNAL\[:AVERage\]?](#) on page 83
- **Frequency Error**
Shows the difference in the measured center frequency and the reference center frequency.
[FETCh:SUMMary:FERRor\[:AVERage\]?](#) on page 85
- **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 87
- **I/Q Offset**
Shows the power at spectral line 0 normalized to the total transmitted power.
[FETCh:SUMMary:IQOFFset\[:AVERage\]?](#) on page 86

- 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 86](#)
- 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 87](#)
- Power**
 Shows the average time domain power of the analyzed signal.
[FETCh:SUMMary:POWer\[:AVERage\]? on page 86](#)
- Crest Factor**
 Shows the peak-to-average power ratio of captured signal.
[FETCh:SUMMary:CRESt\[:AVERage\]? on page 82](#)

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](#).....25

Capture Buffer

The capture buffer result display shows the complete range of captured data for the last data capture. The x-axis represents the time scale. The maximum value of the x-axis is equal to the capture length that you can set in the General Settings dialog box. The y-axis represents the amplitude of the captured I/Q data in dBm (for RF input).

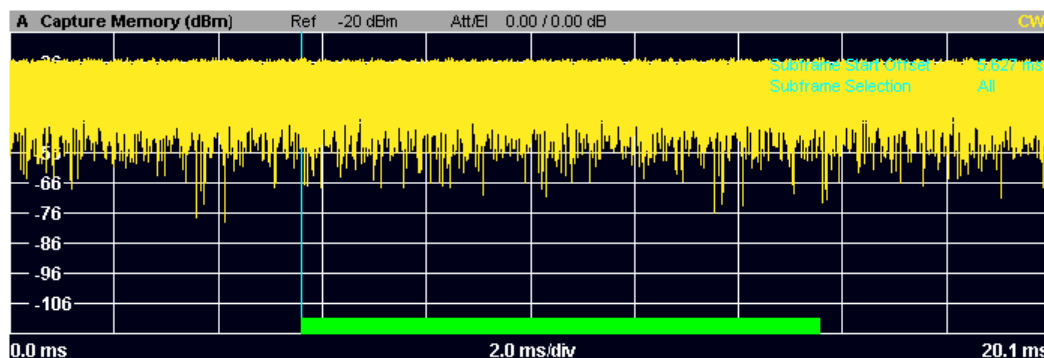


Fig. 4-1: Capture buffer without zoom

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 marks the subframe start. Additionally, the diagram includes the Subframe Start Offset value (blue text). 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.

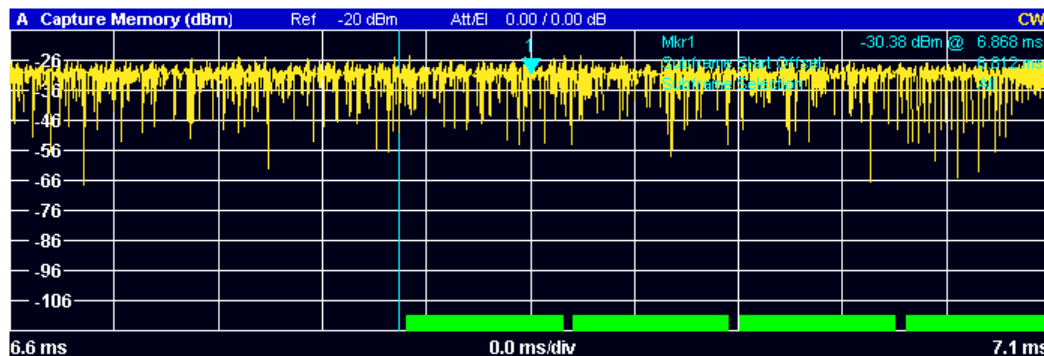


Fig. 4-2: Capture buffer after a zoom has been applied

SCPI command:

```
CALCulate<n>:FEED 'PVT:CBUF'
TRACe:DATA?
```

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.

The EVM is one of the most important indicators for the quality of a signal. For more information on EVM calculation methods refer to [chapter 3, "Measurement Basics"](#), on page 17.

EVM vs Carrier	26
EVM vs Symbol	27
EVM vs Subframe	28

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 OFDM symbols used by the subcarriers. This average subcarrier EVM is determined for each analyzed slot in the capture buffer.

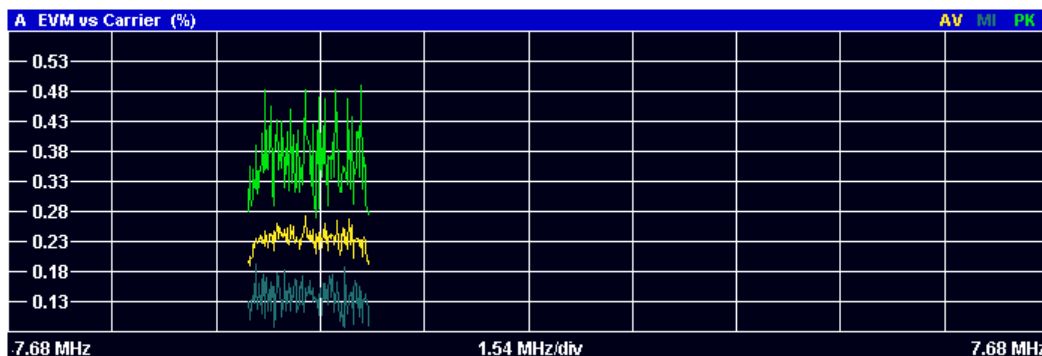
If you analyze all slots, the result display contains three traces.

- 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 65

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](#).



SCPI command:

```
CALCulate<n>:FEED 'EVM:EVCA'  
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 each analyzed slot.

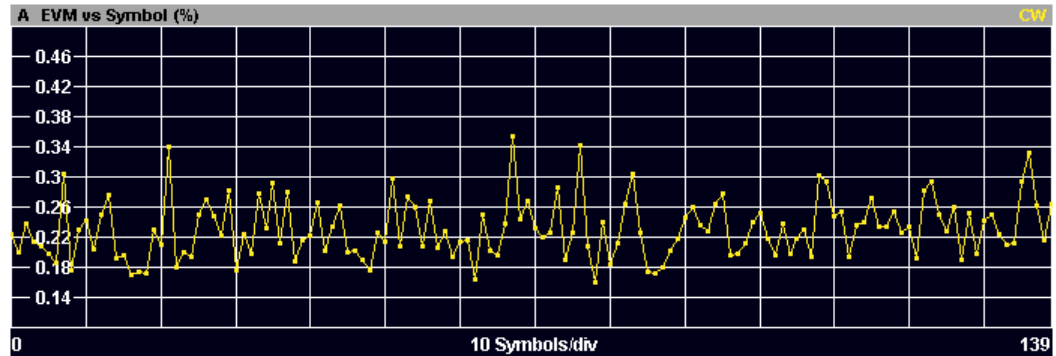
If you analyze all subframes, the result display contains three traces.

- 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 65

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 FSV 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](#)



SCPI command:

```
CALCulate<n>:FEED 'EVM:EVSU'
TRACe:DATA?
```

EVM vs Subframe

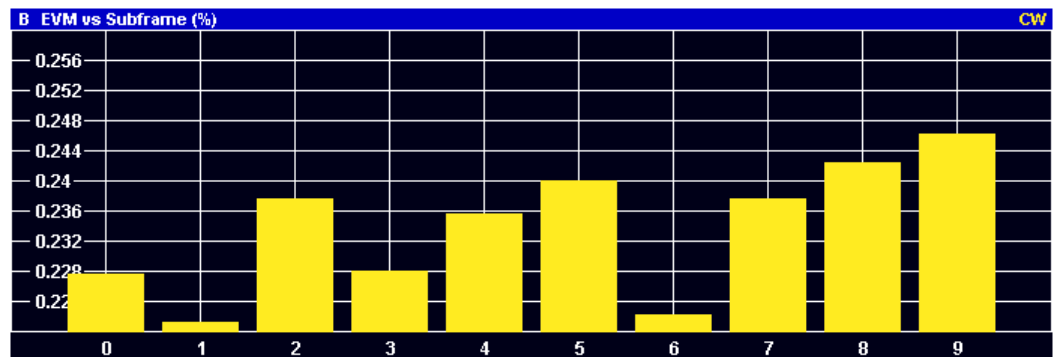
Starts the EVM vs Subframe result display.

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](#).



SCPI command:

```
CALCulate<n>:FEED 'EVM:EVSU'
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.

- [Frequency Sweep Measurements](#).....29
- [I/Q Measurements](#).....32

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 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](#).....29
- [ACLR](#).....30

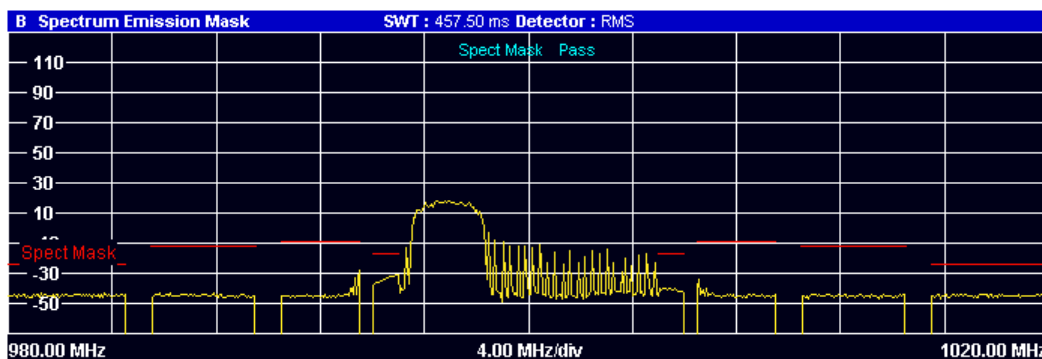
Spectrum Mask

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 R&S FSV puts a label to the limit line to indicate whether the limit check 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						
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

SCPI command:

```
CALCulate<n>:FEED 'SPEC:SEM'
TRACe:DATA?
```

ACLR

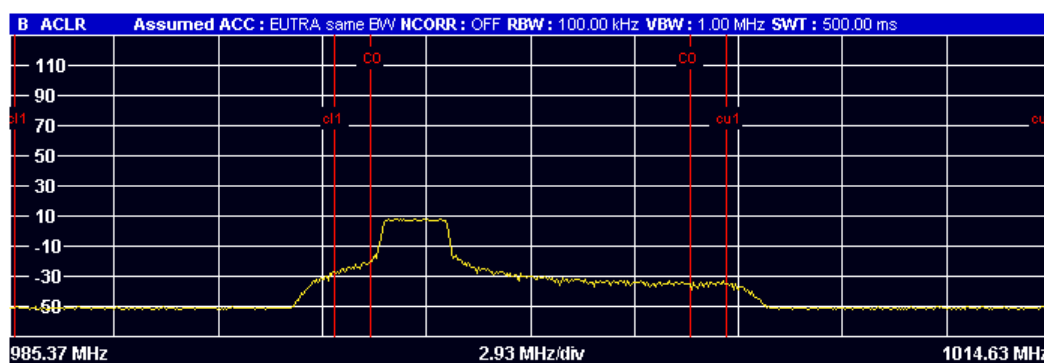
Starts the Adjacent Channel Leakage Ratio (ACLR) measurement.

The Adjacent Channel Leakage Ratio measures the power of the TX channel and the power of adjacent and alternate channels to the left and right side of the TX channel. In this way, you can get information about the power of the channels adjacent to the transmission channel and the leakage into adjacent channels.

The results show the relative power measured in the two nearest channels either side of the transmission channel.

By default the ACLR settings are derived from the LTE Channel Bandwidth. You can change the assumed adjacent channel carrier type and the "Noise Correction" on page 47.

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



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

- **Channel**
Shows the channel type (TX, Adjacent or Alternate Channel).
- **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/EI	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	...
...

SCPI command:

Selection:

CALCulate<n>:FEED 'SPEC:ACP'

Reading results:

CALCulate<n>:MARKer<m>:FUNCTION:POWER:RESult[:CURRENT]?

on page 98

TRACe:DATA?

4.4.2 I/Q Measurements

- [Inband Emissions](#).....32
- [Flatness \(Flat | Grdel | Diff\)](#).....32

4.4.2.1 Inband Emissions

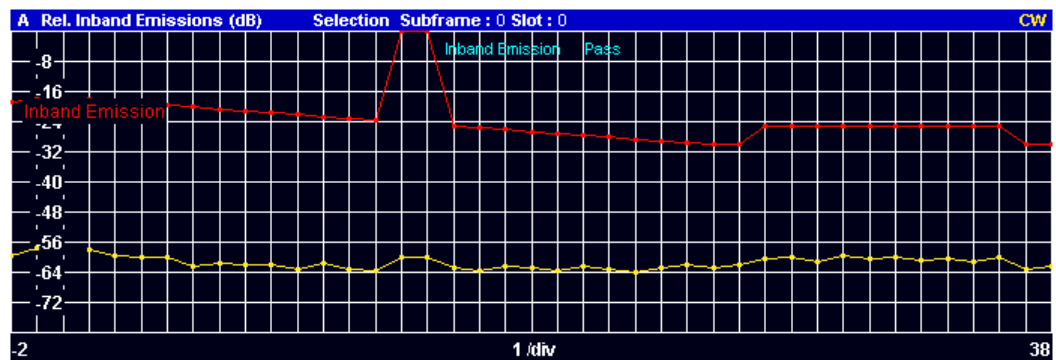
Inband Emission

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.



SCPI command:

```
CALCulate<screenid>:FEED 'SPEC:IE'
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.



SCPI command:

```
CALCulate<n>:FEED 'SPEC:FLAT'
TRACe:DATA?
```

Channel Group Delay

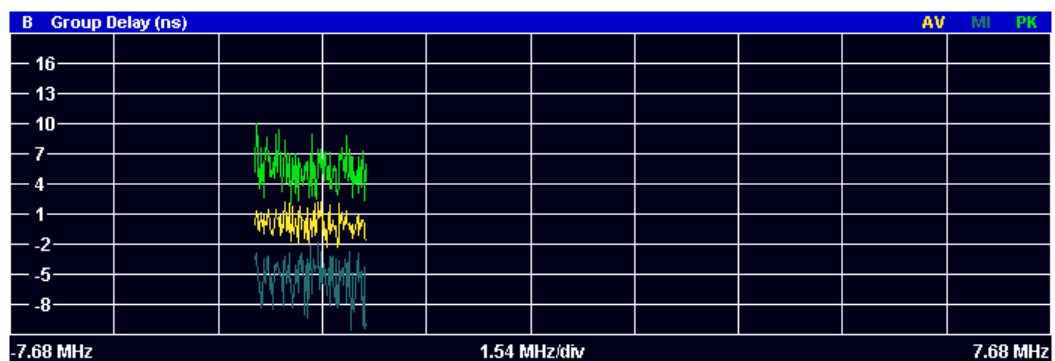
Starts the Channel Group Delay result display.

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.



SCPI command:

```
CALCulate<n>:FEED 'SPEC:GDEL'
TRACe:DATA?
```

Channel Flatness Difference

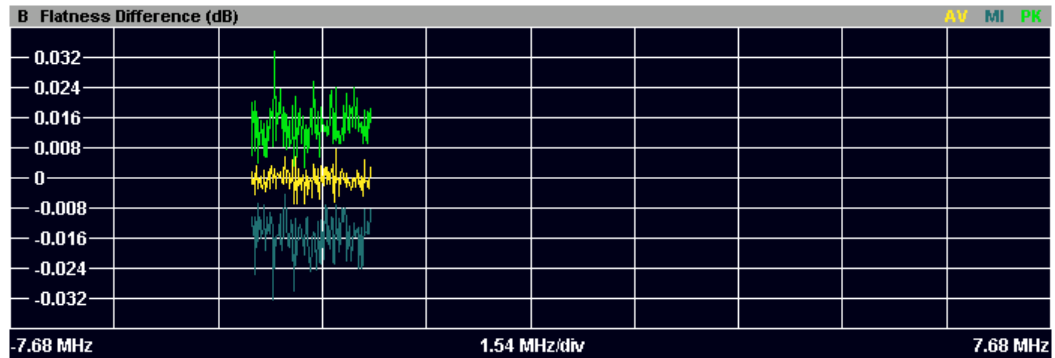
Starts the Channel Flatness Difference result display.

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.



SCPI command:
 CALCulate<n>:FEED 'SPEC:FDIF'
 TRACe:DATA?

4.5 Measuring the Symbol Constellation

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

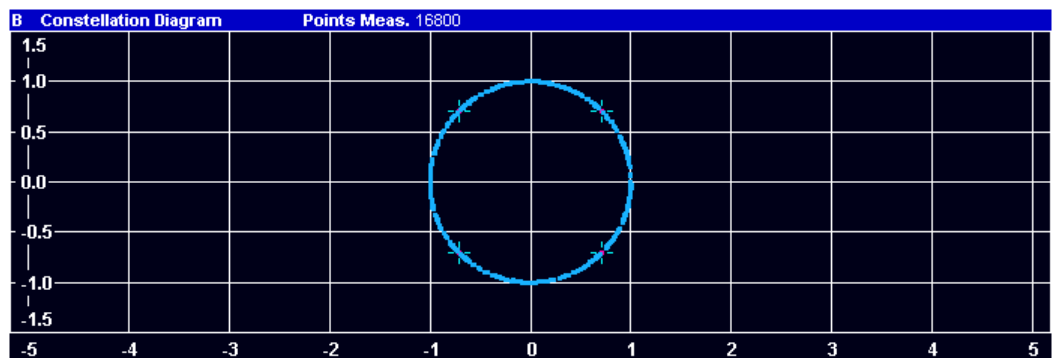
[Constellation Diagram](#).....34

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. 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.



SCPI command:
 CALCulate<n>:FEED 'CONS:CONS'
 TRACe:DATA?

4.6 Measuring Statistics

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

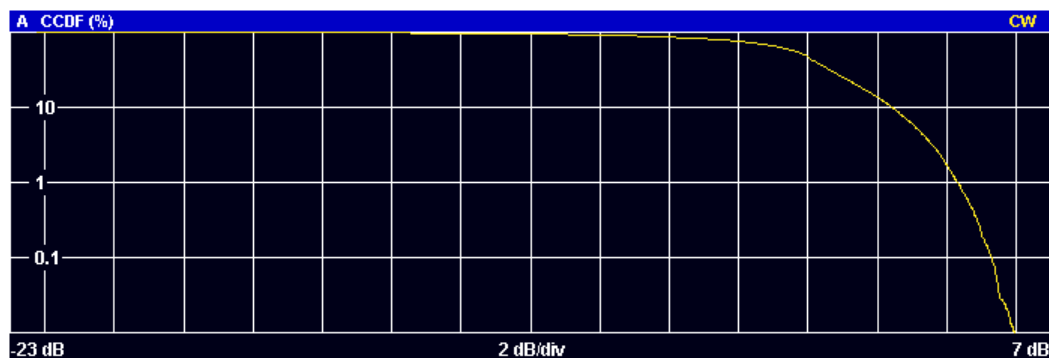
CCDF.....35
 Allocation Summary.....35
 Bit Stream.....36

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 %.



SCPI command:

```
CALCulate<n>:FEED 'STAT:CCDF'
TRACe:DATA?
```

Allocation Summary

Starts the Allocation Summary result display.

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

Sub-frame	Allocation ID	Number of RB	Offset RB	Modulation	Power [dBm]	EVM [%]
0	PUSCH	10	2	QPSK	-30.269	0.227
	DMRS PUSCH			CAZAC	-30.269	0.228
1	PUSCH	10	2	QPSK	-30.269	0.227
	DMRS PUSCH			CAZAC	-30.268	0.184
2	PUSCH	10	2	QPSK	-30.269	0.242
	DMRS PUSCH			CAZAC	-30.269	0.207
3	PUSCH	10	2	QPSK	-30.269	0.232
	DMRS PUSCH			CAZAC	-30.268	0.204

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 following 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](#).

SCPI command:

```
CALCulate<n>:FEED 'STAT:ASUM'
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.

B Bit Stream																				
Sub-frame	Allocation ID	Code-word	Modulation	Symbol Index	Bit Stream															
0	PUSCH	1/1	QPSK	0	02	03	00	00	03	01	01	01	00	00	03	01	00	00	03	02
0	PUSCH	1/1	QPSK	16	00	03	03	03	01	00	03	02	02	03	00	03	00	00	03	00
0	PUSCH	1/1	QPSK	32	03	02	02	00	03	01	00	02	00	02	01	03	01	02	00	02
0	PUSCH	1/1	QPSK	48	00	02	03	01	02	03	01	03	00	02	02	00	03	02	03	02
0	PUSCH	1/1	QPSK	64	03	00	01	02	00	00	03	03	01	00	02	02	01	01	00	00
0	PUSCH	1/1	QPSK	80	01	01	00	01	03	01	03	01	00	01	00	03	00	02	00	00
0	PUSCH	1/1	QPSK	96	03	01	01	03	02	01	00	00	00	03	00	00	03	03	02	03
0	PUSCH	1/1	QPSK	112	00	03	00	02	03	03	01	03	02	02	00	02	01	00	00	03
0	PUSCH	1/1	QPSK	128	01	03	02	00	00	01	02	00	01	00	03	03	01	01	02	01
0	PUSCH	1/1	QPSK	144	03	00	00	00	01	02	00	02	00	03	00	02	03	00	03	00
0	PUSCH	1/1	QPSK	160	01	02	02	00	01	02	01	00	00	01	00	02	00	02	02	00

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/Bit Index**

- **Bit Stream**

The actual bit stream.

SCPI command:

`CALCulate<n>:FEED 'STAT:BSTR'`

`TRACe:DATA?`

5 Configuring and Performing the Measurement

Before you can start a measurement, you have to configure the R&S FSV 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.

- [Performing Measurements](#).....38
- [General Settings](#).....39
- [Configuring Spectrum Measurements](#).....45
- [Advanced General Settings](#).....48
- [Configuring Uplink Signal Demodulation](#).....49
- [Configuring Uplink Frames](#).....52
- [Defining Advanced Signal Characteristics](#).....56

5.1 Performing Measurements

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

Single Sweep and Continuous Sweep

In continuous sweep mode, the R&S FSV 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 FSV captures data, performs the measurement and updates the result display exactly once after the trigger event. After this process, the R&S FSV interrupts the measurement.

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

SCPI command:

[INITiate:CONTinuous](#) on page 79

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 41.

SCPI command:

[\[SENSe\]:POWer:AUTO<analyzer>\[:STATe\]](#) on page 103

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 FSV 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.

SCPI command:

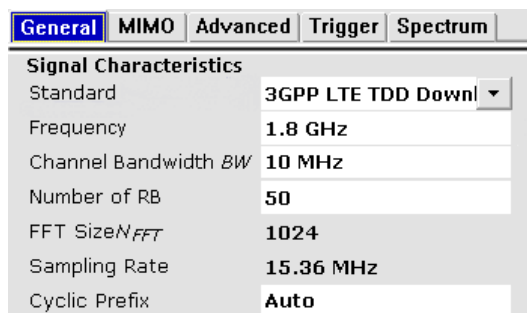
[INITiate:REFresh](#) on page 80

5.2 General Settings

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.



[Selecting the LTE Mode](#).....40

[Defining the Signal Frequency](#).....40

[Channel Bandwidth / Number of Resource Blocks](#).....40

[Cyclic Prefix](#).....41

Selecting the LTE Mode

The standard defines the LTE mode you are testing.

The choices you have depend on the configuration of the R&S FSV.

- 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.

SCPI command:

[CONFigure\[:LTE\]:LDIRection](#) on page 99

[CONFigure\[:LTE\]:DUPLexing](#) on page 99

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.

The frequency setting is available for the RF input source.

SCPI command:

Center frequency:

[\[SENSe\]:FREQuency:CENTer](#) on page 100

Channel Bandwidth / Number of Resource Blocks

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

The channel bandwidth and number of resource blocks (RB) are interdependent. If you enter one, the R&S FSV automatically calculates and adjusts the other.

Currently, the LTE standard recommends six bandwidths (see table below).

If you enter a value different to those recommended by the standard, the R&S FSV labels the parameter as "User", but still does the calculations.

The R&S FSV also calculates the FFT size and sampling rate from the channel bandwidth. 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	23.04	30.72
FFT Size	128	256	512	1024	2048	2048

SCPI command:

`CONFigure[:LTE]:UL:BW` on page 100

`CONFigure[:LTE]:UL:NORB` on page 100

Cyclic Prefix

The cyclic prefix serves as a guard interval between OFDM symbols to avoid interferences. 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.

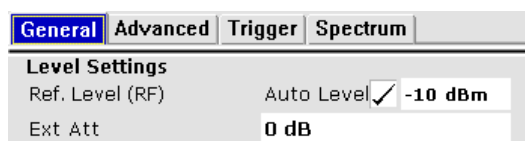
SCPI command:

`CONFigure[:LTE]:UL:CYCPrefix` on page 100

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](#).....41

[Attenuating the Signal](#).....42

Defining a Reference Level

The reference level is the power level the R&S FSV 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**.

Automatic level detection also optimizes RF attenuation.

SCPI command:

Manual (RF):

[CONFigure:POWer:EXPeCted:RF<analyzer>](#) on page 101

Manual (BB):

[CONFigure:POWer:EXPeCted:IQ<analyzer>](#) on page 101

Automatic:

[\[SENSe\]:POWer:AUTO<analyzer>\[:STATe\]](#) on page 103

Auto Level Track Time:

[\[SENSe\]:POWer:AUTO<analyzer>:TIME](#) on page 103

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 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.

SCPI command:

RF attenuation:

[INPut<n>:ATTenuation<analyzer>](#) on page 102

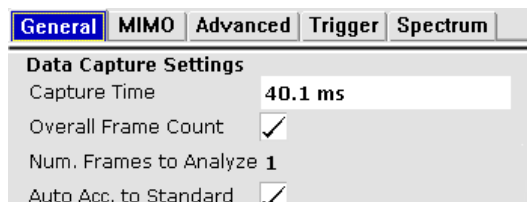
External attenuation:

[DISPlay\[:WINDow<n>\]:TRACe<t>:Y\[:SCALE\]:RLEVEL:OFFSet](#) on page 101

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.



[Capture Time](#).....43
[Overall Frame Count](#).....43
[Number of Frames to Analyze](#).....43
[Auto According to Standard](#).....44

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.

SCPI command:

[\[SENSe\] : SWEEp : TIME](#) on page 104

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 FSV analyzes all complete LTE frames currently in the capture buffer.

SCPI command:

[\[SENSe\] \[: LTE \] : FRAME : COUNT : STATE](#) on page 104

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 FSV 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](#).

SCPI command:

[\[SENSe\] \[: LTE \] : FRAME : COUNT](#) on page 103

Auto According to Standard

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

If active, the R&S FSV 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.

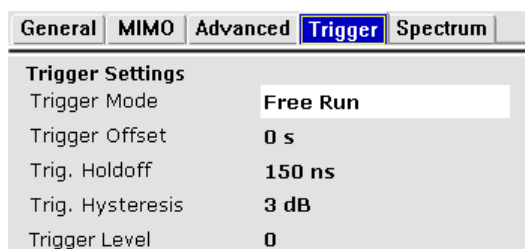
SCPI command:

[SENSe] [:LTE]:FRAMe:COUNT:AUtO on page 104

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](#).....44

Configuring the Trigger

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

While the R&S FSV 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 R&S FSV 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 FSV-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 individual measurements, set a **trigger holdoff**. A trigger holdoff defines a waiting period that must at least pass between one trigger event and the next.

SCPI command:

Trigger mode:

`TRIGger[:SEquence]:MODE` on page 106

Trigger level:

`TRIGger[:SEquence]:LEVel<analyzer>:POWer` on page 106

Trigger offset:

`TRIGger[:SEquence]:HOLDoff<analyzer>` on page 105

Trigger hysteresis:

`TRIGger[:SEquence]:IFPower:HYSTeresis` on page 105

Trigger holdoff:

`TRIGger[:SEquence]:IFPower:HOLDoff` on page 105

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.



[Auto Gating](#).....46
[Span](#).....46

Auto Gating

Turns gating for SEM and ACLR measurements on and off.

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

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.

SCPI command:

[\[SENSe\] :SWEep:EGATe:AUTO](#) on page 79

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.

5.3.2 Configuring SEM Measurements

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



[Category](#).....47

Category

Selects the limit definitions for SEM measurements.

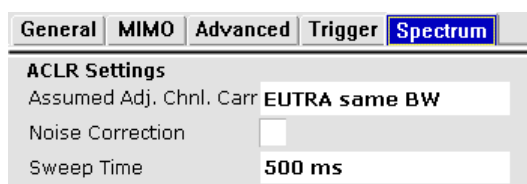
Category A and B are defined in ITU-R recommendation SM.329. The category you should use for the measurement depends on the category that the base station you are testing supports.

SCPI command:

[SENSe]:POWer:SEM:CATegory on page 79

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.....47
 Noise Correction.....47
 Sweep Time.....47

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.

SCPI command:

[SENSe]:POWer:ACHannel:AACHannel on page 78

Noise Correction

Turns noise correction on and off.

For more information see the manual of the R&S FSV.

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.

SCPI command:

[SENSe]:POWer:NCORrection on page 78

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.

5.4 Advanced General Settings

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](#).....48

Swap I/Q

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

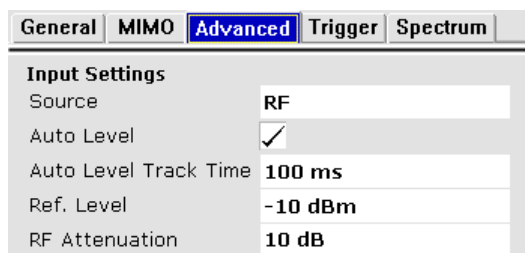
SCPI command:

[\[SENSe\]:SWAPiQ](#) on page 106

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 41.

For more information on signal attenuation see ["Attenuating the Signal"](#) on page 42.

[Selecting the Input Source](#).....48

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 FSV-B17.

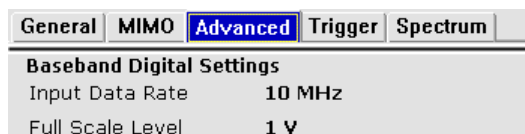
For more information on using hardware option R&S FSV-B17 see the manual of the R&S FSV.

SCPI command:
[INPut:SElect](#) on page 107

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)	49
Full Scale Level	49

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.

SCPI command:
[INPut<n>:DIQ:SRATe](#) on page 108

Full Scale Level

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

SCPI command:
[INPut<n>:DIQ:RANGe \[:UPPer\]](#) on page 108

5.5 Configuring Uplink Signal Demodulation

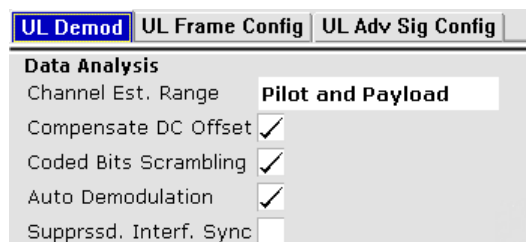
The uplink demodulation settings contain settings that describe the signal processing and the way the signal is measured.

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.



[Channel Estimation Range](#).....50
[Compensate DC Offset](#).....50
[Scrambling of Coded Bits](#).....50
[Auto Demodulation](#).....51
[Suppressed Interference Synchronization](#).....51

Channel Estimation Range

Selects the method for channel estimation.

Choose whether to use only the pilot symbols to perform channel estimation or both pilot and payload carriers.

SCPI command:

[\[SENSe\] \[:LTE\]:UL:DEMod:CEStimation](#) on page 109

Compensate DC Offset

Activates or deactivates DC offset compensation when calculating measurement results.

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

SCPI command:

[\[SENSe\] \[:LTE\]:UL:DEMod:CDcoffset](#) on page 109

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.

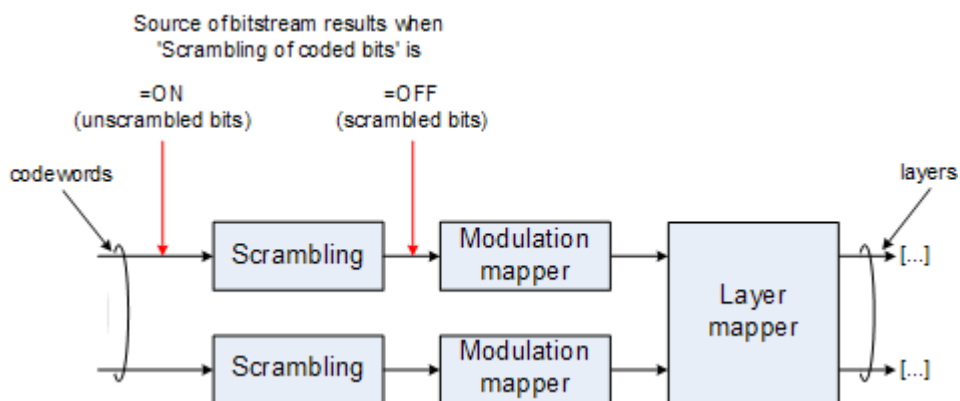


Fig. 5-1: Source for bitstream results if scrambling for coded bits is on and off

SCPI command:

[\[SENSe\] \[:LTE\]:UL:DEMod:CBSCrambling](#) on page 108

Auto Demodulation

Turns automatic demodulation on and off.

If active, the R&S FSV automatically detects the resource allocation of the signal.

Automatic demodulation is not available if the suppressed interference synchronization is active.

SCPI command:

[\[SENSe\] \[:LTE\]:UL:DEMod:AUTO](#) on page 108

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.

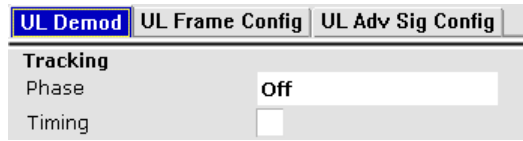
SCPI command:

[\[SENSe\] \[:LTE\]:UL:DEMod:SISync](#) on page 109

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.....52
 Timing.....52

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 Payload" Both reference signal and payload resource elements are used for the estimation of the phase error.

SCPI command:

[SENSe] [:LTE] :UL:TRACking:PHASe on page 110

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.

SCPI command:

[SENSe] [:LTE] :UL:TRACking:TIME on page 110

5.6 Configuring Uplink Frames

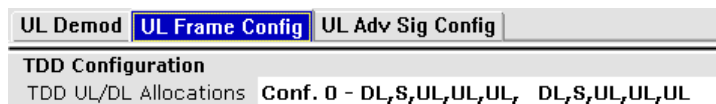
The frame configuration contains settings that define the structure of the uplink LTE signal.

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.....53

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 9 different configurations for the special subframe. However, configurations 7 and 8 only work for a normal cyclic prefix. If you select it using an extended cyclic prefix or automatic detection of the cyclic prefix, the application will show an error message.

SCPI command:

Subframe

[CONFigure\[:LTE\]:UL:TDD:UDConf](#) on page 110

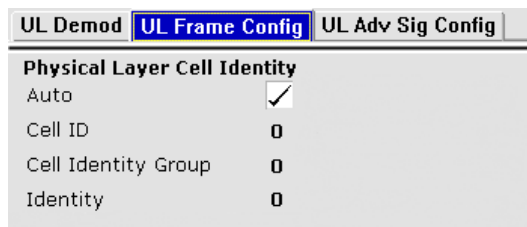
Special Subframe

[CONFigure\[:LTE\]:UL:TDD:SPSC](#) on page 110

5.6.2 Configuring the Physical Layer Cell Identity

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

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



[Configuring the Physical Layer Cell Identity](#).....54

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 R&S FSV 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

SCPI command:

Cell ID:

[CONFigure\[:LTE\]:UL:PLC:CID](#) on page 111

Cell Identity Group:

[CONFigure\[:LTE\]:UL:PLC:CIDGroup](#) on page 111

Identity

[CONFigure\[:LTE\]:UL:PLC:PLID](#) on page 111

5.6.3 Configuring Subframes

The application allows you to configure individual subframes.

If you turn "Auto Demodulation" on, the application automatically determines the subframe configuration. In the default state, automatic configuration is on.

An LTE frame contains 10 subframes. The R&S FSV shows the contents for each subframe in the configuration table. In the configuration table, each row corresponds to one subframe.

You can also define a frame number offset that the software uses to demodulate the captured frame.

Before you start to work on the contents of each subframe, you should define the number of subframes you want to customize with the "Configurable Subframes" parameter. The application supports the configuration of up to 10 subframes.

[Configuring Subframes](#).....55

Configuring Subframes

According to the number of configurable subframes you have set, the R&S FSV adjusts the size of the subframe configuration table. Each row in the table corresponds to one allocation if the subframe is a cluster. Else, the row is a subframe.

The configuration table contains the settings to configure the subframes.

- Subframe
Shows the number of a subframe.
Note that, depending on the configuration, some subframes may not be available for editing. The R&S FSV labels those downlink subframes "(not used)". The corresponding cells in the table are greyed out.
- Enable PUCCH
Turns the PUCCH in the corresponding subframe on and off.
If you turn on a PUCCH, "Modulation", "Number of RBs" and "Offset RB" are unavailable for that subframe.
- Modulation
Selects the modulation scheme for the corresponding PUSCH allocation.
The modulation scheme is either QPSK, 16QAM or 64QAM.
- 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.
- Offset RB

Sets the resource block at which the PUSCH allocation begins.

SCPI command:

Configurable subframes:

[CONFigure\[:LTE\]:UL:CSUBframes](#) on page 112

Frame number offset:

[CONFigure\[:LTE\]:UL:SFNO](#) on page 112

Enable PUCCH:

[CONFigure\[:LTE\]:UL:SUBFrame<subframe>:ALLoc:CONT](#) on page 113

Modulation:

[CONFigure\[:LTE\]:UL:SUBFrame<subframe>:ALLoc:MODulation](#) on page 113

Number of RB:

[CONFigure\[:LTE\]:UL:SUBFrame<subframe>:ALLoc:RBCount](#) on page 112

Offset RB:

[CONFigure\[:LTE\]:UL:SUBFrame<subframe>:ALLoc:RBOffset](#) on page 112

5.7 Defining Advanced Signal Characteristics

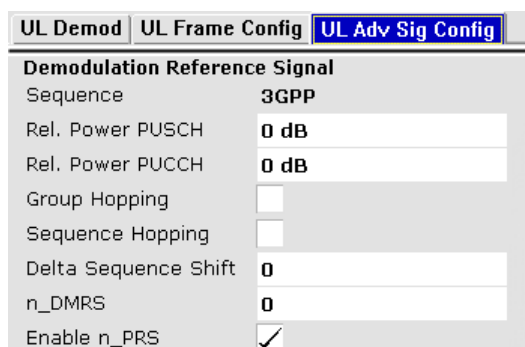
The uplink advanced signal characteristics contain settings that describe the detailed structure of a uplink LTE signal.

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.



Sequence	57
Relative Power PUSCH	57
Relative Power PUCCH	57
Group Hopping	57
Sequence Hopping	57

Delta Sequence Shift.....	58
n(1)_DMRS.....	58
Enable n_PRS.....	58

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

Sets the power offset of the Demodulation Reference Signal (DRS) relative to the power level of the PUSCH allocation of the corresponding subframe. The selected DRS power offset ($P_{\text{DRS_Offset}}$) applies for all subframes. Depending on the allocation of the subframe, the effective power level of the DRS is calculated as following:

$$P_{\text{DRS}} = P_{\text{UE}} + P_{\text{PUSCH}} + P_{\text{DRS_Offset}}$$

The PUSCH Power level (P_{PUSCH}) can vary per subframe.

SCPI command:

[CONFigure\[:LTE\]:UL:DRS\[:PUSCh\]:POWer](#) on page 115

Relative Power PUCCH

Sets the power offset of the Demodulation Reference Signal (DRS) relative to the power level of the PUCCH allocation of the corresponding subframe. The selected DRS power offset ($P_{\text{DRS_Offset}}$) applies for all subframes. Depending on the allocation of the subframe, the effective power level of the DRS is calculated as following:

$$P_{\text{DRS}} = P_{\text{UE}} + P_{\text{PUCCH}} + P_{\text{DRS_Offset}} \text{ (for PUCCH allocation)}$$

The PUCCH Power level (P_{PUCCH}) can vary per subframe.

SCPI command:

[CONFigure\[:LTE\]:UL:DRS:PUCCh:POWer](#) on page 114

Group Hopping

Indicates whether group hopping for the demodulation reference signal is activated or not.

17 different hopping patterns and 30 different sequence shift patterns are used for group hopping. PUSCH and PUCCH use the same group hopping pattern that is calculated if the group hopping is enabled. The group hopping pattern is generated by a pseudo-random sequence generator.

SCPI command:

[CONFigure\[:LTE\]:UL:DRS:GRPHopping](#) on page 114

Sequence Hopping

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

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

SCPI command:

[CONFigure\[:LTE\]:UL:DRS:SEQHopping](#) on page 115

Delta Sequence Shift

Delta Sequence Shift specifies the parameter Δ_{SS}

This parameter can be found in 3GPP TS 36.211 V8.5.0, 5.5.1.3 Group hopping. A sequence shift function f_{ss} is defined for the PUCCH. The corresponding function for the PUSCH is derived by applying this Delta Sequence Shift.

SCPI command:

[CONFigure\[:LTE\]:UL:DRS:DSShift](#) on page 114

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 $n_{DMRS} = n_{DMRS}^{(1)} + n_{DMRS}^{(2)}$.

SCPI command:

[CONFigure\[:LTE\]:UL:DRS:NDMRs](#) on page 114

Enable n_PRs

Enables the use of the pseudo-random sequence n_{PRS} in the calculation of the demodulation reference signal (DMRS) index as defined in 3GPP TS 36.211, chapter 5.5.2.1.1.

If n_{PRS} is disabled, it is possible to set the cyclic shift to 0 for all subframes.

This parameter has to be enabled in order to generate a 3GPP compliant uplink signal.

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
Sounding Reference Signal		
Present	<input type="checkbox"/>	
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.....	59
SRS Rel Power.....	59
SRS Subframe Conf.....	59
SRS Bandwidth B_SRS.....	59
Freq. Domain Pos. n_RRC.....	60
SRS BW Conf. C_SRS.....	60
Transm. Comb. k_TC.....	60
SRS Cyclic Shift N_CS.....	60
Conf. Index I_SRS.....	60
Hopping BW b_hop.....	60

Present

Indicates whether the sounding reference signal is present or not.

SCPI command:

[CONFigure\[:LTE\]:UL:SRS:STAT](#) on page 117

SRS Rel Power

Defines the power offset of the sounding reference signal.

The power offset is relative to the power of the corresponding UE and applies to all subframes.

The effective power level of the SRS is thus

$$P_{\text{SRS}} = P_{\text{UE}} + P_{\text{SRS_Offset}}$$

SCPI command:

[CONFigure\[:LTE\]:UL:SRS:POWer](#) on page 117

SRS Subframe Conf.

Sets the cell specific parameter SRS subframe configuration. The UEs will send shortened PUSCH/PUCCH in these cell-specific subframes, regardless whether the UEs are configured to send a SRS in the according subframe or not.

SCPI command:

[CONFigure\[:LTE\]:UL:SRS:SUConfig](#) on page 117

SRS Bandwidth B_SRS

Sets the UE specific parameter SRS Bandwidth B_{SRS} , as defined in the 3GPP TS 36.211, chapter 5.5.3.2.

The SRS either spans the entire frequency bandwidth or employs frequency hopping where several narrowband SRS cover the same total bandwidth.

There are up to four SRS bandwidths defined in the standard. The most narrow SRS bandwidth ($B_{\text{SRS}} = 3$) spans four resource blocks and is available for all channel bandwidths; the other three values of the parameter B_{SRS} define more wideband SRS bandwidths, available depending on the channel bandwidth.

The SRS transmission bandwidth is determined additionally by the SRS Bandwidth Configuration C_{SRS} .

SCPI command:

[CONFigure\[:LTE\]:UL:SRS:BSRS](#) on page 116

Freq. Domain Pos. n_{RRC}

Sets the UE specific parameter Freq. Domain Position n_{RRC} , as defined in the 3GPP TS 36.211, chapter 5.5.3.2.

This parameter determines the starting physical resource block of the SRS transmission.

SCPI command:

[CONFigure\[:LTE\]:UL:SRS:NRRC](#) on page 116

SRS BW Conf. C_{SRS}

Sets the cell specific parameter SRS Bandwidth Configuration (C_{SRS}).

The SRS Bandwidth Configuration C_{SRS} , the SRS Bandwidth B_{SRS} and the UL Channel Bandwidth determine the length of the sounding reference signal sequence, calculated according to 3GPP TS 36.211.

SCPI command:

[CONFigure\[:LTE\]:UL:SRS:CSRS](#) on page 116

Transm. Comb. k_{TC}

Sets the UE specific parameter transmission comb k_{TC} , as defined in the 3GPP TS 36.211, chapter 5.5.3.2.

SCPI command:

[CONFigure\[:LTE\]:UL:SRS:TRComb](#) on page 117

SRS Cyclic Shift N_{CS}

Sets the cyclic shift n_{CS} used for the generation of the sounding reference signal CAZAC sequence.

Since 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 users to transmit simultaneously their sounding reference signal.

SCPI command:

[CONFigure\[:LTE\]:UL:SRS:CYCS](#) on page 116

Conf. Index I_{SRS}

Sets the UE specific parameter SRS configuration index I_{SRS} . Depending on the selected Duplexing Mode, this parameter determines the parameters SRS Periodicity T_{SRS} and SRS Subframe Offset T_{offset} as defined in the 3GPP TS 36.213, Table 8.2-1 (FDD) and 8.2-2 (TDD) respectively.

SCPI command:

[CONFigure\[:LTE\]:UL:SRS:ISRS](#) on page 116

Hopping BW b_{hop}

Sets the UE specific parameter frequency hopping bandwidth b_{hop} , as defined in the 3GPP TS 36.211, chapter 5.5.3.2.

SRS frequency hopping is enabled, if $b_{HOP} < B_{SRS}$.

SCPI command:

[CONFigure\[:LTE\]:UL:SRS:BHOP](#) on page 115

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
PUSCH Structure		
Freq. Hopping Mode	Off	
PUSCH Hopping Offset	4	
Number of Subbands	4	
Info. in Hopping Bits	0	

Frequency Hopping Mode.....61
 PUSCH Hopping Offset.....61
 Number of Subbands.....61
 Info. in Hopping Bits.....61

Frequency Hopping Mode

Frequency Hopping Mode specifies the hopping mode which is applied to the PUSCH. Available choices are NONE, Inter Subframe and Intra Subframe.

SCPI command:

[CONFigure\[:LTE\]:UL:PUSCh:FHMode](#) on page 118

PUSCH Hopping Offset

Sets 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 used.

SCPI command:

[CONFigure\[:LTE\]:UL:PUSCh:FHOOffset](#) on page 118

Number of Subbands

Number of Subbands specifies the number of subbands for PUSCH.

This parameter can be found in 3GPP TS36.211 V8.5.0, 5.5.3.2 Mapping to physical resources.

SCPI command:

[CONFigure\[:LTE\]:UL:PUSCh:NOSM](#) on page 118

Info. in Hopping Bits

Sets the information in hopping bits according to the PDCCH DCI format 0 hopping bit definition. This information 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.

Frequency hopping is applied according to 3GPP TS36.213.

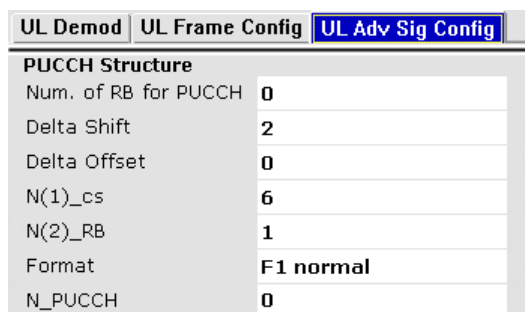
SCPI command:

[CONFigure\[:LTE\]:UL:PUSCh:FHOP:IIHB](#) on page 118

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.



No. of RBs for PUCCH	62
Delta Shift	62
Delta Offset	63
N(1)_cs	63
N(2)_RB	63
Format	63
N_PUCCH	64

No. of RBs for PUCCH

Number of RBs for PUCCH configures the number of resource blocks for PUCCH.

The resource blocks for PUCCH are always allocated at the edges of the LTE spectrum. If an even number of PUCCH resource blocks is specified, half of the available number of PUCCH resource blocks are allocated on the lower and upper edge of the LTE spectrum (outermost resource blocks). In case an odd number of PUCCH resource blocks is specified, 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.

SCPI command:

[CONFigure\[:LTE\]:UL:PUCCh:NORB](#) on page 120

Delta Shift

Sets the delta shift parameter, i.e. the cyclic shift difference between two adjacent PUCCH resource indices with the same orthogonal cover sequence (OC).

The delta shift determinates the number of available sequences in a resource block that can be used for PUCCH formats 1/1a/1b.

This parameter can be found in 3GPP TS36.211 V8.5.0, 5.4 Physical uplink control channel.

SCPI command:

[CONFigure\[:LTE\]:UL:PUCCh:DESHift](#) on page 119

Delta Offset

Sets the PUCCH delta offset parameter, i.e. the cyclic shift offset. The value range depends on the selected Cyclic Prefix.

This parameter can be found in 3GPP TS36.211 V8.5.0, 5.4 Physical uplink control channel.

SCPI command:

[CONFigure\[:LTE\]:UL:PUCCh:DEOffset](#) on page 119

N(1)_cs

Sets 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 follow:

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

This parameter can be found in 3GPP TS36.211 V8.5.0, 5.4 Physical uplink control channel.

SCPI command:

[CONFigure\[:LTE\]:UL:PUCCh:N1CS](#) on page 120

N(2)_RB

Sets 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.

This parameter can be found in 3GPP TS36.211 V8.5.0, 5.4 Physical uplink control channel.

SCPI command:

[CONFigure\[:LTE\]:UL:PUCCh:N2RB](#) on page 120

Format

Configures the physical uplink control channel format. Formats 2a and 2b are only supported for normal cyclic prefix length.

This parameter can be found in 3GPP TS36.211 V8.5.0, Table 5.4-1 Supported PUCCH formats.

SCPI command:

[CONFigure\[:LTE\]:UL:PUCCh:FORMat](#) on page 119

N_PUCCH

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

You can also select "Per Subframe" to set the N_PUCCH on a subframe level. For more information see [chapter 5.6.3, "Configuring Subframes"](#), on page 55.

SCPI command:

[CONFigure\[:LTE\]:UL:PUCCh:NP](#) on page 121

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](#).....64

UE ID/n_RNTI

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

SCPI command:

[CONFigure\[:LTE\]:UL:UEID](#) on page 121

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.

- [Selecting a Particular Signal Aspect](#).....65
- [Defining Measurement Units](#).....66
- [Defining Various Measurement Parameters](#).....66
- [Selecting the Contents of a Constellation Diagram](#).....67
- [Scaling the Y-Axis](#).....67
- [Using the Marker](#).....68

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 software displays.

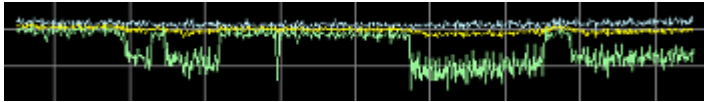
You can select a particular subframe for the following measurements.

Result Summary, EVM vs. Carrier, EVM vs. Symbol, Inband Emission, Channel Flatness, Channel Flatness SRS, Channel Group Delay, Channel Flatness Difference, Constellation Diagram, DFT Precoded Constellation, Allocation Summary and Bit Stream. 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.



SCPI command:

[\[SENSe\] \[:LTE\]:SUBFrame:SElect](#) on page 121

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 %.

SCPI command:

[UNIT:EVM](#) on page 122

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:

Sub-frame	Modulation	Symbol Index	Bit Stream
0	QPSK	0	00 02 03 00 03 03 00 01 03 03 01 03 01 00 00 01
0	QPSK	16	02 02 03 01 02 03 02 03 00 00 01 01 02 02 03 03
0	QPSK	32	02 02 02 02 02 00 00 01 01 00 02 02 03 03 00 02
0	QPSK	48	03 02 03 02 00 00 01 03 00 03 02 02 01 00 03 03
0	QPSK	64	01 01 03 01 01 00 01 00 02 00 01 02 01 03 00 00

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

Sub-frame	Modulation	Bit Index	Bit Stream
0	QPSK	0	0010110011110001111101110100000011010110110111011
0	QPSK	48	000001011010111110101010100000010100101011110010
0	QPSK	96	111011100000011100111010010011110101110101000100
0	QPSK	144	100001100111000010111101101100110100001110111100
0	QPSK	192	001111111110000011110111110001011100110010000010

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

SCPI command:
[UNIT:BSTR](#) on page 122

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.

Constellation Selection

Filters the displayed results. You can filter the results by any combination of modulation, allocation ID, symbol, carrier or location. The results are updated as soon as any change to the constellation selection parameters is made.

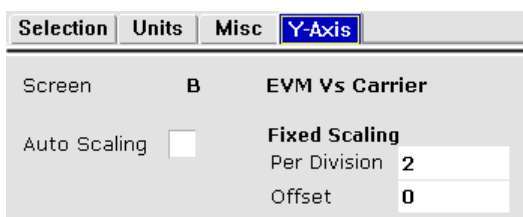
Note that the constellation selection is applied to all windows in split screen mode if the windows contain constellation diagrams.

You can filter the results by the following parameters:

- **Modulation**
Filter by modulation scheme.
- **Symbol**
Filter by OFDM symbol.
- **Carrier**
Filter by subcarrier.

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**).

SCPI command:

Automatic scaling:

`DISPlay[:WINDow]:TRACe:Y:SCALE:AUTO` on page 125

Manual scaling:

`DISPlay[:WINDow]:TRACe:Y:SCALE:FIXScale:OFFSet` on page 125

`DISPlay[:WINDow]:TRACe:Y:SCALE:FIXScale:PERDiv` on page 125

6.6 Using the Marker

The firmware application provides a marker to work with. You can use a marker to mark specific points on traces or to read out measurement results.

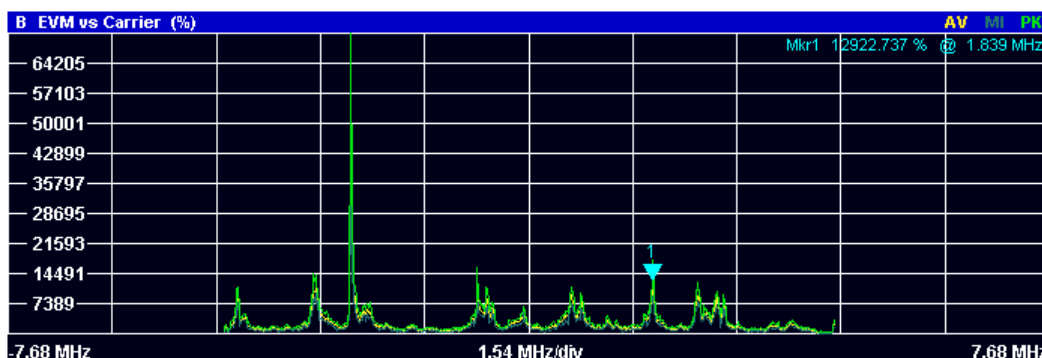


Fig. 6-3: Example: Marker

The MKR key opens the corresponding submenu. You can activate the marker with the "Marker 1" softkey. After pressing the "Marker 1" softkey, you can set the position of the marker in the marker dialog box by entering a frequency value. You can also shift the

marker position by turning the rotary knob. The current marker frequency and the corresponding level is displayed in the upper right corner of the trace display.

The "Marker 1" softkey has three possible states:

If the "Marker 1" softkey is black, the marker is off.



After pressing the "Marker 1" 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.

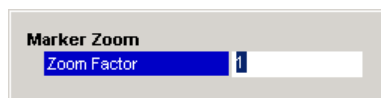


After closing the dialog box, the "Marker 1" softkey turns blue. The marker stays active.



Pressing the "Marker 1" softkey again deactivates the marker. You can also turn off the marker by pressing the "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.



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.

[CALCulate<n>:MARKer<m>\[:STATe\]](#) on page 123

[CALCulate<n>:MARKer<m>:AOFF](#) on page 123

[CALCulate<n>:MARKer<m>:TRACe](#) on page 123

[CALCulate<n>:MARKer<m>:X](#) on page 123

[CALCulate<n>:MARKer<m>:Y?](#) on page 124

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"
DemPilBoostdBPU SCH="0" DemPilBoostdBPU CCH="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 FSV is able to process I/Q data that has been captured with a R&S FSV 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 FSV. 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 FSV.

8 Remote Commands

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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 FSV.



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 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`.

8.2.2 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.

8.2.3 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.

8.2.4 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.

8.2.5 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.

- [Numeric Values](#).....75
- [Boolean](#).....75
- [Character Data](#).....76
- [Character Strings](#).....76
- [Block Data](#).....76

8.2.5.1 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.

8.2.5.2 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

8.2.5.3 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 8.2.1, "Long and Short Form"](#), on page 73.

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

8.2.5.4 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'`

8.2.5.5 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 Selecting and Configuring Measurements

8.3.1 Selecting Measurements

CALCulate<n>:FEED.....	77
DISPlay[:WINDow<n>]:TABLE.....	77

CALCulate<n>:FEED <DispType>

This command selects the measurement and result display.

Parameters:

<DispType>	String containing the short form of the result display. 'EVM:EVCA' (EVM vs carrier result display) 'EVM:EVSY' (EVM vs symbol result display) 'EVM:FEVS' (frequency error vs symbol result display) 'EVM:EVSU' (EVM vs subframe result display) 'PVT:CBUF' (capture buffer result display) 'SPEC:SEM' (spectrum emission mask) 'SPEC:ACP' (ACLR) 'SPEC:PSPE' (power spectrum result display) 'SPEC:FLAT' (spectrum flatness result display) 'SPEC:GDEL' (group delay result display) 'SPEC:FDIF' (flatness difference result display) 'SPEC:IE' (inband emission result display) 'CONS:CONS' (constellation diagram) 'CONS:DFTC' (DFT precoded constellation diagram) 'STAT:BSTR' (bitstream) 'STAT:ASUM' (allocation summary) 'STAT:CCDF' (CCDF)
-------------------------	--

Example:

```
CALC2:FEED 'PVT:CBUF'
```

Select Capture Buffer to be displayed on screen B.

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.

8.3.2 Configuring Frequency Sweep Measurements

ACLR and SEM measurements feature some settings particular to those measurements.

[SENSe]:POWer:ACHannel:AACHannel.....	78
[SENSe]:POWer:NCORrection.....	78
[SENSe]:POWer:SEM:CATegory.....	79
[SENSe]:SWEep:EGATe:AUTO.....	79

[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.

[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.

[SENSe]:POWer:SEM:CATegory <Category>

This command selects the SEM limit category as defined in 3GPP TS 36.101.

Parameters:

<Category> **A**
 Category A
B
 Category B
 *RST: A

Example:

POW:SEM:CAT B
 Selects SEM category B.

[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.

8.4 Remote Commands to Perform Measurements

INITiate:CONTinuous.....	79
INITiate[:IMMediate].....	80
INITiate:REFResh.....	80
[SENSe]:SYNC[:STATe]?	80

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.

INITiate[:IMMediate]

This command initiates a new measurement sequence.

With a frame count > 0, this means a restart of the corresponding number of measurements.

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

[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 Remote Commands to Read Numeric Results

FETCh:CYCPrefix?	82
FETCh:PLC:CIDGroup?	82
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FETCh:SUMMARY:CRESt[:AVERAge]?	82
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FETCh:SUMMARY:OSTP:MAXimum?	86
FETCh:SUMMARY:OSTP:MINimum?	86
FETCh:SUMMARY:POWer:MAXimum?	86
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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

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

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

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

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

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

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

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

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

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

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

FETCh:SUMMary:OSTP:MAXimum?
FETCh:SUMMary:OSTP:MINimum?

Usage: Query only

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

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

FETCh:SUMMary:RSTP:MAXimum?
FETCh:SUMMary:RSTP:MINimum?
Usage: Query only

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

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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.

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 95.

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 95.

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:

Bit Stream																				
Sub-frame	Allocation ID	Code-word	Modulation	Symbol Index	Bit Stream															
0	PUSCH	1/1	QPSK	0	03	01	02	03	03	00	00	00	01	02	02	01	02	01	00	00
0	PUSCH	1/1	QPSK	16	00	03	03	03	02	02	01	00	03	01	02	03	03	03	03	01
0	PUSCH	1/1	QPSK	32	03	03	00	00	03	01	02	00	01	00	02	00	02	00	00	03

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 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 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][Symb0][Carrier1]>, <Q[SF0][Symb0][Carrier1]>, ..., <I[SF0][Symb0][Carrier(n)]>, <Q[SF0][Symb0][Carrier(n)]>,
<I[SF0][Symb1][Carrier1]>, <Q[SF0][Symb1][Carrier1]>, ..., <I[SF0][Symb1][Carrier(n)]>, <Q[SF0][Symb1][Carrier(n)]>,
<I[SF0][Symb(n)][Carrier1]>, <Q[SF0][Symb(n)][Carrier1]>, ..., <I[SF0][Symb(n)][Carrier(n)]>, <Q[SF0][Symb(n)][Carrier(n)]>,
<I[SF1][Symb0][Carrier1]>, <Q[SF1][Symb0][Carrier1]>, ..., <I[SF1][Symb0][Carrier(n)]>, <Q[SF1][Symb0][Carrier(n)]>,
<I[SF1][Symb1][Carrier1]>, <Q[SF1][Symb1][Carrier1]>, ..., <I[SF1][Symb1][Carrier(n)]>, <Q[SF1][Symb1][Carrier(n)]>,
<I[SF(n)][Symb(n)][Carrier1]>, <Q[SF(n)][Symb(n)][Carrier1]>, ..., <I[SF(n)][Symb(n)][Carrier(n)]>, <Q[SF(n)][Symb(n)][Carrier(n)]>
```

With SF = subframe and Symb = 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 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

8.6.1.12 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

8.6.1.13 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 nine 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>, ...
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

<codeword>

Represents the codeword of an allocation. The range is {0...2}.

- 0 = 1/1
- 1 = 1/2
- 2 = 2/2

<modulation>

Represents the modulation scheme. The range is {0...8}.

- 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 88.

Query parameters:

<TraceNumber> **TRACE1 | TRACE2 | TRACE3**

LIST

Usage: Query only

8.6.2 Remote Commands to Read Measurement Results

CALCulate<n>:LIMit<k>:ACPpower:ACHannel:RESult?.....	97
CALCulate<n>:LIMit<k>:ACPpower:ALTErnate:RESult?.....	97
CALCulate<n>:MARKer<m>:FUNctioN:POWer:RESult[:CURRent]?.....	98

CALCulate<n>:LIMit<k>:ACPpower:ACHannel:RESult? <Result>

This command queries the limit check results for the adjacent channels during ACLR measurements.

Query parameters:

<Result>	ALL Queries the overall limit check results.
	REL Queries the channel power limit check results.
	ABS Queries the distance to the limit line.

Return values:

<LimitCheck>	Returns two values, one for the upper and one for the lower adjacent channel.
	1 Limit check has passed.
	0 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>:ACPpower:ALTErnate:RESult? <Result>

This command queries the limit check results for the alternate channels during ACLR measurements.

Query parameters:

<Result>	ALL Queries the overall limit check results.
	REL Queries the channel power limit check results.
	ABS Queries the distance to the limit line.

Return values:

<LimitCheck> Returns two values, one for the upper and one for the lower alternate channel.

1

Limit check has passed.

0

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]?

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:

CPOW This parameter queries the signal power of the SEM measurement.

Return values:

<Result>

SEMResults

Power level in dBm.

ACLRResults

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

8.7 Remote Commands to Configure the Application

- [Remote Commands for General Settings](#).....99
- [Advanced General Settings](#).....106
- [Configuring Uplink Signal Demodulation](#).....108
- [Configuring Uplink Frames](#).....110
- [Defining Advanced Signal Characteristics](#).....114

8.7.1 Remote Commands for General Settings

This chapter contains remote control commands necessary to control the general measurement settings.

For more information see [chapter 5.2, "General Settings"](#), on page 39.

8.7.1.1 Defining Signal Characteristics

CONFigure[:LTE]:DUPLexing	99
CONFigure[:LTE]:LDIRection	99
CONFigure[:LTE]:UL:BW	100
CONFigure[:LTE]:UL:CYCPrefix	100
CONFigure[:LTE]:UL:NORB	100
[SENSe]:FREQuency:CENTer	100

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.

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.
```

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.
```

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.
```

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.

8.7.1.2 Configuring the Input Level

CONFigure:POWer:EXPeCted:IQ<analyzer>.....101
 CONFigure:POWer:EXPeCted:RF<analyzer>.....101
 DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RLEVel:OFFSet.....101
 INPut<n>:ATTenuation<analyzer>.....102
 INPut<n>:EATT.....102
 INPut<n>:EATT:STATe.....102
 INPut<n>:EATT:AUTO.....102
 [SENSe]:POWer:AUTO<analyzer>[:STATe].....103
 [SENSe]:POWer:AUTO<analyzer>:TIME.....103

CONFigure:POWer:EXPeCted:IQ<analyzer> <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.

CONFigure:POWer:EXPeCted:RF<analyzer> <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.

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.

INPut<n>:ATTenuation<analyzer> <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.

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<analyzer>[: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.

[SENSe]:POWer:AUTO<analyzer>: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.

8.7.1.3 Configuring the Data Capture

[SENSe][:LTE]:FRAMe:COUNT.....	103
[SENSe][:LTE]:FRAMe:COUNT:AUTO.....	104
[SENSe][:LTE]:FRAMe:COUNT:STATe.....	104
[SENSe]:SWEp:TIME.....	104

[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
 Activates manual input of frames to be analyzed.
 FRAM:COUN 20
 Analyzes 20 frames.

[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.

[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 FSV analyzes a single sweep.

*RST: ON

Example:

FRAM:COUN:STAT ON
 Turns manual setting of number of frames to analyze on.

[SENSe]:SWEep:TIME <CaptLength>

This command sets the capture time.

Parameters:

<CaptLength> Numeric value in seconds.
 Default unit: s

Example:

SWE:TIME 40
 Defines a capture time of 40 seconds.

8.7.1.4 Configuring On/Off Power Measurements

CONFigure[:LTE]:OOPower:NFRames.....105

CONFigure[:LTE]:OOPower:NFRames <Frames>

This command defines the number of frames that are analyzed for On/Off Power measurements.

Parameters:

<Frames> <numeric value>

Example:

CONF:OOP:NFR 10
 Defines 10 frames to be analyzed.

8.7.1.5 Triggering Measurements

TRIGger[:SEquence]:HOLDoff<analyzer>.....105
 TRIGger[:SEquence]:IFPower:HOLDoff.....105
 TRIGger[:SEquence]:IFPower:HYSteresis.....105
 TRIGger[:SEquence]:LEVel<analyzer>:POWer.....106
 TRIGger[:SEquence]:MODE.....106

TRIGger[:SEquence]:HOLDoff<analyzer> <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<analyzer>: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.

8.7.2 Advanced General Settings

8.7.2.1 Controlling I/Q Data

[SENSe]:SWAPiq.....106

[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.

8.7.2.2 Controlling the Input

For information on the remote commands for reference level and attenuation settings see chapter 8.7.1.2, "Configuring the Input Level", on page 101.

INPut:SElect.....107
 TRACe:IQ:FILTer:FLATness.....107

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 FSV-B71.

DIQ
 Selects the digital baseband input as the data source. This source is available only with option R&S FSV-B17.

Example:

INP DIQ
 Selects the digital baseband input.

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.

8.7.2.3 Configuring the Digital I/Q Input

INPut<n>:DIQ:SRATe.....108
 INPut<n>:DIQ:RANGe[:UPPer].....108

Parameters:

<State> ON | OFF
 *RST: ON

Example:

UL:DEM:CBSC OFF
 Deactivates the scrambling.

[SENSe][:LTE]:UL:DEMod:CDOffset <State>

This command turns DC offset compensation for uplink signals on and off.

Parameters:

<State> ON | OFF
 *RST: ON

Example:

UL:DEM:CD OFF
 Deactivates DC offset compensation.

[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.

[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.

8.7.3.2 Compensating Measurement Errors

[SENSe][:LTE]:UL:TRACking:PHASe.....	110
[SENSe][:LTE]:UL:TRACking:TIME.....	110

[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.

[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.

8.7.4 Configuring Uplink Frames

8.7.4.1 Configuring TDD Signals

CONFigure[:LTE]:UL:TDD:SPSC.....	110
CONFigure[:LTE]:UL:TDD:UDConf.....	110

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.

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.

8.7.4.2 Configuring the Physical Layer Cell Identity

CONFigure[:LTE]:UL:PLC:CID.....111
 CONFigure[:LTE]:UL:PLC:CIDGroup.....111
 CONFigure[:LTE]:UL:PLC:PLID.....111

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

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.

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.

8.7.4.3 Configuring Subframes

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CONFigure[:LTE]:UL:SUBFrame<subframe>:ALLoc:MODulation.....	113

CONFigure[:LTE]:UL:CSUBframes <NofSubframes>

This command selects the number of configurable subframes in the uplink signal.

Parameters:

<NofSubframes> Range: 0 to 9
 *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.

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.

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 or PUSCH to an uplink allocation.

Parameters:

<Content> **NONE**
Turns off the PUSCH and the PUCCH.
PUCCh
Turns on the PUCCH.
PUSCh
Turns on the PUSCH.
PSCC
Turns on the PUCCH as well as the PUSCH.
*RST: PUSC

Example: `CONF:UL:SUBF8:ALL:CONT PUCCh`
Subframe 8 contains a PUCCH.

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.

8.7.5 Defining Advanced Signal Characteristics

8.7.5.1 Configuring the Demodulation Reference Signal

CONFigure[:LTE]:UL:DRS:DSSHift.....	114
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CONFigure[:LTE]:UL:DRS:SEQHopping.....	115

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.

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.

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.

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.

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.

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.

8.7.5.2 Configuring the Sounding Reference Signal

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<code>CONFigure[:LTE]:UL:SRS:BSRS</code>	116
<code>CONFigure[:LTE]:UL:SRS:CSRS</code>	116
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<code>CONFigure[:LTE]:UL:SRS:TRComb</code>	117

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

8.7.5.3 Defining the PUSCH Structure

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CONFigure[:LTE]:UL:PUSCh:FHOFFset.....	118
CONFigure[:LTE]:UL:PUSCh:FHOP:IIHB.....	118
CONFigure[:LTE]:UL:PUSCh:NOSM.....	118

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:PUSCh:FHM NONE
Deactivates frequency hopping for the PUSCH.
```

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:PUSCh:FHOFF 5
Sets the hopping offset to 5.
```

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:PUSCh:FHOP:IIHB 1
Defines type 1 as the information in hopping bits.
```

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.

8.7.5.4 Defining the PUCCH Structure

CONFigure[:LTE]:UL:PUCCh:DEOffset..... 119
 CONFigure[:LTE]:UL:PUCCh:DESHift..... 119
 CONFigure[:LTE]:UL:PUCCh:FORMat..... 119
 CONFigure[:LTE]:UL:PUCCh:N1CS..... 120
 CONFigure[:LTE]:UL:PUCCh:N2RB..... 120
 CONFigure[:LTE]:UL:PUCCh:NORB..... 120
 CONFigure[:LTE]:UL:PUCCh:NPAr..... 121

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:PUCCh: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:PUCCh:DESH 3
 Sets the delta shift of the PUCCH to 3.

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> **F1N (F1 normal)**
 F1S (F1 shortened)
 F1AN (F1a normal)
 F1AS (F1a shortened)
 F1BN (F1b normal)
 F1BS (F1b shortened)
 F2 (F2)
 F2A (F2a)
 F2B (F2b)
 F3 (F3)
 *RST: F1N

Example:

```
CONF:UL:PUCCH:FORM F1N
Sets the PUCCH format to F1 normal.
```

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:PUCCH:N1CS 4
Sets N(1)_cs to 4.
```

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:PUCCH:N2RB 2
Sets N2_RB to 2.
```

CONFigure[:LTE]:UL:PUCCh:NORB <ResourceBlocks>

This command selects the number of resource blocks for the PUCCH.

Parameters:

<ResourceBlocks> <numeric value>
 *RST: 0

Example:

```
CONF:UL:PUCCH:NORB 6
Sets the number of resource blocks to 6.
```


CONFigure[:LTE]:UL:PUCCh:NPAr <NPUCCH>

This command defines the N_PUCCH parameter in the PUCCH structure settings.

Parameters:

<NPUCCH> <numeric value>
 <numeric value>

SUBF

Selects the definition of N_PUCCH on subframe level.

*RST: 0

Example:

CONF:UL:PUCCh:NPAr 2
 Sets N_PUCCH to 2.

8.7.5.5 Defining Global Signal Characteristics

CONFigure[:LTE]:UL:UEID.....121

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.

8.8 Analyzing Measurement Results**8.8.1 General Commands for Result Analysis**

[SENSe][:LTE]:SUBFrame:SElect.....121
 UNIT:BSTR.....122
 UNIT:EVM.....122

[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.

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.

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 %.

8.8.2 Using Markers

CALCulate<n>:MARKer<m>:AOFF.....	123
CALCulate<n>:MARKer<m>[:STATE]	123
CALCulate<n>:MARKer<m>:TRACe.....	123
CALCulate<n>:MARKer<m>:X.....	123
CALCulate<n>:MARKer<m>:Y?.....	124

CALCulate<n>:MARKer<m>:AOFF

This command turns all markers and delta markers off.

Suffix:

<m> 1

Example:

CALC:MARK:AOFF
Switches off all markers.

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
Switches on marker 3 or switches to marker mode.

CALCulate<n>:MARKer<m>:TRACe <Trace>

This command selects the trace the marker is positioned on.

Note that the corresponding trace must have a trace mode other than "Blank".

If necessary, the command activates the marker first.

Suffix:

<m> 1

Parameters:

<Trace> 1 to 6
Trace number the marker is assigned to.

CALCulate<n>:MARKer<m>:X <Position>

This command moves a marker to a particular coordinate on the x-axis.

If necessary, the command activates 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

8.8.3 Scaling the Vertical Diagram Axis

Programming example to scale the y-axis

```
//Start EVM vs Symbol result display in screen B.
CALC2:FEED 'EVM:EVSX'
//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
```

`DISP:[:WINDow]:TRACe:Y:SCALe:AUTO`..... 125
`DISP:[:WINDow]:TRACe:Y:SCALe:FIXScale:OFFSet`..... 125
`DISP:[:WINDow]:TRACe:Y:SCALe:FIXScale:PERDiv`..... 125

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

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 8.8, "Analyzing Measurement Results"](#), on page 121.

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 8.8, "Analyzing Measurement Results"](#), on page 121.

8.9 Configuring the Software

CONFigure:PRESet	126
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MMEMory:LOAD:DEModsetting	126

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

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