R&S®VSE-K8
Bluetooth® BR/EDR/LE Measurements
User Manual

1179646602
Version 01

ROHDE&SCHWARZ
Make ideas real

This manual applies to the following software, version 2.30 and later:

- R&S®VSE Enterprise Edition base software (1345.1105.06)
- R&S®VSE Basic Edition base software (1345.1011.06)

The following software options are described:

- R&S VSE-K8 (1345.1970.xx)

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1179.6466.02 | Version 01 | R&S®VSE-K8

Throughout this manual, products from Rohde & Schwarz are indicated without the ® symbol , e.g. R&S®VSE is indicated as R&S VSE.

Contents

1 Documentation overview

This section provides an overview of the R&S VSE user documentation. Unless specified otherwise, you find the documents at:

www.rohde-schwarz.com/manual/VSE

Further documents are available at:

www.rohde-schwarz.com/product/VSE

1.1 User manuals and help

Separate user manuals are provided for the base software and the firmware applications:

- Base software manual
  Contains the description of all software modes and functions. It also provides an introduction to remote control, a complete description of the remote control commands with programming examples, and information on software interfaces and error messages.
- Firmware application manual
  Contains the description of the specific functions of a firmware application, including remote control commands. Basic information on operating the R&S VSE software is not included.

The contents of the user manuals are available as help in the R&S VSE. The help offers quick, context-sensitive access to the complete information for the base software and the firmware applications.

All user manuals are also available for download or for immediate display on the Internet.

1.2 Data sheets and brochures

The data sheet contains the technical specifications of the R&S VSE. It also lists the firmware applications and their order numbers, and optional accessories.

The brochure provides an overview of the instrument and deals with the specific characteristics.

See www.rohde-schwarz.com/brochure-datasheet/VSE

1.3 Release notes and open-source acknowledgment (OSA)

The release notes list new features, improvements and known issues of the current firmware version, and describe the firmware installation.

The software makes use of several valuable open source software packages. An open-source acknowledgment document provides verbatim license texts of the used open source software.

See www.rohde-schwarz.com/firmware/VSE

1.4 Application notes, application cards, white papers, etc.

These documents deal with special applications or background information on particular topics.

See www.rohde-schwarz.com/application/VSE

2 Welcome to the R&S VSE Bluetooth measurement application

The R&S VSE Bluetooth measurement application adds functionality to perform Bluetooth BR/EDR/LE measurements to the R&S VSE.

This user manual contains a description of the functionality that the application provides, including remote control operation.

General R&S VSE functions

The application-independent functions for general tasks on the R&S VSE are also available for Bluetooth BR/EDR/LE measurements and are described in the R&S VSE user manual. In particular, this comprises the following functionality:

- Controlling instruments and capturing I/Q data
- Data management
- General software preferences and information

The latest version is available for download at the product manuals homepage:

www.rohde-schwarz.com/manual/VSE.

Installation

You can find detailed installation instructions in the R&S VSE user manual or in the Release Notes.

2.1 Key features

The R&S VSE Bluetooth measurement application features:

- Acquisition and analysis of signals according to the Bluetooth standard, up to release 5.2
- Analysis of Basic Rate (BR), Enhanced data rate (EDR) and Low energy (LE) signals
- In-band spurious emission measurements in swept spectrum mode
- Modulation characteristics measurement in I/Q mode, including:
  - Automatic detection of packet type and packet length
  - Constellation
  - Demodulated waveform
  - Demodulated bitstream (symbols)
  - Frequency offsets
  - Frequency drift
  - ICFT
  - Output power

– Adjacent channel power (ACP)

2.2 Starting the R&S VSE Bluetooth measurement application

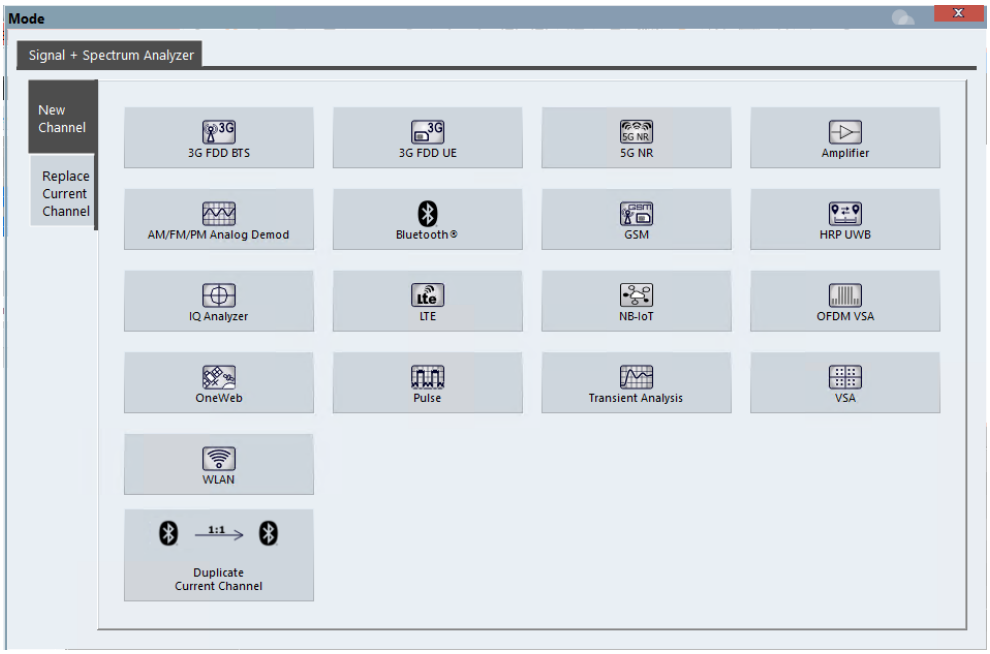
Bluetooth BR/EDR/LE measurements are performed in a separate application on the R&S VSE. They are activated by creating a new measurement channel in VSA mode.

To activate the R&S VSE Bluetooth measurement application

1. 

   Select the "Add Channel" function in the Sequence tool window.

   A dialog box opens that contains all operating modes and applications currently available in your R&S VSE.



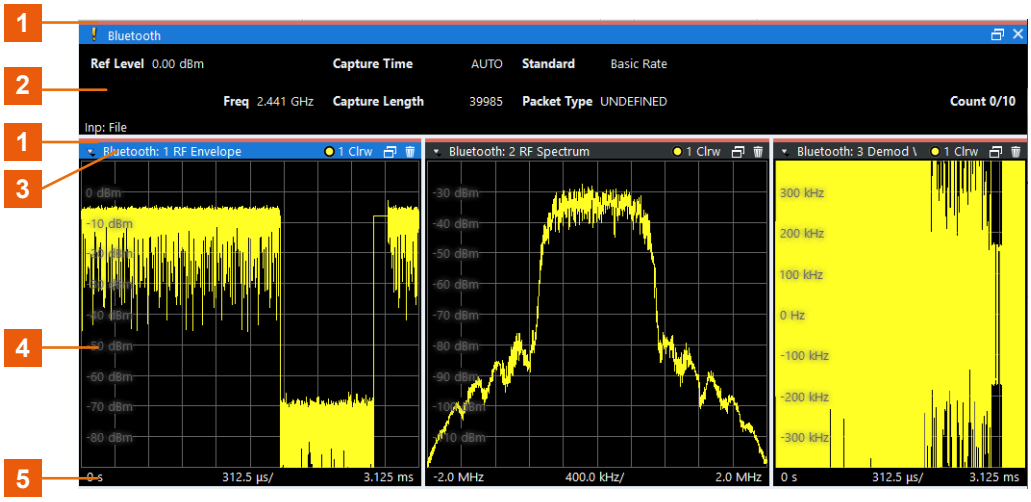
2. Select the "Bluetooth" item.

   The R&S VSE opens a new measurement channel for the R&S VSE Bluetooth measurement application.

The measurement is started immediately with the default settings. You can configured it in the Bluetooth BR/EDR/LE "Overview" dialog box, which is displayed when you select "Overview".

2.3 Understanding the display information

The following figure shows the result display during a basic Bluetooth in-band spurious emissions measurement. All different information areas are labeled. They are explained in more detail in the following sections.



1 = Color coding for windows of same channel
2 = Channel bar with measurement settings
3 = Window title bar with diagram-specific (trace) information
4 = Diagram area
5 = Diagram footer with diagram-specific information, depending on result display

Channel bar information

In the R&S VSE Bluetooth measurement application, the R&S VSE shows the following settings:

Table 2-1: Information displayed in the channel bar in the R&S VSE Bluetooth measurement application

Label	Description
"Ref Level"	Reference level
"m.+el.Att"	Mechanical and electronic RF attenuation
"Offset"	Reference level offset
"Capture Time"	Data acquisition time
"Capture Length"	Number of captured samples per sweep
"Standard"	Selected Bluetooth standard
"Packet Type"	Detected packet type
	Sweep mode, e.g. "SGL" for single sweep
"Count"	Average sweep count

Window title bar information

For each diagram, the header provides the following information:

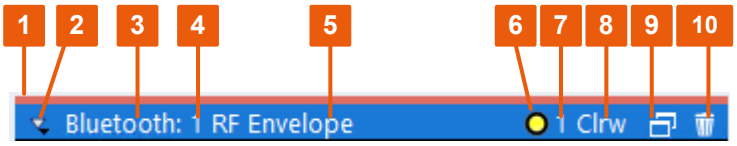


Figure 2-1: Window title bar information in the application for analog modulation analysis

1 = Color coding for windows of same channel
2 = Edit result display function
3 = Channel name
4 = Window number
5 = Window type
6 = Trace color
7 = Trace number
8 = Detector
9 = Dock/undock window function
10 = Close window function

Diagram area

The diagram area displays the results according to the selected result displays (see Chapter 4, "Measurements and result displays", on page 31).

Diagram footer information

The diagram footer (beneath the diagram) indicates the displayed time or frequency range.

Status bar information

The software status, errors and warnings and any irregularities in the software are indicated in the status bar at the bottom of the R&S VSE window.

3 Measurement basics

Some background knowledge on basic terms and principles used in Bluetooth BR/EDR/LE measurements is provided here for a better understanding of the required configuration settings.

3.1 About Bluetooth BR/EDR/LE

The frequency band defined for Bluetooth devices is the unlicensed 2.4 GHz Industrial, Scientific and Medical (ISM) frequency band.

Bluetooth specifies three operating modes. A time division duplex (TDD) scheme for duplex transmission is defined for all three modes.

- The mandatory **basic rate (BR)** uses binary FM modulation. It provides a data rate of 1 Mbps, and a symbol rate equal to 1 Msymbol/s.
  Up to 79 channels with a spacing of 1 MHz are available.
- The optional **enhanced data rate (EDR)** uses two types of PSK modulation, the π/4-DQPSK or 8DPSK, and achieves data rates of 2 Mbps and 3 Mbps, respectively.
  Both modulations schemes have a symbol rate equal to 1 Msymbol/s.
  Up to 79 channels with a spacing of 1 MHz are available.
- Bluetooth **Low Energy (LE)** provides data transfer from low-power devices running on the smallest of batteries to a larger device, such as a PC, a mobile phone, or a PDA. Bluetooth LE establishes a connection, e.g. to a wristwatch, a heart rate sensor, or a digital camera for data transfer.

  Bluetooth Low Energy supports different transmission modes at the physical layer:
  - **LE 1M**: uncoded, 1 symbol per data bit, 1 Msymbol/s data rate
  - **LE 2M**: uncoded, 1 symbol per data bit, 2 Msymbol/s data rate
  - **LE Coded**: 2 symbols per data bit, 1 Msymbol/s data rate
    For LE Coded, the header block of the packet contains a coding indicator, which defines the pattern mapping used by the subsequent payload block.

For LE 1M/Coded: up to 81 channels with a spacing of 1 MHz are available.

For LE 2M: Up to 40 channels with a spacing of 2 MHz are available.

Table 3-1: Bluetooth characteristics

Regulatory range	Operating mode	RF channels k and center frequencies f
2400.0 MHz to 2483.5 MHz	BR/EDR	k = 0 to 78, f = k * 1 MHz + 2402 MHz
	LE 1M/ LE Coded	k = 0 to 80, f = k * 1 MHz + 2402 MHz
	LE 2M	k = 0 to 39, f = k * 2 MHz + 2402 MHz

Output power

The core specification of Bluetooth wireless technology defines the limits of output power levels at the maximum power. The minimum output power is limited to -20 dBm. The maximum output power for LE is limited to 10 dBm.

3.1.1 Bluetooth packet types for BR/EDR

3.1.1.1 ACL packets

The ACL packets are used for asymmetric links and they contain user data or control data. The table and the figures below give an overview of the ACL packets and their structure.

Table 3-2: ACL packet - basic rate

Type	Payload Header (bytes)	User Payload (bytes)	FEC	CRC	Slot number
DM1	1	0-17	2/3	Yes, 16-bit	1
DH1		0-27	no		
DM3	2	0-121	2/3		3
DH3		0-183	no		
DM5		0-224	2/3		5
DH5		0-339	no		
AUX1	1	0-29		no	

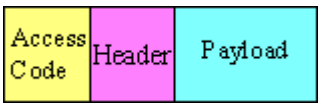


Figure 3-1: Packet structure of ACL packets - basic rate

Table 3-3: ACL packets - enhanced rate

Type	Payload Header (bytes)	User Payload (bytes)	FEC	CRC	Slot number
2-DH1	2	0-54	no	Yes, 16-bit	1
2-DH3		0-367			3
2-DH5		0-679			5
3-DH1		0-83			1
3-DH3		0-552			3
2-DH5		0-1021			5

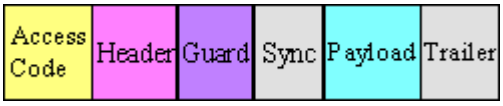


Figure 3-2: Packet structure of ACL packets - enhanced data rate

3.1.1.2 SCO and eSCO packets

The SCO and eSCO packets are used for symmetric links. The SCO packets are used for 64 kb/s speech transmission and for transparent synchronous data. The eSCO packets are also used for 64kb/s speech transmission and transparent data at 64 kb/s but also at other rates.

The tables and the figures below give an overview of the SCO and eSCO packets and their structure.

Table 3-4: SCO packets

Type	Payload Header (bytes)	User Payload (bytes)	FEC	CRC	Slot number
HV1	n.a.	10	1/3	no	n.a.
HV2		20			
HV3		30	2/3		
DV	1 (data only)	10+(0-9)	2/3 (data only)	Yes, 16-bit (data only)	

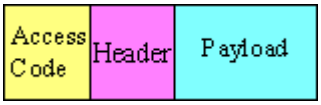


Figure 3-3: Packet structure SCO packets

Figure 3-4: Packet structure SCO packets (data only)

Table 3-5: eSCO packets - basic rate

Type	Payload Header (bytes)	User Payload (bytes)	FEC	CRC	Slot number
EV3	n.a.	1-30	no	Yes, 16-bit (Data only)	1
EV4		1-120	2/3		3
EV5		1-180	no		3

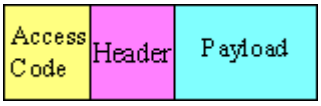


Figure 3-5: Packet structure eSCO packets - basic rate

Table 3-6: eSCO packets - basic rate

Type	Payload Header (bytes)	User Payload (bytes)	FEC	CRC	Slot number
2-EV3	n.a.	1-60	no	Yes, 16-bit	1
2-EV5		1-360			3
3-EV3		1-90			1
3-EV5		1-540			3

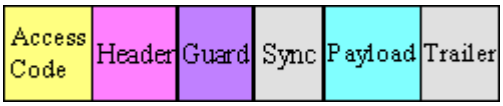


Figure 3-6: Packet structure eSCO packets - enhanced data rate

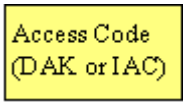
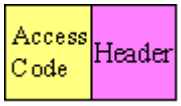
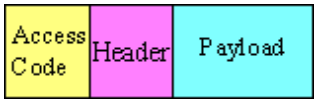
3.1.1.3 Link control packets for ACL, SCO, eSCO transport modes

There are some common kinds of packet types. An overview of these packet types is given in the table below.

Table 3-7: Common link control packets

Transport modes	Type	Payload Header (bytes)	FEC	CRC	Application
SCO, eSCO, ACL	ID				Paging, inquiry, response
SCO, eSCO, ACL	NULL	n.a.	n.a.	n.a.	Carries Link information to the source, e.g. about successfully received signal (ARQN) or the state of the receiving buffer (FLOW)
SCO, eSCO, ACL	POLL				Similar to NULL packet, used by the Central to poll the Peripheral devices, must be confirmed
SCO, ACL	FHS	18	2/3	Yes	Page Central response, inquiry response, in roll switch

Table 3-8: Common link control packets: packet structure

Packet Type ID	Packet Types NULL and PULL	Packet Types FHS
		

3.1.2 Bluetooth transport modes

There are three different transport modes defined in the Bluetooth core specification, each of them with special applications:

- Synchronous connection-oriented (SCO)
  The SCO transport mode is used for a symmetric point-to-point link establishment between a Central and a specific Peripheral in the piconet.
- Extended synchronous connection-oriented (eSCO)
  The eSCO transport mode is used for a symmetric or asymmetric, point-to-point link establishment between the Central and a specific Peripheral.
- Asynchronous connection less (ACL)
  The ACL transport mode is used for a point-to-multipoint link establishment between the Central and all Peripheral participating on the piconet.

There are some common transmitted packets used by all transport modes and some specific packets defined for each transport mode.

3.1.3 Packet structure and fields

Almost all Bluetooth transmitted packets have standard format and consist of the access code, the header and the payload with useful information. The exceptions are the ID packet which consists of the access code only and NULL and POLL packets which carry only the access code and the header.

3.1.3.1 Access code

The access code is used for synchronization, DC offset compensation and identification. The fields of the access code are shown in the figure below and their meaning is explained in the table below.

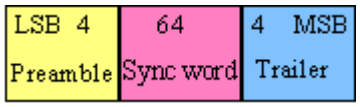


Table 3-9: The access code fields

Field	Description	Packets
Preamble	A fixed zero-one pattern of 4 symbols, used to facilitate DC compensation	All packets
Sync word	A 64-bit code word derived from a 24-bit address, improves timing acquisition	All packets
Trailer	A fixed zero-one pattern of four symbols, extended DC compensation	All packets, except ID

3.1.3.2 Header

The header contains link control information. The fields of the header are shown in the figure and their meaning is explained in the table below.

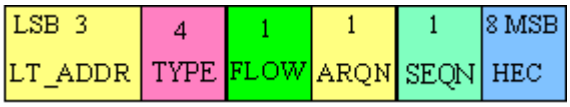


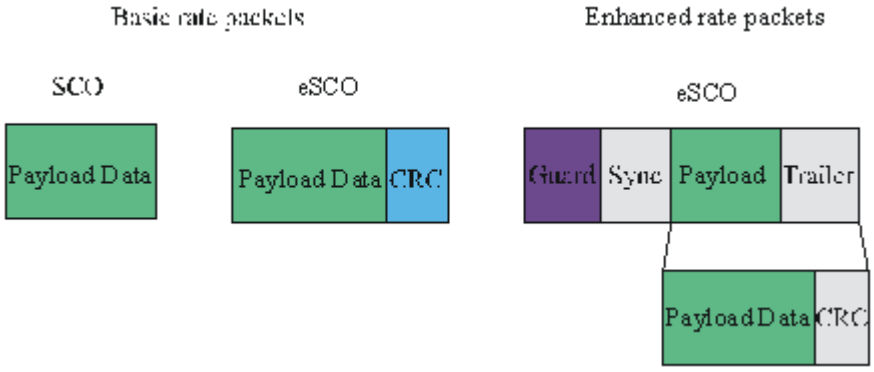
Table 3-10: The header fields

Field	Description	Packets
LT_ADDR	Logical transport address, indicates the destination Peripheral for a packet in a Central-to-Peripheral transmission slot and the source Peripheral for a Peripheral-to-Central transmission slot	
TYPE	Type code, specifies which packet type is used	
FLOW	Flow control, used for flow control of packets over the ACL logical transport. When the RX buffer in the recipient is full, a STOP indication must be returned. When the RX buffer can accept data, a "Go" indication must be returned.	All packets, except ID
ARQN	Automatic repeat request number, acknowledgement indication, used to inform the source of a successful transfer of payload data with CRC can be positive acknowledged ACK or negative acknowledged NAK,	
SEQN	Sequential numbering scheme to order the data packet stream	
HEC	Header-error-check to check the header integrity	

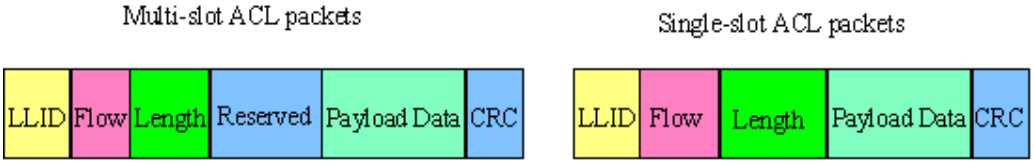
3.1.3.3 Payload format

The payload structure depends on the type of the data field and the data rate. Two fields are defined in the payload: the synchronous data field and the asynchronous data field. The ACL packets only have the asynchronous data field and the SCO and eSCO packets only have the synchronous data field. The exception is DV of SCO transport mode which has both data fields, synchronous and asynchronous.

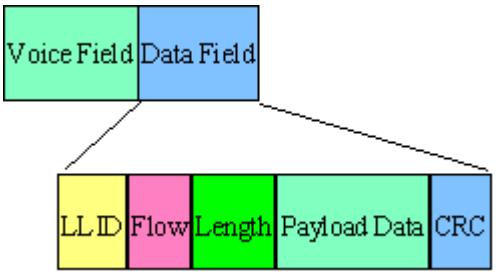
Synchronous data fields



Asynchronous data fields



Synchronous and asynchronous data fields



The meaning of some payload fields is given in the table below.

Table 3-11: The payload fields

Field	Description
CRC	The cyclic redundancy error check
Guard, sync	The guard time and synchronization sequence, used for physical layer change of modulation scheme
LLID	The logical link identifier, specifies the logical link
Flow	Field which controls the flow on the logical channels

The payload format and content of the FHS packet are different from other packets. The fields of the FHS packet are shown in the figure below and their meaning is explained in the table below.

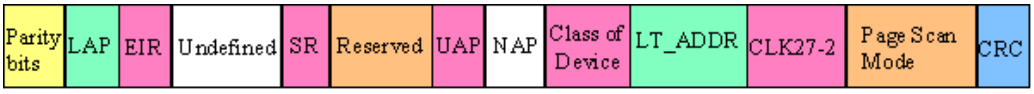


Table 3-12: The payload fields for the FHS packet

Field	Description
Parity bits	Form the first part of the sync word of the access code of the device that sends the FHS packet
LAP	Contains the lower address part of the device that sends the FHS packet
EIR	An extended inquiry response, provides miscellaneous information during the inquiry response procedure
Undefined	Reserved for future use and must be set to zero
SR	The scan repetition field, indicates the interval between two consecutive page scan windows
Reserved	Must be set to 10
UAP	Contains the upper address part of the device that sends the FHS packet
NAP	Contains the non–significant address part of the device that sends the FHS packet
Class of device	Contains the class of device of the device that sends the FHS packet. This field is defined in Bluetooth assigned numbers.
LT_ADDR	Contains the logical transport address
CLK27-2	Contains the value of the native clock of the device that sends the FHS packet, sampled at the beginning of the transmission of the access code of this FHS packet
Page scan mode	Indicates which scan mode is used by default by the sender of the FHS packet

3.1.4 Bluetooth modulation schemes

The modulation used for the basic data rate packets is GFSK (Gaussian Frequency Shift Keying) with a bandwidth bit period product BT = 0.5. The modulation index is between 0.28 and 0.35.

The modulation scheme used for enhanced data rate packets changes within the packet. The access code and packet header have a GFSK modulation scheme and are transmitted with the basic rate 1 Mbps. The subsequent synchronization sequence, payload and trailer sequence have a PSK type of modulation and are transmitted with a data rate of 2 Mbps or optionally 3 Mbps.

The PSK modulation, namely π/4 rotated differential encoded quaternary phase shift keying (π/4–DQPSK) is defined for the 2 Mbps transmission.

The PSK modulation, namely differential encoded 8-ary phase shift keying (8DPSK), is defined for the 3 Mbps transmission.

The modulation types and corresponding packet types are given in the table below.

Table 3-13: The modulation types and corresponding packet types

Modulation type	Packet types
GFSK	ID, NULL, POLL, FHS, DM1, DH1, DM3, DH3, DM5, DH5, AUX1, HV1, HV2, HV3, DV, EV3, EV4, EV5
GFSK + π/4-DQPSK	2-DH1, 2-DH3, 2-DH5, 2-EV3, 2-EV5
GFSK + 8DPSK	3-DH1, 3-DH3, 3-DH5, 3-EV3, 3-EV5

3.1.5 Packet formats for LE

Packet formats for LE uncoded PHY

The following packet format is defined for the LE uncoded PHYs and is used for both advertising channel packets and data channel packets.

Figure 3-7: LE uncoded PHY packet format

Each packet consists of four mandatory fields: preamble, access address, PDU, and CRC. For Bluetooth Direction finding, the optional field Constant Tone Extension (CTE) is added at the end.

Table 3-14: Packet format for LE uncoded PHY

Physical layer	Preamble	Access address	PDU	CRC	CTE
LE 1 Msymbol/s	1 octet	4 octets	2 to 257 octets	3 octets	16 µs to 160 µs

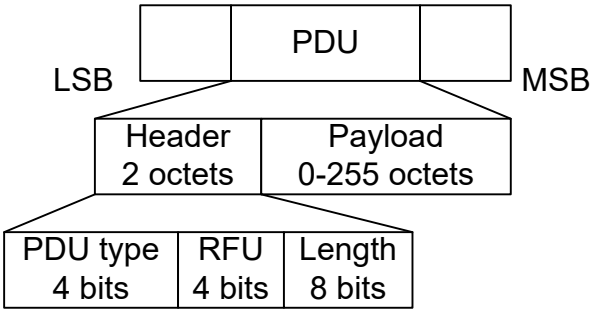
The preamble is transmitted first, followed by the access address, followed by the PDU followed by the CRC and optionally followed by CTE. The entire packet is transmitted at the same symbol rate.

Packets take between 44 µs and 2120 µs to transmit. The period extends by an additional 16 µs to 160 µs, if CTE is active.

3.1.6 Packet types for LE

Test packet types

The test packet PDU is subdivided into a PDU header and the payload field. The PDU header indicates the payload content type and the payload length expresses in octets. RFU field means reserved for future use.



LE test packets are described in the "Air Interface Packets" section of core specification for Bluetooth wireless technology, volume 6, part B.

Advertising channel packet types

The advertising channel PDU has a 16-bit header and a variable size payload. The header fields of the advertising channel PDU are as shown in Chapter 3.1.3.2, "Header", on page 16.

Table 3-15: Advertising packet types:

ADV_IND	SCAN_REQ
ADV_DIRECT_IND	SCAN_RSP
ADV_NONCONN_IND	CONNECT_IND
ADV_SCAN_IND	

Data channel packet types

The data channel PDU has a 16-bit header, a variable size payload, and can include a message integrity check (MIC) field as shown in Chapter 3.1.3.2, "Header", on page 16.

The MIC field is not included in an unencrypted link layer (LL) connection. Nor in an encrypted LL connection with a data channel PDU with a zero length payload. The MIC field is included in an encrypted LL connection, with a data channel PDU with a non-zero length payload. The MIC calculation is specified in the section 1 of core specification for Bluetooth wireless technology, volume 6, part E.

Besides the data packet type, instrument supports the following CONTROL_DATA packet types.

Table 3-16: Control data packet types

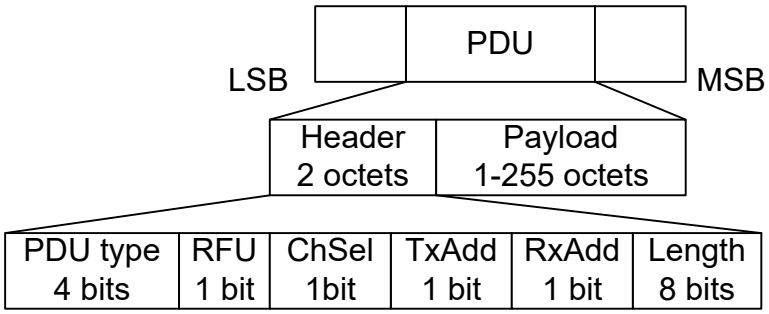
Opcode	CONTROL_DATA	Opcode	CONTROL_DATA
0x00	LL_CONNECTION_UPDATE_IND	0x07	LL_UNKNOWN_RSP
0x01	LL_CHANNEL_MAP_IND	0x08	LL_FEATURE_REQ
0x02	LL_TERMINATE_IND	0x09	LL_FEATURE_RSP
0x03	LL_ENC_REQ	0x0A	LL_PAUSE_ENC_REQ
0x04	LL_ENC_RSP	0x0B	LL_PAUSE_ENC_RSP

Opcode	CONTROL_DATA	Opcode	CONTROL_DATA
0x05	LL_START_ENC_REQ	0x0C	LL_VERSION_IND
0x06	LL_START_ENC_RSP	0x0D	LL_REJECT_IND

3.1.7 Packet structure and fields

3.1.7.1 Advertising channel packet structure

Header



- The possible **PDU types**, indicated in the header of advertising channel PDU, are listed in the previous tables, see Table 3-15.
- The **ChSel**, **TxAdd** and **RxAdd** fields contain information specific to the PDU type. If the ChSel, TxAdd or RxAdd fields are not defined as used in a given PDU then they are considered Reserved for Future Use.
- The **Length** field indicates the payload field length in octets.

Payload

The advertising channel PDU types can be divided into the following three groups.

Table 3-17: Advertising channel PDU types

Advertising PDUs	ADV_IND, ADV_DIRECT_IND, ADV_NONCONN_IND, ADV_SCAN_IND
Scanning PDUs	SCAN_REQ, SCAN_RSP
Initiating PDUs	CONNECT_IND

The following parameters are transmitted in the advertising PDU:

- **AdvA**, **AdvData** for ADV_IND, ADV_NONCONN_IND and ADV_SCAN_IND
- **AdvA**, **TargetA** (formerly InitA) for ADV_DIRECT_IND

The following parameters are transmitted in the scanning PDU:

- **ScanA**, **AdvA** for SCAN_REQ
- **AdvA**, **ScanRspData** for SCAN_RSP

The following parameters are transmitted in the initiating PDU:

- **InitA**, **AdvA**, **LLData** for CONNECT_IND

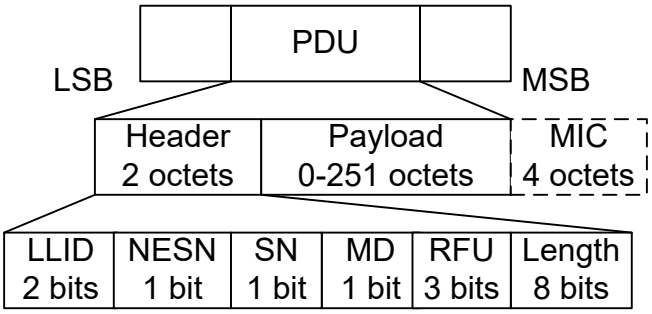
  LLData contains

  – **AA**, **CRCinit**, **WinSize**, **WinOffset**, **Interval**, **Latency**, **Timeout**, **ChM**, **Hop**, and **SCA** fields

For more details, refer to in the section 2.3 Advertising Channel PDU of core specification for Bluetooth wireless technology, volume 6, part B.

3.1.7.2 Data channel packet structure

Header



The 16-bit header field consists of five fields:

- The **LLID** field of the header specifies the payload format, refer to "Payload" on page 22.
- The **NESN** bit indicates a nextExpectedSeqNum used by the peer to acknowledge the last PDU sent, or to request resending.
- The **SN** bit indicates a transmitSeqNum to identify packets sent by the link layer.
- The **MD** bit indicates, whether the device has more data to send.
- The **Length** field indicates the length of the payload and MIC if included.

Payload

- An **LL data PDU** is used to send L2CAP data. The LLID field is set to either 01b or 10b.
  – For the LLID field set to 01b, the LL data PDU is a continuation fragment of an L2CAP message, or an empty PDU.
  The LL of the Central sends an empty PDU to the Peripheral to allow the Peripheral to respond with any data channel PDU, including an empty PDU.
  – For the LLID field set to 10b, the LL data PDU is a start of an L2CAP message or a complete L2CAP message with no fragmentation.
- An **LL control PDU** is used to control the LL connection. The payload consists of Opcode and CtrData fields. All LL control PDUs have a fixed length, depending on the Opcode. The Opcode field identifies different types of LL Opcode PDU, see Table 3-16.

For more details, refer to in the section 2.4 Data Channel PDU of core specification for Bluetooth wireless technology, volume 6, part B.

3.1.8 Modulation scheme for LE

The modulation is Gaussian frequency shift keying (GFSK) with a bandwidth bit period product BT = 0.5. The modulation index has to be between 0.45 and 0.55. The mandatory modulation scheme is 1 Msymbol/s modulation. It uses a shaped, binary FM to minimize transceiver complexity.

3.1.9 Direction finding

Since Bluetooth version 5.1, a Bluetooth LE device can transmit its direction information to a Bluetooth receiver. The information is transmitted in direction finding enabled packets in the LE uncoded PHY. In combination with location information sent on profile-level, the Bluetooth LE receiver can calculate its position.

Angle of Arrival (AoA) method

A Bluetooth LE transmitter sends direction finding enabled packets using a single antenna. A receiving Bluetooth LE peer device consists of an antenna array linked to an RF switch which forwards the combined antennae signal to a Bluetooth LE receiver.

The peer device switches its antennae while receiving parts of the packets and capturing I/Q samples. The I/Q samples are used to calculate the phase difference of the radio signal received by different antennae of the array. For an array of two antennae with distance d, frequency f of the radio signal and speed of light c, the phase difference ψ calculates as follows:

$\psi = 2\pi d * \cos(\Theta) * f / c$

The angle of arrival Θ is calculated as follows:

$\Theta = \arccos((\psi * c) / (2\pi d * f))$

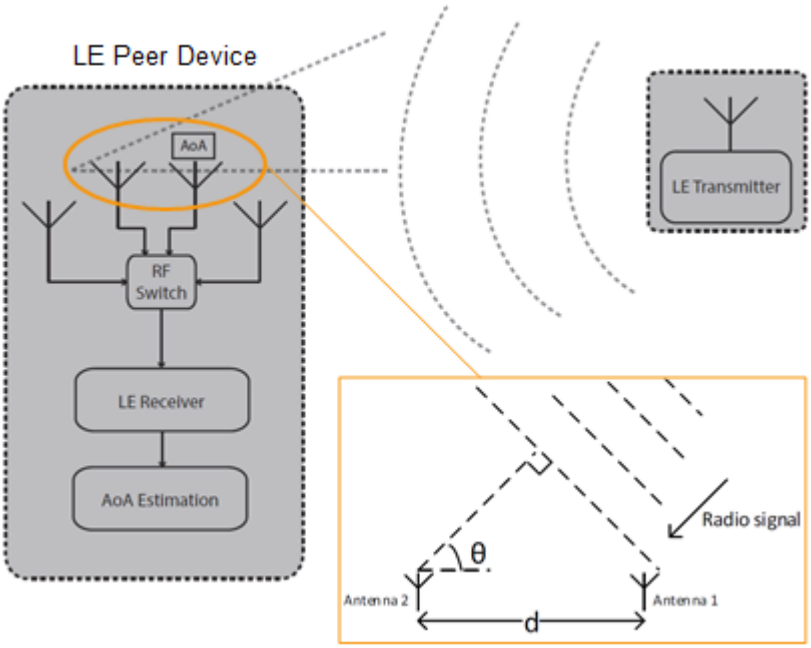


Figure 3-8: Angle of Arrival method

Angle of Departure (AoD) method

A Bluetooth LE transmitter sends direction finding enabled packets using an antenna array. A receiving Bluetooth LE device, consisting of a single antenna, captures I/Q samples and the geometry of the antenna array from profile-level information.

For an array with two antennae with distance d, frequency f of the radio signal and speed of light c, the phase difference ψ calculates as follows:

$\psi = 2\pi d * \cos(\Theta) * f / c$

The angle of departure Θ is calculated as follows:

$\Theta = \arccos((\psi * c) / (2\pi d * f))$

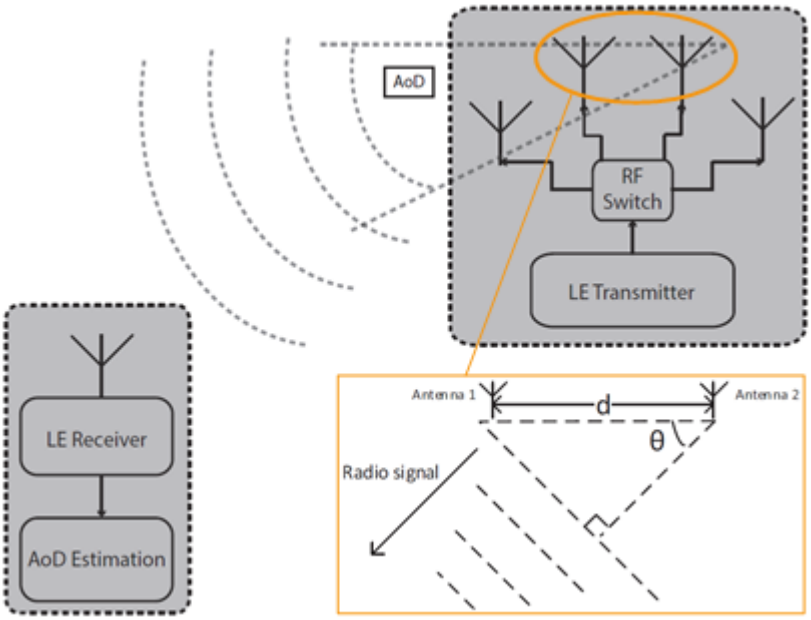


Figure 3-9: Angle of Departure method

The geometry of the antenna array is information that is shared between Bluetooth LE transmitter and receiver on a profile-level. The antenna switching pattern and the method of angle estimation is specified by Constant Tone Extension.

For more information, refer to section 8 Direction Finding Using Bluetooth Low Energy of core specification for Bluetooth wireless technology, volume 1, part A.

Constant tone extension

To transmit direction finding information in packets in the Bluetooth LE Uncoded PHYs, the link layer packet format is extended by an optional field Constant Tone Extension (CTE) as illustrated in Figure 3-7. The field has a length between 16 µs and 160 µs and consists of a constantly modulated series of unwhitened 1s. This modulation results in a CW tone shifted by 250 kHz (LE1M) or 500 kHz (LE2M) from the LE channel center frequency.

The presence, type and length of CTE is specified in the CTEInfo field available for ADV_SYNC_IND and ADV_CHAIN_IND PDUs.

CTEInfo (8 bit)		
CTETime	RFU	CTEType

Figure 3-10: CTEInfo field

The parts of the CTEInfo field are described in the table below. CTEType specifies, if AoA or AoD method is used for direction finding.

CTEInfo field	Length	Value	Description
CTETime	5 bit	2 to 20	CTE length = 8 µs * Value Other values are reserved for future use.
RFU	1 bit	1 to 2	Reserved for future use
CTEType	2 bit	0	AoA Constant tone extension
		1	AoD Constant tone extension with 1 µs slots
		2	AoD Constant tone extension with 2 µs slots
		3	Reserved for future use

If Bluetooth LE devices support AoA/AoD CTE, the antennae within the array follow a switching pattern specified by the Host. After a guard and reference period, time slots of 1 µs or 2 µs provide periods for antenna switching and I/Q sampling.

The following figure illustrates the CTE structure for AoA method. On the transmitting side, there is no antenna switching. On the receiving side, antenna switching and I/Q sampling alternate in the time slots after the guard and reference period.

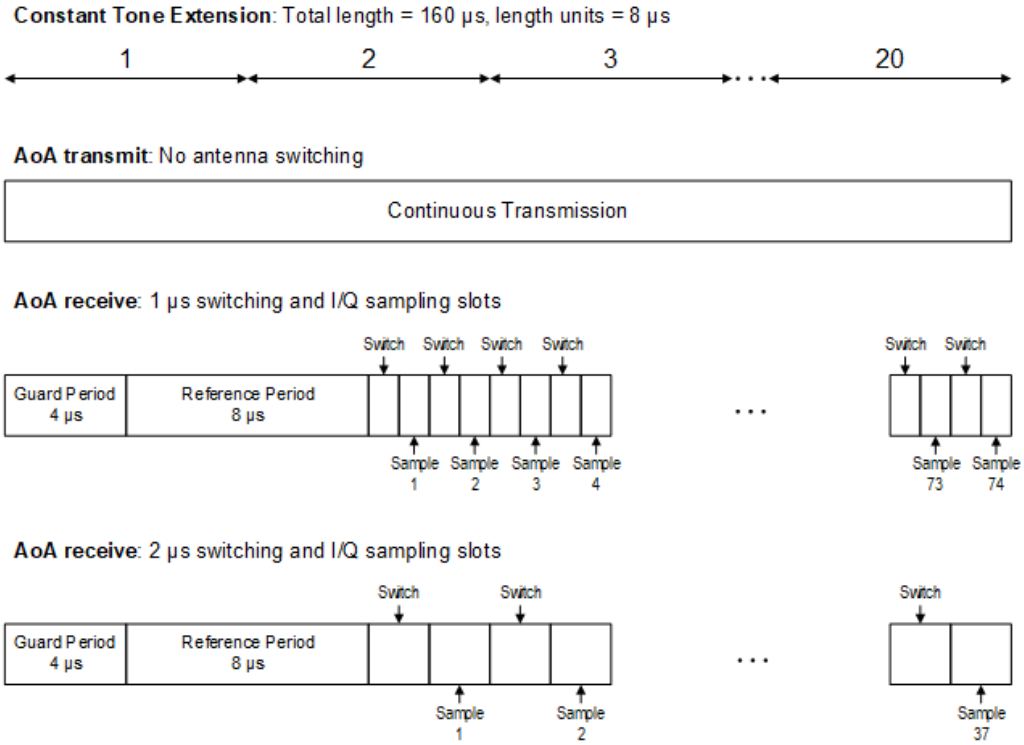


Figure 3-11: CTE structure for AoA method

The following figure illustrates the CTE structure for AoD method. On the transmitting side, antenna switching and I/Q sampling alternate in the time slots after the guard and reference period. On the receiving side, I/Q sampling only is performed in every second time slot after the guard and reference period.

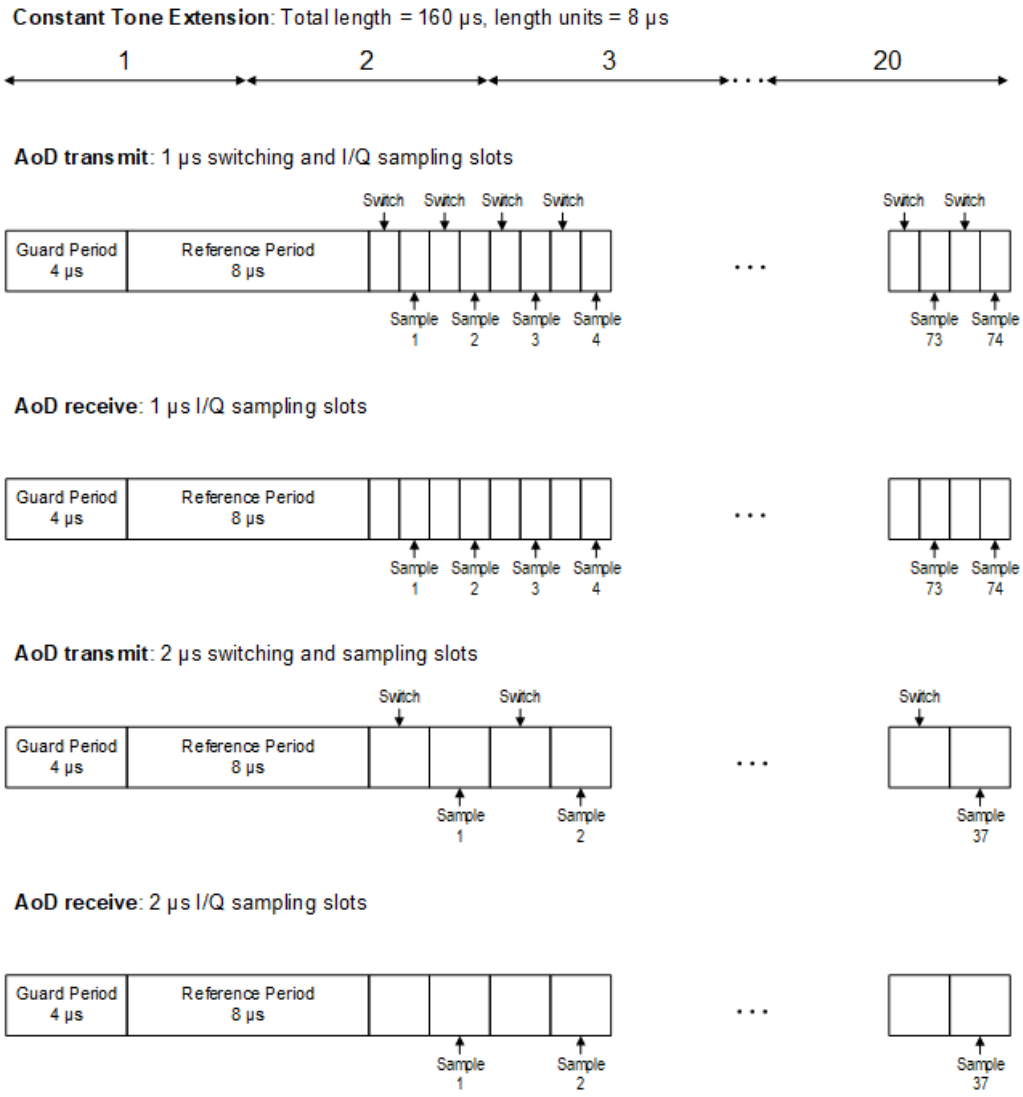


Figure 3-12: CTE structure for AoD method

For more information, refer to section 2.5 Constant Tone Extension and IQ Sampling of core specification for Bluetooth wireless technology, volume 6, part B.

3.2 About the Bluetooth BR/EDR/LE Modulation Characteristics measurement

To determine the modulation characteristics of the Bluetooth input signal, the R&S VSE Bluetooth measurement application performs an I/Q measurement. The measurement determines the maximum frequency deviation of all 8 bit sequences of the payload. In addition, the average value of the maximum frequency deviation for each packet is calculated. For a measurement according to the Bluetooth test specification, the DUT is

configured to transmit packets with the bit patterns "11110000" and "10101010" alternately. The sequence has to be repeated 10 times.

Synchronization

The R&S VSE Bluetooth measurement application detects the bit pattern of the payload and attempts to synchronize the signal using the 64-bit sync word. The lower address part of the Bluetooth device address (LAP, the 24 least significant bits) determines the sync word used for sync search.

In a first step, the application automatically searches a burst within the RF signal. In a triggered measurement, the external trigger or the IF power trigger is used to determine the burst position.

In a second step, the application searches for the sync word position by correlating the signal with the sync word defined in the initialization phase. The application correlates the FM signal directly, not the data bits, which are only available after the phase shifter has been processed. The burst search process continues until the sync word is found.

After determining the position of the sync word, the application calculates the position of the first preamble bit (p0). The position is determined from the average value of all zero-crossing points, as defined in the RF test specification. Finally, the samples are shifted such that each sample matches one zero-crossing point (phase shifting).

Output power

The only results that can be determined without synchronization are the output power results. The specified measurement time is 20% to 80% of the burst length. Without synchronization, the burst length is defined via the -3-dB points of the power trace. With synchronization, the burst starts with the p0 bit. Therefore, the measurement results can vary if the power of the DUT is not constant within the burst.

For EDR signals, the relative transmit power is measured. It is calculated as the ratio of the average transmission power of the GFSK and DPSK-modulated parts of the signal. (GFSK stands for Gaussian Frequency Shift Keying, while DPSK stands for Differential Phase Shift Keying.)

Carrier frequency stability

For EDR signals, the carrier frequency stability is also measured during the modulation characteristics measurement. It verifies that the modulation accuracy and the frequency stability are within the required limits. The RF Test Specification requires evaluating 200 blocks, with a length of 50 µs each.

Initial carrier frequency tolerance (ICFT)

The initial carrier frequency tolerance determines the carrier offset of the four preamble bits. According to the RF Test Specification, the carrier offset is measured from the middle of the first preamble bit to the middle of the bit following the preamble.

3.2.1 Measurement filter

The RF specification allows high distortion power in the first adjacent channels. The 3-MHz filter does not suppress this kind of distortion, which leads to high interference in modulation. Therefore, precise measurement of the frequency deviation is not possible.

To obtain correct deviation results, the analyzer supplies an optional filter whose passband is only appropriate for the channel to measure. The Bluetooth spectrum has a bandwidth of 1 MHz. The filter is flat within 1.04 MHz (ripple: only 0.02 dB) and has steep edges. This measurement filter does not depend on the selected points per symbol value. As a result, the displayed deviation value increases by 3.2%. However, without the filter, the displayed deviation value can increase dramatically due to interference from adjacent channels. Generally, the result is more precise if the displayed deviation is lower with filtering than the deviation without filtering. In these cases, the inaccuracy caused by the adjacent channel interference is higher than the systematic inaccuracy caused by the filter.

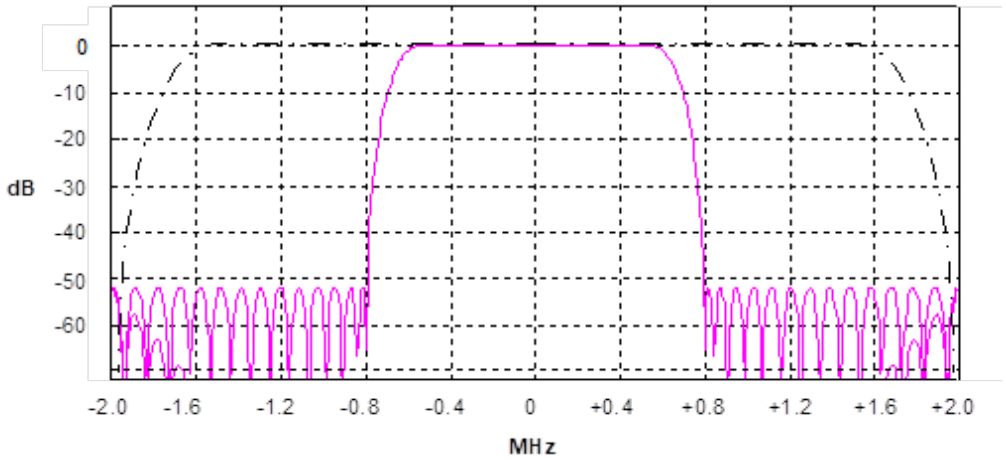


Figure 3-13: Selection of digital filters

Dashed trace = Standard filter with 4 points per symbol
Solid trace = Optional measurement filter, independent of the points per symbol setting

3.2.2 Trigger concepts

As the DUT (Device Under Test) uses frequency hopping, a trigger method is necessary for two reasons:

- A measurement is only possible during the period of time when a TX signal (burst) is available at the frequency under request.
- To determine the modulation characteristics correctly, the signal must be synchronized with the preamble.

To ensure stable synchronization, the DUT must be operated in reduced hopping mode. The DUT is only allowed to toggle between two frequencies, because otherwise the repetition time for the same frequency becomes higher than the record length.

If the test environment supplies an external trigger which marks the channel to be measured, synchronization is also possible with normal hopping operation.

3.3 About the Bluetooth BR/EDR/LE spurious emissions measurement

To measure the channel power in the individual channels of a Bluetooth signal, the specification defines the following procedure:

1. Determine the start and stop frequencies of the measurement:
   <Start frequency> = <Center frequency> - (k/2)<Channel spacing>*
   <Stop frequency> = <Center frequency> + (k/2)<Channel spacing>*
   Where:
   <Channel spacing> = 1 MHz or 2 MHz, depending on the operating mode
   k = number of channels = 79 or 40, depending on the operating mode
2. At the start frequency, perform 10 zero span sweeps with an RBW of 100 kHz and a sweep time of 100 ms.
3. Determine the average of the maximum power levels for each sweep.
4. Move the LO to 100 kHz.
5. Repeat step 2 and step 3 10 times, that is: for a bandwidth of 1 MHz (= 1 channel).
6. Add up the average maximum power values for all subspans to determine the channel power level.

The R&S VSE Bluetooth measurement application performs a compliant measurement that is optimized for speed and performance.

4 Measurements and result displays

The R&S VSE Bluetooth measurement application provides two different measurements to determine the parameters described by the Bluetooth specifications.

The default **"Modulation Characteristics"** measurement determines basic signal parameters concerning packets, output power and bit patterns, for example.

The **"ACP / In-band Spurious Emissions"** measurement provides information on individual channels in the time and frequency domain.

Selecting the measurement type

► To select a different measurement type, select one of the following:

- "Overview" > "Select Measurement"
- [MEAS] > "Select Measurement"

Remote command:

`CONFigure:BTOoth:MEASurement` on page 108

Result display windows

For each measurement, a separate channel is activated. Each channel can provide multiple result displays, which are displayed in individual windows. The measurement windows can be rearranged and configured in the R&S VSE to meet your requirements. All windows that belong to the same measurement (including the channel bar) are indicated by a colored line at the top of the window title bar.

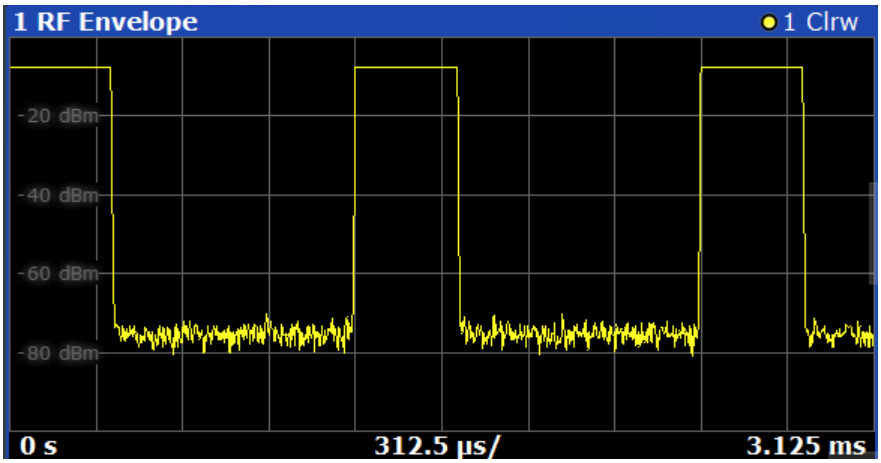
► To add further result displays for the Bluetooth BR/EDR/LE channel, select the "Add Window" icon from the toolbar, or select the "Window" > "New Window" menu item.

For details on working with channels and windows, see the "Operating Basics" chapter in the R&S VSE Base Software User Manual.

Depending on the selected measurement, different result displays are available in the R&S VSE Bluetooth measurement application.

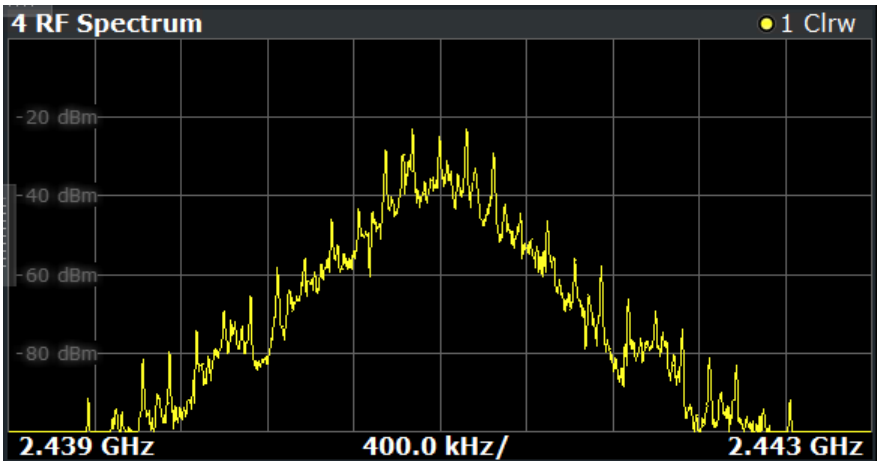
4.1 Result displays for Modulation Characteristics measurements

RF Envelope
Displays the power of the RF signal over time for all channels.



Remote command:
`LAY:ADD? '1',RIGH,RFEN`, see `LAYout:ADD[:WINDow]?` on page 182
Retrieving results:
`TRACe<n>[:DATA]?` on page 190

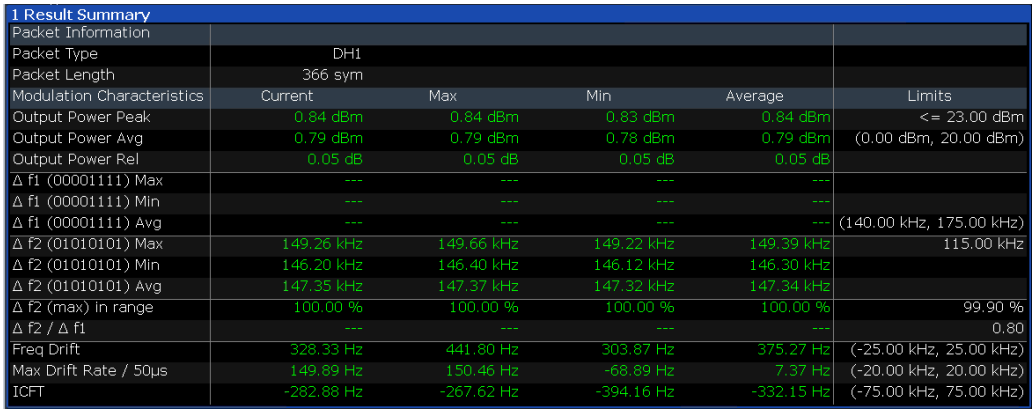
RF Spectrum
Displays the power of the RF signal over frequency for a span of 4 MHz, i.e. 4 channels.



Remote command:
`LAY:ADD? '1',RIGH,RFSP`, see `LAYout:ADD[:WINDow]?` on page 182
Retrieving results:
`TRACe<n>[:DATA]?` on page 190

Result Summary

Displays packet information and the determined numerical modulation characteristics.



1 Result Summary					
Packet Information					
Packet Type	DH1				
Packet Length	366 sym				
Modulation Characteristics	Current	Max	Min	Average	Limits
Output Power Peak	0.84 dBm	0.84 dBm	0.83 dBm	0.84 dBm	<= 23.00 dBm
Output Power Avg	0.79 dBm	0.79 dBm	0.78 dBm	0.79 dBm	(0.00 dBm, 20.00 dBm)
Output Power Rel	0.05 dB	0.05 dB	0.05 dB	0.05 dB	
Δ f1 (00001111) Max	---	---	---	---	
Δ f1 (00001111) Min	---	---	---	---	
Δ f1 (00001111) Avg	---	---	---	---	(140.00 kHz, 175.00 kHz)
Δ f2 (01010101) Max	149.26 kHz	149.66 kHz	149.22 kHz	149.39 kHz	115.00 kHz
Δ f2 (01010101) Min	146.20 kHz	146.40 kHz	146.12 kHz	146.30 kHz	
Δ f2 (01010101) Avg	147.35 kHz	147.37 kHz	147.32 kHz	147.34 kHz	
Δ f2 (max) in range	100.00 %	100.00 %	100.00 %	100.00 %	99.90 %
Δ f2 / Δ f1	---	---	---	---	0.80
Freq Drift	328.33 Hz	441.80 Hz	303.87 Hz	375.27 Hz	(-25.00 kHz, 25.00 kHz)
Max Drift Rate / 50µs	149.89 Hz	150.46 Hz	-68.89 Hz	7.37 Hz	(-20.00 kHz, 20.00 kHz)
ICFT	-282.88 Hz	-267.62 Hz	-394.16 Hz	-332.15 Hz	(-75.00 kHz, 75.00 kHz)

For the modulation characteristics, the following results are provided:

- Current value
- Maximum value
- Minimum value
- Average value
- Specified limits

Values that exceed the specified limits are highlighted red.

Table 4-1: Results for basic rate signals

Result	Description
Packet information	
"Packet Type"	See Chapter 3.1.1, "Bluetooth packet types for BR/EDR", on page 12 and Chapter 3.1.6, "Packet types for LE", on page 19
"Packet Length"	Number of symbols per packet
Modulation characteristics	
"Output Power Peak"	Maximum output power
"Output Power Avg"	Average output power
"Output Power Rel"	Relative output power (Relation maximum to average)
"Δf1 (00001111) Max/Min/Avg"	Frequency offset for first test sequence
"Δf2 (01010101) Max/Min/Avg"	Frequency offset for second test sequence
"Δf2 (max) in range"	Percentage of the maximum frequency offset measurements that remained within the valid range (did not exceed the limits)
"Δf2 / Δf1"	Relation between the frequency offsets of the first and second test sequence
"Freq Drift"	Difference between the average frequency of the 4 preamble bits and the average frequency of any 10-bit group of the payload.

Result	Description
"Max Drift Rate / 50µs"	Maximum frequency drift per packet
"ICFT / 50µs"	Maximum drift of the initial carrier frequency in BR signals for any 50-µs time period within the payload field of the returned packets.

Table 4-2: Results for enhanced data rate signals

Result	Description
Packet information	
"Packet Type"	See Chapter 3.1.1, "Bluetooth packet types for BR/EDR", on page 12
"Packet Length"	Number of symbols within the packet
"Packet Tested"	Packet has been measured: 1: true, 0: false
"Packet Passed"	Packet has passed the limit check: 1: true, 0: false
"BER"	Bit error rate
Modulation characteristics	
"GFSK Avg Power"	Average power for GFSK-modulated part of the signal
"DPSK Avg Power"	Average power for DPSK-modulated part of the signal
"Rel Avg Power"	Ratio of "GFSK Avg Power" to "DPSK Avg Power"
"RMS/Peak/99% DEVM QPSK"	RMS value, peak value and 99-percentile of the differential error vector magnitude for QPSK-modulated part of the signal
"RMS/Peak/99% DEVM 8PSK"	RMS value, peak value and 99-percentile of the differential error vector magnitude for 8PSK-modulated part of the signal
"Initial Frequency Offset"	Offset of the packet before any packet information is sent.
"Block Frequency Offset"	Offset of a block of 50 symbols
"Total Frequency Offset"	Total offset of signal

Table 4-3: Results for low energy signals

Result	Description
Packet information	
"Packet Type"	See Chapter 3.1.1, "Bluetooth packet types for BR/EDR", on page 12 and Chapter 3.1.6, "Packet types for LE", on page 19
"Packet Length"	Number of symbols per packet
Modulation characteristics	
"Output Power Peak"	Maximum output power

Result	Description
"Output Power Avg"	Average output power
"Output Power Rel"	Relative output power (Relation maximum to average)
"Δf1 (00001111) Max/Min/Avg"	Frequency offset for first test sequence
"Δf2 (01010101) Max/Min/Avg"	Frequency offset for second test sequence
"Δf2 (max) in range" "Δf1 (max) in range" (LE coded)	Percentage of the maximum frequency offset measurements that remained within the valid range (did not exceed the limits)
"Δf2 / Δf1"	Relation between the frequency offsets of the first and second test sequence
"Freq Drift"	Difference between the average frequency of the 4 preamble bits and the average frequency of any 10-bit group of the payload.
"Max Drift Rate / 50µs" "Max Drift Rate / 48µs" (LE coded)	Maximum frequency drift per packet
"Freq Offset"	Frequency offset without preamble and payload detection
"Initial Freq Drift"	Drift of the initial carrier frequency

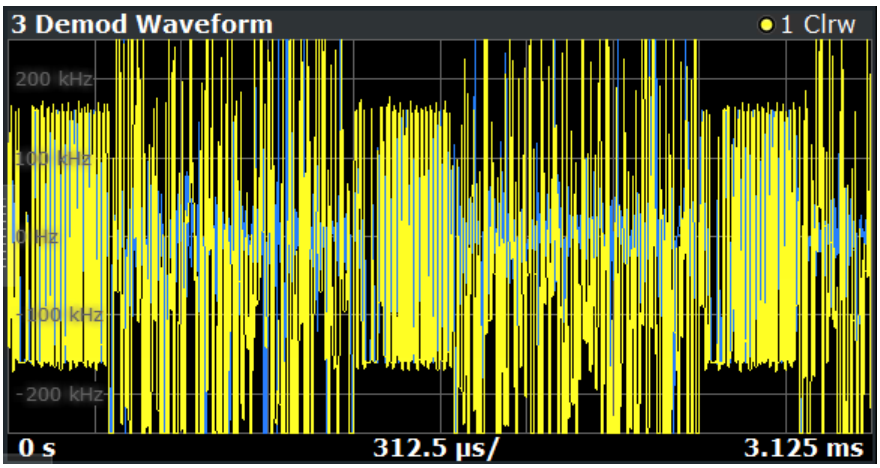
Remote command:
`LAY:ADD? '1',RIGH,RSUM`, see `LAYout:ADD[:WINDow]?` on page 182
Retrieving results:
`TRACe<n>[:DATA]?` on page 190

Marker Table
Displays a table with the current marker values for the active markers.

This table is displayed automatically if configured accordingly.

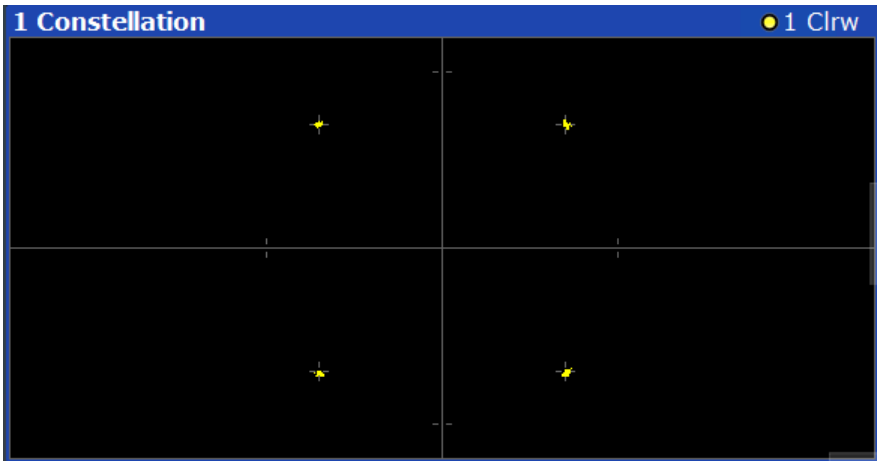
Remote command:
`LAY:ADD? '1',RIGH, MTAB`, see `LAYout:ADD[:WINDow]?` on page 182
Results:
`CALCulate<n>:MARKer<m>:X` on page 170

Demod waveform (not for EDR)
Displays the demodulated signal frequency versus (measurement) time.



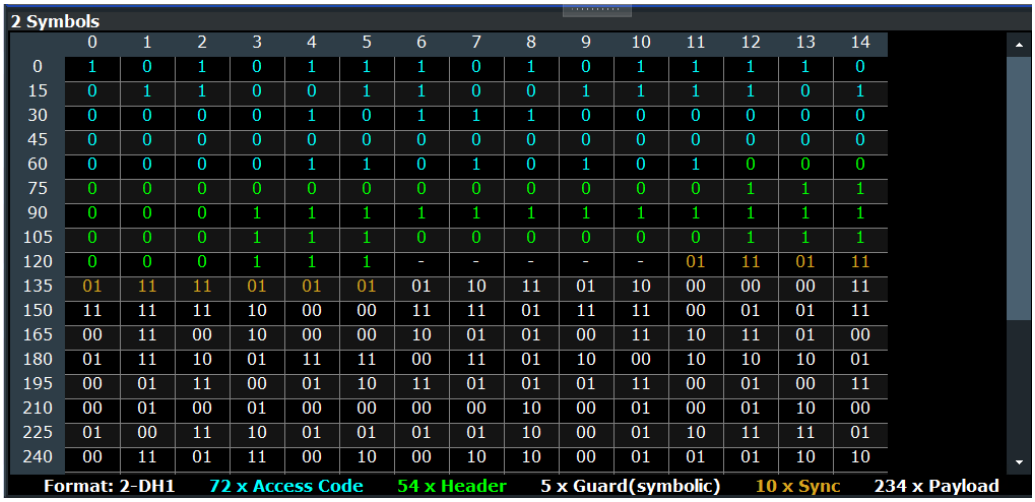
Remote command:
`LAY:ADD? '1',RIGH,DWAV`, see `LAYout:ADD[:WINDow]?` on page 182
Retrieving results:
`TRACe<n>[:DATA]?` on page 190

Constellation (EDR only)
Displays the captured samples in an I/Q plot.



Remote command:
`LAY:ADD? '1',RIGH,CONS`, see `LAYout:ADD[:WINDow]?` on page 182
Retrieving results:
`TRACe<n>[:DATA]?` on page 190

Symbols (EDR only)
Displays the demodulated symbols for all channels.



	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
0	1	0	1	0	1	1	1	0	1	0	1	1	1	1	0
15	0	1	1	0	0	1	1	0	0	1	1	1	1	0	1
30	0	0	0	0	1	0	1	1	1	0	0	0	0	0	0
45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60	0	0	0	0	1	1	0	1	0	1	0	1	0	0	0
75	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
90	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
105	0	0	0	1	1	1	0	0	0	0	0	0	1	1	1
120	0	0	0	1	1	1	-	-	-	-	-	01	11	01	11
135	01	11	11	01	01	01	01	10	11	01	10	00	00	00	11
150	11	11	11	10	00	00	11	11	01	11	11	00	01	01	11
165	00	11	00	10	00	00	10	01	01	00	11	10	11	01	00
180	01	11	10	01	11	11	00	11	01	10	00	10	10	10	01
195	00	01	11	00	01	10	11	01	01	01	11	00	01	00	11
210	00	01	00	01	00	00	00	00	10	00	01	00	01	10	00
225	01	00	11	10	01	01	01	01	10	00	01	10	11	11	01
240	00	11	01	11	00	10	00	10	10	00	01	01	01	10	10

Note: For payload symbols, QPSK-modulated symbols are represented by 2 bits, while 8PSK-modulated symbols are represented by 3 bits.

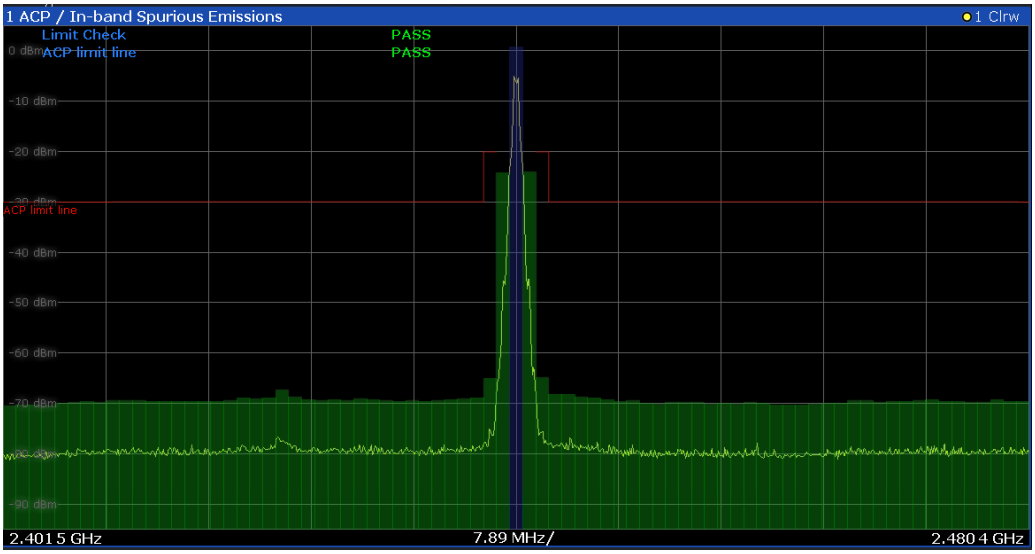
The packet format and the number of symbols for the different packet contents are indicated beneath the table. The symbols for each type of packet content are indicated in a different color.

Remote command:
`LAY:ADD? '1',RIGH,SYMB`, see `LAYout:ADD[:WINDow]?` on page 182
Retrieving results:
`TRACe<n>[:DATA]?` on page 190

4.2 Result displays for In-band Spurious Emissions measurements

ACP / In-band Spurious Emissions
Displays the power of the RF signal over frequency for all channels. In addition, the limit line is displayed, defined by concatenating the specified limits for the different channels. For details, see Chapter 6.2.4, "Checking limits", on page 82.

The results of the ACP and general limit check are indicated.



Any channels that exceed the limits are highlighted in red.

The currently selected transmit (TX) channel is highlighted blue in the table, see Chapter 5.5.1, "Selecting the transmit channel", on page 62. You can step through the individual channels using the TX Channel No function and the rotary knob or arrow keys.

Remote command:
`LAY:ADD? '1',RIGH,SPEC`, see `LAYout:ADD[:WINDow]?` on page 182
Retrieving results:
`TRACe<n>[:DATA]?` on page 190
`CALCulate<n>:LIMit:FAIL?` on page 188

Result Summary
Indicates the numerical power measurement results per channel.

In addition, the most important results for the currently selected transmit and adjacent channels are indicated at the top of the table.

Channel power values that exceed the limit line are highlighted red.

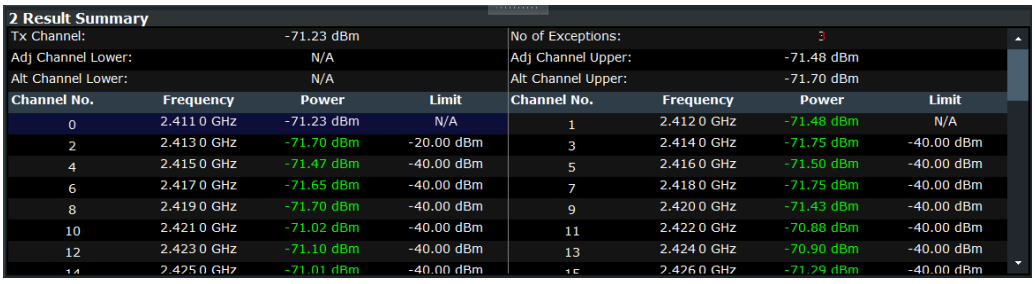


Figure 4-1: Result summary for in-band spurious emissions measurement for basic rate signal

The currently selected transmit channel is highlighted blue in the table, see Chapter 5.5.1, "Selecting the transmit channel", on page 62. You can step through the individual channels using the TX Channel No function and the rotary knob or arrow keys.

Result	Description
ACP results	
"TX channel"	Power of the currently selected TX channel, see "TX Channel No" on page 62
"No. of Exceptions"	Number of channels that exceed the ACP limit line Value turns red if an adjacent or alternate1 channel exceeds the limit line, or if the acceptable number of exceptions is exceeded (see "Allowed Exceptions" on page 83).
"Adj Channel Lower"	Power of the lower adjacent channel
"Adj Channel Upper"	Power of the upper adjacent channel
"Alt Channel Lower"	Power of the lower alternate channel
"Alt Channel Upper"	Power of the upper alternate channel
EDR mode	
"Guard position"	The start of the guard time before the payload in the packet. The measurement starts after the guard time.
"Meas Time"	The time the measurement is actually performed, starting with the guard time.
Channel results	
"Channel No."	Channel number
"Frequency"	Center frequency of the channel
"Power"	Channel power
"Limit"	Defined power limit for the channel (for active limit check only)
Limit check result	Red channel power value: FAIL Green channel power value: PASS White channel power value (Limit check: off): PASS

Remote command:
`LAY:ADD? '1',RIGH,RSUM`, see `LAYout:ADD[:WINDow]?` on page 182
Retrieving results:

Marker Table

Displays a table with the current marker values for the active markers.

This table is displayed automatically if configured accordingly.

Remote command:
`LAY:ADD? '1',RIGH, MTAB`, see `LAYout:ADD[:WINDow]?` on page 182
Results:
`CALCulate<n>:MARKer<m>:X` on page 170

5 Configuration

Access: "Meas Setup" > "Overview"

Multiple access paths to functionality

The easiest way to configure a measurement channel is via the "Overview" dialog box.

Alternatively, you can access the individual dialog boxes from the corresponding menu items, or via tools in the toolbars, if available.

In this documentation, only the most convenient method of accessing the dialog boxes is indicated - usually via the "Overview". For an overview of all available menu items and toolbar icons, see Chapter B, "Menu reference", on page 197.

5.1 Configuration overview

Access: "Meas Setup" > "Overview"

Throughout the measurement channel configuration, an overview of the most important currently defined settings is provided in the "Overview".

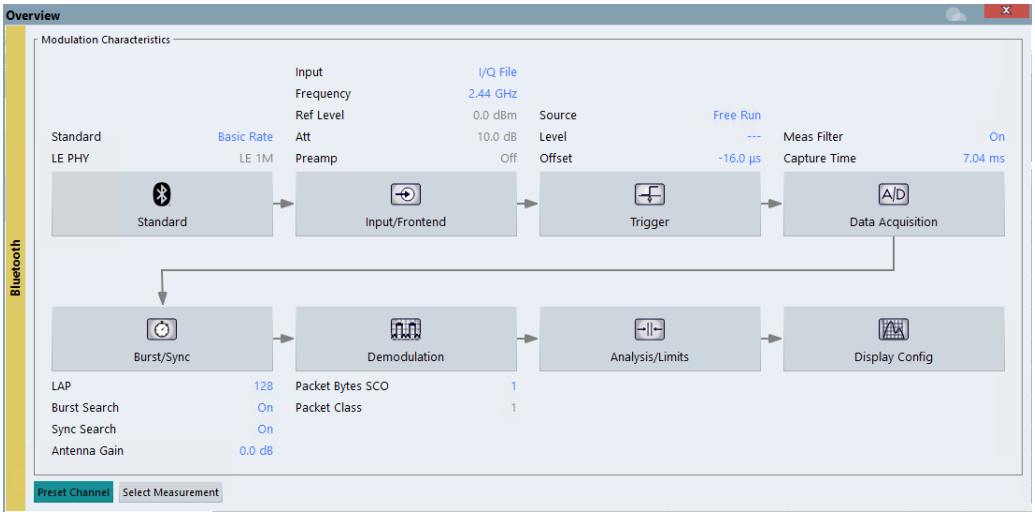


Figure 5-1: Configuration overview for modulation accuracy measurement

In addition to the main measurement settings, the "Overview" provides quick access to the main settings dialog boxes. The individual configuration steps are displayed in the order of the data flow. Thus, you can easily configure an entire measurement channel

from input over processing to output and analysis by stepping through the dialog boxes as indicated in the "Overview".

In particular, the "Overview" provides quick access to the following configuration dialog boxes (listed in the recommended order of processing):

1. "Standard"
   See Chapter 5.2, "Configuration according to digital standards", on page 43
2. "Input/Frontend"
   See Chapter 5.3, "Input and frontend settings", on page 44
3. "Trigger"
   See Chapter 5.6, "Trigger and gate settings", on page 62
4. "Data Acquisition"
   See Chapter 5.4.1, "Data acquisition", on page 59
5. "Burst/Sync"
   See Chapter 5.4.2, "Burst and synchronization settings", on page 60
6. "Demodulation"
   See Chapter 5.4.3, "Demodulation settings", on page 61
7. "Analysis/Limits"
   For modulation accuracy: See Chapter 6.1, "Analyzing modulation characteristics", on page 67 and Chapter 6.1.1.2, "Checking limits (BR)", on page 68
   For in-band spurious emissions: See Chapter 6.2, "Analyzing in-band spurious emissions", on page 78 and Chapter 6.2.4, "Checking limits", on page 82
8. "Display Config"
   See Chapter 6.6, "Display configuration", on page 92

To configure settings

► Select any button in the "Overview" or select a setting in the channel's global info bar to open the corresponding dialog box.

For step-by-step instructions on configuring Bluetooth BR/EDR/LE measurements, see Chapter 7, "How to perform Bluetooth BR/EDR/LE measurements", on page 93.

Preset Channel
Select the "Preset Channel" button in the lower left-hand corner of the "Overview" to restore all measurement settings *in the current channel* to their default values.

Remote command:
`SYSTem:PRESet:CHANnel[:EXEC]` on page 106

Select Measurement
Selects a measurement to be performed.

See Chapter 4, "Measurements and result displays", on page 31.

Remote command:
`CONFigure:BTOoth:MEASurement` on page 108

Specific Settings for
The channel can contain several windows for different results. Thus, the settings indicated in the "Overview" and configured in the dialog boxes vary depending on the selected window.

Select an active window from the "Specific Settings for" selection list that is displayed in the "Overview" and in all window-specific configuration dialog boxes.

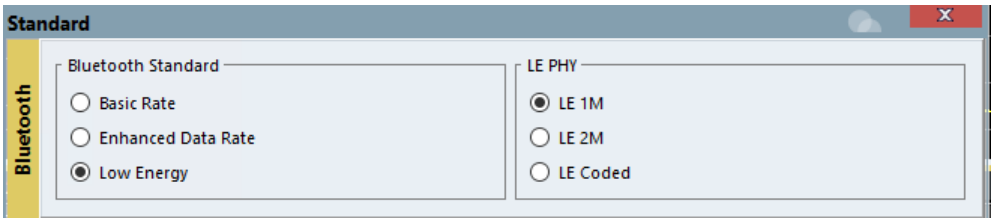
The "Overview" and dialog boxes are updated to indicate the settings for the selected window.

5.2 Configuration according to digital standards

Access: "Overview" > "Standard"

Different Bluetooth standards allow for different modulation modes and energy levels. To configure the R&S VSE Bluetooth measurement application, you must define which standard the input signal complies with.

The measurements are configured according to the specified standard, e.g. regarding demodulation or the power range.



Predefined settings for frequency, channels and trigger settings are also available for in-band spurious emissions analysis, see Chapter 6.2.3, "Saving and loading predefined settings", on page 81.

Standard
Defines the Bluetooth standard that the signal complies with. The measurements are configured according to the specified standard with the correct frequency range and number of channels.

For details on the different standards, see Chapter 3, "Measurement basics", on page 11.

For measurements based on the **low-energy** standard, different substandards are available depending on the used transmission mode (PHY). For details, see Chapter 3.1, "About Bluetooth BR/EDR/LE", on page 11.

- **LE 1M**: uncoded, 1 symbol per data bit, 1 Msymbol/s data rate
- **LE 2M**: uncoded, 1 symbol per data bit, 2 Msymbol/s data rate
- **LE Coded**: 2 symbols per data bit, 1 Msymbol/s data rate

Remote command:
CONFigure:BTOoth[:STANdard] on page 107
CONFigure:BTOoth:LENergy on page 107

5.3 Input and frontend settings

Access: "Overview" > "Input/Frontend" > "Input"

or: "Input & Output"

Some settings are also available in the "Amplitude" tab of the "Amplitude" dialog box.

Output settings are described in the R&S VSE base software user manual.

Input from other sources

The R&S VSE Bluetooth measurement application application can also process input from the following optional sources:

- I/Q Input files
  See Chapter 5.3.2, "I/Q file input", on page 49
- R&S FSV/A3000 with a connected external frontend
  See the R&S VSE base software user manual.
- External mixer
  See the R&S VSE base software user manual.

5.3.1 Radio frequency input

Or: "Input & Output" > "Input Source" > "Radio Frequency"

The default input source for the connected instrument is "Radio Frequency". Depending on the connected instrument, different input parameters are available.

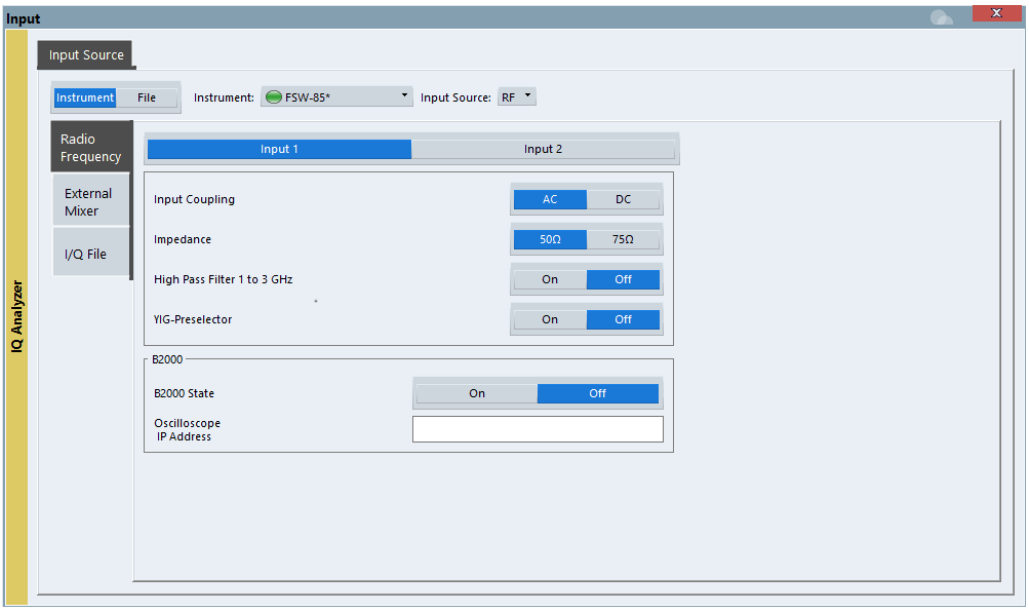


Figure 5-2: RF input source settings for an R&S FSW with B2000 option

If the Frequency Response Correction option (R&S VSE-K544) is installed, the R&S VSE Bluetooth measurement application also supports frequency response correction using Touchstone (`.snp`) files or `.fres` files.

Input Type (Instrument / File)
Selects an instrument or a file as the type of input provided to the channel.

Note: External mixers are only available for input from a connected instrument.

Note: If the R&S VSE software is installed directly on an instrument, or integrated in Cadence®AWR®VSS, some restrictions apply on the available input type.

Remote command:
`INSTrument:BLOCk:CHANnel[:SETTings]:SOURce<si>` on page 115
`INPut<ip>:SELect` on page 114

Instrument
Specifies a configured instrument to be used for input.

Input 1 / Input 2
For instruments with two input connectors, you must define which input source is used for each measurement channel.

If an external frontend is active, select the connector the external frontend is connected to. You cannot use the other RF input connector simultaneously for the same channel. However, you can configure the use of the other RF input connector for another active channel at the same time.

"Input 1"	R&S FSW85: 1.00 mm RF input connector for frequencies up to 85 GHz (90 GHz with option R&S FSW-B90G)
"Input2"	R&S FSW85: 1.85 mm RF input connector for frequencies up to 67 GHz

Remote command:
`INPut:TYPE` on page 114

Input Coupling
The RF input of the R&S VSE can be coupled by alternating current (AC) or direct current (DC).

The RF input of the connected instrument can be coupled by alternating current (AC) or direct current (DC).

AC coupling blocks any DC voltage from the input signal. AC coupling is activated by default to prevent damage to the instrument. Very low frequencies in the input signal can be distorted.

However, some specifications require DC coupling. In this case, you must protect the instrument from damaging DC input voltages manually. For details, refer to the data sheet.

Remote command:
`INPut<ip>:COUPling<ant>` on page 109

Impedance
For some measurements, the reference impedance for the measured levels of the connected instrument can be set to 50 Ω or 75 Ω.

Select 75 Ω if the 50 Ω input impedance is transformed to a higher impedance using a 75 Ω adapter of the RAZ type. (That corresponds to 25Ω in series to the input impedance of the instrument.) The correction value in this case is 1.76 dB = 10 log (75Ω/ 50Ω).

Remote command:
`INPut<ip>:IMPedance<ant>` on page 111

Direct Path
Enables or disables the use of the direct path for small frequencies.

In spectrum analyzers, passive analog mixers are used for the first conversion of the input signal. In such mixers, the LO signal is coupled into the IF path due to its limited isolation. The coupled LO signal becomes visible at the RF frequency 0 Hz. This effect is referred to as LO feedthrough.

To avoid the LO feedthrough the spectrum analyzer provides an alternative signal path to the A/D converter, referred to as the *direct path*. By default, the direct path is selected automatically for RF frequencies close to zero. However, this behavior can be disabled. If "Direct Path" is set to "Off", the spectrum analyzer always uses the analog mixer path.

"Auto" (Default) The direct path is used automatically for frequencies close to zero.

"Off" The analog mixer path is always used.

Remote command:
`INPut:DPATh` on page 110

High Pass Filter 1 to 3 GHz
Activates an additional internal highpass filter for RF input signals from 1 GHz to 3 GHz. This filter is used to remove the harmonics of the analyzer to measure the harmonics for a DUT, for example.

For some connected instruments, this function requires an additional hardware option on the instrument.

Note: For RF input signals outside the specified range, the high-pass filter has no effect. For signals with a frequency of approximately 4 GHz upwards, the harmonics are suppressed sufficiently by the YIG-preselector, if available.)

Remote command:
`INPut:FILTer:HPASs[:STATe]` on page 111

YIG-Preselector
Enables or disables the YIG-preselector.

This setting requires an additional option on the connected instrument.

Note: Note that the YIG-preselector is active only higher frequencies, depending on the connected instrument. Therefore, switching the YIG-preselector on or off has no effect if the frequency is below that value.

To use the optional 90 GHz frequency extension (R&S FSW-B90G), the YIG-preselector must be disabled.

To use the optional 54 GHz frequency extension (R&S FSV3-B54G), the YIG-preselector must be disabled.

Remote command:
`INPut<ip>:FILTer:YIG[:STATe]` on page 111

B2000 State
Activates the optional 2 GHz bandwidth extension (R&S FSW-B2000).

Note: The R&S VSE software supports input from a connected R&S FSW with a B2000 option installed. However, the R&S FSW interface to the oscilloscope must be

set up and aligned directly on the instrument before the R&S VSE software can start analyzing the input.
The analysis bandwidth is defined in the data acquisition settings of the application as usual. Note that the maximum bandwidth cannot be restricted manually as for other bandwidth extension options.

Manual operation on the connected oscilloscope, or remote operation other than by the R&S VSE, is not possible while the B2000 option is active.

Remote command:
`SYSTem:COMMunicate:RDEVice:OSCilloscope[:STATe]` on page 116

Oscilloscope Splitter Mode
Activates the use of the power splitter inserted between the "IF 2 GHZ OUT" connector of the R&S FSW and the "CH1" and "CH3" input connectors of the oscilloscope. Note that this mode requires an additional alignment with the power splitter.

For details see the R&S FSW I/Q Analyzer and I/Q Input user manual.

Remote command:
`SYSTem:COMMunicate:RDEVice:OSCilloscope:PSMode[:STATe]` on page 117

Oscilloscope IP Address
When using the optional 2 GHz bandwidth extension (R&S FSW-B2000) with an R&S FSW as the connected instrument, the entire measurement, as well as both instruments, are controlled by the R&S VSE software. Thus, the instruments must be connected via LAN, and the TCPIP address of the oscilloscope must be defined in the R&S VSE software.

For tips on how to determine the computer name or TCPIP address, see the oscilloscope's user documentation.

Remote command:
`SYSTem:COMMunicate:RDEVice:OSCilloscope:TCPip` on page 116

Preselector State
Turns the preselector on and off.

When you turn on the preselector, you can configure the characteristics of the preselector and add the preamplifier into the signal path.

When you turn off the preselector, the signal bypasses the preselector and the preamplifier, and is fed into the input mixer directly.

Remote command:
`INPut<ip>:PRESelection[:STATe]` on page 112

Preselector Mode
Selects the preselection filters to be applied to the measurement.

"Auto" Automatically applies all available bandpass filters in a measurement. Available with the optional preamplifier.

"Auto Wide" Automatically applies the wideband filters consecutively:

- Lowpass 40 MHz
- Bandpass 30 MHz to 2250 MHz
- Bandpass 2 GHz to 8 GHz
- Bandpass 8 GHz to 26.5 GHz

Available with the optional preselector.

"Auto Narrow" Automatically applies the most suitable narrowband preselection filters in a measurement, depending on the bandwidth you have selected.
For measurement frequencies up to 30 MHz, the connected instrument uses combinations of lowpass and highpass filters. For higher frequencies, the connected instrument uses bandpass filters.
Available with the optional preselector.

"Manual" Applies the filter settings you have defined manually.

Remote command:
`INPut:PRESelection:SET` on page 112

10 dB Minimum Attenuation
Turns the availability of attenuation levels of less than 10 dB on and off.

When you turn on this feature, the attenuation is always at least 10 dB. This minimum attenuation protects the input mixer and avoids accidental setting of 0 dB, especially if you measure EUTs with high RFI voltage.

When you turn it off, you can also select attenuation levels of less than 10 dB.

The setting applies to a manual selection of the attenuation as well as the automatic selection of the attenuation.

Remote command:
`INPut:ATTenuation:PROTection:RESet` on page 109

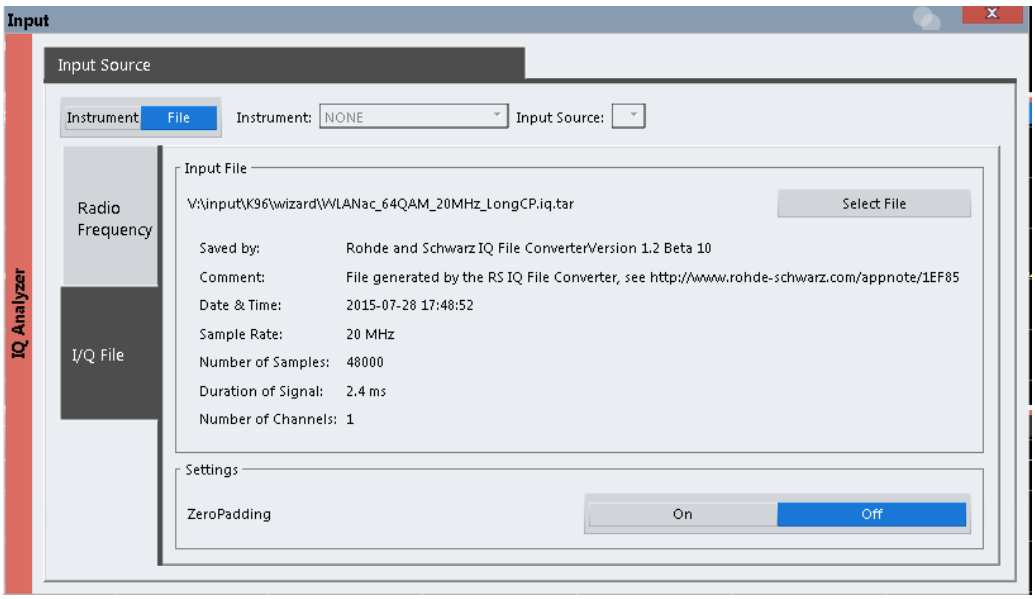
5.3.2 I/Q file input

Or: "Input & Output" > "Input Source" > "I/Q File"

Loading a file via drag&drop
You can load a file simply by selecting it in a file explorer and dragging it to the R&S VSE software. Drop it into the "Measurement Group Setup" window or the channel bar for any channel. The channel is automatically configured for file input, if necessary. If the file contains all essential information, the file input is immediately displayed in the channel. Otherwise, the "Recall I/Q Recording" dialog box is opened for the selected file so you can enter the missing information.

If the file contains data from multiple channels (e.g. from LTE measurements), it can be loaded to individual input sources, if the application supports them.

The "Input Source" settings defined in the "Input" dialog box are identical to those configured for a specific channel in the "Measurement Group Setup" window.



If the Frequency Response Correction option (R&S VSE-K544) is installed, the R&S VSE Bluetooth measurement application also supports frequency response correction using Touchstone (`.snp`) files or `.fres` files.

Encrypted `.wv` files can also be imported. Note, however, that traces resulting from encrypted file input cannot be exported or stored in a saveset.

Input Type (Instrument / File)
Selects an instrument or a file as the type of input provided to the channel.

Note: External mixers are only available for input from a connected instrument.

Note: If the R&S VSE software is installed directly on an instrument, or integrated in Cadence®AWR®VSS, some restrictions apply on the available input type.

Remote command:
`INSTrument:BLOCk:CHANnel[:SETTings]:SOURce<si>` on page 115
`INPut<ip>:SELect` on page 114

Input File
Specifies the I/Q data file to be used for input.

Select "Select File" to open the "Load I/Q File" dialog box.

Zero Padding
Enables or disables zero padding for input from an I/Q data file that requires resampling. For resampling, a number of samples are required due to filter settling. These samples can either be taken from the provided I/Q data, or the software can add the required number of samples (zeros) at the beginning and end of the file.

If enabled, the required number of samples are inserted as zeros at the beginning and end of the file. The entire input data is analyzed. However, the additional zeros can effect the determined spectrum of the I/Q data. If zero padding is enabled, a status message is displayed.

If disabled (default), no zeros are added. The required samples for filter settling are taken from the provided I/Q data in the file. The start time in the R&S VSE Player is adapted to the actual start (after filter settling).

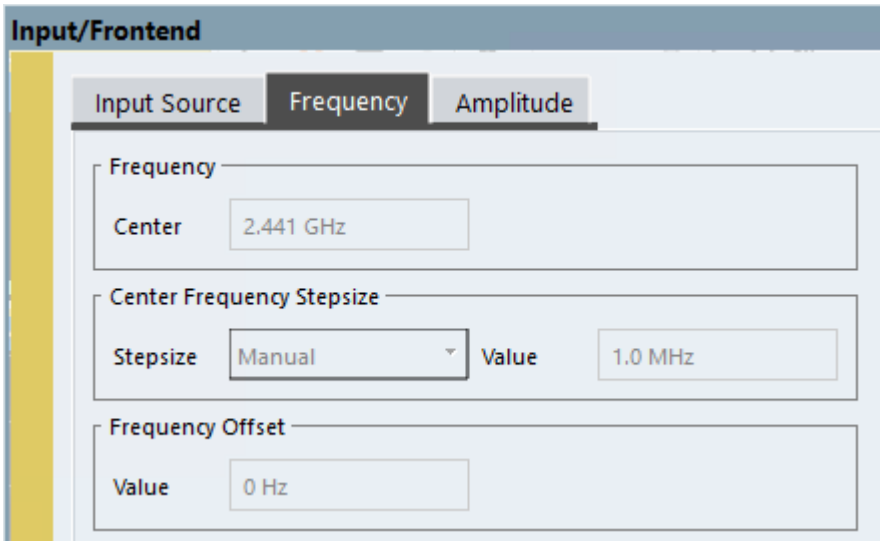
Note: You can activate zero padding directly when you load the file, or afterwards in the "Input Source" settings.

Remote command:
`INPut:FILE:ZPADing` on page 110

5.3.3 Frequency settings

Access: "Overview" > "Frequency"

Or: "Input & Output" > "Frequency"



Center Frequency
Indicates the center frequency (frequency domain) or measuring frequency (time domain).

The value depends on the used standard. See also Chapter 6.2.1, "Measurement settings depending on standard", on page 78.

Remote command:
[SENSe:]FREQuency:CENTer on page 162

Frequency Stepsize
Indicates the step size by which the center frequency is increased or decreased when the arrow keys are pressed. When you use the rotary knob, the center frequency changes in much smaller steps (1/10 the size as for the arrow keys).

The value depends on the used standard. See also Chapter 6.2.1, "Measurement settings depending on standard", on page 78.

Remote command:
[SENSe:]FREQuency:CENTer:STEP on page 162

Frequency Offset
Shifts the displayed frequency range along the x-axis by the defined offset.

This parameter has no effect on the instrument's hardware, on the captured data, or on data processing. It is simply a manipulation of the final results in which absolute frequency values are displayed. Thus, the x-axis of a spectrum display is shifted by a constant offset if it shows absolute frequencies. However, if it shows frequencies relative to the signal's center frequency, it is not shifted.

A frequency offset can be used to correct the display of a signal that is slightly distorted by the measurement setup, for example.

The allowed values range from -1 THz to 1 THz. The default setting is 0 Hz.

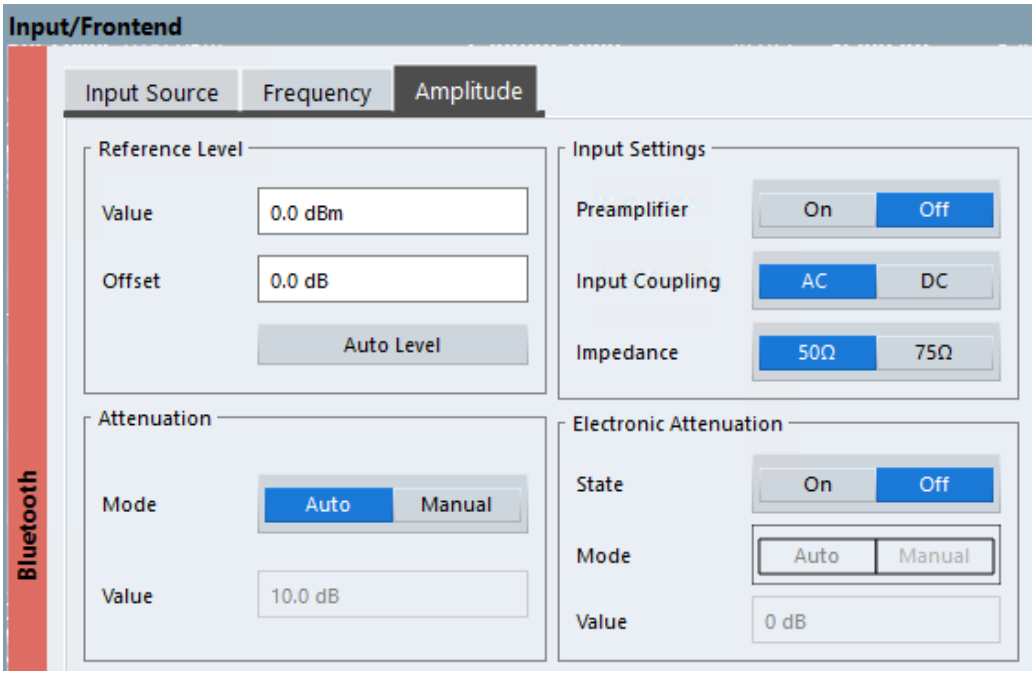
Remote command:
[SENSe:]FREQuency:OFFSet on page 128

5.3.4 Amplitude settings

Access: "Overview" > "Amplitude"

Or: "Input & Output" > "Amplitude"

Amplitude settings affect the signal power or error levels.



Reference Level

Defines the expected maximum reference level. Signal levels above this value are possibly not measured correctly. Signals above the reference level are indicated by an "IF Overload" status display.

The reference level can also be used to scale power diagrams; the reference level is then used for the calculation of the maximum on the y-axis.

Since the hardware of the connected instrument is adapted according to this value, it is recommended that you set the reference level close above the expected maximum signal level. Thus you ensure an optimal measurement (no compression, good signal-to-noise ratio).

Remote command:

`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RLEVel<ant>` on page 119

Shifting the Display (Offset) ← Reference Level
Defines an arithmetic level offset. This offset is added to the measured level. In some result displays, the scaling of the y-axis is changed accordingly.

Define an offset if the signal is attenuated or amplified before it is fed into the R&S VSE so the application shows correct power results. All displayed power level results are shifted by this value.

The setting range is ±200 dB in 0.01 dB steps.

Note, however, that the *internal* reference level (used to adjust the hardware settings to the expected signal) ignores any "Reference Level Offset". Thus, it is important to keep in mind the actual power level the R&S VSE must handle. Do not rely on the displayed reference level (internal reference level = displayed reference level - offset).

Remote command:
`DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RLEVel<ant>:OFFSet` on page 120

Setting the Reference Level Automatically (Auto Level)
The connected instrument automatically determines the optimal reference level for the current input data. At the same time, the internal attenuators and the preamplifier are adjusted so the signal-to-noise ratio is optimized, while signal compression, clipping and overload conditions are minimized. This function is not available on all supported instruments.

Remote command:
`[SENSe:]ADJust:LEVel` on page 145

Input Settings
Some input settings affect the measured amplitude of the signal, as well.

For information on other input settings, see Chapter 5.3, "Input and frontend settings", on page 44

Preamplifier ← Input Settings
If the (optional) internal preamplifier hardware is installed on the connected instrument, a preamplifier can be activated for the RF input signal.

Note: If an optional external preamplifier is activated, the internal preamplifier is automatically disabled, and vice versa.

"Off"	Deactivates the preamplifier.
"15 dB"	The RF input signal is amplified by about 15 dB.
"30 dB"	The RF input signal is amplified by about 30 dB.

Depending on the connected instrument, different settings are available. See the instrument's documentation for details.

Remote command:
`INPut<ip>:GAIN<ant>:STATe` on page 121
`INPut<ip>:GAIN<ant>[:VALue]` on page 122

Input Coupling ← Input Settings
The RF input of the R&S VSE can be coupled by alternating current (AC) or direct current (DC).

The RF input of the connected instrument can be coupled by alternating current (AC) or direct current (DC).

AC coupling blocks any DC voltage from the input signal. AC coupling is activated by default to prevent damage to the instrument. Very low frequencies in the input signal can be distorted.

However, some specifications require DC coupling. In this case, you must protect the instrument from damaging DC input voltages manually. For details, refer to the data sheet.

Remote command:
`INPut<ip>:COUPling<ant>` on page 109

Impedance ← Input Settings
For some measurements, the reference impedance for the measured levels of the connected instrument can be set to 50 Ω or 75 Ω.

Select 75 Ω if the 50 Ω input impedance is transformed to a higher impedance using a 75 Ω adapter of the RAZ type. (That corresponds to 25Ω in series to the input impedance of the instrument.) The correction value in this case is 1.76 dB = 10 log (75Ω/50Ω).

Remote command:
`INPut<ip>:IMPedance<ant>` on page 111

RF Attenuation
Defines the mechanical attenuation for RF input.

This function is not available for input from the optional "Digital Baseband" interface.

Attenuation Mode / Value ← RF Attenuation
Defines the attenuation applied to the RF input of the R&S VSE.

The RF attenuation can be set automatically as a function of the selected reference level (Auto mode). Automatic attenuation ensures that no overload occurs at the RF Input connector for the current reference level. It is the default setting.

In "Manual" mode, you can set the RF attenuation in 1 dB steps (down to 0 dB). Other entries are rounded to the next integer value. The range is specified in the data sheet. If the defined reference level cannot be set for the defined RF attenuation, the reference level is adjusted accordingly and the warning "limit reached" is displayed.

NOTICE! Risk of hardware damage due to high power levels. When decreasing the attenuation manually, ensure that the power level does not exceed the maximum level allowed at the RF input, as an overload can lead to hardware damage.

Remote command:
`INPut:ATTenuation` on page 122
`INPut:ATTenuation:AUTO` on page 122

Optimization ← RF Attenuation
Selects the priority for signal processing *after* the RF attenuation has been applied.

This function is only available for specific instrument hardware.

"Low distortion"
(Default:) Optimized for low distortion by avoiding intermodulation

"Low noise" Optimized for high sensitivity and low noise levels
If this setting is selected, "Low noise" is indicated in the channel information bar.

Remote command:
INPut:ATTenuation:AUTO:MODE on page 120

Using Electronic Attenuation
If the (optional) Electronic Attenuation hardware is installed on the connected instrument, you can also activate an electronic attenuator.

In "Auto" mode, the settings are defined automatically; in "Manual" mode, you can define the mechanical and electronic attenuation separately.

Note: Note that restrictions can apply concerning which frequencies electronic attenuation is available for, depending on which instrument is connected to the R&S VSE software. Check your instrument documentation for details.
In "Auto" mode, RF attenuation is provided by the electronic attenuator as much as possible to reduce the amount of mechanical switching required. Mechanical attenuation can provide a better signal-to-noise ratio, however.

When you switch off electronic attenuation, the RF attenuation is automatically set to the same mode (auto/manual) as the electronic attenuation was set to. Thus, the RF attenuation can be set to automatic mode, and the full attenuation is provided by the mechanical attenuator, if possible.

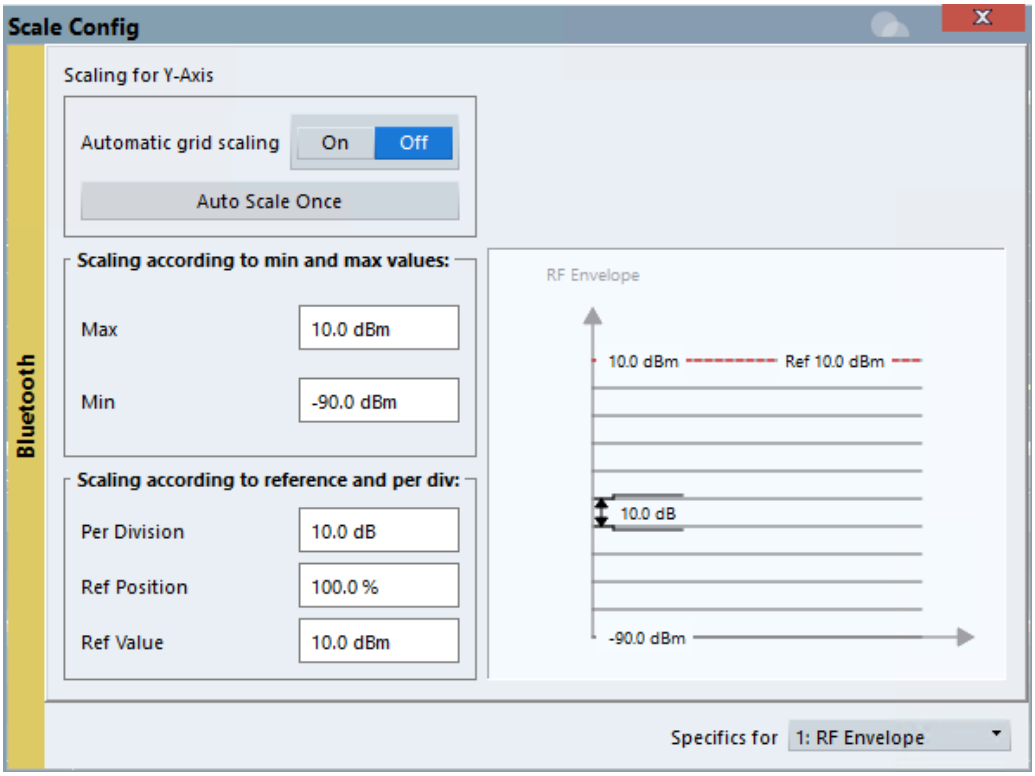
If the defined reference level cannot be set for the given attenuation, the reference level is adjusted accordingly and the warning "limit reached" is displayed in the status bar.

Remote command:
INPut:EATT:STATe on page 123
INPut:EATT:AUTO on page 123
INPut:EATT on page 123

5.3.5 Y-Axis scaling

Access: [AMPT] > "Scale Config"

The scaling for the vertical axis in (most) graphical displays is highly configurable, using either absolute or relative values. These settings are described here.



Automatic Grid Scaling
The y-axis is scaled automatically according to the current measurement settings and results.

Remote command:
`DISPlay[:WINDow<n>][:SUBWindow<n>]:TRACe<t>:Y[:SCALe]:AUTO`
on page 124

Auto Scale Once
Automatically determines the optimal range and reference level position to be displayed for the current measurement settings.

The display is only set once; it is not adapted further if the measurement settings are changed again.

This function is only available for RF measurements.

Remote command:
`DISPlay[:WINDow<n>][:SUBWindow<n>]:TRACe<t>:Y[:SCALe]:AUTO`
on page 124

Absolute Scaling (Min/Max Values)
Define the scaling using absolute minimum and maximum values.

Remote command:
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MAXimum on page 126
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MINimum on page 126

Relative Scaling (Reference/ per Division)
Define the scaling relative to a reference value, with a specified value range per division.

Per Division ← Relative Scaling (Reference/ per Division)
Defines the value range to be displayed per division of the diagram (1/10 of total range).

Note: The value defined per division refers to the default display of 10 divisions on the y-axis. If fewer divisions are displayed (e.g. because the window is reduced in height), the range per division is increased in order to display the same result range in the smaller window. In this case, the per division value does not correspond to the actual display.

Remote command:
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:PDIVision on page 125

Ref Position ← Relative Scaling (Reference/ per Division)
Defines the position of the reference value in percent of the total y-axis range.

Remote command:
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RPOSition on page 125

Ref Value ← Relative Scaling (Reference/ per Division)
Defines the reference value to be displayed at the specified reference position.

Remote command:
DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RVALue on page 125

5.4 Modulation Characteristics measurement settings

Access: "Overview" > "Select Measurement" > "Modulation Characteristics"

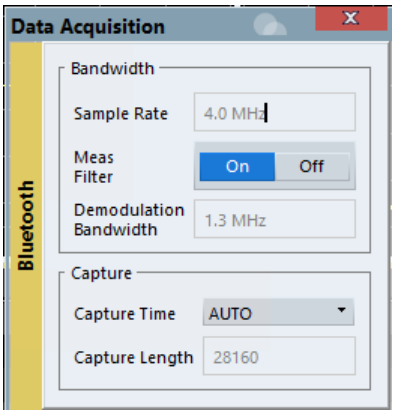
Or: "Meas Setup" > "Meas Mode" > "Modulation Characteristics"

5.4.1 Data acquisition

Access: "Overview" > "Data Acquisition"

Or: "Meas Setup" > "Data Acquisition"

The data acquisition settings define how much and how data is captured from the input signal.



Sample rate
The sample rate in MHz. For Bluetooth BR/EDR/LE measurements, the sample rate is always 4 MHz.

Meas Filter
Enables or disables the use of an optional measurement filter. See Chapter 3.2.1, "Measurement filter", on page 29.

Remote command:
`CONFigure:BTOoth:MEASurement:FILTer` on page 140

Demodulation Bandwidth
Indicates the used demodulation bandwidth, depending on whether or not a measurement filter is used. (For reference only).

If the measurement filter is used, the demodulation bandwidth is 1.3 MHz. Otherwise, it is 3 MHz.

Remote command:
`CONFigure:BTOoth:MEASurement:BWIDth?` on page 140

Capture Time
Defines the packet type used in the Bluetooth BR/EDR/LE signal and thus the required capture time.

The Bluetooth BR/EDR/LE specification defines fixed packet lengths for the basic rate and EDR operating modes (see Chapter 3.1.1, "Bluetooth packet types for BR/EDR", on page 12). For low energy mode, the packet lengths vary depending on the length of the payload.

"DH1"	Captures one slot
"DH3"	Captures 3 slots
"DH5"	Captures 5 slots
"AUTO"	For BR + EDR: Captures 5 slots
"LE 1M" / "LE 2M" / "LE CODED"	For LE, the R&S VSE Bluetooth measurement application determines the required capture time to cover the payload automatically.

Remote command:
`CONFigure:BTOoth:PTYPe` on page 141

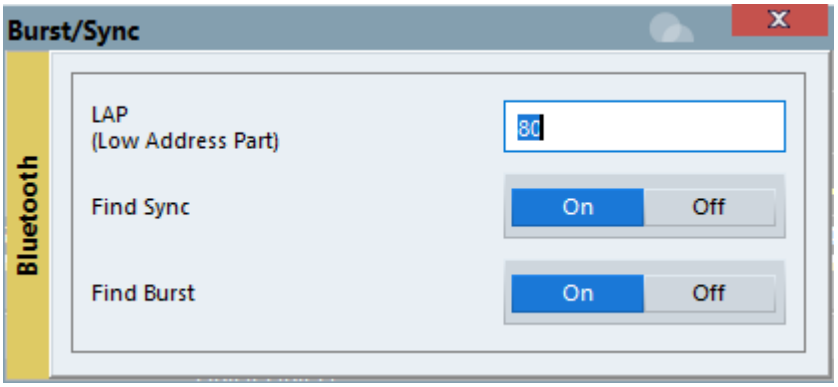
Capture Length
Number of samples captured during one sweep. Indicated for reference only, calculated as Capture Time*Sample rate.

5.4.2 Burst and synchronization settings

Access: "Overview" > "Burst/Sync"

Or: "Meas Setup" > "Burst/Sync"

The burst and synchronization settings determine how the R&S VSE Bluetooth measurement application tries to find the sync word in the signal and synchronize to it.



LAP (Low Address Part)
The lower address part of the Bluetooth device address (LAP, the 24 least significant bits) determines the sync word used for sync search. See "Synchronization" on page 28.

Not available for LE signals.

Remote command:
[SENSe:]DDEMod:SEARch:SYNC:LAP on page 195

Find Sync
Enables or disables the search for the sync word. The only results that can be determined without synchronization are the output power results. See "Synchronization" on page 28.

Remote command:
[SENSe:]DDEMod:SEARch:SYNC:STATe on page 195

Find Burst
Enables or disables the search for a signal burst based on the measured power. If both Find Sync and "Find Burst" are enabled, the search area for the sync word is limited to the detected burst.

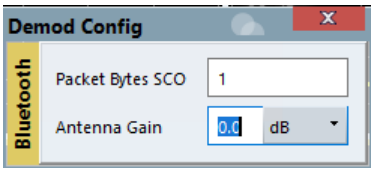
Remote command:
[SENSe:]DDEMod:SEARch:PULSe:STATe on page 194

5.4.3 Demodulation settings

Access: "Overview" > "Demodulation"

Or: "Meas Setup" > "Demod"

The demodulation settings contain the settings required to demodulate the signal.



Packet Bytes SCO
Defines the number of payload bytes for SCO packets. SCO packets do not have a payload header.

Remote command:
CONFigure:BTOoth:PBSCo on page 142

Antenna Gain
Defines an external gain that the R&S VSE Bluetooth measurement application considers for the measurement results.

The value depends on the used standard. See also Chapter 6.2.1, "Measurement settings depending on standard", on page 78.

Remote command:
[SENSe:]CORRection:EGAin:INPut[:MAGNitude] on page 142

5.5 In-band Spurious Emissions measurement settings

Access: "Overview" > "Select Measurement" > "ACP / In-band Spurious Emissions"

Or: "Meas Setup" > "Meas Mode" > "ACP / In-band Spurious Emissions"

5.5.1 Selecting the transmit channel

Access: [MEAS CONFIG] > "TX Channel"

All measurement results are based on the transmit (TX) channel. You can define the TX channel either manually, or according to the channel power levels.

TX Channel No
Allows you to select the transmit channel within the Bluetooth signal manually. Measurement results are based on this channel.

The currently selected transmit channel is highlighted blue in the result summary table and the diagrams, see Chapter 4.2, "Result displays for In-band Spurious Emissions measurements", on page 37.

You can step through the individual channels using the rotary knob or arrow keys.

Remote command:
`CONFigure:BTOoth:CHANnel` on page 143

TX Channel
Selects the transmit channel within the Bluetooth signal based on its position in the band.

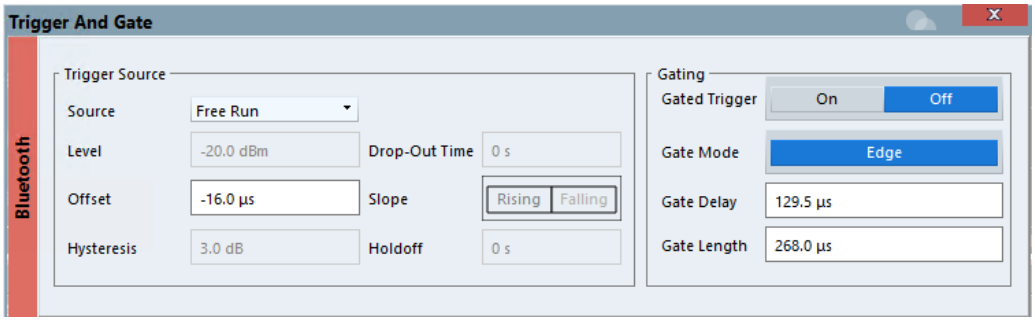
Select the softkey multiple times to toggle through the settings. The current setting is highlighted.

"Low"	Selects the channel 0.
"Mid"	Selects the channel in the middle of the band (depending on the standard).
"High"	Selects the channel with the highest channel number (depending on the standard).
"Manual"	Selects the channel specified manually by "TX Channel No" on page 62.

Remote command:
Not available, use `CONFigure:BTOoth:CHANnel` on page 143

5.6 Trigger and gate settings

Access: "Overview" > "Trigger/Gate"



Trigger output is described in the R&S VSE base software user manual.

External triggers from one of the TRIGGER INPUT / OUTPUT connectors on the R&S VSE are configured in a separate tab of the dialog box.

Trigger Source
Selects the trigger source. If a trigger source other than "Free Run" is set, "TRG" is displayed in the channel bar and the trigger source is indicated.

Note that the availability of trigger sources depends on the connected instrument.

Remote command:
`TRIGger[:SEQuence]:SOURce` on page 131

Free Run ← Trigger Source
No trigger source is considered. Data acquisition is started manually or automatically and continues until stopped explicitly.

Remote command:
`TRIG:SOUR IMM`, see `TRIGger[:SEQuence]:SOURce` on page 131

External Trigger / Trigger Channel X ← Trigger Source
Data acquisition starts when the signal fed into the specified input connector or input channel of the connected instrument meets or exceeds the specified trigger level.

Note: Which input and output connectors are available depends on the connected instrument. For details, see the instrument's documentation.

For a connected R&S oscilloscope, the following signals are used as trigger input:

- "External Trigger": EXT TRIGGER INPUT connector on rear panel of instrument
- "Trigger Channel 2"/"Trigger Channel 3"/"Trigger Channel 4": Input at channel connectors CH 2/3/4 on front panel of instrument - if not used as an input source

Remote command:
`TRIG:SOUR EXT`, `TRIG:SOUR EXT2`, `TRIG:SOUR EXT3`, `TRIG:SOUR EXT4`
See `TRIGger[:SEQuence]:SOURce` on page 131

Magnitude (Offline) ← Trigger Source
For (offline) input from a file, rather than an instrument. Triggers on a specified signal level.

Remote command:
`TRIG:SOUR MAGN`, see `TRIGger[:SEQuence]:SOURce` on page 131

Manual ← Trigger Source
Only available for a connected R&S RTP:

Any trigger settings in the R&S VSE software are ignored; only trigger settings defined on the connected instrument are considered. Thus, you can make use of the more complex trigger settings available on an R&S RTP.

Remote command:
`TRIG:SOUR MAN`, see `TRIGger[:SEQuence]:SOURce` on page 131

Trigger Level
Defines the trigger level for the specified trigger source.

For details on supported trigger levels, see the instrument data sheet.

Remote command:
`TRIGger[:SEQuence]:LEVel[:EXTernal<port>]` on page 130

Drop-Out Time
Defines the time that the input signal must stay below the trigger level before triggering again.

Remote command:
`TRIGger[:SEQuence]:DTIMe` on page 128

Trigger Offset
Defines the time offset between the trigger event and the start of the sweep.

Offset > 0:	Start of the sweep is delayed
Offset < 0:	Sweep starts earlier (pretrigger)

(If supported by the connected instrument.)

Remote command:
`TRIGger[:SEQuence]:HOLDoff[:TIME]` on page 129

Hysteresis
Defines the distance in dB to the trigger level that the trigger source must exceed before a trigger event occurs. Setting a hysteresis avoids unwanted trigger events caused by noise oscillation around the trigger level.

This setting is only available for "IF Power" or "Magnitude (Offline)" trigger sources.

Remote command:
`TRIGger[:SEQuence]:IFPower:HYSTeresis` on page 129
`TRIGger[:SEQuence]:MAPower:HYSTeresis` on page 131

Trigger Holdoff
Defines the minimum time (in seconds) that must pass between two trigger events. Trigger events that occur during the holdoff time are ignored.

Remote command:
`TRIGger[:SEQuence]:IFPower:HOLDoff` on page 129
`TRIGger[:SEQuence]:MAPower:HOLDoff` on page 131

Slope
For all trigger sources except time, you can define whether triggering occurs when the signal rises to the trigger level or falls down to it.

For gated measurements in "Edge" mode, the slope also defines whether the gate starts on a falling or rising edge.

Remote command:
`TRIGger[:SEQuence]:SLOPe` on page 131

Gated Trigger
Switches gated triggering on or off.

If the gate is switched on, an (offline) magnitude or a time trigger controls the gates for the sweep.

Remote command:
`[SENSe:]SWEep:EGATe` on page 135

Gate Mode
Sets the gate mode.

The R&S VSE R&S VSE Bluetooth measurement application supports gating in edge mode only. After the gate signal has been detected, the gate remains open until the gate length is over.

Gate Delay
Defines the delay time between the gate signal and the continuation of the measurement.

Remote command:
`[SENSe:]SWEep:EGATe:HOLDoff` on page 137

Gate Length
Defines how long the gate is open when it is triggered.

Remote command:
[SENSe:]SWEep:EGATe:LENGth on page 137

6 Analysis

Access: "Overview" > "Analysis"

6.1 Analyzing modulation characteristics

Access: "Overview" > "Select Measurement" > "Modulation Characteristics"

Or: "Meas Setup" > "Meas Mode" > "Modulation Characteristics"

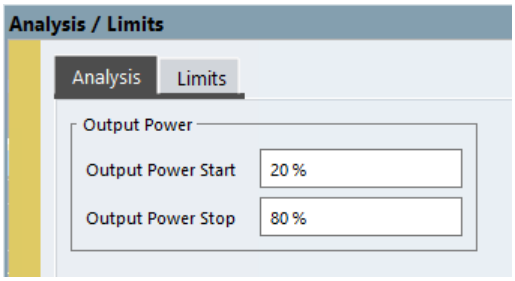
6.1.1 BR and LE signals

6.1.1.1 Power range for analysis

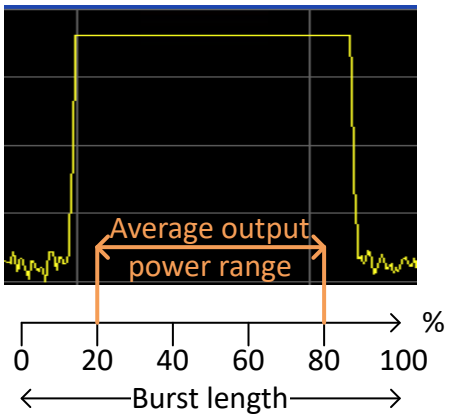
Access: "Overview" > "Analysis / Limits"

Or: "Meas Setup" > "Analysis / Limits"

The core specification of Bluetooth wireless technology defines the limits of output power levels for the maximum power. The maximum power is determined by a percentage of the power range, which corresponds to the burst length.



Output Power Start / Output Power Stop
Start and stop positions of the power range in which the average maximum power is determined. Defined as percentages of the burst length. See also "Output power" on page 12.



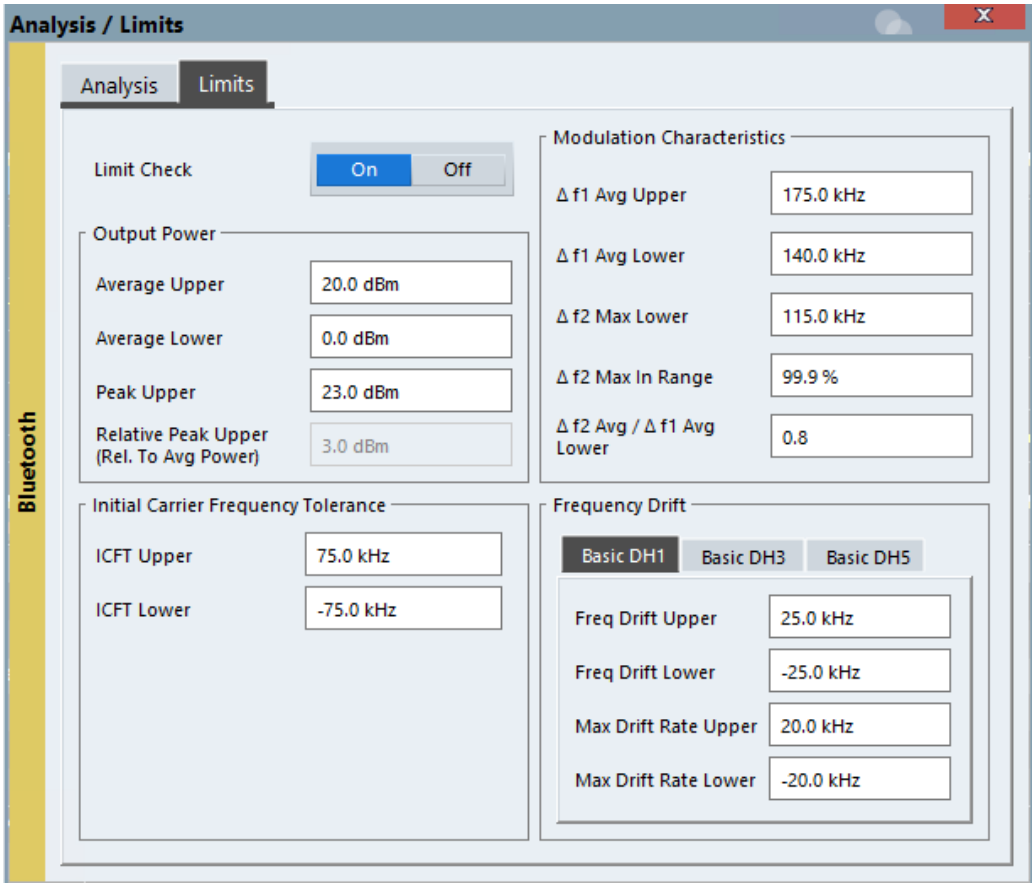
Remote command:
`CONFigure:BTOoth:POWer:AVERage:STARt` on page 145
`CONFigure:BTOoth:POWer:AVERage:STOP` on page 146

6.1.1.2 Checking limits (BR)

Access: "Overview" > "Analysis / Limits" > "Limits"

Or: "Meas Setup" > "Analysis / Limits" > "Limits"

By default, the measured Bluetooth signal characteristics are checked against the limits defined in the specification. However, you can define your own limits to check the results against.



Limit Check
Enables or disables a limit check for the measured results.

Remote command:
`CALCulate<n>:LIMit:TRACe<t>:CHECk` on page 146

Average Upper/ Average Lower
Defines the upper/lower limit for the average output power.

Remote command:
CONFigure:BTOoth:POWer:AVERage:ULIMit on page 154
CONFigure:BTOoth:POWer:AVERage:LLIMit on page 154

Peak Upper
Defines the upper limit for the peak output power.

Remote command:
CONFigure:BTOoth:POWer:PEAK:ULIMit on page 155

Relative Peak Upper (Rel. to Avg Power)
Indicates the (calculated) limit for the peak output power relative to the average output power.

Remote command:
CONFigure:BTOoth:POWer:PEAK:RLIMit on page 154

ICFT Upper / ICFT Lower
Defines the upper/lower limit for the initial carrier frequency tolerance (ICFT) in BR signals.

Remote command:
CONFigure:BTOoth:ICFTolerance:ULIMit on page 150
CONFigure:BTOoth:ICFTolerance:LLIMit on page 150

Δf1 Avg Upper / Δf1 Avg Lower
Defines the upper/lower limit for the average frequency offset for the first test sequence (00001111).

Remote command:
CONFigure:BTOoth:MODulation:F1AVerage:ULIMit on page 152
CONFigure:BTOoth:MODulation:F1AVerage:LLIMit on page 152

Δf2 Max Lower
Defines the lower limit for the maximum frequency offset for the second test sequence (01010101).

Remote command:
CONFigure:BTOoth:MODulation:F2Max:LLIMit on page 153

Δf2 Max In Range
Percentage of the maximum frequency offset measurements that remained within the valid range (did not exceed the limits)

Remote command:
CONFigure:BTOoth:MODulation:F2Max:IRANge on page 153

Δf2 Avg / Δf1 Avg Lower
Defines the lower limit for the ratio of average f2 offset to average f1 offset (not available for LE Coded).

Remote command:
CONFigure:BTOoth:MODulation:FDIVision:LLIMit on page 153

Frequency Drift
The frequency drift limits are defined individually for each packet type.

Freq Drift Upper / Freq Drift Lower ← Frequency Drift
Defines the upper/lower limit for the frequency drift.

Remote command:
BR:
`CONFigure:BTOoth:DH<pt>:FDRift:ULIMit` on page 147
`CONFigure:BTOoth:DH<pt>:FDRift:LLIMit` on page 147
LE:
`CONFigure:BTOoth:FDRift:ULIMit` on page 149
`CONFigure:BTOoth:FDRift:LLIMit` on page 148

Max Drift Rate Upper / Max Drift Rate Lower ← Frequency Drift
Defines the upper/lower limit for the maximum frequency drift per packet.

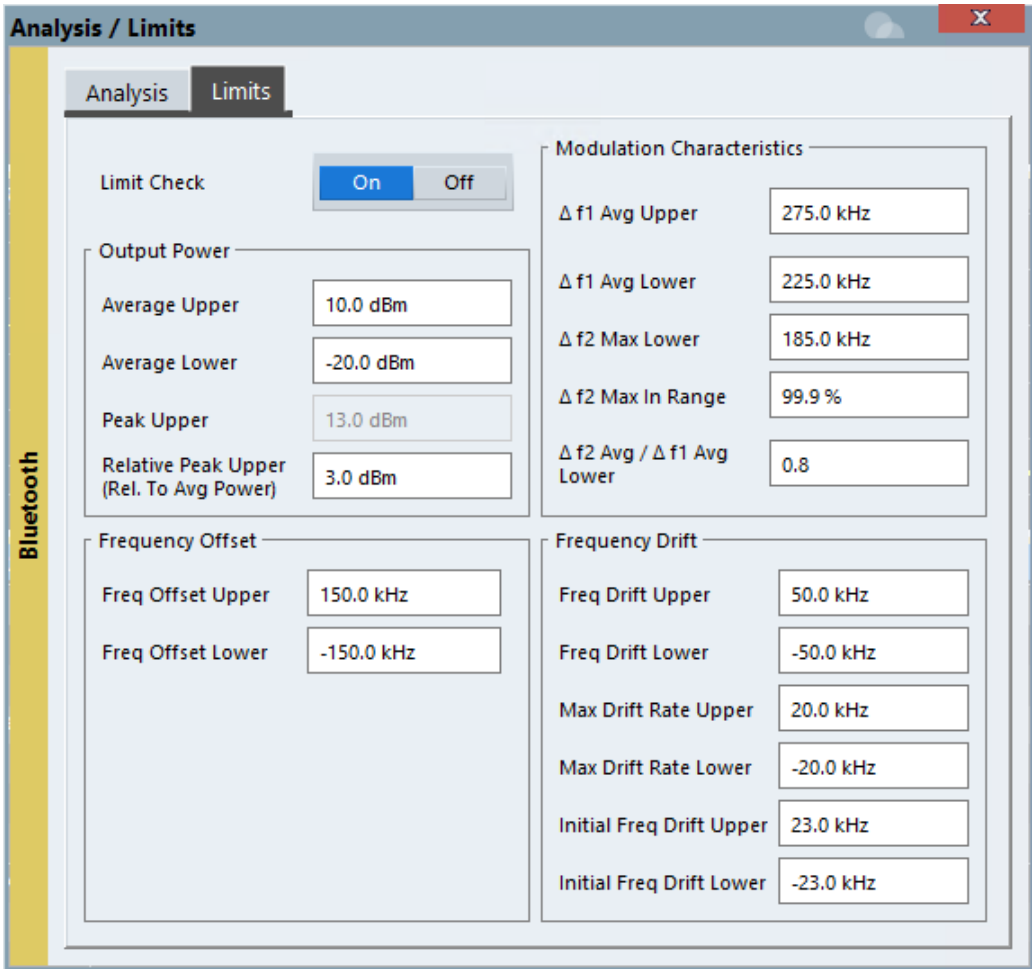
Remote command:
BR:
`CONFigure:BTOoth:DH<pt>:MDRate:ULIMit` on page 148
`CONFigure:BTOoth:DH<pt>:MDRate:LLIMit` on page 148
LE:
`CONFigure:BTOoth:MDRate:ULIMit` on page 151
`CONFigure:BTOoth:MDRate:LLIMit` on page 151

6.1.1.3 Checking limits (LE)

Access: "Overview" > "Analysis / Limits" > "Limits"

Or: "Meas Setup" > "Analysis / Limits" > "Limits"

By default, the measured Bluetooth signal characteristics are checked against the limits defined in the specification. However, you can define your own limits to check the results against. Note that the limits differ depending on the used transmission mode (PHY).



Limit Check
Enables or disables a limit check for the measured results.

Remote command:
`CALCulate<n>:LIMit:TRACe<t>:CHECk` on page 146

Average Upper/ Average Lower
Defines the upper/lower limit for the average output power.

Remote command:
CONFigure:BTOoth:POWer:AVERage:ULIMit on page 154
CONFigure:BTOoth:POWer:AVERage:LLIMit on page 154

Peak Upper
Defines the upper limit for the peak output power.

Remote command:
CONFigure:BTOoth:POWer:PEAK:ULIMit on page 155

Relative Peak Upper (Rel. to Avg Power)
Indicates the (calculated) limit for the peak output power relative to the average output power.

Remote command:
CONFigure:BTOoth:POWer:PEAK:RLIMit on page 154

Freq Offset Upper / Lower
Defines the upper/lower limit for the frequency offset.

Remote command:
CONFigure:BTOoth:FOFFset:ULIMit on page 149
CONFigure:BTOoth:FOFFset:LLIMit on page 149

Δf1 Avg Upper / Δf1 Avg Lower
Defines the upper/lower limit for the average frequency offset for the first test sequence (00001111).

Remote command:
CONFigure:BTOoth:MODulation:F1AVerage:ULIMit on page 152
CONFigure:BTOoth:MODulation:F1AVerage:LLIMit on page 152

Δf2 Max Lower
Defines the lower limit for the maximum frequency offset for the second test sequence (01010101).

Remote command:
CONFigure:BTOoth:MODulation:F2Max:LLIMit on page 153

Δf1 Max Lower (LE Coded)
Defines the lower limit for the maximum frequency offset for the first test sequence (for LE Coded).

Remote command:
CONFigure:BTOoth:MODulation:F1Max:LLIMit on page 153

Δf2 Max In Range
Percentage of the maximum frequency offset measurements that remained within the valid range (did not exceed the limits)

Remote command:
CONFigure:BTOoth:MODulation:F2Max:IRANge on page 153

Δf1 Max In Range (LE Coded)
Percentage of the maximum frequency offset measurements that remained within the valid range (did not exceed the limits) for LE Coded.

Remote command:
CONFigure:BTOoth:MODulation:F1Max:IRANge on page 152

Δf2 Avg / Δf1 Avg Lower
Defines the lower limit for the ratio of average f2 offset to average f1 offset (not available for LE Coded).

Remote command:
CONFigure:BTOoth:MODulation:FDIVision:LLIMit on page 153

Frequency Drift
The frequency drift limits are defined individually for each packet type.

Freq Drift Upper / Freq Drift Lower ← Frequency Drift
Defines the upper/lower limit for the frequency drift.

Remote command:
BR:
CONFigure:BTOoth:DH<pt>:FDRift:ULIMit on page 147
CONFigure:BTOoth:DH<pt>:FDRift:LLIMit on page 147
LE:
CONFigure:BTOoth:FDRift:ULIMit on page 149
CONFigure:BTOoth:FDRift:LLIMit on page 148

Max Drift Rate Upper / Max Drift Rate Lower ← Frequency Drift
Defines the upper/lower limit for the maximum frequency drift per packet.

Remote command:
BR:
CONFigure:BTOoth:DH<pt>:MDRate:ULIMit on page 148
CONFigure:BTOoth:DH<pt>:MDRate:LLIMit on page 148
LE:
CONFigure:BTOoth:MDRate:ULIMit on page 151
CONFigure:BTOoth:MDRate:LLIMit on page 151

Initial Freq Drift Upper / Initial Freq Drift Lower ← Frequency Drift
Defines the upper/lower limit for the initial frequency drift.

Remote command:
CONFigure:BTOoth:IFDRift:ULIMit on page 151
CONFigure:BTOoth:IFDRift:LLIMit on page 150

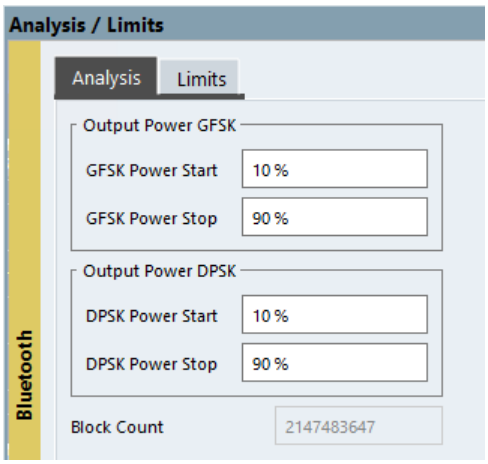
6.1.2 EDR signals

6.1.2.1 Evaluation range

Access: "Overview" > "Analysis / Limits"

Or: "Meas Setup" > "Analysis / Limits"

For EDR signals, the relative transmit power is measured. It is calculated as the ratio of the average transmission power of the GFSK and DPSK-modulated parts of the signal. (GFSK stands for Gaussian Frequency Shift Keying, while DPSK stands for Differential Phase Shift Keying.) To determine the transmit power values, you must configure the percentage of the measurement time in which the corresponding modulation type is used.



GFSK Power Start / GFSK Power Stop
Defines the percentage of the total measurement time at which the power measurement of the GFSK-modulated part of the signal starts and stops.

Remote command:
`CONFigure:BTOoth:RTPower:GAVerage:STARt` on page 156
`CONFigure:BTOoth:RTPower:GAVerage:STOP` on page 156

DPSK Power Start / DPSK Power Stop
Defines the percentage of the total measurement time at which the power measurement of the DPSK-modulated part of the signal starts and stops.

Remote command:
`CONFigure:BTOoth:RTPower:DAVerage:STARt` on page 155
`CONFigure:BTOoth:RTPower:DAVerage:STOP` on page 156

Block Count
Defines the number of blocks to be measured for the carrier frequency stability. (See "Carrier frequency stability" on page 28.)

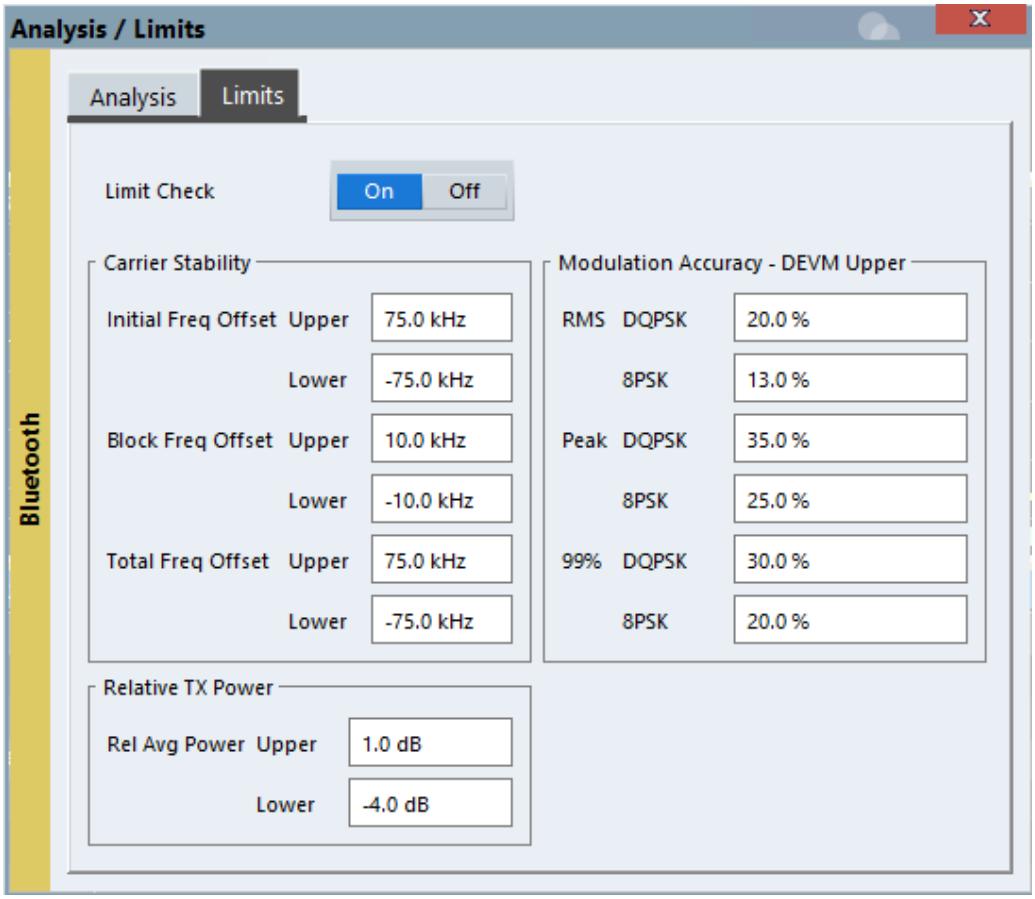
Remote command:
`CONFigure:BTOoth:CFSTability:BCOunt` on page 155

6.1.2.2 Checking limits (EDR)

Access: "Overview" > "Analysis / Limits" > "Limits"

Or: "Meas Setup" > "Analysis / Limits" > "Limits"

By default, the measured Bluetooth signal characteristics are checked against the limits defined in the specification. However, you can define your own limits to check the results against.



Limit Check
Enables or disables a limit check for the measured results.

Remote command:
CALCulate<n>:LIMit:TRACe<t>:CHECk on page 146

Carrier Stability
The carrier stability measurement verifies that the modulation accuracy and the frequency stability are within the required limits.

Initial Freq Offset Upper / Lower ← Carrier Stability
Defines the upper/lower limit of the initial frequency offset.

Remote command:
CONFigure:BTOoth:CFSTability:IFRequency:ULIMit on page 158
CONFigure:BTOoth:CFSTability:IFRequency:LLIMit on page 158

Block Freq Offset Upper / Lower ← Carrier Stability
Defines the upper/lower limit of the block frequency offset.

Remote command:
CONFigure:BTOoth:CFSTability:BFRequency:ULIMit on page 157
CONFigure:BTOoth:CFSTability:BFRequency:LLIMit on page 157

Total Freq Offset Upper / Lower ← Carrier Stability
Defines the upper/lower limit of the total frequency offset.

Remote command:
CONFigure:BTOoth:CFSTability:TFRequency:ULIMit on page 158
CONFigure:BTOoth:CFSTability:TFRequency:LLIMit on page 158

Modulation Accuracy - DEVM Upper
Differential error vector magnitude

RMS DQPSK / 8PSK ← Modulation Accuracy - DEVM Upper
Defines the upper limit for the RMS DEVM for the DQPSK-/8PSK-modulated part of the signal.

Remote command:
CONFigure:BTOoth:MODulation:RDQPsk:ULIMit on page 160
CONFigure:BTOoth:MODulation:R8PSk:ULIMit on page 160

Peak DQPSK / 8PSK ← Modulation Accuracy - DEVM Upper
Defines the upper limit for the peak DEVM for the DQPSK-/8PSK-modulated part of the signal.

Remote command:
CONFigure:BTOoth:MODulation:PDQPsk:ULIMit on page 159
CONFigure:BTOoth:MODulation:P8PSk:ULIMit on page 159

99% DQPSK / 8PSK ← Modulation Accuracy - DEVM Upper
Defines the upper limit for the 99-percentile DEVM for the DQPSK-/8PSK-modulated part of the signal.

Remote command:
CONFigure:BTOoth:MODulation:DQ99:ULIMit on page 159
CONFigure:BTOoth:MODulation:PS99:ULIMit on page 160

Rel. Avg Power Upper / Lower
Defines the upper/lower limit of the relative average TX power.

Remote command:
CONFigure:BTOoth:RTPower:ULIMit on page 161
CONFigure:BTOoth:RTPower:LLIMit on page 161

6.2 Analyzing in-band spurious emissions

Access: "Overview" > "Select Measurement" > "In-band Spurious Emissions"

Or: "Meas Setup" > "Meas Mode" > "In-band Spurious Emissions"

6.2.1 Measurement settings depending on standard

Several measurement settings related to the number of channels in the Bluetooth signal differ depending on the used standard. In addition, the specifications for in-band spurious emissions measurements differ for France and the rest of the world. Thus, to check the measurement results against limits for a particular standard, you must define the geographical location to consider (see "Geography" on page 80). Table 6-1 and Table 6-2 indicate the used or allowed values for different standards. For details on the parameters, see Chapter 6.2.2, "Measurement settings", on page 79.

Table 6-1: In-band spurious emissions measurement settings depending on used standard (France)

Parameter	Used/allowed values		
	Default	**Min**	**Max**
BR/EDR			
Center frequency	2.465 GHz	device-specific	
Frequency stepsize	1 MHz	1 MHz	10 MHz
Captured no. of channels	23	3	23
Sweep count	10	1	100
Antenna gain	0 dB	0 dB	200 dB
LE			
Center frequency	2.465 GHz	device-specific	
Frequency stepsize	2 MHz	2 MHz	10 MHz

Parameter	Used/allowed values		
	Default	Min	Max
Captured no. of channels	23	3	23
Sweep count	10	1	100
Antenna gain	0 dB	0 dB	200 dB

Table 6-2: In-band spurious emissions measurement settings depending on used standard (other)

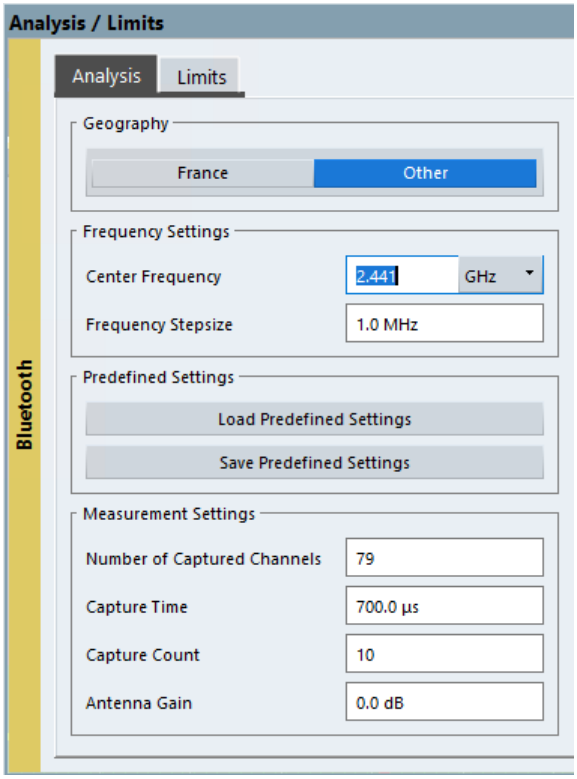
Parameter	Used/allowed values		
	Default	Min	Max
BR/EDR			
Center frequency	2.441 GHz	device-specific	
Frequency stepsize	1 MHz	1 MHz	10 MHz
Captured no. of channels	79	3	79
Sweep count	10	1	100
Antenna gain	0 dB	0 dB	200 dB
LE			
Center frequency	2.441 GHz	device-specific	
Frequency stepsize	2 MHz	2 MHz	10 MHz
Captured no. of channels	81	3	81
Sweep count	10	1	100
Antenna gain	0 dB	0 dB	200 dB

6.2.2 Measurement settings

Access: "Overview" > "Analysis"

Or: "Meas Setup" > "Analysis / Limits"

Define the measurement settings depending on the used standard.



You can save and load predefined settings for commonly used scenarios. See Chapter 6.2.3, "Saving and loading predefined settings", on page 81.

Geography
The specifications for in-band spurious emissions measurements differ for France and the rest of the world. Thus, to check the measurement results against limits for a particular standard, you must define the geographical location to consider. See also Chapter 6.2.1, "Measurement settings depending on standard", on page 78.

Remote command:
`CONFigure:BTOoth:IBSemissions:GEOGraphy` on page 164

Center Frequency
Indicates the center frequency (frequency domain) or measuring frequency (time domain).

The value depends on the used standard. See also Chapter 6.2.1, "Measurement settings depending on standard", on page 78.

Remote command:
[SENSe:]FREQuency:CENTer on page 162

Frequency Stepsize
Indicates the step size by which the center frequency is increased or decreased when the arrow keys are pressed. When you use the rotary knob, the center frequency changes in much smaller steps (1/10 the size as for the arrow keys).

The value depends on the used standard. See also Chapter 6.2.1, "Measurement settings depending on standard", on page 78.

Remote command:
[SENSe:]FREQuency:CENTer:STEP on page 162

Number of Captured Channels
Defines the number of channels that are captured by the in-band spurious emissions measurement. The number must be an odd number.

The value depends on the used standard. See also Chapter 6.2.1, "Measurement settings depending on standard", on page 78.

Remote command:
CONFigure:BTOoth:IBSemissions:NCHannels on page 164

Capture Time
Defines the required capture time.

Remote command:
[SENSe:]SWEep:TIME on page 163

Sweep Count
Defines the number of sweeps that the application uses to average traces. In continuous sweep mode, the application calculates the moving average over the average count. In single sweep mode, the application stops the measurement and calculates the average after the average count has been reached.

The value depends on the used standard. See also Chapter 6.2.1, "Measurement settings depending on standard", on page 78.

Remote command:
[SENSe:]SWEep:COUNt on page 163

Antenna Gain
Defines an external gain that the R&S VSE Bluetooth measurement application considers for the measurement results.

The value depends on the used standard. See also Chapter 6.2.1, "Measurement settings depending on standard", on page 78.

Remote command:
[SENSe:]CORRection:EGAin:INPut[:MAGNitude] on page 142

6.2.3 Saving and loading predefined settings

Access: "Analysis"

For commonly performed measurements, standard setup files are provided for quick and easy configuration. Simply load an existing standard settings file and, if necessary, adapt the measurement settings to your specific requirements. In addition, you can create your own settings files for user-specific analysis.

For details on the available files, see Chapter A, "Predefined standards and settings", on page 196.

Load Predefined Settings
Loads the selected measurement settings file.

For an overview of predefined standards and settings, see Chapter A, "Predefined standards and settings", on page 196.

Remote command:
`CONFigure:BTOoth:LOAD` on page 164

Save Predefined Settings
Saves the current measurement settings for a specific standard as a file with the defined name.

For an overview of predefined standards and settings, see Chapter A, "Predefined standards and settings", on page 196.

Remote command:
`CONFigure:BTOoth:STORe` on page 164

Selecting Storage Location - Drive/ Path/ Files
Select the storage location of the file on the software or an external drive.

The default storage location for the SEM settings files is:
`C:\ProgramData\Rohde-Schwarz\VSE\<version>\sem_std`.

File Name
Contains the name of the data file without the path or extension.

File names must be compatible with the Windows conventions for file names. In particular, they must not contain special characters such as ":", "*", "?".

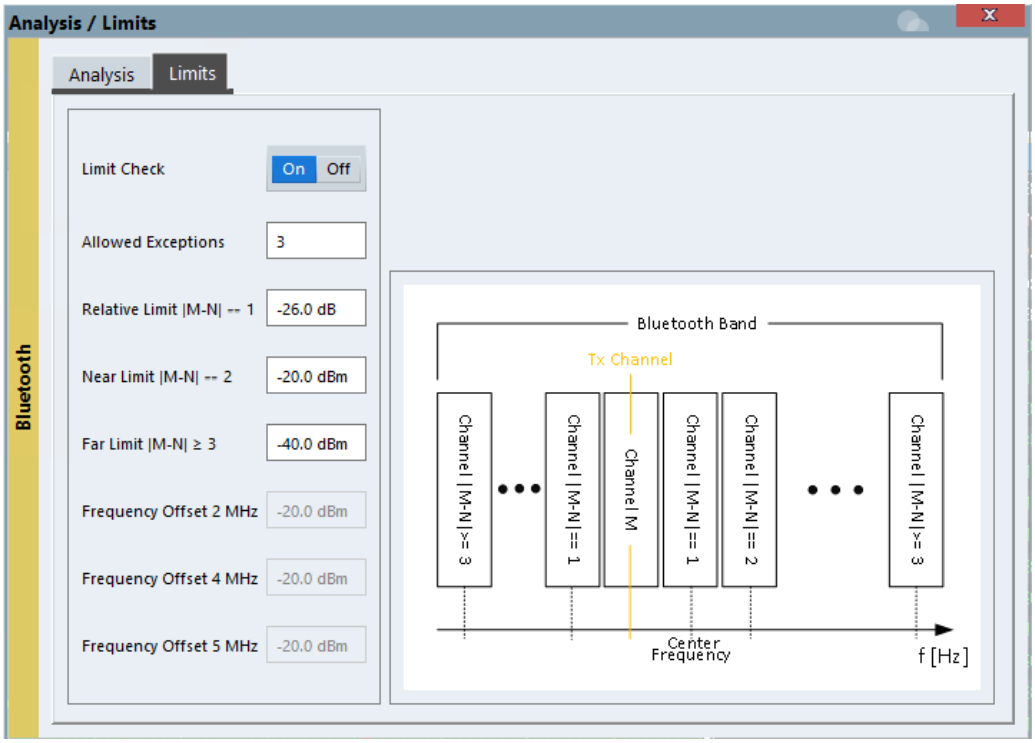
6.2.4 Checking limits

Access: "Overview" > "Limits"

Or: "Meas Setup" > "Limits" > "Limits"

The Bluetooth BR/EDR/LE standard defines the limits to check the measured channel power levels against. The limits are predefined in the R&S VSE Bluetooth measurement application according to the selected Standard. However, you can change the settings for customized evaluation. Note that not all limits are available for all standards.

All limits are defined in relation to the currently selected TX channel (see Chapter 5.5.1, "Selecting the transmit channel", on page 62).



The limit line, defined by concatenating the specified limits for the different channels, is displayed in the "ACP / In-band Spurious Emissions" on page 37.

Limit Check
Enables or disables a limit check for the measured results.

Remote command:
`CALCulate<n>:LIMit:TRACe<t>:CHECk` on page 146

Allowed Exceptions
Defines the number of acceptable exceptions for the limit check to be considered passed. Limit violations by adjacent or alternate1 channels are never allowed. If such a violation occurs, the limit check is automatically failed.

Remote command:
`CONFigure:BTOoth:IBSemissions:NFAilures` on page 166

Relative Limit
Maximum power in the adjacent channel.

Note: Limit violations by adjacent channels are never allowed (see "Allowed Exceptions" on page 83). If such a violation occurs, the limit check is automatically failed.

This setting is only available for BT EDR mode.

Remote command:
`CONFigure:BTOoth:IBSemissions:RLIMit` on page 167

Near Limit
Maximum power in the first alternate channel.

Note: Limit violations by alternate1 channels are never allowed (see "Allowed Exceptions" on page 83). If such a violation occurs, the limit check is automatically failed.

This setting is not available for BT LE mode.

Remote command:
`CONFigure:BTOoth:IBSemissions:NLIMit` on page 167

Far Limit
Maximum power in the second or further alternate channels.

Remote command:
`CONFigure:BTOoth:IBSemissions:FLIMit` on page 165

Limits for channels at frequency offsets
Defines the maximum power in channels at a specified frequency offset from the transmit frequency.

This setting is only available for BT LE mode.

"2 MHz" For LE 1M and LE coded only

"4 MHz" For LE 2M only

"5 MHz" For LE 2M only

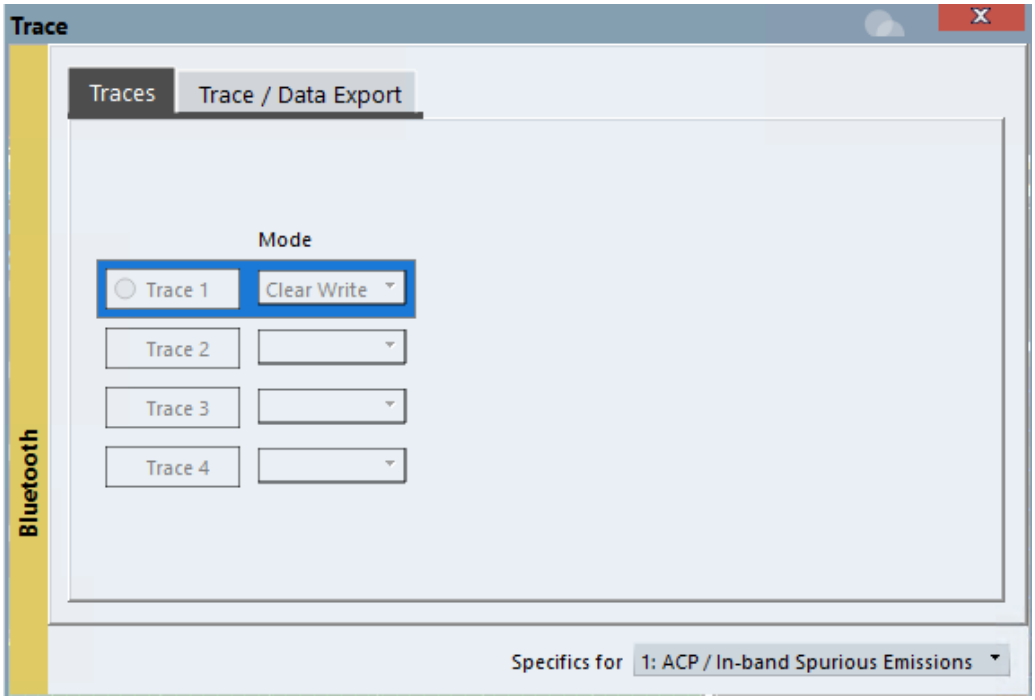
Remote command:
`CONFigure:BTOoth:IBSemissions:L2MHz` on page 165
`CONFigure:BTOoth:IBSemissions:L4MHz` on page 166
`CONFigure:BTOoth:IBSemissions:L5MHz` on page 166

6.3 Trace settings

Access: "Trace"

Currently, only a single clear/write trace is supported in each graphical display.

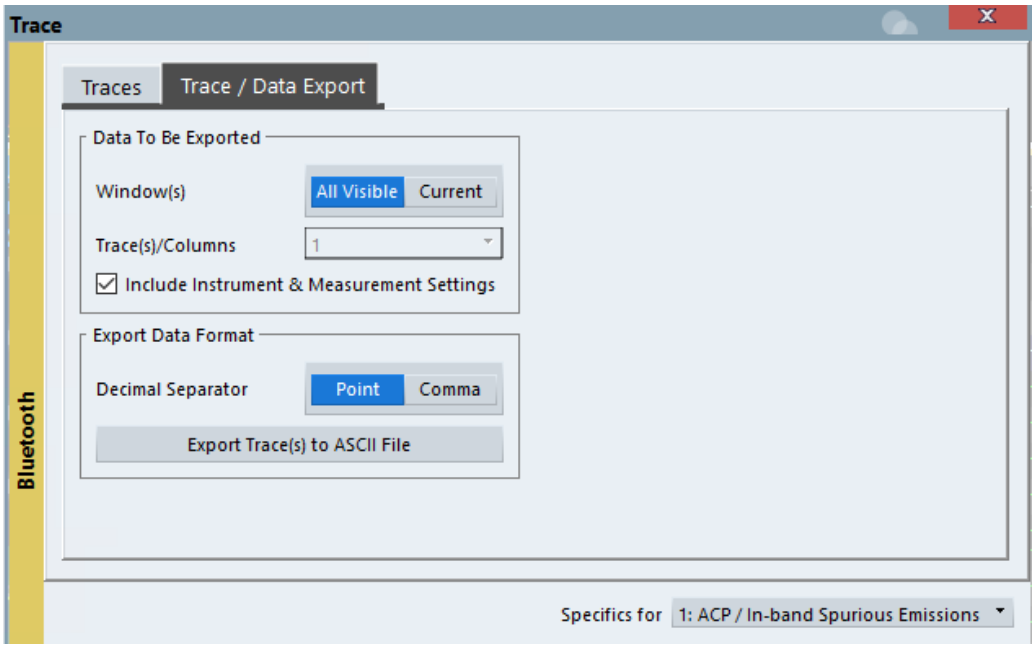
Trace data can also be exported to an ASCII file for further analysis. For details see Chapter 6.4, "Trace / data export configuration", on page 85.



6.4 Trace / data export configuration

Access: "Trace" > "Trace" > "Trace / Data Export"

The R&S VSE provides various evaluation methods for the results of the performed measurements. However, if you want to evaluate the data with other, external applications, you can export the measurement data to an ASCII file.



Selecting data to export
The "Window(s)" toggle button selects the data that you want to export.

"All Visible" exports all traces in all result displays that are currently visible.

"Current" exports the traces in the currently selected (highlighted blue) result display.

If you export data from the currently selected result display, you can also select if you want to export all traces in that result display, or a single trace only from the "Trace(s) / Columns" dropdown menu.

Remote command:
`MMEMory:STORe<n>:TRACe` on page 189

Include Instrument & Measurement Settings
Includes additional instrument and measurement settings in the header of the export file for result data.

Remote command:
`FORMat:DEXPort:HEADer` on page 189

Decimal Separator
Defines the decimal separator for floating-point numerals for the data export/import files. Evaluation programs require different separators in different languages.

Remote command:
`FORMat:DEXPort:DSEParator` on page 188

Export Trace to ASCII File
Opens a file selection dialog box and saves the selected trace in ASCII format (`.dat`) to the specified file and directory.

The results are output in the same order as they are displayed on the screen: window by window, trace by trace, and table row by table row.

Remote command:
`MMEMory:STORe<n>:TRACe` on page 189

6.5 Working with markers in the R&S VSE Bluetooth measurement application

Access: "Marker" > "Marker"

Markers help you analyze your measurement results by determining particular values in the diagram. Thus you can extract numeric values from a graphical display.

6.5.1 Marker settings

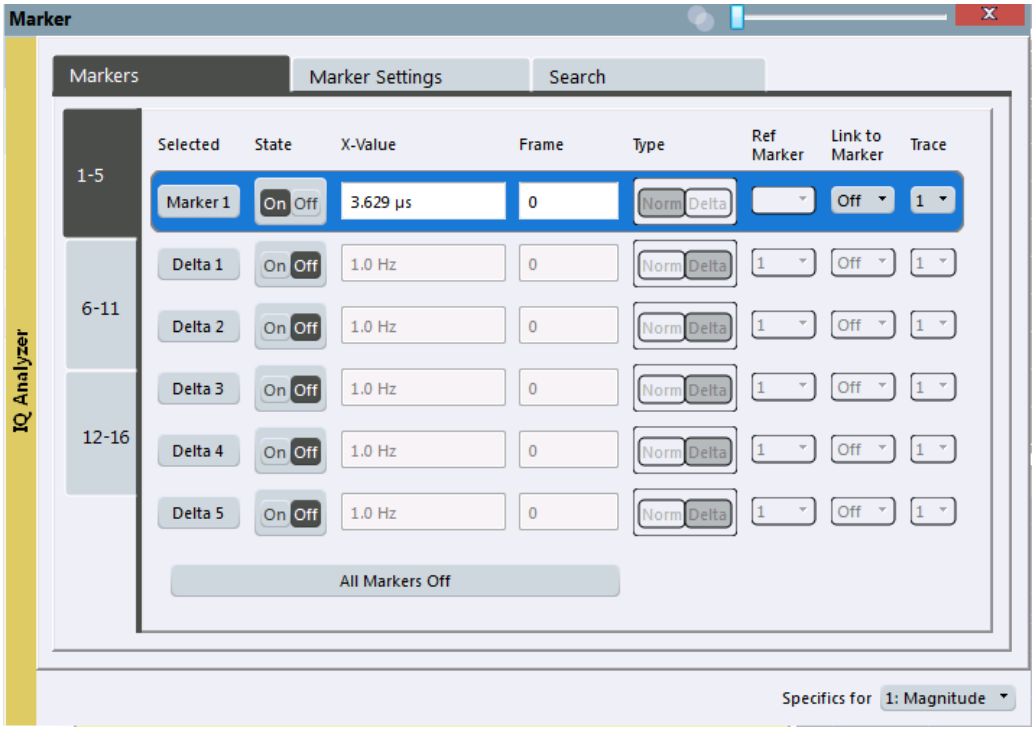
Access: "Marker" > "Marker"

The remote commands required to define these settings are described in Chapter 9.5.3, "Working with markers", on page 167.

6.5.1.1 Individual marker setup

Access: "Marker" > "Marker"

In the R&S VSE Bluetooth measurement application, up to 17 markers or delta markers can be activated for each window simultaneously.



The markers are distributed among 3 tabs for a better overview. By default, the first marker is defined as a normal marker, whereas all others are defined as delta markers with reference to the first marker. All markers are assigned to trace 1, but only the first marker is active.

Place New Marker
Activates the next currently unused marker and sets it to the peak value of the current trace in the current window.

Marker 1/ Delta Marker 1/ Delta Marker 2/ Delta Marker 16
To activate a marker, select the arrow on the marker selection list in the toolbar, or select a marker from the "Marker" > "Select Marker" menu. Enter the marker position ("X-value") in the edit dialog box.

To deactivate a marker, select the marker name in the marker selection list in the toolbar (not the arrow) to display the "Select Marker" dialog box. Change the "State" to "Off".

Marker 1 is always the default reference marker for relative measurements. If activated, markers 2 to 16 are delta markers that refer to marker 1. These markers can be converted into markers with absolute value display using the "Marker Type" function.

Remote command:
`CALCulate<n>:MARKer<m>[:STATe]` on page 169
`CALCulate<n>:MARKer<m>:X` on page 170
`CALCulate<n>:DELTamarker<m>[:STATe]` on page 173
`CALCulate<n>:DELTamarker<m>:X` on page 172

Selected Marker
Marker name. The marker which is currently selected for editing is highlighted orange.

Remote command:
Marker selected via suffix <m> in remote commands.

Marker State
Activates or deactivates the marker in the diagram.

Remote command:
`CALCulate<n>:MARKer<m>[:STATe]` on page 169
`CALCulate<n>:DELTamarker<m>[:STATe]` on page 173

Marker Position X-value
Defines the position (x-value) of the marker in the diagram. For normal markers, the absolute position is indicated. For delta markers, the position relative to the reference marker is provided.

Remote command:
`CALCulate<n>:MARKer<m>:X` on page 170
`CALCulate<n>:DELTamarker<m>:X` on page 172

Marker Type

Toggles the marker type.

The type for marker 1 is always "Normal", the type for delta marker 1 is always "Delta". These types cannot be changed.

Note: If normal marker 1 is the active marker, switching the "Mkr Type" activates an additional delta marker 1. For any other marker, switching the marker type does not activate an additional marker, it only switches the type of the selected marker.

"Normal" A normal marker indicates the absolute value at the defined position in the diagram.

"Delta" A delta marker defines the value of the marker relative to the specified reference marker (marker 1 by default).

Remote command:
`CALCulate<n>:MARKer<m>[:STATe]` on page 169
`CALCulate<n>:DELTamarker<m>[:STATe]` on page 173

Reference Marker
Defines a marker as the reference marker which is used to determine relative analysis results (delta marker values).

Remote command:
`CALCulate<n>:DELTamarker<m>:MREFerence` on page 172

Linking to Another Marker
Links the current marker to the marker selected from the list of active markers. If the x-axis value of the initial marker is changed, the linked marker follows to the same position on the x-axis. Linking is off by default.

Using this function you can set two markers on different traces to measure the difference (e.g. between a max hold trace and a min hold trace or between a measurement and a reference trace).

Remote command:
`CALCulate<n>:MARKer<ms>:LINK:TO:MARKer<md>` on page 168
`CALCulate<n>:DELTamarker<ms>:LINK:TO:MARKer<md>` on page 171
`CALCulate<n>:DELTamarker<m>:LINK` on page 171

Assigning the Marker to a Trace
The "Trace" setting assigns the selected marker to an active trace. The trace determines which value the marker shows at the marker position. If the marker was previously assigned to a different trace, the marker remains on the previous frequency or time, but indicates the value of the new trace.

If a trace is turned off, the assigned markers and marker functions are also deactivated.

Remote command:
`CALCulate<n>:MARKer<m>:TRACe` on page 169

All Markers Off

Deactivates all markers in one step.

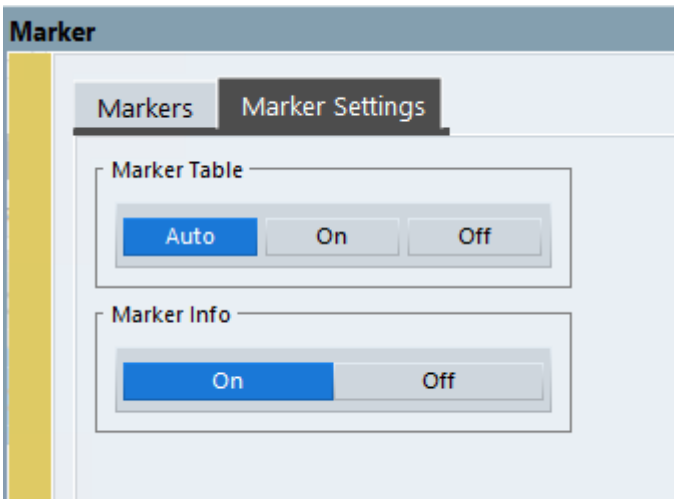
Remote command:
`CALCulate<n>:MARKer<m>:AOFF` on page 168

6.5.1.2 General marker settings

Access:

[MKR] > "Marker Config" > "Marker Settings" tab

Some general marker settings allow you to influence the marker behavior for all markers.



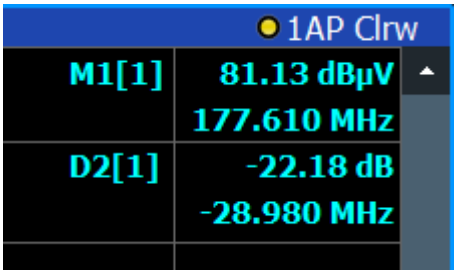
Marker Table Display
Defines how the marker information is displayed.

"On" Displays the marker information in a table in a separate area beneath the diagram.

"Off" No separate marker table is displayed.

Remote command:
`DISPlay[:WINDow<n>]:MTABle` on page 174

Marker Info
Turns the marker information displayed in the diagram on and off.



Remote command:
`DISPlay[:WINDow<n>]:MINFo[:STATe]` on page 173

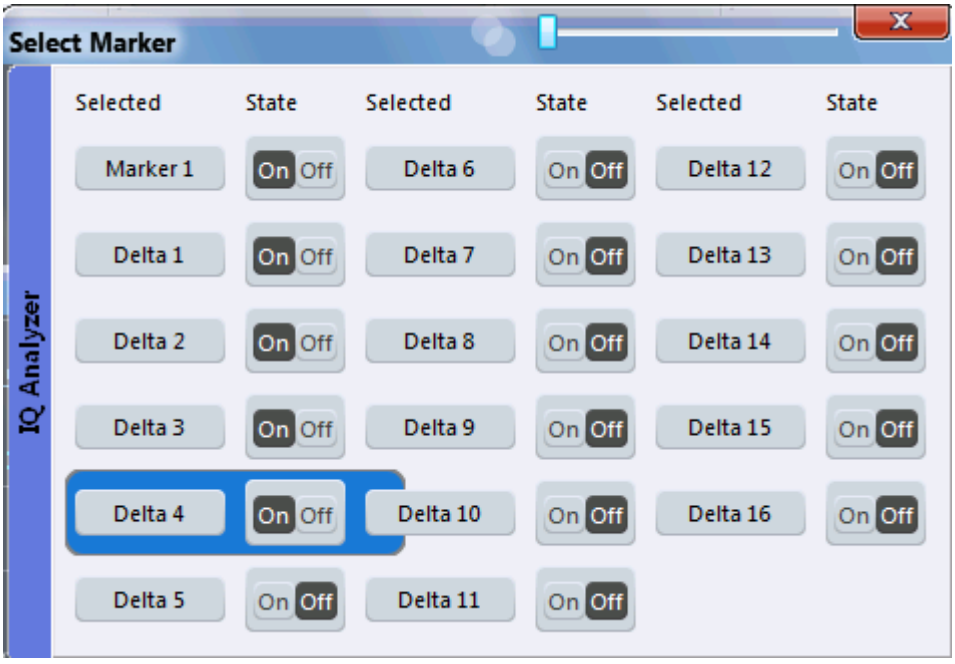
6.5.2 Marker positioning functions

Access: "Marker" toolbar

The following functions set the currently selected marker to the result of a peak search or set other characteristic values to the current marker value.

Select Marker

The "Select Marker" function opens a dialog box to select and activate or deactivate one or more markers quickly.



Remote command:
`CALCulate<n>:MARKer<m>[:STATe]` on page 169
`CALCulate<n>:DELTamarker<m>[:STATe]` on page 173

Peak Search

Sets the selected marker/delta marker to the maximum of the trace. If no marker is active, marker 1 is activated.

Remote command:
`CALCulate<n>:MARKer<m>:MAXimum[:PEAK]` on page 177
`CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]` on page 175

Search Next Peak
Sets the selected marker/delta marker to the next (lower) maximum of the assigned trace. If no marker is active, marker 1 is activated.

Remote command:
CALCulate<n>:MARKer<m>:MAXimum:NEXT on page 177
CALCulate<n>:MARKer<m>:MAXimum:RIGHt on page 177
CALCulate<n>:MARKer<m>:MAXimum:LEFT on page 177
CALCulate<n>:DELTamarker<m>:MAXimum:NEXT on page 175
CALCulate<n>:DELTamarker<m>:MAXimum:RIGHt on page 175
CALCulate<n>:DELTamarker<m>:MAXimum:LEFT on page 175

Search Minimum

Sets the selected marker/delta marker to the minimum of the trace. If no marker is active, marker 1 is activated.

Remote command:
CALCulate<n>:MARKer<m>:MINimum[:PEAK] on page 178
CALCulate<n>:DELTamarker<m>:MINimum[:PEAK] on page 176

Search Next Minimum
Sets the selected marker/delta marker to the next (higher) minimum of the selected trace. If no marker is active, marker 1 is activated.

Remote command:
CALCulate<n>:MARKer<m>:MINimum:NEXT on page 178
CALCulate<n>:MARKer<m>:MINimum:LEFT on page 178
CALCulate<n>:MARKer<m>:MINimum:RIGHt on page 178
CALCulate<n>:DELTamarker<m>:MINimum:NEXT on page 176
CALCulate<n>:DELTamarker<m>:MINimum:LEFT on page 176
CALCulate<n>:DELTamarker<m>:MINimum:RIGHt on page 176

6.6 Display configuration

Access: "Overview" > "Display Config"

The captured signal can be displayed using various evaluation methods. All evaluation methods available for the current application are displayed in the evaluation bar in SmartGrid mode.

For a description of the available evaluation methods, see Chapter 4, "Measurements and result displays", on page 31.

7 How to perform Bluetooth BR/EDR/LE measurements

The following step-by-step instructions demonstrate how to perform a Bluetooth BR/EDR/LE measurement with the R&S VSE-K8 option.

To analyze Bluetooth BR/EDR/LE modulation characteristics

1. Start the R&S VSE Bluetooth measurement application:
   a) In the Sequence tool, for the default channel, select "Replace Channel".
   b) Select "Bluetooth".
2. Configure the input source to be used as described in the R&S VSE Base Software User Manual.
3. Select "Meas Setup > Overview" to display the Bluetooth BR/EDR/LE "Overview".
4. Select "Standard" to select the used Bluetooth BR/EDR/LE standard. For "Low Energy", also select the "PHY" type.
5. Select "Select Measurement" > "Modulation Characteristics".
6. Select "Data Acquisition" to define the signal capture settings.
7. Select the "Display Config" button and select the displays that are of interest to you.
   Arrange them on the display to suit your preferences.
8. Start a new sweep with the defined settings.
9. Optionally, export the trace data of the measured signal to a file.
   a) Select "Trace" > "Trace" > "Trace / Data Export".
   b) Select "Export Trace to ASCII File".
   c) Define a file name and storage location and select "OK".

To analyze Bluetooth BR/EDR/LE in-band spurious emissions

1. Start the R&S VSE Bluetooth measurement application:
   a) In the Sequence tool, for the default channel, select "Replace Channel".
   b) Select "Bluetooth".
2. Configure the input source to be used as described in the R&S VSE Base Software User Manual.
3. Select "Meas Setup > Overview" to display the Bluetooth BR/EDR/LE "Overview".
4. Select "Standard" to select the used Bluetooth BR/EDR/LE standard. For "Low Energy", also select the "PHY" type.
5. Select "Select Measurement" > "ACP / In-band Spur Emissions".
6. Select "Frequency" to define the measurement settings.

a) To measure a Bluetooth signal according to French specifications, select "Geography": "France".
The default values are adapted accordingly.
b) If available for your signal type, select "Load Predefined Settings". See Chapter A, "Predefined standards and settings", on page 196.
c) To restrict the measurement to fewer channels, and thus reduce the required measurement time, define the "Number of Captured Channels"
d) If necessary, define an "Antenna Gain" to consider for data acquisition.

7. For EDR measurements, define the trigger to be used.
   a) Select "Trigger".
   b) Define a trigger and gate as required.
8. Select "Display Config" and select the displays that are of interest to you. Arrange them on the display to suit your preferences.
9. Start a new sweep with the defined settings.
10. Optionally, export the trace data of the measured signal to a file.
    a) Select "Trace" > "Trace" > "Trace / Data Export".
    b) Select "Export Trace to ASCII File".
    c) Define a file name and storage location and select "OK".

8 Measurement examples

The following examples demonstrate how to analyze typical Bluetooth signals for various scenarios.

8.1 Measurement example 1: Analyzing modulation accuracy for a basic Bluetooth signal

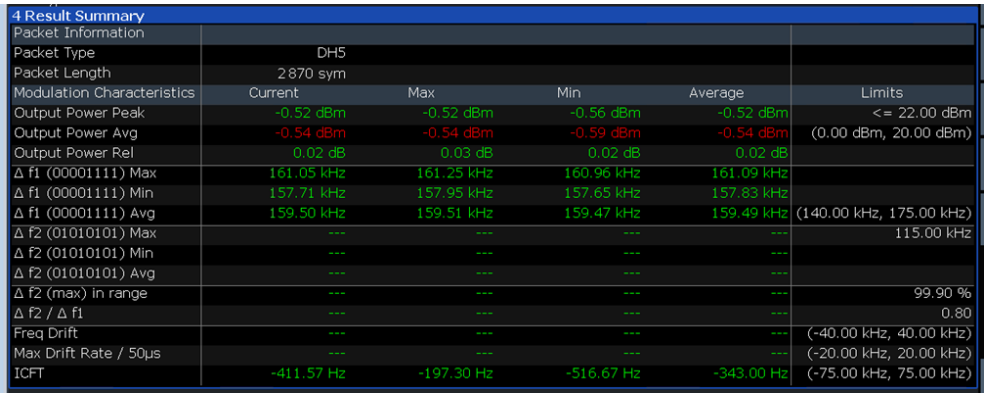
The following example demonstrates how to analyze the modulation accuracy for a typical basic rate (BR) Bluetooth signal. Note that the procedures can include steps that reflect the default settings for demonstration purposes.

This measurement example assumes that the following Bluetooth signal is used as input:

- Center frequency: 2.441 GHz
- Payload of test sequence Δf1: *00001111*
- Payload of test sequence Δf2: *01010101*
- Lower address part: 80

To analyze Bluetooth BR/EDR/LE modulation characteristics

1. Select [MODE] > "Bluetooth" to start a Bluetooth measurement channel.
2. Select "Standard" > "Basic rate".
3. Select "Overview" to display the configuration "Overview" for a Bluetooth BR/EDR/LE measurement.
4. Select "Select Measurement" > "Modulation Characteristics".
5. Select "Input / Frontend" > "Frequency".
6. Enter the center frequency *2.441 GHz*.
7. Select "Burst / Sync" > "LAP".
8. Enter the lower address part: *80*.
9. Select "Limits" > "Limit Check": "On" to enable the limit check for the results.
10. Apply the input signal with the first test sequence Δf1.
11. Select [RUN CONT] to start a continuous measurement.
12. Check the "Result Summary" for the Δf1 results.



4 Result Summary					
Packet Information					
Packet Type	DH5				
Packet Length	2870 sym				
Modulation Characteristics	Current	Max	Min	Average	Limits
Output Power Peak	-0.52 dBm	-0.52 dBm	-0.56 dBm	-0.52 dBm	<= 22.00 dBm
Output Power Avg	-0.54 dBm	-0.54 dBm	-0.59 dBm	-0.54 dBm	(0.00 dBm, 20.00 dBm)
Output Power Rel	0.02 dB	0.03 dB	0.02 dB	0.02 dB	
Δ f1 (00001111) Max	161.05 kHz	161.25 kHz	160.96 kHz	161.09 kHz	
Δ f1 (00001111) Min	157.71 kHz	157.95 kHz	157.65 kHz	157.83 kHz	
Δ f1 (00001111) Avg	159.50 kHz	159.51 kHz	159.47 kHz	159.49 kHz	(140.00 kHz, 175.00 kHz)
Δ f2 (01010101) Max	---	---	---	---	115.00 kHz
Δ f2 (01010101) Min	---	---	---	---	
Δ f2 (01010101) Avg	---	---	---	---	
Δ f2 (max) in range	---	---	---	---	99.90 %
Δ f2 / Δ f1	---	---	---	---	0.80
Freq Drift	---	---	---	---	(-40.00 kHz, 40.00 kHz)
Max Drift Rate / 50µs	---	---	---	---	(-20.00 kHz, 20.00 kHz)
ICFT	-411.57 Hz	-197.30 Hz	-516.67 Hz	-343.00 Hz	(-75.00 kHz, 75.00 kHz)

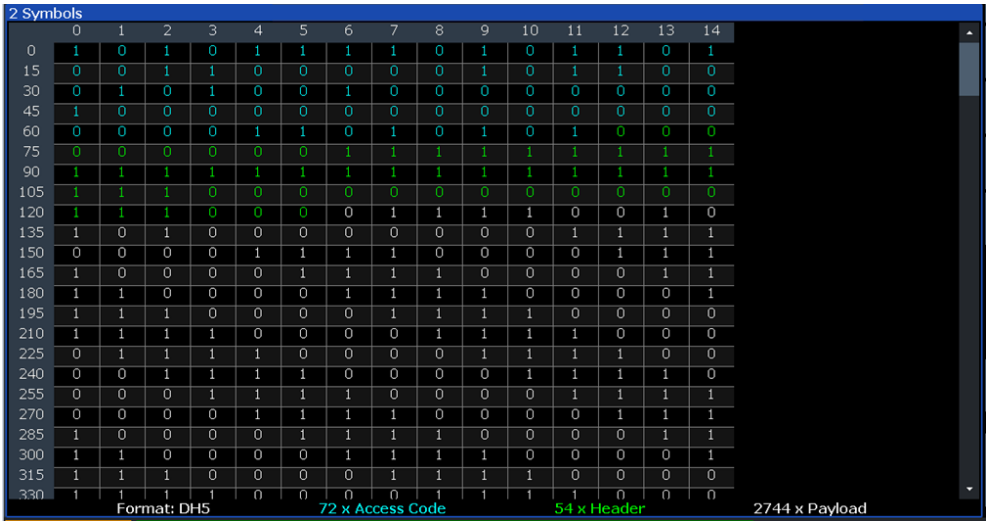
Any limit failures are indicated in red. In this example, the average output power is too low.

13. Increase the power level of the input signal.

4 Result Summary					
Packet Information					
Packet Type	DH5				
Packet Length	2870 sym				
Modulation Characteristics	Current	Max	Min	Average	Limits
Output Power Peak	0.46 dBm	0.46 dBm	-0.56 dBm	-0.34 dBm	<= 22.00 dBm
Output Power Avg	0.44 dBm	0.44 dBm	-0.59 dBm	-0.36 dBm	(0.00 dBm, 20.00 dBm)
Output Power Rel	0.02 dB	0.09 dB	0.02 dB	0.02 dB	
Δ f1 (00001111) Max	161.11 kHz	161.34 kHz	160.96 kHz	161.12 kHz	
Δ f1 (00001111) Min	157.89 kHz	157.98 kHz	157.58 kHz	157.84 kHz	
Δ f1 (00001111) Avg	159.51 kHz	159.54 kHz	159.47 kHz	159.51 kHz	(140.00 kHz, 175.00 kHz)
Δ f2 (01010101) Max	---	---	---	---	115.00 kHz
Δ f2 (01010101) Min	---	---	---	---	
Δ f2 (01010101) Avg	---	---	---	---	
Δ f2 (max) in range	---	---	---	---	99.90 %
Δ f2 / Δ f1	---	---	---	---	0.80
Freq Drift	---	---	---	---	(-40.00 kHz, 40.00 kHz)
Max Drift Rate / 50µs	---	---	---	---	(-20.00 kHz, 20.00 kHz)
ICFT	-335.78 Hz	-197.30 Hz	-516.67 Hz	-347.02 Hz	(-75.00 kHz, 75.00 kHz)

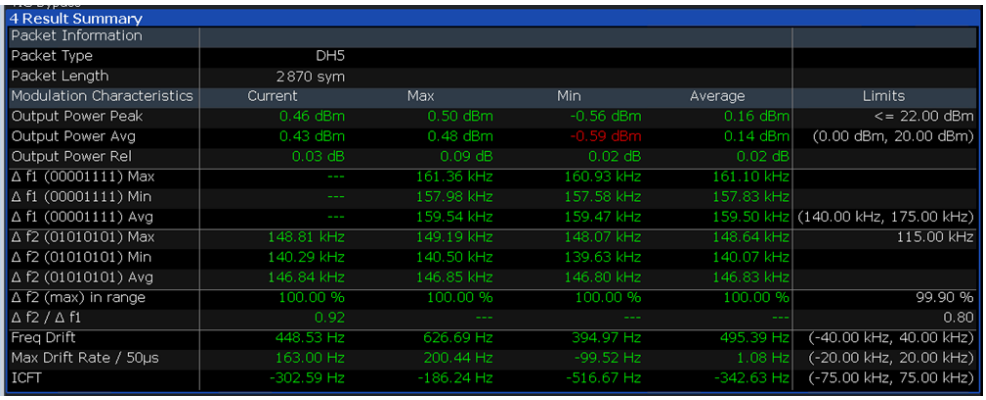
The current output power values turn green because the lower limit is no longer exceeded, but the minimum value still reflects the failure of the previously lower output.

14. Select "Display Config" and drag the "Symbols" display into the SmartGrid. Arrange the windows on the display to suit your preferences.
15. Exit the SmartGrid mode.
16. Compare the demodulated payload symbols in the display (white) with the test sequence Δf1 (*00001111*).



The package type is correctly identified as "DH5".

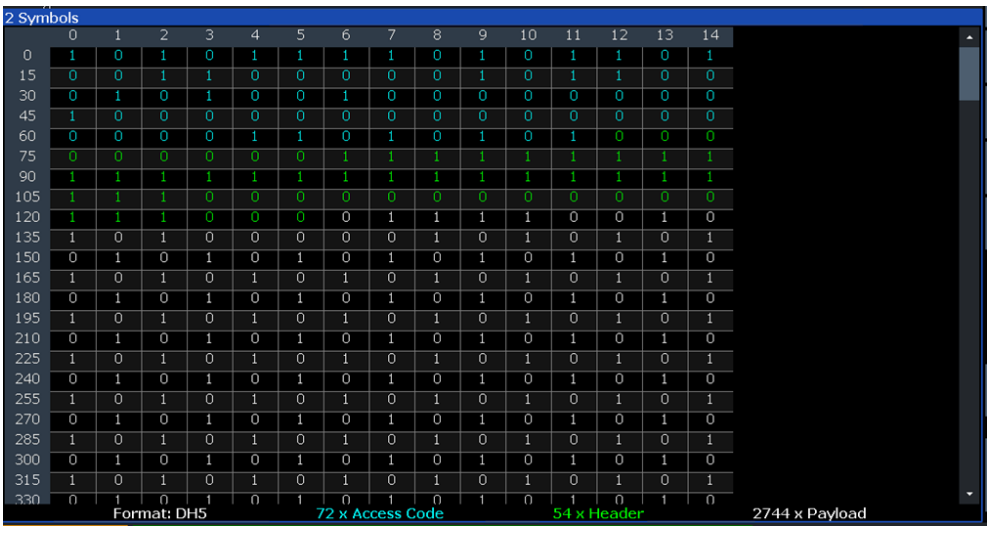
17. Apply the input signal with the second test sequence Δf2.
18. Check the "Result Summary" for the Δf2 and combined Δf1/ Δf2 results.



4 Result Summary

Packet Information					
Packet Type	DH5				
Packet Length	2870 sym				
Modulation Characteristics	Current	Max	Min	Average	Limits
Output Power Peak	0.46 dBm	0.50 dBm	-0.56 dBm	0.16 dBm	<= 22.00 dBm
Output Power Avg	0.43 dBm	0.48 dBm	-0.59 dBm	0.14 dBm	(0.00 dBm, 20.00 dBm)
Output Power Rel	0.03 dB	0.09 dB	0.02 dB	0.02 dB	
Δ f1 (00001111) Max	---	161.36 kHz	160.93 kHz	161.10 kHz	
Δ f1 (00001111) Min	---	157.98 kHz	157.58 kHz	157.83 kHz	
Δ f1 (00001111) Avg	---	159.54 kHz	159.47 kHz	159.50 kHz	(140.00 kHz, 175.00 kHz)
Δ f2 (01010101) Max	148.81 kHz	149.19 kHz	148.07 kHz	148.64 kHz	115.00 kHz
Δ f2 (01010101) Min	140.29 kHz	140.50 kHz	139.63 kHz	140.07 kHz	
Δ f2 (01010101) Avg	146.84 kHz	146.85 kHz	146.80 kHz	146.83 kHz	
Δ f2 (max) in range	100.00 %	100.00 %	100.00 %	100.00 %	99.90 %
Δ f2 / Δ f1	0.92	---	---	---	0.80
Freq Drift	448.53 Hz	626.69 Hz	394.97 Hz	495.39 Hz	(-40.00 kHz, 40.00 kHz)
Max Drift Rate / 50µs	163.00 Hz	200.44 Hz	-99.52 Hz	1.08 Hz	(-20.00 kHz, 20.00 kHz)
ICFT	-302.59 Hz	-186.24 Hz	-516.67 Hz	-342.63 Hz	(-75.00 kHz, 75.00 kHz)

19. Check the "Symbols" display.



The payload symbols (white) now show the second test sequence Δf2 (*01010101*).

20. Optionally, export the trace data of the measured signals to a file.
    a) Select [TRACE] > "Trace Export".
    b) Select "Export Trace to ASCII File".
    c) Define a file name and storage location and select "OK".

8.2 Measurement example 2: Analyzing in-band spurious emissions for a basic Bluetooth signal

The following example demonstrates how to analyze the channel power for a typical Bluetooth basic rate signal, outside of France. Note that the procedures can include steps that reflect the default settings for demonstration purposes.

This measurement example uses the predefined settings file `C:\ProgramData\Rohde-Schwarz\VSE\<version_no>\user\predefined\BTOPredefined\Bluetooth_DH1DH3DH5.xml`.

It assumes that the following Bluetooth signal is used as input:

- Center frequency: 2.441 GHz
- Sample rate: 102.4 MHz
- Duration of signal: 100 ms
- Number of channels: 79
- Antenna gain: 0.0 dB

1. Press the [MODE] key on the front panel and select the "Bluetooth" operating mode.
2. Select "Standard" > "Basic Rate".
3. Select "Overview" to display the configuration "Overview" for a Bluetooth BR/EDR/LE measurement.
4. Select "Select Measurement" > "ACP / In-band Spur Emissions".
5. Select "Frequency" to define the measurement settings.
    a) Select "Load Predefined Settings".
    b) Select the settings file `C:\ProgramData\Rohde-Schwarz\VSE\<version_no>\user\predefined\BTOPredefined\Bluetooth_DH1DH3DH5.xml`.
6. Select "TX Channel": "Mid" to select the middle channel as the transmit channel.
7. Select [RUN SINGLE] to start a new sweep with the defined settings.
8. Check the result of the "Limit Check" in the "ACP / In-band Spurious Emissions" display.

9. If the limit check failed, check the channel power details in the "Result Summary" to determine which channel exceeded the limit.
10. Select the next channel as the transmit channel and repeat the measurement.
    a) Select "TX Channel No".
    b) Use the rotary knob or the arrow keys to move through the channels.
    c) Select [RUN SINGLE].
11. Optionally, export the trace data of the measured signal to a file.
    a) Select [TRACE] > "Trace Export".
    b) Select "Export Trace to ASCII File".
    c) Define a file name and storage location and select "OK".

9 Remote commands to perform Bluetooth BR/EDR/LE measurements

The commands required to perform measurements in the R&S VSE Bluetooth measurement application in a remote environment are described here.

It is assumed that the R&S VSE has already been set up for remote control in a network as described in the R&S VSE User Manual.

A programming example at the end of the remote commands description demonstrates the most important commands in a typical application scenario, see Chapter 9.8, "Programming examples: Measuring Bluetooth BR/EDR/LE signals", on page 192.

Note that basic tasks that are also performed in the base unit in the same way are not described here. For a description of such tasks, see the R&S VSE User Manual.

In particular:

- Basic instrument configuration, e.g. checking the system configuration, customizing the screen layout, or configuring networks and remote operation
- Using the common status registers

Status registers

The R&S VSE-K7 option uses the status registers of the base unit (except for the `STATus:QUEStionable:ACPLimit` register).

For a description, see the R&S VSE User Manual.

General R&S VSE Remote Commands

The application-independent remote commands for general tasks on the R&S VSE are also available for Bluetooth BR/EDR/LE measurements and are described in the R&S VSE User Manual. In particular:

- Managing settings and results
- Setting up the instrument
- Using the status register

9.1 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, usually, 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, they 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 VSE.

Remote command examples

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

9.1.1 Conventions used in descriptions

The following conventions are used in the remote command descriptions:

- **Command usage**
  If not specified otherwise, commands can be used both for setting and for querying parameters.
  If a command can be used for setting or querying only, or if it initiates an event, the usage is stated explicitly.
- **Parameter usage**
  If not specified otherwise, a parameter can be used to set a value and it is the result of a query.
  Parameters required only for setting are indicated as **Setting parameters**.
  Parameters required only to refine a query are indicated as **Query parameters**.
  Parameters that are only returned as the result of a query are indicated as **Return values**.
- **Conformity**
  Commands that are taken from the SCPI standard are indicated as **SCPI confirmed**. All commands used by the R&S VSE follow the SCPI syntax rules.
- **Asynchronous commands**
  A command which does not automatically finish executing before the next command starts executing (overlapping command) is indicated as an **Asynchronous command**.
- **Reset values (*RST)**

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

- **Default unit**
  The default unit is used for numeric values if no other unit is provided with the parameter.
- **Manual operation**
  If the result of a remote command can also be achieved in manual operation, a link to the description is inserted.

9.1.2 Long and short form

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

The short form is emphasized in uppercase 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`.

9.1.3 Numeric suffixes

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

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

If you do not 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.

9.1.4 Optional keywords

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

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.

9.1.5 Alternative keywords

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

Example:

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

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

9.1.6 SCPI parameters

Many commands feature one or more parameters.

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

Example:

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

Parameters can have different forms of values.

9.1.6.1 Numeric values

Numeric values can be entered in any form, i.e. with sign, decimal point or exponent. For 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. for 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. Sometimes, you can customize the step size with a corresponding command.

Querying numeric values

When you query numeric values, the system returns a number. For physical quantities, it applies the basic unit (e.g. Hz for 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`

Sometimes, numeric values are 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 if errors occur.

9.1.6.2 Boolean

Boolean parameters represent two states. The "on" state (logically true) is represented by "`ON`" or the 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`

9.1.6.3 Character data

Character data follows the syntactic rules of keywords. You can enter text using a short or a long form. For more information, see Chapter 9.1.2, "Long and short form", on page 102.

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`

9.1.6.4 Character strings

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

Example:

```
INSTRument:DELete 'Spectrum'
```

9.1.6.5 Block data

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

The ASCII character # introduces the data block. The next number indicates how many of the following digits describe the length of the data block. 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 an `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.

9.2 Common suffixes

In the R&S VSE Bluetooth measurement application, the following common suffixes are used in remote commands:

Table 9-1: Common suffixes used in remote commands in the R&S VSE Bluetooth measurement application

Suffix	Value range	Description
<m>	1 to 16	Marker
<n>	1 to 6	Window (**in the currently selected channel**)

Suffix	Value range	Description
<t>	1 to 4	Trace
	1 to 8	Limit line

9.3 Activating Bluetooth BR/EDR/LE measurements

Bluetooth BR/EDR/LE measurements require a special application in the R&S VSE. The common commands for configuring and controlling measurement channels, as well as blocks and sequences, are also used in the R&S VSE Bluetooth measurement application.

They are described in the R&S VSE base software user manual.

9.4 Configuring Bluetooth BR/EDR/LE measurements

9.4.1 Restoring the default configuration (preset)

SYSTem:PRESet:CHANnel[:EXEC]

Restores the default software settings in the current channel.

Use `INST:SEL` to select the channel.

Example: `INST:SEL 'Spectrum2'`
Selects the channel for "Spectrum2".
`SYST:PRES:CHAN:EXEC`
Restores the factory default settings to the "Spectrum2"channel.

Usage: Event

Manual operation: See "Preset Channel" on page 42

9.4.2 Selecting the standard and measurement

CONFigure:BTOoth[:STANdard] <Standard>

Defines the Bluetooth standard the signal complies with.

For details on the different standards, see Chapter 3, "Measurement basics", on page 11.

Parameters:

<Standard> BR | EDR | LE

BR
Basic rate

EDR
Enhanced data rate

LE
Low energy
Requires a substandard, see `CONFigure:BTOoth:LENergy` on page 107

*RST: BR

Example:

```
CONF:BTO LE
CONF:BTO:LEN LE2M
```

Manual operation: See "Standard" on page 43

CONFigure:BTOoth:LENergy <LE1M>

For measurements based on the **low-energy** standard (`CONFigure:BTOoth[:STANdard]LE`), this command defines the substandard depending on the used physical layer (PHY).

Parameters:

<LE1M> LE1M | LE2M | LECoded

LE1M
uncoded, 1 symbol per data bit, 1 Msymbol/s data rate

LE2M
uncoded, 1 symbol per data bit, 2 Msymbol/s data rate

LECoded
2 symbols per data bit, 1 Msymbol/s data rate

*RST: LE1M

Example:

```
CONF:BTO LE
CONF:BTO:LEN LE2M
```

Manual operation: See "Standard" on page 43

CONFigure:BTOoth:MEASurement <Measurement type>

Selects a measurement to be performed.

See Chapter 4, "Measurements and result displays", on page 31.

Parameters:

<Measurement type> MOD | SEM

MOD
Modulation characteristics

SEM
In-band spurious emissions

*RST: MOD

Example: `CONF:BTO SEM`

Manual operation: See "Select Measurement" on page 42

9.4.3 Configuring data input

The following commands are required to configure data input.

9.4.3.1 RF input

Remote commands exclusive to configuring RF input:

INPut:ATTenuation:PROTection[:STATe] <State>

Turns the availability of attenuation levels of 10 dB or less on and off.

Parameters:

<State> ON | OFF | 1 | 0

ON | 1
Attenuation levels of 10 dB or less are not allowed to protect the RF input connector of the connected instrument.

OFF | 0
Attenuation levels of 10 dB or less are not blocked. Provide appropriate protection for the RF input connector of the connected instrument yourself.

*RST: 1

Example: `INP:ATT:PROT ON`
Turns on the input protection.

INPut:ATTenuation:PROTection:RESet [<DeviceName>]

Resets the attenuator and reconnects the RF input with the input mixer for the connected instrument after an overload condition occurred and the protection mechanism intervened. The error status bit (bit 3 in the `STAT:QUES:POW` status register) and the `INPUT OVLD` message in the status bar are cleared.

The command works only if the overload condition has been eliminated first.

For details on the protection mechanism, see the instrument's documentation.

Setting parameters:

<DeviceName> string

Name of the instrument for which the RF input protection is to be reset.

Example: `INP:ATT:PROT:RES 'MyDevice'`

Manual operation: See "10 dB Minimum Attenuation" on page 49

INPut<ip>:COUPling<ant> <CouplingType>

Selects the coupling type of the RF input.

Suffix:

<ip> 1 | 2
irrelevant

<ant> Input source (for MIMO measurements only)

Parameters:

<CouplingType> AC | DC

AC
AC coupling

DC
DC coupling

*RST: AC

Example: `INP:COUP DC`

Manual operation: See "Input Coupling" on page 46

INPut:DPATh <DirectPath>

Enables or disables the use of the direct path for frequencies close to 0 Hz.

Parameters:

<DirectPath> AUTO | OFF

AUTO | 1
(Default) the direct path is used automatically for frequencies close to 0 Hz.

OFF | 0
The analog mixer path is always used.

Example: `INP:DPAT OFF`

Manual operation: See "Direct Path" on page 46

INPut:FILE:ZPADing <State>

Enables or disables zeropadding for input from an I/Q data file that requires resampling. For resampling, a number of samples are required due to filter settling. These samples can either be taken from the provided I/Q data, or the software can add the required number of samples (zeros) at the beginning and end of the file.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example: `INP:FILE:ZPAD ON`

Manual operation: See "Zero Padding" on page 51

INPut:FILTer:HPASs[:STATe] <State>

Activates an additional internal high-pass filter for RF input signals from 1 GHz to 3 GHz. This filter is used to remove the harmonics of the connected instrument to measure the harmonics for a DUT, for example.

Requires an additional high-pass filter hardware option.

(Note: for RF input signals outside the specified range, the high-pass filter has no effect. For signals with a frequency of approximately 4 GHz upwards, the harmonics are suppressed sufficiently by the YIG-preselector, if available.)

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example: `INP:FILT:HPAS ON`
Turns on the filter.

Manual operation: See "High Pass Filter 1 to 3 GHz" on page 47

INPut<ip>:FILTer:YIG[:STATe] <State>

Enables or disables the YIG filter.

Suffix:

<ip> 1 | 2
irrelevant

Parameters:

<State> ON | OFF | 0 | 1

Example: `INP:FILT:YIG OFF`
Deactivates the YIG-preselector.

Manual operation: See "YIG-Preselector" on page 47

INPut<ip>:IMPedance<ant> <Impedance>

Selects the nominal input impedance of the RF input. In some applications, only 50 Ω are supported.

Suffix:

<ip> 1 | 2
irrelevant

<ant> Input source (for MIMO measurements only)

Parameters:

<Impedance> 50 | 75

*RST: 50 Ω
Default unit: OHM

Example: `INP:IMP 75`

Manual operation: See "Impedance" on page 46

INPut:PRESelection:SET <Mode>

Selects the preselector mode.

The command is available with the optional preselector.

Parameters:

<Mode>

NARRow
Performs a measurement by automatically applying all available combinations of low and high pass filters consecutively. These combinations all have a narrow bandwidth.

WIDE
Performs a measurement by automatically applying all available bandpass filters consecutively. The bandpass filters have a wide bandwidth.

Manual operation: See "Preselector Mode" on page 48

INPut<ip>:PRESelection[:STATe] <State>

Turns the preselector on and off.

Suffix:

<ip> 1 | 2
irrelevant

Manual operation: See "Preselector State" on page 48

INPut:RF:CAPMode <CAPMode>

Determines how data from an oscilloscope is input to the R&S VSE software.

Is only available for connected oscilloscopes.

Parameters:

<CAPMode> AUTO | IQ | WAVeform

IQ
The measured waveform is converted to I/Q data directly on the R&S oscilloscope (requires option K11), and input to the R&S VSE software as I/Q data.

WAVeform
The data is input in its original waveform format and converted to I/Q data in the R&S VSE software. No additional options are required on the R&S oscilloscope.

AUTO
Uses "I/Q" mode when possible, and "Waveform" only when required by the application (e.g. Pulse measurement).

*RST: IQ

Example:
```
INP:RF:CAPM WAV
```

INPut:RF:CAPMode:IQ:SRATe <SamplingRate>

Determines the sample rate used by the connected oscilloscope for I/Q capture mode (see INPut:RF:CAPMode on page 112).

This setting is only available if an R&S oscilloscope is used to obtain the input data.

Parameters:

<SamplingRate> 20 GHz | 40 GHz

No other sample rate values are allowed.

20 GHz
Achieves a higher decimation gain, but reduces the record length by half.
Only available for R&S oscilloscope models that support a sample rate of 20 GHz (see data sheet).

40 GHz
Provides a maximum sample rate.
Only available for R&S RTP13/RTP16 models that support a sample rate of 40 GHz (see data sheet).

*RST: 20 GHz
Default unit: HZ

Example:
```
INP:RF:CAPM IQ
INP:RF:CAPM:IQ:SRAT 40 GHZ
```

INPut:RF:CAPMode:WAVeform:SRATe <SamplingRate>

Determines the sample rate used by the connected oscilloscope for waveform capture mode (see INPut:RF:CAPMode on page 112).

This setting is only available if an R&S oscilloscope is used to obtain the input data, either directly or via the R&S FSW.

Parameters:

<SamplingRate> 10 GHz | 20 GHz

No other sample rate values are allowed.

10 GHz
Default ; provides maximum record length

20 GHz
Achieves a higher decimation gain, but reduces the record length by half.
Only available for R&S oscilloscope models that support a sample rate of 20 GHz (see data sheet).
For R&S oscilloscopes with an analysis bandwidth of 4 GHz or larger, a sample rate of 20 GHZ is always used.

*RST: 10 GHz
Default unit: HZ

Example:
```
INP:RF:CAPM WAV
INP:RF:CAPM:WAVE:SRAT 10000000
```

INPut<ip>:SELect <Source>

Selects the signal source for measurements, i.e. it defines which connector is used to input data to the R&S VSE.

Suffix:
<ip> 1 | 2
For R&S FSW85 models with two RF input connectors:
1: Input 1 (1 mm [RF Input] connector)
2: Input 2 (1.85 mm [RF2 Input] connector)
For all other models:
irrelevant

Parameters:
<Source>

RF
Radio Frequency ("RF INPUT" connector)

FIQ
I/Q data file

*RST: RF

Manual operation: See "Input Type (Instrument / File)" on page 45

INPut:TYPE <Input>

The command selects the input path for R&S FSW85 models.

Parameters:
<Input>

INPUT1
Selects RF input 1.

INPUT2
Selects RF input 2.

*RST: INPUT1

Example:
```
//Select input path
INP:TYPE INPUT1
```

Manual operation: See "Input 1 / Input 2" on page 46

INSTrument:BLOCk:CHANnel[:SETTings]:SOURce<si> <Type>

Selects an instrument or a file as the source of input provided to the channel.

Suffix:
<si> 1 to 99
LTE-MIMO only: input source number

Parameters:
<Type> FILE | DEVice | NONE

FILE
A loaded file is used for input.

DEVice
A configured device provides input for the measurement

NONE
No input source defined.

Manual operation: See "Input Type (Instrument / File)" on page 45

INSTrument:BLOCk:CHANnel[:SETTings]:SOURce<si>:CONFig <Port>

Configures the port to be used for input on the selected instrument.

Is only available if an oscilloscope is connected.

Suffix:
<si> 1 to 99
LTE-MIMO only: input source number

Parameters:
<Port>

INSTrument:BLOCk:CHANnel[:SETTings]:SOURce<si>:TYPE <Source>

Configures the source of input to be used from the selected instrument.

Not all input sources are supported by all R&S VSE applications.

Suffix:
<si> 1 to 99
LTE-MIMO only: input source number

Parameters:
<Source>

RF
Radio Frequency ("RF INPUT" connector)

'Channel 1' | 'Channel 2' | 'Channel 3' | 'Channel 4'
Oscilloscope input channel 1, 2, 3, or 4

'Channel 1,2 (I+Q)'
I/Q data provided by oscilloscope input channels 1 and 2 (for oscilloscopes with 2 channels only)

'Channel 1,3 (I+Q)' | 'Channel 2,4 (I+Q)'
I/Q data provided by oscilloscope input channels 1 and 3, or 2 and 4 (for oscilloscopes with 4 channels only)

'Channels 1-4 (diff. I+Q)'
Differential I/Q data provided by oscilloscope input channels (for oscilloscopes with 4 channels only):
Channel 1: I (pos.)
Channel 2: $\bar{I}$ (neg.)
Channel 3: Q (pos.)
Channel 4: $\bar{Q}$ (neg.)

'Channels 1,3 (Waveform)'
Waveform data provided by oscilloscope input channels 1 and 3 (for oscilloscopes with 2 channels only)

'Channels 2,4 (Waveform)'
Waveform data provided by oscilloscope input channels 2 and 4 (for oscilloscopes with 2 channels only)

'Channels 1-4 (Waveform)'
Waveform data provided by oscilloscope input channels 1 to 4 (for oscilloscopes with 4 channels only)

*RST: RF

Example: INST:BLOC:CHAN:SOUR:TYPE 'Channel 2,4 (I+Q)'
I/Q data is provided by oscilloscope input channels 2 and 4

SYSTem:COMMunicate:RDEVice:OSCilloscope[:STATe] <State>

Activates the optional 2 GHz bandwidth extension (R&S FSW-B2000).

Note: Manual operation on the connected oscilloscope, or remote operation other than by the R&S VSE, is not possible while the B2000 option is active.

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `SYST:COMM:RDEV:OSC ON`

Manual operation: See "B2000 State" on page 47

SYSTem:COMMunicate:RDEVice:OSCilloscope:TCPip <Address>

Defines the TCPIP address or computer name of the oscilloscope connected to the R&S VSE via LAN.

Note: The IP address is maintained after a [PRESET], and is transferred between applications.

Parameters:

<Address> computer name or IP address

Example:
```
SYST:COMM:RDEV:OSC:TCP '192.0.2.0'
```

Example:
```
SYST:COMM:RDEV:OSC:TCP 'FSW43-12345'
```

Manual operation: See "Oscilloscope IP Address" on page 48

SYSTem:COMMunicate:RDEVice:OSCilloscope:PSMode[:STATe] <State>

Activates the use of the power splitter inserted between the "IF 2 GHZ OUT" connector of the R&S VSE and the "CH1" and "CH3" input connectors of the oscilloscope. Note that this mode requires an additional alignment with the power splitter.

For details see the R&S FSW I/Q Analyzer and I/Q Input User Manual

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example:
```
SYST:COMM:RDEV:OSC:PSM ON
```

Manual operation: See "Oscilloscope Splitter Mode" on page 48

SYSTem:COMMunicate:RDEVice:OSCilloscope:SRATe <Rate>

Determines whether the 10 GHz mode (default) or 20 GHz mode of the connected oscilloscope is used. The 20 GHZ mode achieves a higher decimation gain, but reduces the record length by half.

Parameters:

<Rate> 10 GHz | 20 GHz

No other sample rate values are allowed.

*RST: 10 GHz
Default unit: HZ

Example:
```
TRAC:IQ:SRAT?
//Result: 100000000
TRAC:IQ:RLEN?
//Result: 3128
SYST:COMM:RDEV:OSC:SRAT 20GHZ
TRAC:IQ:SRAT?
//Result: 200000000
TRAC:IQ:RLEN?
//Result: 1564
```

SYSTem:COMMunicate:RDEVice:OSCilloscope:VDEVice?

Queries whether the connected instrument is supported by the 2 GHz bandwidth extension option(B2000).

Return values:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `SYST:COMM:RDEV:OSC:VDEV?`

Usage: Query only

SYSTem:COMMunicate:RDEVice:OSCilloscope:VFIRmware?

Queries whether the firmware on the connected oscilloscope is supported by the 2 GHz bandwidth extension (B2000) option.

Return values:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `SYST:COMM:RDEV:OSC:VFIR?`

Usage: Query only

9.4.4 Amplitude settings

Amplitude and scaling settings allow you to configure the vertical (y-)axis display and for some result displays also the horizontal (x-)axis.

Useful commands for amplitude settings described elsewhere:

- `INPut<ip>:COUPling<ant>` on page 109
- `INPut<ip>:IMPedance<ant>` on page 111
- `[SENSe:]ADJust:LEVel` on page 145

Remote commands exclusive to amplitude settings:

CALCulate<n>:UNIT:POWer <Unit>

Selects the unit of the y-axis.

The unit applies to all power-based measurement windows with absolute values.

Suffix:
<n> irrelevant

Parameters:
<Unit> DBM | V | A | W | DBPW | WATT | DBUV | DBMV | VOLT | DBUA | AMPere

*RST: dBm

Example: `CALC:UNIT:POW DBM`
Sets the power unit to dBm.

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RLEVel<ant> <ReferenceLevel>

Defines the reference level (for all traces in all windows).

With a reference level offset ≠ 0, the value range of the reference level is modified by the offset.

Suffix:
<n> irrelevant

<w> subwindow
Not supported by all applications

<t> irrelevant

<ant> Input source (for MIMO measurements only)

Parameters:
<ReferenceLevel> The unit is variable.

Range: see datasheet
*RST: 0 dBm
Default unit: DBM

Example: `DISP:TRAC:Y:RLEV -60dBm`

Manual operation: See "Reference Level" on page 53

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RLEVel<ant>:OFFSet <Offset>

Defines a reference level offset (for all traces in all windows).

Suffix:

<n> irrelevant

<w> subwindow
Not supported by all applications

<t> irrelevant

<ant> Input source (for MIMO measurements only)

Parameters:

<Offset> Range: -200 dB to 200 dB
*RST: 0dB
Default unit: DB

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

Manual operation: See "Shifting the Display (Offset)" on page 54

INPut:ATTenuation:AUTO:MODE <OptMode>

Selects the priority for signal processing *after* the RF attenuation has been applied.

Parameters:

<OptMode> LNOise | LDIStortion

LNOise
Optimized for high sensitivity and low noise levels

LDIStortion
Optimized for low distortion by avoiding intermodulation

*RST: LDIStortion (WLAN application: LNOise)

Example:
```
INP:ATT:AUTO:MODE LNO
```

Manual operation: See "Optimization" on page 55

INPut:CONNector <ConnType>

Determines which connector the input for the measurement is taken from.

Parameters:

<ConnType> **RF**
RF input connector

RFPRobe
Active RF probe

*RST: RF

Example:
```
INP:CONN RF
```
Selects input from the RF input connector.

INPut:EGAin[:STATe] <State>

Before this command can be used, the external preamplifier must be connected to the R&S VSE. See the preamplifier's documentation for details.

When activated, the R&S VSE automatically compensates the magnitude and phase characteristics of the external preamplifier in the measurement results.

Note that when an optional external preamplifier is activated, the internal preamplifier is automatically disabled, and vice versa.

When deactivated, no compensation is performed even if an external preamplifier remains connected.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
No data correction is performed based on the external preamplifier

ON | 1
Performs data corrections based on the external preamplifier

*RST: 0

Example:
```
INP:EGA ON
```

INPut<ip>:GAIN<ant>:STATe <State>

Turns the internal preamplifier on the connected instrument on and off. It requires the additional preamplifier hardware option on the connected instrument.

Suffix:

<ip> 1 | 2
irrelevant

<ant> Input source (for MIMO measurements only)

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example:
```
INP:GAIN:STAT ON
INP:GAIN:VAL 15
```
Switches on 15 dB preamplification.

Manual operation: See "Preamplifier" on page 54

INPut<ip>:GAIN<ant>[:VALue] <Gain>

Selects the "gain" if the preamplifier is activated (`INP:GAIN:STAT ON`, see `INPut<ip>:GAIN<ant>:STATe` on page 121).

The command requires the additional preamplifier hardware option.

Suffix:

<ip> 1 | 2
irrelevant

<ant> Input source (for MIMO measurements only)

Parameters:

<Gain> 15 dB and 30 dB
All other values are rounded to the nearest of these two.
30 dB
Default unit: DB

Example:
```
INP:GAIN:STAT ON
INP:GAIN:VAL 30
```
Switches on 30 dB preamplification.

Manual operation: See "Preamplifier" on page 54

INPut:ATTenuation <Attenuation>

Defines the total attenuation for RF input.

If you set the attenuation manually, it is no longer coupled to the reference level, but the reference level is coupled to the attenuation. Thus, if the current reference level is not compatible with an attenuation that has been set manually, the command also adjusts the reference level.

Parameters:

<Attenuation> Range: see data sheet
Increment: 5 dB (with optional electr. attenuator: 1 dB)
*RST: 10 dB (AUTO is set to ON)
Default unit: DB

Example:
```
INP:ATT 30dB
```
Defines a 30 dB attenuation and decouples the attenuation from the reference level.

Manual operation: See "Attenuation Mode / Value" on page 55

INPut:ATTenuation:AUTO <State>

Couples or decouples the attenuation to the reference level. Thus, when the reference level is changed, the R&S VSE determines the signal level for optimal internal data processing and sets the required attenuation accordingly.

Parameters:
<State> ON | OFF | 0 | 1
*RST: 1

Example: `INP:ATT:AUTO ON`
Couples the attenuation to the reference level.

Manual operation: See "Attenuation Mode / Value" on page 55

INPut:EATT <Attenuation>

Defines an electronic attenuation manually. Automatic mode must be switched off (`INP:EATT:AUTO OFF`, see `INPut:EATT:AUTO` on page 123).

If the current reference level is not compatible with an attenuation that has been set manually, the command also adjusts the reference level.

Parameters:
<Attenuation> attenuation in dB
Range: see data sheet
Increment: 1 dB
*RST: 0 dB (OFF)
Default unit: DB

Example:
```
INP:EATT:AUTO OFF
INP:EATT 10 dB
```

Manual operation: See "Using Electronic Attenuation" on page 56

INPut:EATT:AUTO <State>

Turns automatic selection of the electronic attenuation on and off.

If on, electronic attenuation reduces the mechanical attenuation whenever possible.

Parameters:
<State> ON | OFF | 0 | 1
OFF | 0
Switches the function off
ON | 1
Switches the function on
*RST: 1

Example: `INP:EATT:AUTO OFF`

Manual operation: See "Using Electronic Attenuation" on page 56

INPut:EATT:STATe <State>

Turns the electronic attenuator on and off.

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example: `INP:EATT:STAT ON`
Switches the electronic attenuator into the signal path.

Manual operation: See "Using Electronic Attenuation" on page 56

9.4.5 Scaling

The scaling for the vertical axis is highly configurable, using either absolute or relative values. These commands are described here.

DISPlay[:WINDow<n>][:SUBWindow<n>]:TRACe<t>:Y[:SCALe]:AUTO <State>

If enabled, the Y-axis is scaled automatically according to the current measurement.

Suffix:
<n> Window

<w> subwindow
Not supported by all applications

<t> irrelevant

Parameters for setting and query:
<State> **OFF**
Switch the function off

ON
Switch the function on

ONCE
Execute the function once

*RST: ON

Manual operation: See "Automatic Grid Scaling" on page 57
See "Auto Scale Once" on page 57

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:PDIVision <Value>

This remote command determines the grid spacing on the Y-axis for all diagrams, where possible.

In spectrum displays, for example, this command is not available.

Suffix:
<n> Window

<w> subwindow
Not supported by all applications

<t> irrelevant

Parameters:
<Value> numeric value WITHOUT UNIT (unit according to the result display)

Defines the range per division (total range = 10*<Value>)

*RST: depends on the result display
Default unit: DBM

Example: `DISP:TRAC:Y:PDIV 10`
Sets the grid spacing to 10 units (e.g. dB) per division

Manual operation: See "Per Division" on page 58

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RPOSition <Position>

Defines the vertical position of the reference level on the display grid (for all traces).

The R&S VSE adjusts the scaling of the y-axis accordingly.

Suffix:
<n> Window

<w> subwindow
Not supported by all applications

<t> irrelevant

Example: `DISP:TRAC:Y:RPOS 50PCT`

Manual operation: See "Ref Position" on page 58

DISPlay[:WINDow<n>][:SUBWindow<w>]:TRACe<t>:Y[:SCALe]:RVALue <Value>

Defines the reference value assigned to the reference position in the specified window. Separate reference values are maintained for the various displays.

Suffix:
<n> Window

<w> subwindow

<t> irrelevant

Parameters:
<Value> Default unit: DB

Example: `DISP:TRAC:Y:RVAL 0`
Sets the value assigned to the reference position to 0 Hz

Manual operation: See "Ref Value" on page 58

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MAXimum <Value>

Defines the maximum value on the y-axis in the specified window.

Suffix:
<n> Window

<t> irrelevant

Parameters:
<Max> numeric value

Example: `DISP:WIND2:TRAC:Y:SCAL:MAX 10`

Manual operation: See "Absolute Scaling (Min/Max Values)" on page 58

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:MINimum <Value>

Defines the minimum value on the y-axis in the specified window.

Suffix:
<n> Window

<t> irrelevant

Parameters:
<Min> numeric value

Example: `DISP:WIND2:TRAC:Y:SCAL:MIN -90`

Manual operation: See "Absolute Scaling (Min/Max Values)" on page 58

9.4.6 Frequency settings

[SENSe:]FREQuency:CENTer <Frequency>

Defines the center frequency.

Parameters:

<Frequency> The allowed range and f_{max} is specified in the data sheet.

*RST: fmax/2
Default unit: Hz

Example:

```
FREQ:CENT 100 MHz
FREQ:CENT:STEP 10 MHz
FREQ:CENT UP
```

Sets the center frequency to 110 MHz.

[SENSe:]FREQuency:CENTer:STEP <StepSize>

Defines the center frequency step size.

Parameters:

<StepSize> f_{max} is specified in the data sheet.

Range: 1 to fMAX
*RST: 0.1 x span
Default unit: Hz

Example:

```
//Set the center frequency to 110 MHz.
FREQ:CENT 100 MHz
FREQ:CENT:STEP 10 MHz
FREQ:CENT UP
```

[SENSe:]FREQuency:CENTer:STEP:LINK <CouplingType>

Couples and decouples the center frequency step size to the span or the resolution bandwidth.

Parameters:

<CouplingType> SPAN | RBW | OFF

SPAN
Couples the step size to the span. Available for measurements in the frequency domain.

OFF
Decouples the step size.

*RST: SPAN

Example:

```
//Couple step size to span
FREQ:CENT:STEP:LINK SPAN
```

[SENSe:]FREQuency:CENTer:STEP:LINK:FACTor <Factor>

Parameters:

<Factor> 1 to 100 PCT

*RST: 10
Default unit: PCT

Example: //Couple frequency step size to span and define a step size factor
```
FREQ:CENT:STEP:LINK SPAN
FREQ:CENT:STEP:LINK:FACT 20PCT
```

[SENSe:]FREQuency:OFFSet <Offset>

Defines a frequency offset.

If this value is not 0 Hz, the application assumes that the input signal was frequency shifted outside the application. All results of type "frequency" will be corrected for this shift numerically by the application.

Parameters:

<Offset>
Range: -1 THz to 1 THz
*RST: 0 Hz
Default unit: HZ

Example:
```
FREQ:OFFS 1GHZ
```

Manual operation: See "Frequency Offset" on page 52

9.4.7 Triggering measurements

The trigger commands define the beginning of a measurement.

Useful commands for triggering measurments described elsewhere:

- `[SENSe:]SWEep:TIME` on page 163

Remote commands exclusive to triggering measurements:

TRIGger[:SEQuence]:DTIMe <DropoutTime>

Defines the time the input signal must stay below the trigger level before a trigger is detected again.

Parameters:

<DropoutTime> Dropout time of the trigger.

Range: 0 s to 10.0 s
*RST: 0 s
Default unit: S

Manual operation: See "Drop-Out Time" on page 64

TRIGger[:SEQuence]:HOLDoff[:TIME] <Offset>

Defines the time offset between the trigger event and the start of the sweep.

Parameters:

<Offset>

*RST: 0 s
Default unit: S

Example:

```
TRIG:HOLD 500us
```

Manual operation: See "Trigger Offset" on page 64

TRIGger[:SEQuence]:IFPower:HOLDoff <Period>

Defines the holding time before the next trigger event.

Note that this command can be used for **any trigger source**, not just IF Power (despite the legacy keyword).

Parameters:

<Period>

Range: 0 s to 10 s
*RST: 0 s
Default unit: S

Example:

```
TRIG:SOUR EXT
```

Sets an external trigger source.

```
TRIG:IFP:HOLD 200 ns
```

Sets the holding time to 200 ns.

Manual operation: See "Trigger Holdoff" on page 65

TRIGger[:SEQuence]:IFPower:HYSTeresis <Hysteresis>

Defines the trigger hysteresis, which is only available for "IF Power" trigger sources.

Parameters:

<Hysteresis>

Range: 3 dB to 50 dB
*RST: 3 dB
Default unit: DB

Example:

```
TRIG:SOUR IFP
```

Sets the IF power trigger source.

```
TRIG:IFP:HYST 10DB
```

Sets the hysteresis limit value.

Manual operation: See "Hysteresis" on page 65

TRIGger[:SEQuence]:LEVel[:EXTernal<port>] <TriggerLevel>

Defines the level the external signal must exceed to cause a trigger event.

Suffix:
<port> Selects the trigger port.
1 = trigger port 1 (TRIGGER INPUT connector on front panel)
2 = trigger port 2 (TRIGGER INPUT/OUTPUT connector on front panel)
3 = trigger port 3 (TRIGGER3 INPUT/OUTPUT connector on rear panel)

Parameters:
<TriggerLevel> Range: 0.5 V to 3.5 V
*RST: 1.4 V
Default unit: V

Example: `TRIG:LEV 2V`

Manual operation: See "Trigger Level" on page 64

TRIGger[:SEQuence]:LEVel:IFPower <TriggerLevel>

Defines the power level at the third intermediate frequency that must be exceeded to cause a trigger event.

Note that any RF attenuation or preamplification is considered when the trigger level is analyzed. If defined, a reference level offset is also considered.

Parameters:
<TriggerLevel> For details on available trigger levels and trigger bandwidths, see the data sheet.
*RST: -20 dBm
Default unit: DBM

Example: `TRIG:LEV:IFP -30DBM`

TRIGger[:SEQuence]:LEVel:MAPower <TriggerLevel>

Defines the power level that must be exceeded to cause a trigger event for (offline) input from a file.

Parameters:
<TriggerLevel> For details on available trigger levels and trigger bandwidths, see the data sheet.
Default unit: DBM

Example: `TRIG:LEV:MAP -30DBM`

TRIGger[:SEQuence]:MAPower:HOLDoff <Period>

Defines the holding time before the next trigger event for (offline) input from a file.

Parameters:

<Period>
Range: 0 s to 10 s
*RST: 0 s
Default unit: S

Example:
```
TRIG:SOUR MAGN
```
Sets an offline magnitude trigger source.
```
TRIG:MAP:HOLD 200 ns
```
Sets the holding time to 200 ns.

Manual operation: See "Trigger Holdoff" on page 65

TRIGger[:SEQuence]:MAPower:HYSTeresis <Hysteresis>

Defines the trigger hysteresis for the (offline) magnitude trigger source (used for input from a file).

Parameters:

<Hysteresis>
Range: 3 dB to 50 dB
*RST: 3 dB
Default unit: DB

Example:
```
TRIG:SOUR MAP
```
Sets the (offline) magnitude trigger source.
```
TRIG:MAP:HYST 10DB
```
Sets the hysteresis limit value.

Manual operation: See "Hysteresis" on page 65

TRIGger[:SEQuence]:SLOPe <Type>

Parameters:

<Type>
POSitive | NEGative

POSitive
Triggers when the signal rises to the trigger level (rising edge).

NEGative
Triggers when the signal drops to the trigger level (falling edge).

*RST: POSitive

Example:
```
TRIG:SLOP NEG
```

Manual operation: See "Slope" on page 65

TRIGger[:SEQuence]:SOURce <Source>

Selects the trigger source.

Note that the availability of trigger sources depends on the connected instrument.

Note on external triggers:

If a measurement is configured to wait for an external trigger signal in a remote control program, remote control is blocked until the trigger is received and the program can continue. Make sure that this situation is avoided in your remote control programs.

Parameters:

<Source>

IMMediate
Free Run

EXTernal
Trigger signal from the "Trigger Input" connector.

MAGNitude
For (offline) input from a file, rather than an instrument.
The trigger level is specified by `TRIGger[:SEQuence]:LEVel:MAPower`.

MAIT
For trigger information stored as markers in an `.iqx` file.

MANual
Only available for a connected R&S RTP:
Any trigger settings in the R&S VSE software are ignored; only trigger settings defined on the connected instrument are considered. Thus, you can use the more complex trigger settings available on an R&S RTP.

*RST: IMMediate

Example:
```
TRIG:SOUR EXT
```
Selects the external trigger input as source of the trigger signal

Manual operation:
See "Trigger Source" on page 63
See "Free Run" on page 63
See "External Trigger / Trigger Channel X" on page 63
See "Magnitude (Offline)" on page 64
See "Manual" on page 64

[SENSe:]BANDwidth[:RESolution] <Bandwidth>

Defines the resolution bandwidth and decouples the resolution bandwidth from the span.

Example:
```
BAND 1 MHz
```
Sets the resolution bandwidth to 1 MHz

9.4.8 Configuring the trigger output

The following commands are required to send the trigger signal to one of the variable "TRIGGER INPUT/OUTPUT" connectors on the connected instrument.

OUTPut<up>:TRIGger<tp>:DIRection <Direction>

Selects the trigger direction for trigger ports that serve as an input as well as an output.

Suffix:
<up> irrelevant

<tp>

Parameters:
<Direction> INPut | OUTPut

INPut
Port works as an input.

OUTPut
Port works as an output.

*RST: INPut

OUTPut<up>:TRIGger<tp>:LEVel <Level>

Defines the level of the (TTL compatible) signal generated at the trigger output.

Works only if you have selected a user-defined output with `OUTPut<up>:TRIGger<tp>:OTYPe`.

Suffix:
<up> 1..n

<tp> Selects the trigger port to which the output is sent.

Parameters:
<Level>

HIGH
5 V

LOW
0 V

*RST: LOW

Example:
```
OUTP:TRIG2:LEV HIGH
```

OUTPut<up>:TRIGger<tp>:OTYPe <OutputType>

Selects the type of signal generated at the trigger output.

Suffix:
<up> 1..n

<tp> Selects the trigger port to which the output is sent.

Parameters:

<OutputType>

DEVice
Sends a trigger signal when the R&S VSE has triggered internally.

TARMed
Sends a trigger signal when the trigger is armed and ready for an external trigger event.

UDEFined
Sends a user-defined trigger signal. For more information, see `OUTPut<up>:TRIGger<tp>:LEVel`.

*RST: DEVice

OUTPut<up>:TRIGger<tp>:PULSe:IMMediate

Generates a pulse at the trigger output.

Suffix:

<up> Selects the trigger port to which the output is sent.

<tp> 1..n

OUTPut<up>:TRIGger<tp>:PULSe:LENGth <Length>

Defines the length of the pulse generated at the trigger output.

Suffix:

<up> 1..n

<tp> Selects the trigger port to which the output is sent.

Parameters:

<Length> Pulse length in seconds.
Default unit: S

Example:

```
OUTP:TRIG2:PULS:LENG 0.02
```

9.4.9 Gating

[SENSe:]SWEep:EGATe <State>

Turns gated measurements on and off.

For measurements with an magnitude (offline) trigger gate, the measured values are recorded as long as the gate is opened. During a sweep the gate can be opened and closed several times. The synchronization mechanisms with *OPC, *OPC? and *WAI remain completely unaffected.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example:
```
SWE:EGAT ON
```
Switches on the gate mode.
```
SWE:EGAT:TYPE EDGE
```
Switches on the edge-triggered mode.
```
SWE:EGAT:HOLD 100US
```
Sets the gate delay to 100 µs.
```
SWE:EGAT:LEN 500US
```
Sets the gate opening time to 500 µs.
```
INIT;*WAI
```
Starts a sweep and waits for its end.

Manual operation: See "Gated Trigger" on page 65

[SENSe:]SWEep:EGATe:AUTO <State>

Determines whether the same or different triggers are used for general measurement and gating.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
The gate is opened by the trigger source defined by `[SENSe:]SWEep:EGATe:SOURce`, but only after a trigger from the general `TRIGger[:SEQuence]:SOURce` occurs.

ON | 1
(Default:) The trigger defined by `TRIGger[:SEQuence]:SOURce` is used both for the general measurement trigger and the gating trigger.

*RST: 1

Example:
```
SENS:SWE:EGAT:AUTO 0
SENS:SWE:EGAT:SOUR EXT2
SENS:SWE:EGAT:LEV:EXT2 1V
```
Sets the gating trigger to a level of 1 V at trigger port 2.

[SENSe:]SWEep:EGATe:CONTinuous:PCOunt <Amount>

Defines the number of gate periods to be measured after a single trigger event.

Parameters:

<Amount> integer

Range: 1 to <file_length> / <cont._period_length>
Increment: 1
*RST: 100

Example:
```
SWE:EGAT:CONT:PCO 50
```

[SENSe:]SWEep:EGATe:CONTinuous:PLENgth <Time>

Defines the length in seconds of a single gate period in continuous gating. The length is determined from the beginning of one gate measurement to the beginning of the next one.

Parameters:

<Time> Range: 1 / <file_sample_rate> to <file_length>
*RST: 5 ms
Default unit: S

Example:
```
SWE:EGAT:CONT:PLEN 10
```

[SENSe:]SWEep:EGATe:CONTinuous[:STATe] <State>

Activates or deactivates continuous gating.

This setting is only available if `[SENSe:]SWEep:EGATe` is "On".

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example:
```
SWE:EGAT ON
```
Activate gating
```
SWE:EGAT:CONT:STAT ON
```
Activate continuous gating

[SENSe:]SWEep:EGATe:HOLDoff <DelayTime>

Defines the delay time between the gate signal and the continuation of the measurement.

Parameters:

<DelayTime>
Range: 0 s to 30 s
*RST: 0 s
Default unit: S

Example:
```
SWE:EGAT:HOLD 100us
```

Manual operation: See "Gate Delay" on page 65

[SENSe:]SWEep:EGATe:LENGth <GateLength>

Defines the gate length.

Parameters:

<GateLength>
Range: 125 ns to 30 s
*RST: 400µs
Default unit: S

Example:
```
SWE:EGAT:LENG 10ms
```

Manual operation: See "Gate Length" on page 65

[SENSe:]SWEep:EGATe:LEVel[:EXTernal<tp>] <GateLevel>

Defines the gate level for which the gate is open.

Is only available for triggered gated measurements (`[SENSe:]SWEep:EGATe:AUTO MAN`).

Suffix:

<tp>
Selects the trigger port.
1 = trigger port 1 (TRIGGER INPUT connector on front panel)
2 = trigger port 2 (TRIGGER INPUT/OUTPUT connector on front panel)
3 = trigger port 3 (TRIGGER3 INPUT/OUTPUT connector on rear panel)

Parameters:

<GateLevel>
numeric value

Range: 0.5 V to 3.5 V
*RST: 1.4 V
Default unit: V

Example:
```
SENS:SWE:EGAT:AUTO MAN
SENS:SWE:EGAT:SOUR EXT2
SENS:SWE:EGAT:LEV:EXT2 1V
```
Sets the gating trigger to a level of 1 V at trigger port 2.

[SENSe:]SWEep:EGATe:LEVel:IFPower <GateLevel>

Defines the the power level at the third intermediate frequency that must be exceeded for the gate to be open.

Note that any RF attenuation or preamplification is considered when the trigger level is analyzed. If defined, a reference level offset is also considered.

Is only available for triggered gated measurements (`[SENSe:]SWEep:EGATe:AUTO MAN`).

Parameters:

<GateLevel> For details on available trigger levels and trigger bandwidths see the data sheet.

*RST: -10 dBm
Default unit: DBM

Example:

```
SENS:SWE:EGAT:AUTO MAN
SENS:SWE:EGAT:SOUR IFP
SENS:SWE:EGAT:LEV:IFP 0
```

Sets the gating trigger to a level of 0 dBm at the third IF.

[SENSe:]SWEep:EGATe:LEVel:RFPower <GateLevel>

Defines the gate level for which the gate is open. Note that any RF attenuation or pre-amplification is considered when the trigger level is analyzed. If defined, a reference level offset is also considered.

The input signal must be between 500 MHz and 8 GHz.

Is only available for triggered gated measurements (`[SENSe:]SWEep:EGATe:AUTO MAN`).

Parameters:

<GateLevel> For details on available trigger levels and trigger bandwidths see the data sheet.

*RST: -20 dBm
Default unit: DBM

Example:

```
SENS:SWE:EGAT:AUTO MAN
SENS:SWE:EGAT:SOUR RFP
SENS:SWE:EGAT:LEV:RFP -10
```

Sets the gating trigger to a level of -10 dBm at the RF input.

[SENSe:]SWEep:EGATe:POLarity <Polarity>

Selects the polarity of an external gate signal.

The setting applies both to the edge of an edge-triggered signal and the level of a level-triggered signal.

Parameters:
<Polarity> POSitive | NEGative
*RST: POSitive

Example: `SWE:EGAT:POL POS`

[SENSe:]SWEep:EGATe:SKIP <Comment>

Ignores the specified gates in a continuous gate measurement. This setting is only available for magnitude (offline) triggered measurements.

Parameters:
<Comment> String containing a comma-separated list of gate numbers to be ignored during a measurement.

Example: `SENS:SWEE:EGAT:SKIP '1,4-5'`

[SENSe:]SWEep:EGATe:SOURce <Source>

Selects the signal source for gated measurements.

If an IF power signal is used, the gate is opened as soon as a signal at > -20 dBm is detected within the IF path bandwidth (10 MHz).

For more information see "Trigger Source" on page 63.

Parameters:
<Source> *RST: IFPower

Example: `SWE:EGAT:SOUR IFP`
Switches the gate source to IF power.

[SENSe:]SWEep:EGATe:TYPE <Type>

Selects the way gated measurements are triggered.

Parameters:
<Type>
LEVel
The trigger event for the gate to open is a particular power level.
After the gate signal has been detected, the gate remains open until the signal disappears.
EDGE
The trigger event for the gate to open is the detection of the signal edge.
After the gate signal has been detected, the gate remains open until the gate length is over.
*RST: EDGE

Example: `SWE:EGAT:TYPE EDGE`

9.4.10 Configuring Modulation Characteristics measurements

9.4.10.1 Data acquisition

CONFigure:BTOoth:MEASurement:BWIDth?

Queries the used demodulation bandwidth, which depends on whether or not a measurement filter is used.

If the measurement filter is used, the demodulation bandwidth is 1.3 MHz. Otherwise, it is 3 MHz.

Example: Query whether measurement filter is used.
```
CONF:BTO:MEAS:FILT?
//Result: 0
```
Query the demodulation bandwidth.
```
CONF:BTO:MEAS:BWID?
//Result: 3000000
```

Usage: Query only

Manual operation: See "Demodulation Bandwidth" on page 59

CONFigure:BTOoth:MEASurement:FILTer <State>

Enables or disables the use of an optional measurement filter (see Chapter 3.2.1, "Measurement filter", on page 29).

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example:
```
CONF:BTO:MEAS:FILT ON
```

Manual operation: See "Meas Filter" on page 59

CONFigure:BTOoth:PTYPe <PacketType>

Defines the packet type used in the Bluetooth signal and thus the required capture time.

Parameters:

<PacketType>

DH1
Captures one slot

DH3
Captures 3 slots

DH5
Captures 5 slots

AUTO
For BR + EDR: captures 5 slots
For LE: The R&S VSE Bluetooth measurement application determines the required capture time to cover the payload automatically.

LE1M | LE2M | LECODED
For LE, the R&S VSE Bluetooth measurement application determines the required capture time to cover the payload automatically.

Example: `CONF:BTO:PTYP DH3`

Manual operation: See "Capture Time" on page 59

9.4.10.2 Burst synchronization

CONFigure:BTOoth:SEARch:PULSe:STATe <SearchBurstMode>

Enables or disables the search for a signal burst based on the measured power. If both `CONFigure:BTOoth:SEARch:SYNC:STATe ON` and `CONFigure:BTOoth:SEARch:PULSe:STATe ON`, the search area for the sync word is limited to the detected burst.

Example: `CONFigure:BTOoth:SEARch:PULSe:STATe ON`

CONFigure:BTOoth:SEARch:SYNC:LAP <LAP>

Sets or queries the lower address part of the Bluetooth device address (LAP, the 24 least significant bits). The LAP determines the sync word used for sync search.

Is not available for LE mode.

Parameters:

<LAP> hexadecimal number

Range: 0x000000 to 0xffffff
*RST: 0x0001

Example: `CONFigure:BTOoth:SEARch:SYNC:LAP 0x0001`

CONFigure:BTOoth:SEARch:SYNC:STATe <State>

Enables or disables the search for the sync word. The only results that can be determined without synchronization are the output power results. See "Synchronization" on page 28.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example: `CONFigure:BTOoth:SEARch:SYNC:STATe ON`

9.4.10.3 Demodulation

[SENSe:]CORRection:EGAin:INPut[:MAGNitude] <External Gain>

Defines an external gain that the R&S VSE Bluetooth measurement application takes into account for the measurement results.

The value depends on the used standard. See alsoChapter 5.2, "Configuration according to digital standards", on page 43 .

Parameters:

<External Gain> numeric value

Range: -200 to +200
*RST: 0
Default unit: DB

Example: `CORR:EGA:INP 10DB`
Takes 10 dB external gain into account.

Manual operation: See "Antenna Gain" on page 61

CONFigure:BTOoth:PBSCo <PayloadSize>

Defines the number of payload bytes for SCO packets. SCO packets do not have a payload header.

Parameters:
<PayloadSize> integer
Range: 1 to 1000
*RST: 1

Example: `CONF:BTO:PBSC 50`

Manual operation: See "Packet Bytes SCO" on page 61

9.4.11 Configuring In-band Spurious Emissions measurements

CONFigure:BTOoth:CHANnel <Tx>

Selects the transmit channel within the Bluetooth signal. Measurement results are based on this channel.

Parameters:
<Tx> integer
Range: 0 to 80

Example: `CONF:BTO:CHAN 39`

Manual operation: See "TX Channel No" on page 62
See "TX Channel" on page 62

9.4.12 Adjusting settings automatically

The following remote commands are required to adjust settings automatically in a remote environment.

[SENSe:]ADJust:CONFigure:LEVel:DURation <Duration>

To determine the ideal reference level, the R&S VSE performs a measurement on the current input data. This command defines the length of the measurement if `[SENSe:]ADJust:CONFigure:LEVel:DURation:MODE` is set to `MANual`.

Parameters:
<Duration> Numeric value in seconds
Range: 0.001 to 16000.0
*RST: 0.001
Default unit: s

Example: `ADJ:CONF:DUR:MODE MAN`
Selects manual definition of the measurement length.
`ADJ:CONF:LEV:DUR 5ms`
Length of the measurement is 5 ms.

[SENSe:]ADJust:CONFigure:LEVel:DURation:MODE <Mode>

To determine the ideal reference level, the R&S VSE performs a measurement on the current input data. This command selects the way the R&S VSE determines the length of the measurement .

Parameters:

<Mode>

AUTO
The R&S VSE determines the measurement length automatically according to the current input data.

MANual
The R&S VSE uses the measurement length defined by `[SENSe:]ADJust:CONFigure:LEVel:DURation` on page 143.

*RST: AUTO

[SENSe:]ADJust:CONFigure:HYSTeresis:LOWer <Threshold>

Parameters:

<Threshold>

Range: 0 dB to 200 dB
*RST: +1 dB
Default unit: dB

Example: `SENS:ADJ:CONF:HYST:LOW 2`
For an input signal level of currently 20 dBm, the reference level is only adjusted when the signal level falls below 18 dBm.

[SENSe:]ADJust:CONFigure:HYSTeresis:UPPer <Threshold>

Parameters:

<Threshold>

Range: 0 dB to 200 dB
*RST: +1 dB
Default unit: dB

Example: `SENS:ADJ:CONF:HYST:UPP 2`

Example: For an input signal level of currently 20 dBm, the reference level is only adjusted when the signal level rises above 22 dBm.

[SENSe:]ADJust:LEVel

Initiates a single (internal) measurement that evaluates and sets the ideal reference level for the current input data and measurement settings. Thus, the settings of the RF attenuation and the reference level are optimized for the signal level. The R&S VSE is not overloaded and the dynamic range is not limited by an S/N ratio that is too small.

Example: `ADJ:LEV`

Manual operation: See "Setting the Reference Level Automatically (Auto Level)" on page 54

9.5 Analyzing Bluetooth BR/EDR/LE measurements

9.5.1 Analyzing modulation characteristics

9.5.1.1 BR and LE signals

Power range

CONFigure:BTOoth:POWer:AVERage:STARt <Position>

Start position of the power range in which the average maximum power is determined.

Parameters:

<Position> Percentage of the burst length

Range: 0 to 100
*RST: 20
Default unit: PCT

Example:
```
CONF:BTO:POW:AVER:STAR 20
CONF:BTO:POW:AVER:STOP 80
```

Manual operation: See "Output Power Start / Output Power Stop" on page 68

CONFigure:BTOoth:POWer:AVERage:STOP <Position>

Stop position of the power range in which the average maximum power is determined.

Parameters:

<Position> Percentage of the burst length
Range: 0 to 100
*RST: 80
Default unit: PCT

Example:
```
CONF:BTO:POW:AVER:STAR 20
CONF:BTO:POW:AVER:STOP 80
```

Manual operation: See "Output Power Start / Output Power Stop" on page 68

Defining limit checks

CALCulate<n>:LIMit:TRACe<t>:CHECk <State>

Enables or disables a limit check for the measured results.

Note that this command replaces the two commands from previous signal and spectrum analyzers (which are still supported): `CALCulate<n>:LIMit<li>:TRACe<t>` + `CALCulate<n>:LIMit<li>:STATe`.

Suffix:
<n> irrelevant

<t> irrelevant

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 0

Example: `CALC:LIM:TRAC2:CHEC ON`
Enables a limit check on trace 2.

Manual operation: See "Limit Check" on page 69
See "Limit Check" on page 76

CONFigure:BTOoth:DH<pt>:FDRift:LLIMit <LowerLimit>

Defines the lower limit for the frequency drift for the specified packet type.

Suffix:
<pt> 1|3|5
packet type: 1, 3, or 5 slots

Parameters:
<LowerLimit> numeric value

Range: -500000 to 500000
*RST: DH1: -25000; DH3, DH5: -40000
Default unit: HZ

Example:
```
CALC:LIM:TRAC:CHEC ON
CONF:BTO:DH1:FDR:LLIM -80000
```

Manual operation: See "Freq Drift Upper / Freq Drift Lower" on page 71

CONFigure:BTOoth:DH<pt>:FDRift:ULIMit <UpperLimit>

Defines the upper limit for the frequency drift for the specified packet type.

Suffix:
<pt> 1|3|5
packet type: 1, 3, or 5 slots

Parameters:
<UpperLimit> numeric value

Range: -500000 to 500000
*RST: DH1: 25000; DH3, DH5: 40000
Default unit: HZ

Example:
```
CALC:LIM:TRAC:CHEC ON
CONF:BTO:DH1:FDR:ULIM 80000
```

Manual operation: See "Freq Drift Upper / Freq Drift Lower" on page 71

CONFigure:BTOoth:DH<pt>:MDRate:LLIMit <LowerLimit>

Defines the lower limit for the maximum frequency drift rate.

Suffix:
<pt> 1|3|5
packet type: 1, 3, or 5 slots

Parameters:
<LowerLimit> numeric value

Range: -500000 to 500000
*RST: 20000
Default unit: HZ

Example:
```
CALC:LIM:TRAC:CHEC ON
CONF:BTO:DH1:MDR:LLIM 8000
```

Manual operation: See "Max Drift Rate Upper / Max Drift Rate Lower" on page 71

CONFigure:BTOoth:DH<pt>:MDRate:ULIMit <UpperLimit>

Defines the upper limit for the maximum frequency drift rate.

Suffix:
<pt> 1|3|5
packet type: 1, 3, or 5 slots

Parameters:
<UpperLimit> numeric value

Range: -500000 to 500000
*RST: -20000
Default unit: HZ

Example:
```
CALC:LIM:TRAC:CHEC ON
CONF:BTO:DH1:MDR:ULIM -8000
```

Manual operation: See "Max Drift Rate Upper / Max Drift Rate Lower" on page 71

CONFigure:BTOoth:FDRift:LLIMit <LowerLimit>

Defines the lower limit for the frequency drift in LE signals.

Parameters:

<LowerLimit> numeric value

The lower limit must be at least 1 kHz lower than the upper limit.

Range: -500000 to 500000
*RST: -50000
Default unit: HZ

Example:

```
CALC:LIM:TRAC:CHEC ON
CONF:BTO:FDR:LLIM -50000
```

Manual operation: See "Freq Drift Upper / Freq Drift Lower" on page 71

CONFigure:BTOoth:FDRift:ULIMit <UpperLimit>

Defines the upper limit for the frequency drift in LE signals.

Parameters:

<UpperLimit> numeric value

The upper limit must be at least 1 kHz higher than the lower limit.

Range: -500000 to 500000
*RST: 50000
Default unit: HZ

Example:

```
CALC:LIM:TRAC:CHEC ON
CONF:BTO:FDR:ULIM 50000
```

Manual operation: See "Freq Drift Upper / Freq Drift Lower" on page 71

CONFigure:BTOoth:FOFFset:LLIMit <LowerLimit>

Defines the lower limit for the frequency offset in LE signals.

Parameters:

<LowerLimit> numeric value

The lower limit must be at least 1 kHz lower than the upper limit.

Range: -500000 to 500000
*RST: -150000
Default unit: HZ

Example:

```
CALC:LIM:TRAC:CHEC ON
CONF:BTO:FOFF:LLIM -50000
```

Manual operation: See "Freq Offset Upper / Lower" on page 73

CONFigure:BTOoth:FOFFset:ULIMit <UpperLimit>

Defines the upper limit for the frequency offset in LE signals.

Parameters:

<UpperLimit> numeric value

The upper limit must be at least 1 kHz higher than the lower limit.

Range: -500000 to 500000
*RST: 150000
Default unit: HZ

Example:

```
CALC:LIM:TRAC:CHEC ON
CONF:BTO:FODD:ULIM 50000
```

Manual operation: See "Freq Offset Upper / Lower" on page 73

CONFigure:BTOoth:ICFTolerance:LLIMit <LowerLimit>

Defines the lower limit for the initial carrier frequency tolerance (ICFT).

Parameters:

<LowerLimit> numeric value

The lower limit must be at least 1 kHz lower than the upper limit.

Range: -500000 to 500000
*RST: -75000
Default unit: HZ

Example:

```
CALC:LIM:TRAC:CHEC ON
CONF:BTO:ICFT:LLIM -80000
```

Manual operation: See "ICFT Upper / ICFT Lower" on page 70

CONFigure:BTOoth:ICFTolerance:ULIMit <UpperLimit>

Defines the upper limit for the initial carrier frequency tolerance (ICFT).

Parameters:

<UpperLimit> numeric value

Range: -500000 to 500000
*RST: 75000
Default unit: HZ

Example:

```
CALC:LIM:TRAC:CHEC ON
CONF:BTO:ICFT:ULIM 80000
```

Manual operation: See "ICFT Upper / ICFT Lower" on page 70

CONFigure:BTOoth:IFDRift:LLIMit <LowerLimit>

Defines the lower limit for the initial frequency drift of LE packets.

Parameters:

<LowerLimit> numeric value

Range: -500000 to 500000
*RST: -150000
Default unit: HZ

Example:

```
CALC:LIM:TRAC:CHEC ON
CONF:BTO:IFDR:ULIM -23000
```

Manual operation: See "Initial Freq Drift Upper / Initial Freq Drift Lower" on page 74

CONFigure:BTOoth:IFDRift:ULIMit <UpperLimit>

Defines the upper limit for the initial frequency drift of LE packets.

Parameters:

<UpperLimit> numeric value

Range: -500000 to 500000
*RST: -150000
Default unit: HZ

Example:

```
CALC:LIM:TRAC:CHEC ON
CONF:BTO:IFDR:ULIM 80000
```

Manual operation: See "Initial Freq Drift Upper / Initial Freq Drift Lower" on page 74

CONFigure:BTOoth:MDRate:LLIMit <LowerLimit>

Defines the lower limit for the maximum frequency drift rate in LE signals.

Parameters:

<LowerLimit> numeric value

Range: -500000 to 500000
*RST: -20000
Default unit: HZ

Example:

```
CALC:LIM:TRAC:CHEC ON
CONF:BTO:MDR:LLIM -50000
```

Manual operation: See "Max Drift Rate Upper / Max Drift Rate Lower" on page 71

CONFigure:BTOoth:MDRate:ULIMit <UpperLimit>

Defines the lower limit for the maximum frequency drift rate in LE signals.

Parameters:

<UpperLimit> numeric value

Range: -500000 to 500000
*RST: 20000
Default unit: HZ

Example:
```
CALC:LIM:TRAC:CHEC ON
CONF:BTO:MDR:ULIM 50000
```

Manual operation: See "Max Drift Rate Upper / Max Drift Rate Lower" on page 71

CONFigure:BTOoth:MODulation:F1AVerage:LLIMit <LowerLimit>

Defines the lower limit for the average frequency offset for the first test sequence (00001111).

Parameters:

<LowerLimit> numeric value

The lower limit must be at least 1 kHz lower than the upper limit.

Range: -500000 to 500000
*RST: 115000
Default unit: HZ

Example:
```
CALC:LIM:TRAC:CHEC ON
CONF:BTO:MOD:F1AV:LLIM 120000
```

Manual operation: See "Δf1 Avg Upper / Δf1 Avg Lower" on page 70

CONFigure:BTOoth:MODulation:F1AVerage:ULIMit <UpperLimit>

Defines the upper limit for the average frequency offset for the first test sequence (00001111).

Parameters:

<UpperLimit> numeric value

Range: -500000 to 500000
*RST: 175000
Default unit: HZ

Example:
```
CALC:LIM:TRAC:CHEC ON
CONF:BTO:MOD:F1AV:ULIM 180000
```

Manual operation: See "Δf1 Avg Upper / Δf1 Avg Lower" on page 70

CONFigure:BTOoth:MODulation:F1Max:IRANge <InRange>

Defines the limit for the maximum frequency offset for the first test sequence to be in range (for LE Coded).

Parameters:

<InRange> Allowed range for the maximum offset

Range: 0 to 1
*RST: 0.999
Default unit: PCT

Example:
```
CALC:LIM:TRAC:CHEC ON
CONF:BTO:MOD:F1M:LLIM 0.8
```

Manual operation: See "Δf1 Max In Range (LE Coded)" on page 74

CONFigure:BTOoth:MODulation:F1Max:LLIMit <LowerLimit>

Defines the lower limit for the maximum frequency offset for the first test sequence (for LE coded).

Parameters:

<LowerLimit> numeric value

Range: -500000 to 500000
*RST: 115000
Default unit: HZ

Example:
```
CALC:LIM:TRAC:CHEC ON
CONF:BTO:MOD:F1MAX:LLIM 8000
```

Manual operation: See "Δf1 Max Lower (LE Coded)" on page 73

CONFigure:BTOoth:MODulation:FDIVision:LLIMit <LowerLimit>

Defines the lower limit for the ratio of average f2 offset to average f1 offset.

Parameters:

<LowerLimit> Lower limit for the average offset ratio of f2 to f1.

Range: 0 to 1
*RST: 0.8

Example:
```
CALC:LIM:TRAC:CHEC ON
CONF:BTO:MOD:FDIV:LLIM 0.78
```

Manual operation: See "Δf2 Avg / Δf1 Avg Lower" on page 70

CONFigure:BTOoth:MODulation:F2Max:IRANge <InRange>

Defines the limit for the maximum frequency offset for the second test sequence (01010101) to be in range.

Parameters:

<InRange> Allowed range for the maximum offset

Range: 0 to 1
*RST: 0.999
Default unit: PCT

Example:
```
CALC:LIM:TRAC:CHEC ON
CONF:BTO:MOD:F2M:LLIM 0.8
```

Manual operation: See "Δf2 Max In Range" on page 70

CONFigure:BTOoth:MODulation:F2Max:LLIMit <LowerLimit>

Defines the lower limit for the maximum frequency offset for the second test sequence (01010101).

Parameters:

<LowerLimit> numeric value

Range: -500000 to 500000
*RST: 115000
Default unit: HZ

Example:

```
CALC:LIM:TRAC:CHEC ON
CONF:BTO:MOD:F2MAX:LLIM 8000
```

Manual operation: See "Δf2 Max Lower" on page 70

CONFigure:BTOoth:POWer:AVERage:LLIMit <LowerLimit>

Defines the lower limit for the average output power.

Parameters:

<LowerLimit>

Range: -200 to 100
*RST: 0
Default unit: DBM

Example:

```
CALC:LIM:TRAC:CHEC ON
CONF:BTO:POW:AVER:LLIM 20
CONF:BTO:POW:AVER:ULIM 80
```

Manual operation: See "Average Upper/ Average Lower" on page 69

CONFigure:BTOoth:POWer:AVERage:ULIMit <UpperLimit>

Defines the upper limit for the average output power.

Parameters:

<UpperLimit>

Range: -200 to 100
*RST: 20
Default unit: DBM

Example:

```
CALC:LIM:TRAC:CHEC ON
CONF:BTO:POW:AVER:LLIM 20
CONF:BTO:POW:AVER:ULIM 80
```

Manual operation: See "Average Upper/ Average Lower" on page 69

CONFigure:BTOoth:POWer:PEAK:RLIMit <RelativeLimit>

The (calculated) limit for the peak output power relative to the average output power.

See `CONFigure:BTOoth:POWer:PEAK:ULIMit` and `CONFigure:BTOoth:POWer:AVERage:ULIMit`.

Parameters:

<RelativeLimit> numeric value

Range: -200 to 100
*RST: 3
Default unit: DBM

Example:
```
CALC:LIM:TRAC:CHEC ON
CONF:BTO:POW:PEAK:ULIM?
CONF:BTO:POW:AVER:ULIM?
CONF:BTO:POW:PEAK:RLIM?
```

Manual operation: See "Relative Peak Upper (Rel. to Avg Power)" on page 70

CONFigure:BTOoth:POWer:PEAK:ULIMit <UpperLimit>

Defines the upper limit for the peak output power.

Parameters:

<UpperLimit>
Range: -200 to 100
*RST: 23
Default unit: DBM

Example:
```
CALC:LIM:TRAC:CHEC ON
CONF:BTO:POW:PEAK:ULIM 25
```

Manual operation: See "Peak Upper" on page 70

9.5.1.2 EDR signals

Evaluation range

CONFigure:BTOoth:CFSTability:BCOunt <BlockCount>

Defines the number of blocks to be measured for the carrier frequency stability. (See "Carrier frequency stability" on page 28.)

Parameters:

<BlockCount>
numeric value
Range: 0 to 1000000
*RST: 200

Example:
```
CONF:BTO:CFST:BCO 250
```

Manual operation: See "Block Count" on page 75

CONFigure:BTOoth:RTPower:DAVerage:STARt <Time>

Defines the start time of the power measurement for the DPSK-modulated part of the signal.

Parameters:

<Time> Percentage of the total measurement time

Range: 0 to 100
*RST: 10
Default unit: PCT

Example: `CONF:BTO:RTP:DAV:STAR 20`

Manual operation: See "DPSK Power Start / DPSK Power Stop" on page 75

CONFigure:BTOoth:RTPower:DAVerage:STOP <Time>

Defines the stop time of the power measurement for the DPSK-modulated part of the signal.

Parameters:

<Time> Percentage of the total measurement time

Range: 0 to 100
*RST: 90
Default unit: PCT

Example: `CONF:BTO:RTP:DAV:STOP 20`

Manual operation: See "DPSK Power Start / DPSK Power Stop" on page 75

CONFigure:BTOoth:RTPower:GAVerage:STARt <Percentage>

Defines the start time of the power measurement for the GFSK-modulated part of the signal.

Parameters:

<Percentage> Percentage of the total measurement time

Range: 0 to 100
*RST: 10
Default unit: PCT

Example: `CONF:BTO:RTP:GAV:STAR 20`

Manual operation: See "GFSK Power Start / GFSK Power Stop" on page 75

CONFigure:BTOoth:RTPower:GAVerage:STOP <Time>

Defines the stop time of the power measurement for the GFSK-modulated part of the signal.

Parameters:

<Time> Percentage of the total measurement time

Range: 0 to 100
*RST: 90
Default unit: PCT

Example: `CONF:BTO:RTP:GAV:STOP 20`

Manual operation: See "GFSK Power Start / GFSK Power Stop" on page 75

Defining limit checks

CONFigure:BTOoth:CFSTability:BFRequency:LLIMit <Limit>

Defines the lower limit of the block frequency.

Parameters:

<Limit> numeric value

The lower limit must be at least 1 kHz lower than the upper limit.

Range: -1000000 to 1000000
*RST: -10000
Default unit: HZ

Example:
```
CALC:LIM:TRAC:CHEC ON
CONF:BTO:CFST:BFR:LLIM -8000
```

Manual operation: See "Block Freq Offset Upper / Lower" on page 77

CONFigure:BTOoth:CFSTability:BFRequency:ULIMit <Limit>

Defines the upper limit of the initial frequency.

Parameters:

<Limit> numeric value

The upper limit must be at least 1 kHz higher than the lower limit.

Range: -1000000 to 1000000
*RST: 10000
Default unit: HZ

Example:
```
CALC:LIM:TRAC:CHEC ON
CONF:BTO:CFST:BFR:ULIM 8000
```

Manual operation: See "Block Freq Offset Upper / Lower" on page 77

CONFigure:BTOoth:CFSTability:IFRequency:LLIMit <Limit>

Defines the lower limit of the initial frequency.

Parameters:

<Limit> numeric value

The lower limit must be at least 1 kHz lower than the upper limit.

Range: -1000000 to 1000000
*RST: -75000
Default unit: HZ

Example:
```
CALC:LIM:TRAC:CHEC ON
CONF:BTO:CFST:IFR:LLIM -80000
```

Manual operation: See "Initial Freq Offset Upper / Lower" on page 77

CONFigure:BTOoth:CFSTability:IFRequency:ULIMit <Limit>

Defines the upper limit of the initial frequency.

Parameters:

<Limit> numeric value

The upper limit must be at least 1 kHz higher than the lower limit.

Range: -1000000 to 1000000
*RST: 75000
Default unit: HZ

Example:
```
CALC:LIM:TRAC:CHEC ON
CONF:BTO:CFST:IFR:ULIM 80000
```

Manual operation: See "Initial Freq Offset Upper / Lower" on page 77

CONFigure:BTOoth:CFSTability:TFRequency:LLIMit <Limit>

Defines the lower limit of the total frequency offset.

Parameters:

<Limit> numeric value

The lower limit must be at least 1 kHz lower than the upper limit.

Range: -1000000 to 1000000
*RST: -75000
Default unit: HZ

Example:
```
CALC:LIM:TRAC:CHEC ON
CONF:BTO:CFST:TFR:LLIM -80000
```

Manual operation: See "Total Freq Offset Upper / Lower" on page 77

CONFigure:BTOoth:CFSTability:TFRequency:ULIMit <Limit>

Defines the upper limit of the total frequency offset.

Parameters:

<Limit> numeric value

The upper limit must be at least 1 kHz higher than the lower limit.

Range: -1000000 to 1000000
*RST: 75000
Default unit: HZ

Example:

```
CALC:LIM:TRAC:CHEC ON
CONF:BTO:CFST:TFR:ULIM 8000
```

Manual operation: See "Total Freq Offset Upper / Lower" on page 77

CONFigure:BTOoth:MODulation:DQ99:ULIMit <UpperLimit>

Defines the upper limit for the 99-percentile DEVM for the DQPSK-modulated part of the signal.

Parameters:

<UpperLimit> numeric value

Range: 0 to 100
*RST: 35
Default unit: PCT

Example:

```
CALC:LIM:TRAC:CHEC ON
CONF:BTO:MOD:DQ99:ULIM 20
```

Manual operation: See "99% DQPSK / 8PSK" on page 77

CONFigure:BTOoth:MODulation:P8PSk:ULIMit <UpperLimit>

Defines the upper limit for the peak DEVM for the 8PSK-modulated part of the signal.

Parameters:

<UpperLimit> numeric value

The lower limit must be at least 1 kHz lower than the upper limit.

Range: 0 to 100
*RST: 25
Default unit: PCT

Example:

```
CALC:LIM:TRAC:CHEC ON
CONF:BTO:MOD:P8PS:ULIM 20
```

Manual operation: See "Peak DQPSK / 8PSK" on page 77

CONFigure:BTOoth:MODulation:PDQPsk:ULIMit <UpperLimit>

Defines the upper limit for the peak DEVM for the DQPSK-modulated part of the signal.

Parameters:
<UpperLimit> numeric value
Range: 0 to 100
*RST: 35
Default unit: PCT

Example:
```
CALC:LIM:TRAC:CHEC ON
CONF:BTO:MOD:PDQP:ULIM 20
```

Manual operation: See "Peak DQPSK / 8PSK" on page 77

CONFigure:BTOoth:MODulation:PS99:ULIMit <UpperLimit>

Defines the upper limit for the 99-percentile DEVM for the 8PSK-modulated part of the signal.

Parameters:
<UpperLimit> numeric value
Range: 0 to 100
*RST: 20
Default unit: PCT

Example:
```
CALC:LIM:TRAC:CHEC ON
CONF:BTO:MOD:PS99:ULIM 20
```

Manual operation: See "99% DQPSK / 8PSK" on page 77

CONFigure:BTOoth:MODulation:R8PSk:ULIMit <UpperLimit>

Defines the upper limit for the RMS DEVM for the 8PSK-modulated part of the signal.

Parameters:
<UpperLimit> numeric value
Range: 0 to 100
*RST: 13
Default unit: PCT

Example:
```
CALC:LIM:TRAC:CHEC ON
CONF:BTO:MOD:R8PS:ULIM 20
```

Manual operation: See "RMS DQPSK / 8PSK" on page 77

CONFigure:BTOoth:MODulation:RDQPsk:ULIMit <UpperLimit>

Defines the upper limit for the RMS DEVM for the DQPSK-modulated part of the signal.

Parameters:
<UpperLimit> numeric value
Range: 0 to 100
*RST: 20
Default unit: PCT

Example:
```
CALC:LIM:TRAC:CHEC ON
CONF:BTO:MOD:RDQP:ULIM 80
```

Manual operation: See "RMS DQPSK / 8PSK" on page 77

CONFigure:BTOoth:RTPower:LLIMit <LowerLimit>

Defines the lower limit of the relative TX power.

Parameters:

<LowerLimit> numeric value

Range: -100 to 100
*RST: -4
Default unit: DB

Example:
```
CALC:LIM:TRAC:CHEC ON
CONF:BTO:RTP:LLIM -80
```

Manual operation: See "Rel. Avg Power Upper / Lower" on page 78

CONFigure:BTOoth:RTPower:ULIMit <UpperLimit>

Defines the upper limit of the relative TX power.

Parameters:

<LowerLimit> numeric value

Range: -100 to 100
*RST: 1
Default unit: DB

Example:
```
CALC:LIM:TRAC:CHEC ON
CONF:BTO:RTP:ULIM 80
```

Manual operation: See "Rel. Avg Power Upper / Lower" on page 78

9.5.2 Analyzing in-band spurious emissions

9.5.2.1 Measurement settings

Useful commands for configuring in-band spurious emissions measurements described elsewhere:

- `[SENSe:]CORRection:EGAin:INPut[:MAGNitude]` on page 142

Remote commands exclusive to configuring in-band spurious emissions measurements:

[SENSe:]FREQuency:CENTer <Frequency>

Defines the center frequency (frequency domain) or measuring frequency (time domain).

Parameters:

<Frequency> Values depend on standard, see Table 3-1.
Default unit: HZ

Example:
```
SENS:FREQ:CENT 1 GHz
```

Manual operation: See "Center Frequency" on page 51

[SENSe:]FREQuency:CENTer:STEP <FrequencyStep>

Defines the center frequency step size.

You can increase or decrease the center frequency quickly in fixed steps using the `SENS:FREQ UP` AND `SENS:FREQ DOWN` commands, see `[SENSe:]FREQuency:CENTer` on page 162.

Parameters:

<FrequencyStep> f_{max} is specified in the data sheet.
Range: 1 to fMAX
*RST: 0.1 x span
Default unit: Hz

Example:
```
//Set the center frequency to 110 MHz.
FREQ:CENT 100 MHz
FREQ:CENT:STEP 10 MHz
FREQ:CENT UP
```

Manual operation: See "Frequency Stepsize" on page 52

[SENSe:]FREQuency:CENTer:STEP:LINK <StepLink>

Couples and decouples the center frequency step size to the span.

Parameters:

<StepLink> SPAN | OFF

SPAN
Couples the step size to the span. Available for measurements in the frequency domain.

OFF
Decouples the step size.

*RST: SPAN

Example: //Couple step size to span
```
FREQ:CENT:STEP:LINK SPAN
```

[SENSe:]SWEep:COUNt <SweepCount>

Defines the number of sweeps that the application uses to average traces.

In continuous sweep mode, the application calculates the moving average over the average count.

In single sweep mode, the application stops the measurement and calculates the average after the average count has been reached.

Parameters:
<SweepCount> If you set a sweep count of 0 or 1, the application performs one single sweep in single sweep mode.
In continuous sweep mode, if the average count is set to 0, a moving average over 10 sweeps is performed.

Range: 0 to 32767
*RST: 0

Example:
```
SWE:COUN 64
```
Sets the number of sweeps to 64.
```
INIT:CONT OFF
```
Switches to single sweep mode.
```
INIT;*WAI
```
Starts a sweep and waits for its end.

Manual operation: See "Sweep Count" on page 81

[SENSe:]SWEep:TIME <Time>

Defines the signal capture time. It automatically decouples the time from any other settings.

The value depends on the used standard. See also Chapter 6.2.1, "Measurement settings depending on standard", on page 78.

Parameters:
<Time> Range: 400 us to 190 ms
Default unit: s

Example:
```
SENSe:SWEep:TIME 0.1
```

Manual operation: See "Capture Time" on page 81

CONFigure:BTOoth:IBSemissions:GEOGraphy <Geography>

The specifications for in-band spurious emissions measurements differ for France and the rest of the world. Thus, in order to check the measurement results against limits for a particular standard, you must define the geographical location to consider. See also Chapter 6.2.1, "Measurement settings depending on standard", on page 78.

Parameters:

<Geography> FRANce | OTHer

Example: `CONF:BTO:IBS:GEOG OTH`

Manual operation: See "Geography" on page 80

CONFigure:BTOoth:IBSemissions:NCHannels <Channels>

Defines the number of channels that are captured by the in-band spurious emissions measurement. The number must be an odd number.

Parameters:

<Channels> odd-numbered integer

The value depends on the used standard. See also Chapter 6.2.1, "Measurement settings depending on standard", on page 78.

Example: `CONF:BTO:IBS:NCH 21`
The R&S VSE Bluetooth measurement application measures 21 channels.

Manual operation: See "Number of Captured Channels" on page 81

CONFigure:BTOoth:LOAD <FilePath>

Loads the measurement settings for the selected standard from a file with the defined name.

For an overview of predefined standards and settings, see Chapter A, "Predefined standards and settings", on page 196.

Parameters:

<FilePath> String containing the path and name of the file. Do not include the file extension.

Example: `CONF:BTO:LOAD 'BT_2-DH1'`

Usage: Setting only

Manual operation: See "Load Predefined Settings" on page 82

CONFigure:BTOoth:STORe <FilePath>

Saves the current measurement settings for a specific standard as a file with the defined name.

Parameters:

<FilePath> String containing the path and name of the file. Do not include the file extension.

Example: `CONF:BTO:STOR 'BT_LE_1M'`

Usage: Setting only

Manual operation: See "Save Predefined Settings" on page 82

9.5.2.2 Checking limits

Useful commands for checking limits described elsewhere:

- `CALCulate<n>:LIMit:TRACe<t>:CHECk` on page 146

Remote commands exclusive to checking limits in in-band spurious emissions measurements:

CONFigure:BTOoth:IBSemissions:FLIMit <Far Limit>

Defines the minimum power difference between the TX channel and the second or further alternate channels.

Parameters:

<Far Limit>
Range: -200 to +100
*RST: -40
Default unit: DBM

Example: `CONF:BTO:IBS:FLIM -40 dBm`

Manual operation: See "Far Limit" on page 84

CONFigure:BTOoth:IBSemissions:L2MHz <Limit>

Defines the minimum power difference at a specified frequency offset from the transmit frequency.

This setting is only available for BT LE 1M and LE coded mode.

Parameters:

<Limit>
Range: -200 to +100
*RST: -20
Default unit: DBM

Example: `CONF:BTO:IBS:L2MHz -20 dBm`

Manual operation: See "Limits for channels at frequency offsets" on page 84

CONFigure:BTOoth:IBSemissions:L4MHz <Limit>

Defines the minimum power difference at a specified frequency offset from the transmit frequency.

This setting is only available for BT LE 2M mode.

Parameters:

<Limit>
Range: -200 to +100
*RST: -20
Default unit: DBM

Example:
```
CONF:BTO:IBS:L4MHz -20 dBm
```

Manual operation: See "Limits for channels at frequency offsets" on page 84

CONFigure:BTOoth:IBSemissions:L5MHz <Limit>

Defines the minimum power difference at a specified frequency offset from the transmit frequency.

This setting is only available for BT LE 2M mode.

Parameters:

<Limit>
Range: -200 to +100
*RST: -20
Default unit: DBM

Example:
```
CONF:BTO:IBS:L4MHz -20 dBm
```

Manual operation: See "Limits for channels at frequency offsets" on page 84

CONFigure:BTOoth:IBSemissions:NFAilures <NofFailures>

Defines the number of acceptable exceptions for the limit check to be considered passed.

Parameters:

<NofFailures>
integer
Range: 0 to 80
*RST: 0

Example:
```
CONF:BTO:IBS:NFA 4
```
The result of the lmiit check is pass even if 4 limit check failures are detected.

Manual operation: See "Allowed Exceptions" on page 83

CONFigure:BTOoth:IBSemissions:NLIMit <Near Limit>

Defines the minimum power difference between the TX channel and the first alternate channel.

This setting is not available for BT LE mode.

Parameters:

<Near Limit> Range: -200 to +100
*RST: -20
Default unit: DBM

Example: `CONF:BTO:IBS:NLIM -20 dBm`

Manual operation: See "Near Limit" on page 84

CONFigure:BTOoth:IBSemissions:RLIMit <Relative Limit>

Defines the minimum power difference between the TX channel and the adjacent channel.

This setting is not available for BT LE mode.

Parameters:

<Relative Limit> Range: -200 to +100
*RST: -26
Default unit: DBM

Example: `CONF:BTO:IBS:RLIM -26 dBm`

Manual operation: See "Relative Limit" on page 84

9.5.3 Working with markers

Markers help you analyze your measurement results by determining particular values in the diagram. Thus you can extract numeric values from a graphical display.

Manual configuration of markers is described in Chapter 6.5, "Working with markers in the R&S VSE Bluetooth measurement application", on page 86.

9.5.3.1 Individual marker settings

In VSA evaluations, up to 5 markers can be activated in each diagram at any time.

CALCulate<n>:MARKer<m>:AOFF

Turns off all markers.

Suffix:
<n> Window

<m> Marker

Example: `CALC:MARK:AOFF`
Switches off all markers.

Manual operation: See "All Markers Off" on page 89

CALCulate<n>:MARKer<m>:LINK <MarkerCoupling>

With this command markers between several screens can be coupled, i.e. use the same x-value. All screens can be linked with the marker x-value scaled in symbols or time, except those showing the capture buffer. If several capture buffer measurements are visible, their markers are coupled, too.

Suffix:
<n> Window

<m> Marker

Setting parameters:
<MarkerCoupling> ON | OFF | 1 | 0
*RST: 0

CALCulate<n>:MARKer<ms>:LINK:TO:MARKer<md> <State>

Links the normal source marker <ms> to any active destination marker <md> (normal or delta marker).

If you change the horizontal position of marker <md>, marker <ms> changes its horizontal position to the same value.

Suffix:
<n> Window

<ms> source marker, see Marker

<md> destination marker, see Marker

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:MARK4:LINK:TO:MARK2 ON`
Links marker 4 to marker 2.

Manual operation: See "Linking to Another Marker" on page 89

CALCulate<n>:MARKer<m>[:STATe] <State>

Turns markers on and off. If the corresponding marker number is currently active as a delta marker, it is turned into a normal marker.

Suffix:

<n> Window

<m> Marker

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:MARK3 ON`
Switches on marker 3.

Manual operation: See "Marker 1/ Delta Marker 1/ Delta Marker 2/ Delta Marker 16" on page 88
See "Marker State" on page 88
See "Marker Type" on page 88
See "Select Marker" on page 91

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

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:

<n> Window

<m> Marker

Parameters:

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

Example: //Assign marker to trace 1
`CALC:MARK3:TRAC 2`

Manual operation: See "Assigning the Marker to a Trace" on page 89

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

Moves a marker to a specific coordinate on the x-axis.

If necessary, the command activates the marker.

If the marker has been used as a delta marker, the command turns it into a normal marker.

Suffix:

<n> Window

<m> Marker

Parameters:

<Position> Numeric value that defines the marker position on the x-axis.
The unit depends on the result display.

Range: The range depends on the current x-axis range.
Default unit: Hz

Example: `CALC:MARK2:X 1.7MHz`
Positions marker 2 to frequency 1.7 MHz.

Manual operation: See "Marker Table" on page 35
See "Marker 1/ Delta Marker 1/ Delta Marker 2/ Delta Marker 16" on page 88
See "Marker Position X-value" on page 88

CALCulate<n>:MARKer<m>:Y?

Queries the result at the position of the specified marker.

Suffix:

<n> 1..n

<m> 1..n

Return values:

<Result> Default unit: DBM

Usage: Query only

CALCulate<n>:DELTamarker<m>:AOFF

Turns off *all* delta markers.

Suffix:
<n> Window

<m> irrelevant

Example: CALC:DELT:AOFF
Turns off all delta markers.

CALCulate<n>:DELTamarker<m>:LINK <State>

Links delta marker <m> to marker 1.

If you change the horizontal position (x-value) of marker 1, delta marker <m> changes its horizontal position to the same value.

Suffix:
<n> Window

<m> Marker

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: CALC:DELT2:LINK ON

Manual operation: See "Linking to Another Marker" on page 89

CALCulate<n>:DELTamarker<ms>:LINK:TO:MARKer<md> <State>

Links the delta source marker <ms> to any active destination marker <md> (normal or delta marker).

Suffix:
<n> Window

<ms> source marker, see Marker

<md> destination marker, see Marker

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: CALC:DELT4:LINK:TO:MARK2 ON
Links the delta marker 4 to the marker 2.

Manual operation: See "Linking to Another Marker" on page 89

CALCulate<n>:DELTamarker<m>:MREFerence <Reference>

Selects a reference marker for a delta marker other than marker 1.

Suffix:
<n> Window

<m> Marker

Parameters:
<Reference>

Example: `CALC:DELT3:MREF 2`
Specifies that the values of delta marker 3 are relative to marker 2.

Manual operation: See "Reference Marker" on page 89

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

Moves a delta marker to a particular coordinate on the x-axis.

If necessary, the command activates the delta marker and positions a reference marker to the peak power.

Suffix:
<n> Window

<m> Marker

Example: `CALC:DELT:X?`
Outputs the absolute x-value of delta marker 1.

Manual operation: See "Marker 1/ Delta Marker 1/ Delta Marker 2/ Delta Marker 16" on page 88
See "Marker Position X-value" on page 88

CALCulate<n>:DELTamarker<m>:Y?

Queries the result at the position of the specified delta marker.

Suffix:
<n> 1..n

<m> 1..n

Return values:
<Result> Result at the position of the delta marker.
The unit is variable and depends on the one you have currently set.
Default unit: DBM

Usage: Query only

CALCulate<n>:DELTamarker<m>[:STATe] <State>

Turns delta markers on and off.

If necessary, the command activates the delta marker first.

No suffix at DELTamarker turns on delta marker 1.

Suffix:
<n> Window

<m> Marker

Parameters:
<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

Example: `CALC:DELT2 ON`
Turns on delta marker 2.

Manual operation: See "Marker 1/ Delta Marker 1/ Delta Marker 2/ Delta Marker 16" on page 88
See "Marker State" on page 88
See "Marker Type" on page 88
See "Select Marker" on page 91

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

Selects the trace a delta 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:
<n> Window

<m> Marker

Parameters:
<Trace> Trace number the marker is assigned to.

Example: `CALC:DELT2:TRAC 2`
Positions delta marker 2 on trace 2.

9.5.3.2 General marker settings

DISPlay[:WINDow<n>]:MINFo[:STATe] <State>

Turns the marker information in all diagrams on and off.

Suffix:
<n> irrelevant

Parameters:
<State> **ON | 1**
Displays the marker information in the diagrams.
OFF | 0
Hides the marker information in the diagrams.
*RST: 1

Example: `DISP:MINF OFF`
Hides the marker information.

Manual operation: See "Marker Info" on page 90

DISPlay[:WINDow<n>]:MTABle <DisplayMode>

Turns the marker table on and off.

Suffix:
<n> irrelevant

Parameters:
<DisplayMode> **ON | 1**
Turns on the marker table.
OFF | 0
Turns off the marker table.
*RST: AUTO

Example: `DISP:MTAB ON`
Activates the marker table.

Manual operation: See "Marker Table Display" on page 90

9.5.3.3 Marker search and positioning settings

Several functions are available to set the marker to a specific position very quickly and easily. In order to determine the required marker position, searches may be performed. The search results can be influenced by special settings.

Useful commands for positioning markers described elsewhere:

- `CALCulate<n>:MARKer<m>:TRACe` on page 169
- `CALCulate<n>:DELTamarker<m>:TRACe` on page 173

Remote commands exclusive to positioning markers:

CALCulate<n>:DELTamarker<m>:MAXimum:LEFT

Moves a delta marker to the next positive peak value.

The search includes only measurement values to the left of the current marker position.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Next Peak" on page 92

CALCulate<n>:DELTamarker<m>:MAXimum:NEXT

Moves a marker to the next positive peak value.

Suffix:
<n> 1..n
Window

<m> 1..n
Marker

Manual operation: See "Search Next Peak" on page 92

CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]

Moves a delta marker to the highest level.

If the marker is not yet active, the command first activates the marker.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Peak Search" on page 91

CALCulate<n>:DELTamarker<m>:MAXimum:RIGHt

Moves a delta marker to the next positive peak value on the trace.

The search includes only measurement values to the right of the current marker position.

Suffix:
<n> Window
<m> Marker

Manual operation: See "Search Next Peak" on page 92

CALCulate<n>:DELTamarker<m>:MINimum:LEFT

Moves a delta marker to the next minimum peak value.

The search includes only measurement values to the right of the current marker position.

Suffix:
<n> Window
<m> Marker

Manual operation: See "Search Next Minimum" on page 92

CALCulate<n>:DELTamarker<m>:MINimum:NEXT

Moves a marker to the next minimum peak value.

Suffix:
<n> Window
<m> Marker

Manual operation: See "Search Next Minimum" on page 92

CALCulate<n>:DELTamarker<m>:MINimum[:PEAK]

Moves a delta marker to the minimum level.

If the marker is not yet active, the command first activates the marker.

Suffix:
<n> Window
<m> Marker

Manual operation: See "Search Minimum" on page 92

CALCulate<n>:DELTamarker<m>:MINimum:RIGHt

Moves a delta marker to the next minimum peak value.

The search includes only measurement values to the right of the current marker position.

Suffix:
<n> Window
<m> Marker

Manual operation: See "Search Next Minimum" on page 92

CALCulate<n>:MARKer<m>:MAXimum:LEFT

Moves a marker to the next positive peak.

The search includes only measurement values to the left of the current marker position.

Suffix:
<n> Window
<m> Marker

Manual operation: See "Search Next Peak" on page 92

CALCulate<n>:MARKer<m>:MAXimum:NEXT

Moves a marker to the next positive peak.

Suffix:
<n> Window
<m> Marker

Manual operation: See "Search Next Peak" on page 92

CALCulate<n>:MARKer<m>:MAXimum:RIGHt

Moves a marker to the next positive peak.

The search includes only measurement values to the right of the current marker position.

Suffix:
<n> Window
<m> Marker

Manual operation: See "Search Next Peak" on page 92

CALCulate<n>:MARKer<m>:MAXimum[:PEAK]

Moves a marker to the highest level.

If the marker is not yet active, the command first activates the marker.

Suffix:
<n> Window
<m> Marker

Manual operation: See "Peak Search" on page 91

CALCulate<n>:MARKer<m>:MINimum:LEFT

Moves a marker to the next minimum peak value.

The search includes only measurement values to the right of the current marker position.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Next Minimum" on page 92

CALCulate<n>:MARKer<m>:MINimum:NEXT

Moves a marker to the next minimum peak value.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Next Minimum" on page 92

CALCulate<n>:MARKer<m>:MINimum:RIGHt

Moves a marker to the next minimum peak value.

The search includes only measurement values to the right of the current marker position.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Next Minimum" on page 92

CALCulate<n>:MARKer<m>:MINimum[:PEAK]

Moves a marker to the minimum level.

If the marker is not yet active, the command first activates the marker.

Suffix:
<n> Window

<m> Marker

Manual operation: See "Search Minimum" on page 92

9.6 Configuring the result display

The commands required to configure the screen display in a remote environment are described here.

The tasks for manual operation are described in the R&S VSE User Manual.

9.6.1 Global layout commands

The following commands are required to change the evaluation type and rearrange the screen layout across measurement channels as you do in manual operation.

For compatibility with other Rohde & Schwarz Signal and Spectrum Analyzers, the layout commands described in Chapter 9.6.2, "Working with windows in the display", on page 182 are also supported. Note, however, that the commands described there only allow you to configure the layout within the *active* measurement channel.

LAYout:GLOBal:ADD[:WINDow]?
<ExChanName>,<ExWinName>,<Direction>,<NewChanName>,<NewWinType>

Adds a window to the display next to an existing window. The new window may belong to a different channel than the existing window.

To replace an existing window, use the `LAYout:GLOBal:REPLace[:WINDow]` command.

Parameters:

<ExChanName> string
Name of an existing channel

<ExWinName> string
Name of the existing window within the <ExChanName> channel the new window is inserted next to.
By default, the name of a window is the same as its index. To determine the name and index of all active windows use the `LAYout:GLOBal:IDENtify[:WINDow]?` query.

<Direction> LEFT | RIGHt | ABOVe | BELow | TAB

Direction the new window is added relative to the existing window.

TAB
The new window is added as a new tab in the specified existing window.

<NewChanName> string

Name of the channel for which a new window is to be added.

<NewWinType> string

Type of result display (evaluation method) you want to add.
See the table below for available parameter values.

Return values:

<NewWindowName> When adding a new window, the command returns its name (by default the same as its number) as a result.

Example:
```
LAYout:GLOBal:ADD:WINDow? 'IQ Analyzer','1',RIGH,'IQ Analyzer2','FREQ'
```
Adds a new window named 'Spectrum' with a Spectrum display to the right of window 1 in the channel 'IQ Analyzer'.

Usage: Query only

LAYout:GLOBal:CATalog[:WINDow]?

Queries the name and index of all active windows from top left to bottom right for each active channel. The result is a comma-separated list of values for each window, with the syntax:

<ChannelName_1>: <WindowName_1>,<WindowIndex_1>..<WindowName_n>,<WindowIndex_n>

..

<ChannelName_m>: <WindowName_1>,<WindowIndex_1>..<WindowName_n>,<WindowIndex_n>

Return values:

<ChannelName> String containing the name of the channel. The channel name is displayed as the tab label for the measurement channel.

<WindowName> string

Name of the window.
In the default state, the name of the window is its index.

<WindowIndex> **numeric value**
Index of the window.

Example: `LAY:GLOB:CAT?`
Result:
`IQ Analyzer: '1',1,'2',2`
`Analog Demod: '1',1,'4',4`
For the I/Q Analyzer channel, two windows are displayed, named '2' (at the top or left), and '1' (at the bottom or right).
For the Analog Demodulation channel, two windows are displayed, named '1' (at the top or left), and '4' (at the bottom or right).

Usage: Query only

LAYout:GLOBal:IDENtify[:WINDow]? <ChannelName>,<WindowName>

Queries the **index** of a particular display window in the specified channel.

Note: to query the **name** of a particular window, use the `LAYout:WINDow<n>:IDENtify?` query.

Parameters:
<ChannelName> String containing the name of the channel. The channel name is displayed as the tab label for the measurement channel.

Query parameters:
<WindowName> String containing the name of a window.

Return values:
<WindowIndex> Index number of the window.

Example: `LAYout:GLOBal:ADD:WINDow? IQ,'1',RIGH,'Spectrum',FREQ`
Adds a new window named 'Spectrum' with a Spectrum display to the right of window 1.

Example: `LAYout:GLOBal:IDENtify? 'IQ Analyzer','Spectrum'`
Result:
`2`
Window index is: 2.

Usage: Query only

LAYout:GLOBal:REMove[:WINDow] <ChannelName>, <WindowName>

Setting parameters:
<ChannelName>

<WindowName>

Usage: Setting only

LAYout:GLOBal:REPLace[:WINDow] <ExChannelName>, <WindowName>, <NewChannelName>, <WindowType>

Setting parameters:
<ExChannelName>

<WindowName>

<NewChannelName>

<WindowType>

Usage: Setting only

9.6.2 Working with windows in the display

Note that the suffix <n> always refers to the window *in the currently selected channel*.

The following commands are required to change the evaluation type and rearrange the screen layout for a channel as you do in manual operation. Since the available evaluation types depend on the selected application, some parameters for the following commands also depend on the selected channel.

Note that the suffix <n> always refers to the window *in the currently selected channel*.

To configure the layout of windows across channels, use the Chapter 9.6.1, "Global layout commands", on page 179.

LAYout:ADD[:WINDow]? <WindowName>, <Direction>, <WindowType>

Adds a window to the display in the active channel.

Is always used as a query so that you immediately obtain the name of the new window as a result.

To replace an existing window, use the `LAYout:REPLace[:WINDow]` command.

Query parameters:

<WindowName> String containing the name of the existing window the new window is inserted next to.
By default, the name of a window is the same as its index. To determine the name and index of all active windows, use the `LAYout:CATalog[:WINDow]?` query.

<Direction> LEFT | RIGHt | ABOVe | BELow

Direction the new window is added relative to the existing window.

<WindowType> text value

Type of result display (evaluation method) you want to add.
See the table below for available parameter values.
Note that the window type must be valid for the active channel.
To create a window for a different channel, use the `LAYout:GLOBal:REPLace[:WINDow]` command.

Return values:

<NewWindowName> When adding a new window, the command returns its name (by default the same as its number) as a result.

Usage: Query only

Manual operation: See "RF Envelope" on page 32
See "RF Spectrum" on page 32
See "Result Summary" on page 33
See "Marker Table" on page 35
See "Demod waveform (not for EDR)" on page 35
See "Constellation (EDR only)" on page 36
See "Symbols (EDR only)" on page 36
See "ACP / In-band Spurious Emissions" on page 37
See "Result Summary" on page 38

Table 9-2: <WindowType> parameter values for Bluetooth application

Parameter value	Window type
CONS	Constellation
DWAV	Demod waveform
MTAB	Marker Table
RSUM	Result Summary
RFEN	RF Envelope
RFSP	RF Spectrum
SPEC	ACP/ In-band Spurious Emissions
SYMB	Symbols

LAYout:CATalog[:WINDow]?

Queries the name and index of all active windows in the active channel from top left to bottom right. The result is a comma-separated list of values for each window, with the syntax:

<WindowName_1>,<WindowIndex_1>..<WindowName_n>,<WindowIndex_n>

To query the name and index of all windows in all channels, use the `LAYout:GLOBal:CATalog[:WINDow]?` command.

Return values:

<WindowName> string
Name of the window.
In the default state, the name of the window is its index.

<WindowIndex> **numeric value**
Index of the window.

Example: `LAY:CAT?`
Result:
`'2',2,'1',1`
Two windows are displayed, named '2' (at the top or left), and '1' (at the bottom or right).

Usage: Query only

LAYout:IDENtify[:WINDow]? <WindowName>

Queries the **index** of a particular display window in the active channel.

Note: to query the **name** of a particular window, use the `LAYout:WINDow<n>:IDENtify?` query.

To query the index of a window in a different channel, use the `LAYout:GLOBal:IDENtify[:WINDow]?` command.

Query parameters:

<WindowName> String containing the name of a window.

Return values:

<WindowIndex> Index number of the window.

Example: `LAY:IDEN:WIND? '2'`
Queries the index of the result display named '2'.
Response:
`2`

Usage: Query only

LAYout:MOVE[:WINDow] <WindowName>, <WindowName>, <Direction>

Setting parameters:

<WindowName> String containing the name of an existing window that is to be moved.
By default, the name of a window is the same as its index. To determine the name and index of all active windows in the active channel, use the `LAYout:CATalog[:WINDow]?` query.

<WindowName> String containing the name of an existing window the selected window is placed next to or replaces.
By default, the name of a window is the same as its index. To determine the name and index of all active windows in the active channel, use the `LAYout:CATalog[:WINDow]?` query.

<Direction> LEFT | RIGHt | ABOVe | BELow | REPLace
Destination the selected window is moved to, relative to the reference window.

Example: `LAY:MOVE '4','1',LEFT`
Moves the window named '4' to the left of window 1.

Example: `LAY:MOVE '1','3',REPL`
Replaces the window named '3' by window 1. Window 3 is deleted.

Usage: Setting only

LAYout:REMove[:WINDow] <WindowName>

Removes a window from the display in the active channel.

Setting parameters:
<WindowName> String containing the name of the window. In the default state, the name of the window is its index.

Example: `LAY:REM '2'`
Removes the result display in the window named '2'.

Usage: Setting only

LAYout:REPLace[:WINDow] <WindowName>,<WindowType>

Replaces the window type (for example from "Diagram" to "Result Summary") of an already existing window in the active channel while keeping its position, index and window name.

To add a new window, use the `LAYout:ADD[:WINDow]?` command.

Setting parameters:
<WindowName> String containing the name of the existing window.
By default, the name of a window is the same as its index. To determine the name and index of all active windows in the active channel, use the `LAYout:CATalog[:WINDow]?` query.

<WindowType> Type of result display you want to use in the existing window.
See `LAYout:ADD[:WINDow]?` on page 182 for a list of available window types.
Note that the window type must be valid for the active channel. To create a window for a different channel, use the `LAYout:GLOBal:REPLace[:WINDow]` command.

Example: `LAY:REPL:WIND '1',MTAB`
Replaces the result display in window 1 with a marker table.

Usage: Setting only

LAYout:WINDow<n>:ADD? <Direction>,<WindowType>

Adds a measurement window to the display. Note that with this command, the suffix <n> determines the existing window next to which the new window is added. Unlike `LAYout:ADD[:WINDow]?`, for which the existing window is defined by a parameter.

To replace an existing window, use the `LAYout:WINDow<n>:REPLace` command.

Is always used as a query so that you immediately obtain the name of the new window as a result.

Suffix:
<n> Window

Query parameters:
<Direction> LEFT | RIGHt | ABOVe | BELow

<WindowType> Type of measurement window you want to add.
See `LAYout:ADD[:WINDow]?` on page 182 for a list of available window types.
Note that the window type must be valid for the active channel.
To create a window for a different channel, use the `LAYout:GLOBal:ADD[:WINDow]?` command.

Return values:
<NewWindowName> When adding a new window, the command returns its name (by default the same as its number) as a result.

Example:
```
LAY:WIND1:ADD? LEFT,MTAB
```
Result:
```
'2'
```
Adds a new window named '2' with a marker table to the left of window 1.

Usage: Query only

LAYout:WINDow<n>:IDENtify?

Queries the **name** of a particular display window (indicated by the <n> suffix) in the active channel.

Note: to query the **index** of a particular window, use the `LAYout:IDENtify[:WINDow]?` command.

Suffix:
<n> Window

Return values:
<WindowName> String containing the name of a window.
In the default state, the name of the window is its index.

Example:
```
LAY:WIND2:IDEN?
```
Queries the name of the result display in window 2.
Response:
```
'2'
```

Usage: Query only

LAYout:WINDow<n>:REMove

Removes the window specified by the suffix <n> from the display in the active channel.

The result of this command is identical to the `LAYout:REMove[:WINDow]` command.

To remove a window in a different channel, use the `LAYout:GLOBal:REMove[:WINDow]` command.

Suffix:
<n> Window

Example: `LAY:WIND2:REM`
Removes the result display in window 2.

Usage: Event

LAYout:WINDow<n>:REPLace <WindowType>

Changes the window type of an existing window (specified by the suffix <n>) in the active channel.

The effect of this command is identical to the `LAYout:REPLace[:WINDow]` command.

To add a new window, use the `LAYout:WINDow<n>:ADD?` command.

Suffix:
<n> Window

Setting parameters:
<WindowType> Type of measurement window you want to replace another one with.
See `LAYout:ADD[:WINDow]?` on page 182 for a list of available window types.
Note that the window type must be valid for the active channel.
To create a window for a different channel, use the `LAYout:GLOBal:REPLace[:WINDow]` command.

Example: `LAY:WIND2:REPL MTAB`
Replaces the result display in window 2 with a marker table.

Usage: Setting only

9.7 Retrieving results

In order to retrieve the trace and marker results in a remote environment, use the following commands:

Useful commands for retrieving results described elsewhere:

- `CALCulate<n>:MARKer<m>:Y?` on page 170

Remote commands exclusive to retrieving results:

CALCulate<n>:LIMit:FAIL?

Queries the results of the limits check.

Suffix:
<n> 1..n

Return values:
<Result> 0 | 1

0
Limit check passed

1
Limit check failed

Example:
```
CALCulate1:LIMit1:FAIL?
//Result: 0
//Limit check passed.
```

Usage: Query only

Manual operation: See "ACP / In-band Spurious Emissions" on page 37

FORMat:DEXPort:DSEParator <Separator>

Selects the decimal separator for data exported in ASCII format.

Parameters:
<Separator> POINt | COMMa

COMMa
Uses a comma as decimal separator, e.g. *4,05*.

POINt
Uses a point as decimal separator, e.g. *4.05*.

*RST: *RST has no effect on the decimal separator. Default is POINt.

Example:
```
FORM:DEXP:DSEP POIN
```
Sets the decimal point as separator.

Manual operation: See "Decimal Separator" on page 86

FORMat:DEXPort:HEADer <State>

If enabled, additional instrument and measurement settings are included in the header of the export file for result data. If disabled, only the pure result data from the selected traces and tables is exported.

Trace data resulting from encrypted file input cannot be queried.

Parameters:

<State> ON | OFF | 0 | 1
*RST: 1

Manual operation: See "Include Instrument & Measurement Settings" on page 86

MMEMory:STORe:BT:MEAS <FileName>

Exports trace data for all active traces in all active windows to a file in .csv format.

Tip: To store trace data for an individual trace or an individual window, use `MMEMory:STORe<n>:TRACe` on page 189.

Setting parameters:

<FileName> String containing the path and name of the file.

Example:
```
MMEM:STOR:BT:MEAS 'C:\MyResults.csv'
```

Usage: Setting only

MMEMory:STORe<n>:TRACe <Trace>, <FileName>

Exports the selected trace data to a file in ASCII format. Define the decimal separator (decimal point or comma) for floating-point numerals contained in the file using `FORMat:DEXPort:DSEParator`.

Tip: to store trace data for all active traces in all active windows to a file in .csv format, use `MMEMory:STORe:BT:MEAS` on page 189.

Suffix:

<n> 1..n
Window

Setting parameters:

<Trace> Number of the trace you want to save.
Note that the available number of traces depends on the selected result display. The value "0" exports all traces in a window.
Range: 0 to 4

<FileName> String containing the path and file name.

Example:
```
//Export all traces in all windows to the specified file.
FORM:DEXP:TRAC ALL
MMEM:STOR:TRAC 0,'C:\TraceResults'
//Export all traces in window 2 to the specified file.
FORM:DEXP:TRAC SING
MMEM:STOR2:TRAC 0,'C:\TraceResults'
//Export the second trace in window 2 to the specified file.
MMEM:STOR2:TRAC 2,'C:\TraceResults'
```

Usage: Setting only

Manual operation: See "Selecting data to export" on page 86
See "Export Trace to ASCII File" on page 86

TRACe<n>[:DATA]? <Trace>

Returns the measurement results of the selected trace.

For details on the values see Chapter 4, "Measurements and result displays", on page 31.

Suffix:
<n> 1..n

Query parameters:
<Trace> TRACe1 | TRACe2 | TRACe3 | TRACe4

Usage: Query only

Manual operation: See "RF Envelope" on page 32
See "RF Spectrum" on page 32
See "Result Summary" on page 33
See "Demod waveform (not for EDR)" on page 35
See "Constellation (EDR only)" on page 36
See "Symbols (EDR only)" on page 36
See "ACP / In-band Spurious Emissions" on page 37

Table 9-3: Return values for the modulation characteristics result summary for BR signals

```
<PacketType>,<PacketLength>,
<OutputPowerPeak_Current>,<OPP_Max>,<OPP_Min>,<OPP_Avg>,<OPP_LL>,<OPP_UL>,
<OutputPowerAvg_Current>,<OPA_Max>,<OPA_Min>,<OPA_Avg>,<OPA_LL>,<OPA_UL>,
<OutputPowerRel_Current>,<OPR_Max>,<OPR_Min>,<OPR_Avg>,
<df1Max_Current>,<df1Max_Max>,<df1Max_Min>,<df1Max_Avg>,
<df1Min_Current>,<df1Min_Max>,<df1Min_Min>,<df1Min_Avg>,
<df1Avg_Current>,<df1Avg_Max>,<df1Avg_Min>,<df1Avg_Avg>,<df1Avg_LL>,<df1Avg_UL>,
<df2Max_Current>,<df2Max_Max>,<df2Max_Min>,<df2Max_Avg>,<df2Max_LL>,<df2Max_UL>,
<df2Min_Current>,<df2Min_Max>,<df2Min_Min>,<df2Min_Avg>,
<df2Avg_Current>,<df2Avg_Max>,<df2Avg_Min>,<df2Avg_Avg>,
<df2MaxInRange_Current>,<df2MaxR_Max>,<df2MaxR_Min>,<df2MaxR_Avg>,<df2MaxR_LL>,<df2MaxR_UL>,
<df2/df1_Current>,<df2/df1_Max>,<df2/df1_Min>,<df2/df1_Avg>,<df2/df1_LL>,<df2/df1_UL>,
<FreqDrift_Current>,<FD_Max>,<FD_Min>,<FD_Avg>,
<MaxDriftRatePerPacket_Current>,<MDR_Max>,<MDR_Min>,<MDR_Avg>,
<ICFT_Current>,<ICFT_Max>,<ICFT_Min>,<ICFT_Avg>,<ICFT_LL>,<ICFT_UL>
```

Table 9-4: Return values for the modulation characteristics result summary for EDR signals

```
<PacketType>,<PacketLength>,<PacketTested>,<PacketPassed>,<BER>,
<GFSKAvgPower_Current>,<GFSKAP_Max>,<GFSKAP_Min>,<GFSKAP_Avg>,
<DPSKAvgPower>,<DPSKAP_Max>,<DPSKAP_Min>,<DPSKAP_Avg>,
<RelAvgPower>,<RAP_Max>,<RAP_Min>,<RAP_Avg>,<RAP_LL>,<RAP_UL>,
<RMSDEVMQPSK>,<RMSQ_Max>,<RMSQ_Min>,<RMSQ_Avg>,<RMSQ_LL>,<RMSQ_UL>,
<PeakDEVMQPSK>,<PQ_Max>,<PQ_Min>,<PQ_Avg>,<PQ_LL>,<PQ_UL>,
<99%DEVMQPSK>,<99Q_Max>,<99Q_Min>,<99Q_Avg>,<99Q_LL>,<99Q_UL>,
<RMSDEVM8PSK>,<RMS8_Max>,<RMS8_Min>,<RMS8_Avg>,<RMS8_LL>,<RMS8_UL>,
<PeakDEVM8PSK>,<P8_Max>,<P8_Min>,<P8_Avg>,<P8_LL>,<P8_UL>,
<99%DEVM8PSK>,<998_Max>,<998_Min>,<998_Avg>,<998_LL>,<998_UL>,
<InitialFrequencyOffset>,<IFO_Max>,<IFO_Min>,<IFO_Avg>,<IFO_LL>,<IFO_UL>,
<BlockFrequencyOffset>,<BFO_Max>,<BFO_Min>,<BFO_Avg>,<BFO_LL>,<BFO_UL>,
<TotalFrequencyOffset>,<TFO_Max>,<TFO_Min>,<TFO_Avg>,<TFO_LL>,<TFO_UL>,
```

Table 9-5: Return values for the modulation characteristics result summary for LE signals

```
<PacketType>,<PacketLength>,
<OutputPowerPeak_Current>,<OPP_Max>,<OPP_Min>,<OPP_Avg>,
<OutputPowerAvg_Current>,<OPA_Max>,<OPA_Min>,<OPA_Avg>,<OPA_LL>,<OPA_UL>,
<OutputPowerRel_Current>,<OPR_Max>,<OPR_Min>,<OPR_Avg>,<OPR_LL>,<OPR_UL>,
<df1Max_Current>,<df1Max_Max>,<df1Max_Min>,<df1Max_Avg>,
<df1Min_Current>,<df1Min_Max>,<df1Min_Min>,<df1Min_Avg>,
<df1Avg_Current>,<df1Avg_Max>,<df1Avg_Min>,<df1Avg_Avg>,<df1Avg_LL>,<df1Avg_UL>,
<df2Max_Current>,<df2Max_Max>,<df2Max_Min>,<df2Max_Avg>,<df2Max_LL>,<df2Max_UL>,
<df2Min_Current>,<df2Min_Max>,<df2Min_Min>,<df2Min_Avg>,
<df2Avg_Current>,<df2Avg_Max>,<df2Avg_Min>,<df2Avg_Avg>,
<df2MaxInRange_Current>,<df2MaxR_Max>,<df2MaxR_Min>,<df2MaxR_Avg>,<df2MaxR_LL>,<df2MaxR_UL>,
<df2/df1_Current>,<df2/df1_Max>,<df2/df1_Min>,<df2/df1_Avg>,<df2/df1_LL>,<df2/df1_UL>,
<FreqDrift_Current>,<FD_Max>,<FD_Min>,<FD_Avg>,<FD_LL>,<FD_UL>,
<MaxDriftRatePerPacket_Current>,<MDR_Max>,<MDR_Min>,<MDR_Avg>,<MDR_LL>,<MDR_UL>,
<FreqOff_Current>,<FO_Max>,<FO_Min>,<FO_Avg>,<FO_LL>,<FO_UL>,
<ICFT_Current>,<ICFT_Max>,<ICFT_Min>,<ICFT_Avg>,<ICFT_LL>,<ICFT_UL>
```

Table 9-6: Return values for the in-band spurious emissions result summary

```
<TxChannelPower>,<TXChannelFrequency>,<NumberOfExceptions>,<AdjacentChannelPowerLower>,
<AdjacentChannelPowerUpper>,
//EDR only -------
<GuardPosition>,<MeasTime>,
//---------------
<ChannelNumberChannel0>,<ChannelFrequencyChannel0>,<PowerChannel0>,<LimitChannel0>,
<LimitCheckResult0>,
…
<ChannelNumberChannel78>,<ChannelFrequencyChannel78>,<PowerChannel78>,<LimitChannel78>,
<LimitCheckResult78>
```

9.8 Programming examples: Measuring Bluetooth BR/EDR/LE signals

9.8.1 Programming example 1: Measuring modulation accuracy

This example demonstrates how to determine modulation characteristics for a Bluetooth signal in a remote environment.

```
//---------- Preparing the application ------------
// Preset the instrument
*RST
// Start the Blutooth option
INSTrument:SELect BTO
```

```
//-----------Configuring the measurement ------------
//Select the Bluetooth basic rate standard
CONF:BTO BR
//Select the modulation accuracy measurement
CONF:BTO:MEAS MOD

//--------------Performing the Measurement-----
//Select single sweep mode.
INIT:CONT OFF
//Initiate a new measurement and wait until the sweep has finished.
INIT;*WAI


//---------------Retrieving Results-------------
//Check the result of the limit check
CALC:LIM:FAIL?

// Store the result summary data to a file.
MMEMory:STORe2:TRAC 1, 'C:\TraceResults'
```

9.8.2 Programming example 2: Measuring in-band spurious emissions

This example demonstrates how to determine and check in-band spurious emissions for a Bluetooth signal in a remote environment. It corresponds to the Chapter 8.2, "Measurement example 2: Analyzing in-band spurious emissions for a basic Bluetooth signal", on page 98 for manual operation.

```
//---------- Preparing the application ------------
// Preset the instrument
*RST
// Start the Blutooth option
INSTrument:SELect BTO

//-----------Configuring the measurement ------------
//Select the Bluetooth basic rate standard
CONF:BTO BR
//Select the in-band spurious emissions measurement
CONF:BTO:MEAS SEM
//Load the predefined settings file
CONF:BTO:LOAD 'C:\R_S\INSTR\USER\predefined\BTOPredefined\
Bluetooth_DH1DH3DH5.xml'
//Select the channel 39 as the transmit channel.
CONF:BTO:CHAN 39

//--------------Performing the Measurement-----
//Select single sweep mode.
```

```
INIT:CONT OFF
//Initiate a new measurement and wait until the sweep has finished.
INIT;*WAI

//---------------Retrieving Results-------------
//Check the result of the limit check
CALC:LIM:FAIL?

// Store the result summary data to a file.
MMEMory:STORe2:TRAC 1, 'C:\TraceResults'

//Determine the limit check result for the channel at -3 MHz offset from the
//TX channel = channel 39-3 = 36
TRAC2:DATA? TRACe1
//Result:
//5 general results:
//<TxChannelPower>,<TXChannelFrequency>,<NumberOfExceptions>,
//<AdjacentChannelPowerLower>,<AdjacentChannelPowerUpper>,
//35*4 channel results
//<ChannelNumberChannel36>,<ChannelFrequencyChannel36>,<PowerChannel36>,
//The 149th result value is the required limit check result:
//<LimitChannel36>
```

9.9 Deprecated commands

The following commands are provided for compatibility to other signal analyzers only. For new remote control programs, use the specified alternative commands.

[SENSe:]DDEMod:SEARch:PULSe:STATe <State>

Enables or disables the search for a signal burst based on the measured power.

Note that this command is maintained for compatibility reasons only. For new remote control programs, use `CONFigure:BTOoth:SEARch:PULSe:STATe` on page 141.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 1

Manual operation: See "Find Burst" on page 61

[SENSe:]DDEMod:SEARch:SYNC:LAP <LAP>

Sets or queries the lower address part of the Bluetooth device address (LAP, the 24 least significant bits). The LAP determines the sync word used for sync search.

Note that this command is maintained for compatibility reasons only. For new remote control programs, use `CONFigure:BTOoth:SEARch:SYNC:LAP` on page 141.

Parameters:

<LAP> Hexadecimal number

Range: 000000h to FFFFFFh
*RST: 128

Manual operation: See "LAP (Low Address Part)" on page 60

[SENSe:]DDEMod:SEARch:SYNC:STATe <State>

Enables or disables the search for the sync word.

Note that this command is maintained for compatibility reasons only. For new remote control programs, use `CONFigure:BTOoth:SEARch:SYNC:STATe` on page 142.

Parameters:

<State> ON | OFF | 0 | 1

OFF | 0
Switches the function off

ON | 1
Switches the function on

*RST: 1

Manual operation: See "Find Sync" on page 61

Annex

A Predefined standards and settings

You can configure the R&S VSE Bluetooth measurement application using predefined standard settings. This allows for quick and easy configuration for commonly performed measurements.

The default storage location for the settings files is:
`C:\ProgramData\Rohde-Schwarz\VSE\<version_no>\user\predefined\BTOPredefined`.

Predefined settings

The following parameters can be stored in a standard settings file. Any parameters that are not included in the xml file are set to their default values when the standard is loaded.

Table A-1: List of predefined standards and settings

File name	Standard	Capt. channels	Capt. time	Sweep count	Trigger source	Trigger level	Trigger drop-out time	Trigger slope	Trigger holdoff	Gated trigger	Gate delay	Gate length
BT_DH1	BR	79	100 ms	10	Free Run	-14 dBm	0	Rising	0	Off	0	0
BT_DH3	BR	79	100 µs	10	Free Run	-14 dBm	0	Rising	0	Off	0	0
BT_DH5	BR	79	100 µs	10	Free Run	-14 dBm	0	Rising	0	Off	0	0
BT_2-DH1	EDR	79	700 µs	10	RF Power	-14 dBm	0	Rising	625 µs	On	129.5 µs	268 µs
BT_2-DH3	EDR	79	2.1 ms	10	RF Power	-14 dBm	0	Rising	625 µs	On	129.5 µs	1520 µs
BT_2-DH5	EDR	79	3.5 ms	10	RF Power	-14 dBm	0	Rising	625 µs	On	129.5 µs	2772 µs
BT_3-DH1	EDR	79	700 µs	10	RF Power	-14 dBm	0	Rising	625 µs	On	129.5 µs	268 µs
BT_3-DH3	EDR	79	2.1 ms	10	RF Power	-14 dBm	0	Rising	625 µs	On	129.5 µs	1520 µs
BT_3-DH5	EDR	79	3.5 ms	10	RF Power	-14 dBm	0	Rising	625 µs	On	129.5 µs	2772 µs

B Menu reference

Most functions in the R&S VSE are available from the menus.

B.1 Common R&S VSE menus

The following menus provide **basic functions for all applications**:

B.1.1 File menu

The "File" menu includes all functionality directly related to any file operations, printing or setting up general parameters.

For a description of these functions see the "Data Management" chapter in the R&S VSE base software user manual.

Menu item	Corresponding icon in toolbar	Description
Save		Saves the current software configuration to a file
Recall		Recalls a saved software configuration from a file
Save IQ Recording	-	Saves the recorded I/Q data from a measurement channel to a file
Recall IQ Recording	-	Loads the recorded I/Q data from a file
Measurement Group >	-	Configures measurement channels and groups
> New Group	-	Inserts a new group in the measurement sequence
> Rename Group	-	Changes the name of the selected group
> New Measurement Channel	-	Inserts a new channel in the selected group
> Replace Measurement Channel	-	Replaces the currently selected channel by the selected application.
> Rename Measurement Channel	-	Changes the name of the selected channel.
> Delete Current Measurement Channel	-	Deletes the currently selected channel.

Menu item	Corresponding icon in toolbar	Description
> Measurement Group Setup	-	Displays the "Measurement Group Setup" tool window.
Instruments >	-	Configures instruments to be used for input to the R&S VSE software
> New	-	Creates a new instrument configuration
> Search	-	Searches for connected instruments in the network
> Delete All	-	Deletes all current instrument configurations
> Setup	-	Hides or displays the "Instrument" tool window
Preset >	-	Restores stored settings
> Selected Channel	-	Restores the default software configuration for an individual channel
> All	-	Restores the default software configuration globally for the entire software
> All & Delete Instruments		Restores the default software configuration globally for the entire software and deletes all instrument configurations
> Reset VSE Layout	-	Restores the default layout of windows, toolbars etc. in the R&S VSE
Preferences >	-	Configures global software settings
> General	-	
> Displayed Items	-	Hides or shows individual screen elements
> Theme & Color	-	Configures the style of individual screen elements
> Network & Remote	-	Configures the network settings and remote access to or from other devices
> Recording	-	Configures general recording parameters
Print	-	Opens "Print" dialog to print selected measurement results
Exit	-	Closes the R&S VSE

B.1.2 Window menu

The "Window" menu allows you to hide or show individual windows.

Menu item	Corresponding icon in toolbar	Description
Player	-	Displays the "Player" tool window to recall I/Q data recordings
Instruments	-	Displays the "Instruments" window to configure input instruments
Measurement Group Setup	-	Displays the "Measurement Group Setup" window to configure a measurement sequence

Menu item	Corresponding icon in toolbar	Description
New Window >		Inserts a new result display window for the selected measurement channel
Channel Information >	-	Displays the channel bar with global channel information for the selected measurement channel
Active Windows >	-	Selects a result display as the active window; the corresponding channel is also activated

B.1.3 Help menu

The "Help" menu provides access to help, support and licensing functions.

Menu item	Corresponding icon in toolbar	Description
Help	?	Opens the Online help window
License	-	Licensing, version and options information
Support	-	Support functions
Register VSE	-	Opens the Rohde & Schwarz support page (http://www.rohde-schwarz.com/support) in a browser for registration.
Online Support	-	Opens the default web browser and attempts to establish an Internet connection to the Rohde & Schwarz product site.
About	-	Software version information

B.2 Bluetooth menus

The following menus are only available if a Bluetooth channel is selected.

B.2.1 Edit menu

The "Edit" menu contains functions for processing the temporarily stored current measurement results.

Menu item	Corresponding icon in toolbar	Description
Trace Export	-	Stores the currently selected trace in the active window to an ASCII file. See Chapter 6.4, "Trace / data export configuration", on page 85.
Copy to Clipboard	-	Copies the graphical measurement results (ASCII data) to the Windows clipboard for further processing.

B.2.2 Input & output menu

The "Input & Output" menu provides functions to configure the input source, frontend parameters and output settings for the measurement.

This menu is application-specific.

Table B-1: "Input" menu items for Bluetooth

Menu item	Description
Amplitude	Chapter 5.3.4, "Amplitude settings", on page 52
Scale	Chapter 5.3.5, "Y-Axis scaling", on page 56
Frequency	Chapter 5.3.3, "Frequency settings", on page 51
Trigger	Chapter 5.6, "Trigger and gate settings", on page 62
Input Source	Chapter 5.3.1, "Radio frequency input", on page 44
Output	Trigger output See R&S VSE base software user manual

B.2.3 Meas setup menu

The "Meas Setup" menu provides access to most measurement-specific settings, as well as bandwidth, sweep and auto configuration settings, and the configuration "Overview" window.

This menu is application-specific.

Table B-2: "Meas Setup" menu items for Bluetooth

Menu item	Description
Capture Time	"Capture Time" on page 59
Capture Count	"Capture Length" on page 60
Meas mode	"Select Measurement" on page 42
Input / Frontend	Chapter 5.3, "Input and frontend settings", on page 44
Data Acquisition	Chapter 5.4.1, "Data acquisition", on page 59
Burst / Sync	Chapter 5.4.2, "Burst and synchronization settings", on page 60

Menu item	Description
Demod	Chapter 5.4.3, "Demodulation settings", on page 61
Analysis / Limits	Chapter 6, "Analysis", on page 67
User Correction	User-defined frequency response correction, see the R&S VSE Base Software User Manual.
Overview	Chapter 5.1, "Configuration overview", on page 41

B.2.4 Trace menu

The "Trace" menu provides access to trace-specific functions.

See Chapter 6.3, "Trace settings", on page 84

This menu is application-specific.

Table B-3: "Trace" menu items for Bluetooth

Menu item	Description
Trace <x>	Selects the corresponding trace for configuration. The currently selected trace is highlighted blue
Trace ...	Opens the "Traces" configuration dialog box

B.2.5 Marker menu

The "Marker" menu provides access to marker-specific functions.

This menu is application-specific.

Table B-4: "Marker" menu items for Bluetooth

Menu item	Corresponding icon in toolbar	Description
Select marker <x>		"M1 Marker 1/ Delta Marker 1/ Delta Marker 2/ Delta Marker 16" on page 88
Marker to Trace	-	"Assigning the Marker to a Trace" on page 89
All Markers Off		"All Markers Off" on page 89
Marker		Chapter 6.5.1.1, "Individual marker setup", on page 87
Search		Chapter 6.5.2, "Marker positioning functions", on page 91

B.2.6 Limits menu

The "Limits" menu is not used by the R&S VSE Bluetooth measurement application.

C Reference of toolbar functions

Common functions can be performed via the icons in the toolbars.

Individual toolbars can be hidden or displayed.

Hiding and displaying a toolbar

1. Right-click any toolbar or the menu bar.

   A context menu with a list of all available toolbars is displayed.

2. Select the toolbar you want to hide or display.

   A checkmark indicates that the toolbar is currently displayed.

   The toolbar is toggled on or off.

Note that some icons are only available for specific applications. Those functions are described in the individual application's User Manual.

General toolbars

The following functions are generally available for all applications:

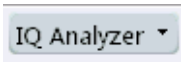
"Main" toolbar

Table C-1: Functions in the "Main" toolbar

Icon	Description
	Overview: Displays the configuration overview for the current measurement channel
	Save: Saves the current software configuration to a file
	Recall: Recalls a saved software configuration from a file
	Save I/Q recording: Stores the recorded I/Q data to a file
	Recall I/Q recording: Loads recorded I/Q data from a file
	Print immediately: prints the current display (screenshot) as configured
	Add Window: Inserts a new result display window for the selected measurement channel
	MultiView mode: displays windows for all active measurement channels (disabled: only windows for currently selected channel are displayed)

"Control" toolbar

Table C-2: Functions in the "Control" toolbar

Icon	Description
	Selects the currently active channel
	Capture: performs the selected measurement
	Pause: temporarily stops the current measurement
	Continuous: toggles to continuous sweep mode for next capture
	Single: toggles to single sweep mode for next capture
	Record: performs the selected measurement and records the captured data and results
	Refresh: Repeats the evaluation of the data currently in the capture buffer without capturing new data (VSA application only).

"Help" toolbar

Table C-3: Functions in the "Help" toolbar

Icon	Description
	Help (+ Select): allows you to select an object for which context-specific help is displayed (not available in standard Windows dialog boxes or measurement result windows)
	Help: displays context-sensitive help topic for currently selected element

Application-specific toolbars

The following toolbars are application-specific; not all functions shown here may be available in each application:

"Zoom" toolbar

Table C-4: Functions in the "Zoom" toolbar

Icon	Description
	Normal mouse mode: the cursor can be used to select (and move) markers in a zoomed display
	Zoom mode: displays a dotted rectangle in the diagram that can be expanded to define the zoom area
	Multiple zoom mode: multiple zoom areas can be defined for the same diagram
	Zoom off: displays the diagram in its original size

Table C-5: Functions in the "Marker" toolbar

Icon	Description
	Place new marker
	Percent Marker (CCDF only)
	Select marker
	Marker type "normal"
	Marker type "delta"
	Global peak
	Absolute peak (Currently only for GSM application)
	Next peak to the left
	Next peak to the right
	Next peak up (for spectrograms only: search in more recent frames)
	Next peak down (for spectrograms only: search in previous frames)
	Global minimum
	Next minimum left
	Next minimum right
	Next min up (for spectrograms only: search in more recent frames)
	Next min down (for spectrograms only: search in previous frames)
	Set marker value to center frequency
	Set reference level to marker value
	All markers off
	Marker search configuration
	Marker configuration

Table C-6: Functions in the "AutoSet" toolbar

Icon	Description
	Refresh measurement results (R&S VSE VSA and OFDM VSA applications only)
	Auto level
	Auto frequency
	Auto trigger (R&S VSE GSM application only)
	Auto frame (R&S VSE GSM application only)
	Auto search (R&S VSE 3GPP FDD application only)
	Auto scale (R&S VSE 3GPP FDD + Pulse applications only)
	Auto scale all (R&S VSE 3GPP FDD + Pulse applications only)
	Auto all
	Configure auto settings

Glossary: Abbreviations

A

ACL: Asynchronous connection-oriented logical transport mode

AoA: Angle of arrival
Direction finding method

AoD: Angle of departure
Direction finding method

B

BER: Bit error rate

BR: Basic rate
Bluetooth operating mode

C

CTE: Constant tone extension

D

DEVM: Differential error vector magnitude

DPSK: Differential phase shift keying

DUT: Device under test

E

EDR: Enhanced data rate
Bluetooth operating mode

eSCO: Extended synchronous connection-oriented logical transport mode

F

f1: Frequency of the first test signal (00001111)

f2: Frequency of the seconds test signal (01010101)

FHS: Frequency hop synchronization

G

GFSK: Gaussian frequency shift keying

I

IBSM: In-band spurious emissions measurement

ICT: Initial carrier frequency tolerance

L

LAP: Lower address part

LE: Low energy
Bluetooth operating mode

LSB: Least significant bit first
Describes the order of bits in symbols

M

MIC: Message integrity check

MSB: Most significant bit first
Describes the order of bits in symbols

P

p0: First preamble bit

PDU: Protocol data unit

S

SCO: Synchronous connection-oriented logical transport mode

U

UAP: Upper address part

List of commands (Bluetooth)