ROHDE&SCHWARZ

Test and Measurement
Division

Release Notes

3G FDD UE

Application Firmware R&S FS-K73
Release 4.20
with Service Pack 1

for R&S FSP, FSU, FSQ, FSG, FSMR, FSUP, FMU
Analyzer Firmware 4.2x

New Features:

- Support for instrument R&S FSG.
- Softkey REF VALUE Y AXIS available now for CDP measurements, too.

Release Note Revision: 6

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Contents

History

Date	Rel Note Rev	Changes
19 July 2007	1	First revision for R&S FS-K73 version 4.20.
22 August 2007	2	Chapter *Modifications to the Operating Manual* corrected. *Explanation of displayed IQ impairments* was erroneously removed.
12 October 2007	3	Problem eliminated with Service Pack 1 added.
08 November 2007	4	Description of the update procedure adjusted to new update ZIP file.
22 November 2007	5	FMU added.
09 October 2008	6	FSUP added.

Explanation of displayed IQ impairments

General Topics

Hardware Requirements

Please note that R&S FS-K73 requires option R&S FSP-B15 in order to run on an R&S FSP.
If the required hardware option is not installed the unit will not accept the license key for the corresponding application firmware.

Additionally please note that FRAME based analysis with R&S FS-K73 on an R&S FSP is only possible if R&S FSP-B70 is installed; otherwise only SLOT based analysis will be available on the R&S FSP.

Compatibility of the R&S FS-K73 3G FDD UE Application Firmware

The following table shows the compatible versions of the basic analyzer firmware and the 3G FDD UE Application Firmware:

Table of compatible versions:

R&S FS-K73 Application Firmware	R&S FSP Basic Firmware	R&S FSU Basic Firmware	R&S FSQ Basic Firmware	R&S FSMR Basic Firmware	R&S FSUP Basic Firmware	R&S FMU Basic Firmware	R&S FSG Basic Firmware
4.20 SP1	4.20	4.21	4.25	-	4.27	4.28	4.29
4.20	4.20	4.21	4.25	-	-	-	4.29
4.17			-	-	4.17	-	-
4.10	4.10	4.11	4.15	-	-	-	-
4.01	-	-	-	-	-	4.08	-
4.00	4.00	4.01	4.05	-	-	-	-
3.90 SP1	3.90	3.91	3.95	3.96	3.99	-	-
3.90	3.90	3.91	3.95	3.96	-	-	-
3.80	3.80	3.81	3.85	3.86	-	-	-
3.70	3.70	3.71	3.75	-	-	-	-
3.60 SP1	3.60	3.61	3.65	3.66 SP1	-	-	-
3.60	3.60	3.61	3.65	-	-	-	-
3.50	3.50	3.51	3.55	-	-	-	-
3.40	3.40	3.41	3.45	-	-	-	-
3.35	-	-	3.35	-	-	-	-
3.30	3.30	3.31	-	-	-	-	-
3.28	3.20	3.21	3.25	-	-	-	-
3.24	3.10	3.11	3.15	-	-	-	-
3.20	3.00	-	3.05	-	-	-	-
2.80	2.80	2.81	-	-	-	-	-
2.60	2.60	2.61	-	-	-	-	-
2.40	2.40	2.41	2.45	-	-	-	-
2.35	-	-	2.35	-	-	-	-
2.30	2.30	2.31	-	-	-	-	-
2.28	2.20	2.21	2.25	-	-	-	-
2.24	2.10	2.11	2.15	-	-	-	-
1.21	-	-	2.05	-	-	-	-
1.20	1.80	1.81	1.85	-	-	-	-

Application firmware versions 3.xx/4.xx running on FSPs with order # 1164.4391.xx or FSU with order # 1166.1660.xx are adequate to version 2.xx for FSPs with order # 1093.4495.xx or FSU with order # 1129.9003.xx. (Version 3.20 is adequate to 1.20)

On the FSQ application firmware versions 3.xx requires the Windows-XP upgrade kit FSQ-U2, order # 1162.9696.02.

Note:

Applications with version number 3.xx are only compatible with basic firmware 3.yy (see table above). Do not install them on basic firmware versions below 3.00!

Firmware Update of the R&S FS-K73 3G FDD UE Application Firmware

Since basic firmware version 4.2x a ZIP file with the update sets of the basic system firmware and all available applications is provided. This ZIP file is available in the instruments FIRMWARE section, e.g. R&S FSU of the Service Board on GLORIS.

Please follow the steps described in the instrument's basic firmware release note to perform a complete firmware update.

Enabling the Application Firmware via License Key Code Entry

This section can be skipped if the option key was entered once.

After installing the application firmware package a license key for validation must be entered. The license key is printed either on a label on the rear panel of the instrument or delivered as a part of the R&S FS-K73 3G FDD UE application firmware package.

The key sequence for entering the license key is:

SETUP - GENERAL SETUP – OPTIONS - INSTALL OPTION

Use the numeric keypad to input the license key number and press ENTER.

- On a successful validation the message 'option key valid' will appear.

- If the validation failed, the application firmware is not installed.

  The most probable reason will be that the instrument is not equipped with the correct basic firmware version. Therefore a message box will appear asking for installation of the correct basic firmware version.

  If the application firmware package was not installed prior to entering the license key code, a message will appear asking for installation of the application firmware package.

  In any case please make sure that the correct basic firmware version <u>and</u> the application firmware package is installed prior to entering the license key code.

Modified Functions

The version numbers in brackets indicate the version in which the function was modified.

1. [V1.12] New result display type Power vs. Symbol

2. [V3.24/V2.24] Code Domain Error Power measurement is now available

3. [V3.24/V2.24] Improved Resolution of Trigger to Frame measurement

4. [V3.24/V2.24] Improved absolute accuracy of Trigger to Frame measurement

5. [V3.24/V2.24] Trace statistic available on result summary parameters (MIN Hold, MAX Hold, Averaging)

6. [V3.28/V2.28] Unit circle display in constellation diagrams

7. [V3.28] Option FS-K9 power sensor support for RF measurements

8. [V3.30/V2.30] Multi-Frame Measurement supported

9. [V3.30/V2.30] Read out of spectrum emission mask worst fail position

10. [V3.35/V2.35] Detecting of incorrect pilot symbols of the DPCCH

11. [V3.40/V2.40] Detection of HS-DPCCH in HSDPA signal (TM5)

12. [V3.40/V2.40] Remote readout of frame bit-stream available

13. [V3.50/V2.60] Full Support of Uplink HSDPA signals (TM5)

14. [V3.50/V2.60] Eliminate 25us of each slot for EVM calculation:
According to 3GPP specification Release 5 the measurement interval for error vector magnitude (EVM) is one slot (4096 chips) less 25 µs at each end of the burst (3904 chips). This requirement depends on the expected power changes of the channel. The consideration of eliminating the tail of a slot can be switched ON or OFF.

15. [V3.50/V2.60] Absolute and relative slot power display for Power vs Slot

16. [V3.50/V2.60] Disable/Enable root raised cosine (RRC) receiver filter

17. [V3.50/V2.60] Extended trigger range:

In external trigger mode, the trigger event is expected in a time range of a half slot (333us) before and a half slot (-333us) after the start of the frame

18. [V3.60/V2.60] Display of frequency error versus slot, phase discontinuity versus slot, symbol magnitude error, symbol phase error

22. [V3.60/V2.60] Result Summary: added value RHO and timing offset

23. [V3.60/V2.60] Scrambling code input in hexadecimal and in decimal format

24**. [V3.60/V2.60] HSDPA mode channel detection can be switched ON or OFF**

25. [V3.60/V2.60] SEM: Adjustable transition frequency (30 kHz/1 MHz RBW)

26. [V3.60/V2.60] External trigger level adjustable from 0.5 to 3.5

27. [V3.60/V2.60] Carrier frequency step size softkey available

28. [V3.70] Remote command to read out total power versus slot

29. [V3.70] ACP/MCACP: number of adjacent channels increased to 12

30. [V3.70] ACP/MCACP: power mode to max hold the power results

31. [V3.80/V2.80] Support of enhanced channels (HSUPA)

32. [V3.80/V2.80] Trace view available within code domain analyzer

33. [V4.00] Vector error of Error Vector Magnitude (EVM) versus chip, Magnitude error of Error Vector Magnitude (EVM) versus chip, Phase error of Error Vector Magnitude (EVM) versus chip, Composite constellation diagram of scrambled chip buffer available

33. [V4.00] Spectrum emission mask: List evaluation in lower screen now supported

34. [V4.00SP1] Error Vector Magnitude (EVM) versus chip for composite signal
In the vector error, magnitude error and phase error display the averaging interval for RMS values is shown.

35. [V4.00SP1] Automatic determination of measurement interval for EVM (RMS) versus slot measurement according to 3GPP specification 34.121

36. [V4.10] New remote command CALC:MARK:FUNC:WCDP:RES? MTYPe | ACHannels

37. [V4.20] Support for instrument R&S FSG.

38. [V4.20] Soft key REF VALUE Y AXIS available for CDP measurements.

Problems Eliminated with 4.20

None.

Problems eliminated with Service Pack 1

Service Pack 1 fixes the following problems.

The version numbers in brackets indicate the version in which the problem was observed for the first time.

1. [V4.10] Application crashes in code domain power measurements.

This bug does not affect the down link direction (option R&S FS-K72).

Modifications to the Operating Manual

The R&S FS-K73 3G FDD UE analyzer functions are included in a separate manual set. Please refer to the following order numbers:

- 1154.7275.44-03 (German and English)

Modified Chapters for manual operation

Code Domain Power Menu – Overview

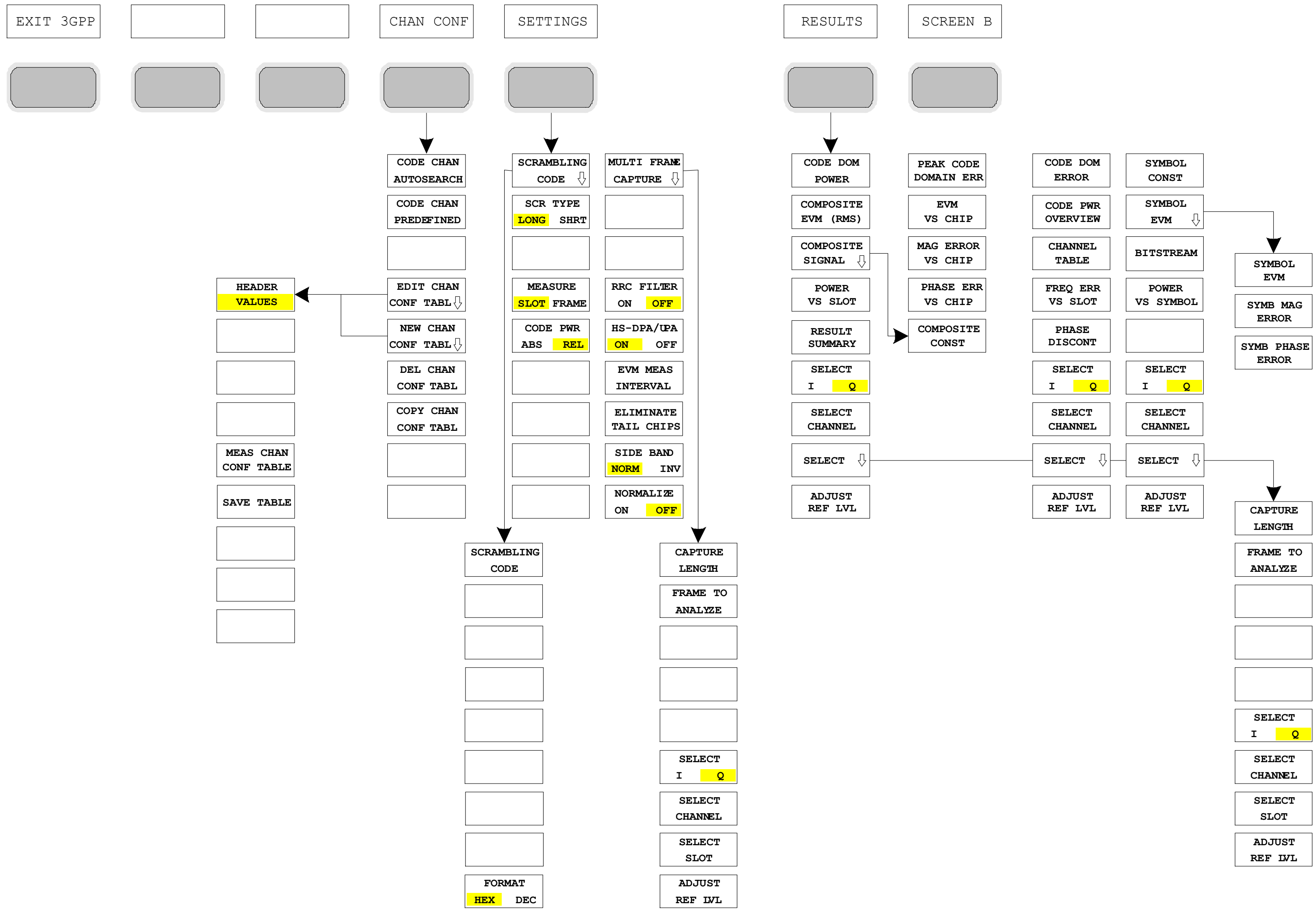


Figure 1: Code Domain Power Menu – Overview

Measurement Menu – Overview

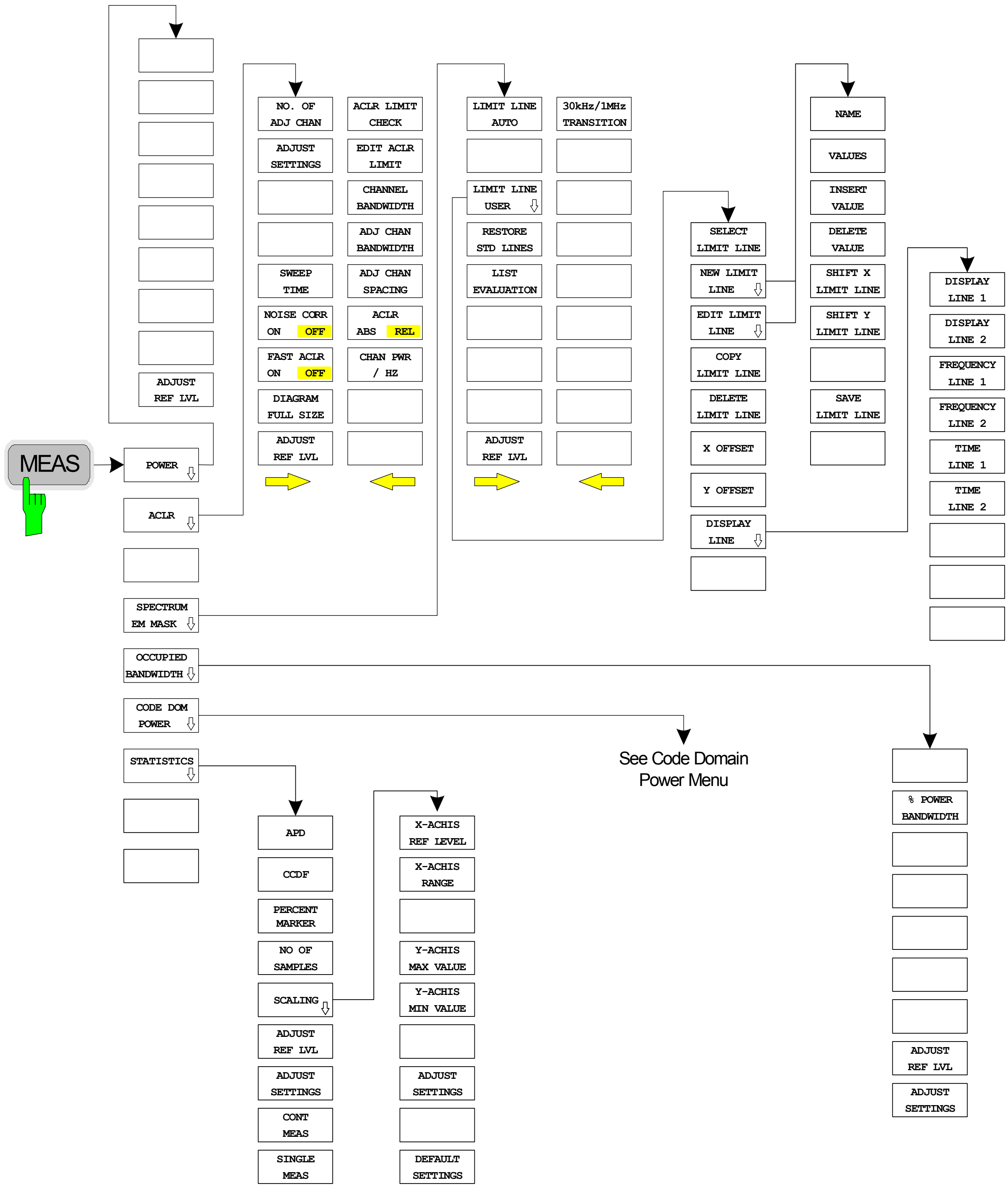


Figure 2: Overview of menus - measurements

Signal Power Check – SPECTRUM EM MASK

MEAS key

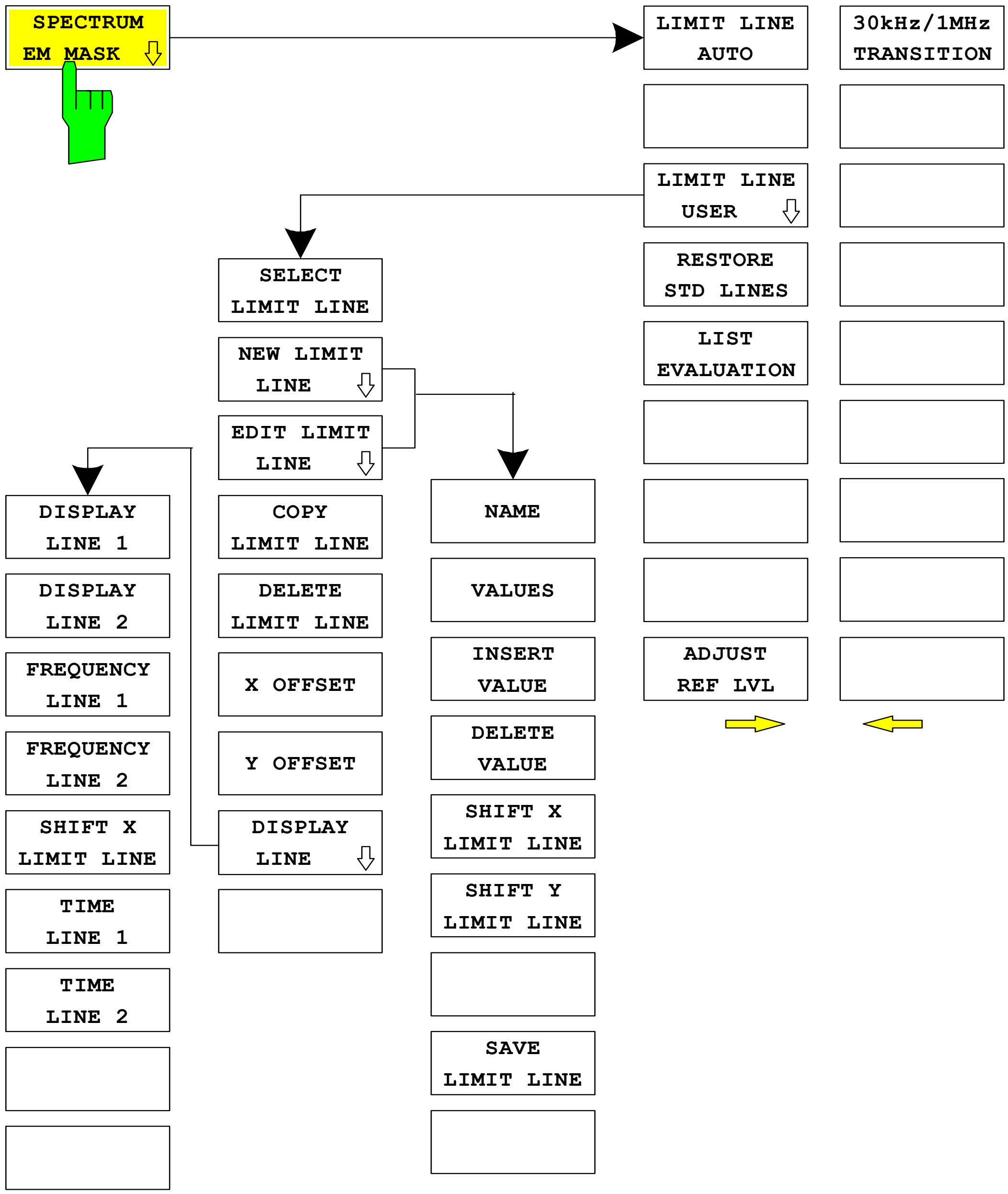


Figure 3: Spectrum emission mask measurement menu

The *SPECTRUM EM MASK* softkey starts the determination of the power of the 3GPP FDD signal in defined offsets from the carrier and compares the power values with a spectral mask specified by 3GPP.

IEC/IEEE bus command: `:CONF:WCDP:MEAS ESP`

Query of results: `:CALC:LIMit:FAIL? and visual evaluation`

Configuration of CDP Measurement – SETTINGS hotkey

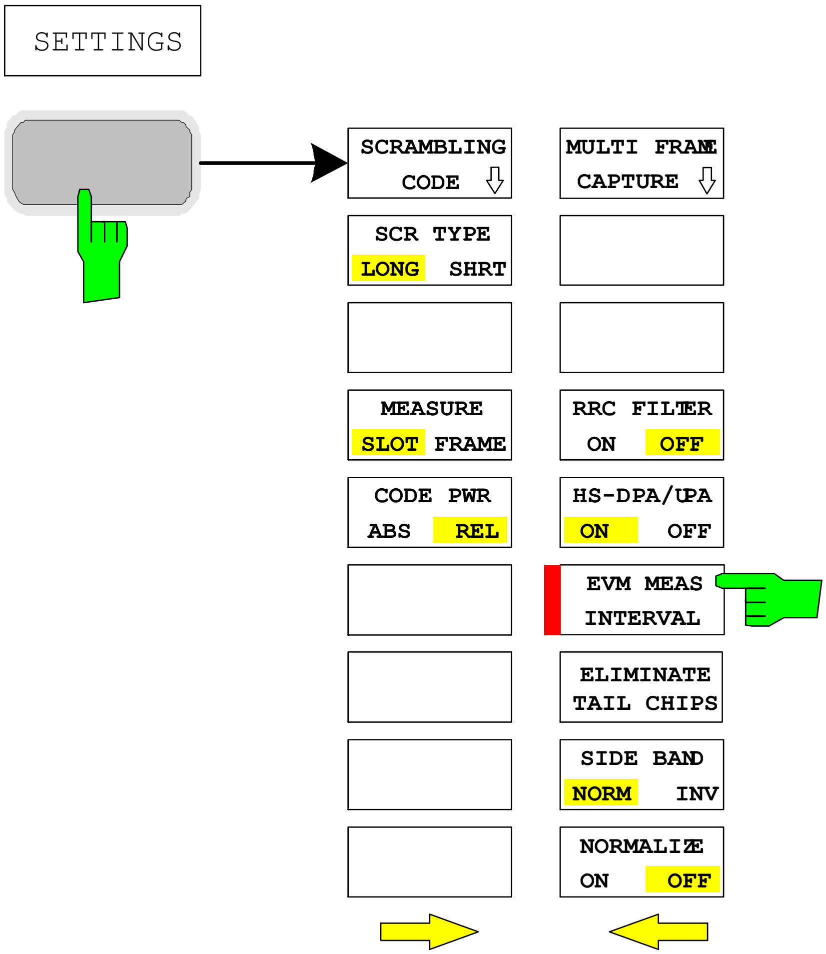
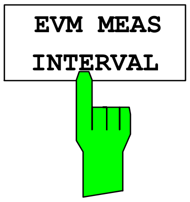


Figure 4: Settings menu of code domain analyzer

Settings for automatic determination of measurement interval for EVM_{RMS}



The softkey *EVM MEAS INTERVAL* sets the mode of determining the average interval of the root mean square (RMS) calculation for error vector magnitude (EVM_{rms}) versus slot. The softkey influences the display of *COMPOSITE EVM* (RMS)

According to 3GPP TS 34.121 version V7.1.0 chapter 5.13.1A “Error Vector Magnitude (EVM) with HS-DPCCH”, the average interval for root mean square calculation of EVM_{rms} is not fixed to a full slot length. For signals containing power controlled channels that are not aligned to DPCCH slot timing, the interval is reduced to the period of constant power of each individual channel

By the means of the softkey the user is able to decide the way unaligned power controlled channels should influence the average interval:

CHIP 0 TO 2559:

The measurement interval of EVM_{rms} is set to a complete slot.

INT OF CONST POW:

The measurement interval of EVM_{rms} is determined by the measurement software. If the signal contains channels with a slot timing not aligned to DPCCH slot timing the measurement interval is reduced to the period during which the power of each individual code remains constant. No channel should change ist power within this interval. The length of the measurement interval should be at least one half slot. The determination of measurement interval is done for each slot individually for the period of constant power can change according to channels being switched off for some slots.

CHIP 0 TO 1279:

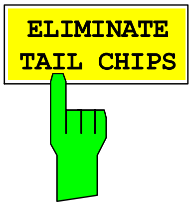
If the channel configuration is that way that the interval of constant power is exactly one half slot the user should be able to determine which half of the slot he likes to be used. *CHIP 0 To 1279* sets the measurement interval of of EVM_{rms} to the first half of the slot.

CHIP 1280 TO 2559:

The measurement interval of of EVM_{rms} is set to the second half of the slot.

The measurement interval is also influenced by the softkey *ELIMINATE TAIL CHIPS* for details please refer to the related description.

IEC/IEEE bus command:	`SENSe1:CDPower:EINTerval SLOT | MEAS | FHALf | SHALf`
Default Setting:	`SLOT`



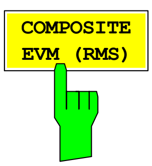
By the means of the *ELIMINATE TAIL CHIPS* the user is able to influence the measurement interval for calculation of error vector magnitude (EVM). In accordance with 3GPP specification, the EVM measurement interval is reduced by 25 µs at each end of the period of constant power of each individual code if power changes are expected. If no power changes are expected, the evaluation length is one slot. *ELIMINATE TAIL CHIPS* always reduces the measurement interval – whatever it is like – by 25 µs at both ends. However, the resulting measurement interval after reduction should be at least one half slot according to 3GPP. The measurement interval of error vector magnitude is determined by means of the softkey *EVM MEAS INTERVAL*. Please refer to that softkey for detailed description.

ON: Changes of power are expected. Therefore the EVM measurement interval is reduced by 25 µs at each end.

OFF: Changes of power are not expected. No reduction is done. (Default setting)

IEC/IEEE bus command: `:SENS:CDP:ETCH ON|OFF`

Root Mean Square Error Vector Magnitude (EVM_{RMS}) versus slot display



The COMPOSITE EVM (RMS) softkey selects the root mean square composite EVM (modulation accuracy) display model according to the 3GPP specification. During the composite EVM measurement, the square root of the mean squared errors between the real and imaginary components of the received signal and an ideal reference signal (EVM refererenced to the total signal) is determined. Thus, composite EVM is a measurement of the composite signal.

$$EVM_{RMS} = \sqrt{\frac{\sum_{n=N_{begin}}^{N_{end}} |s_n - x_n|^2}{\sum_{n=N_{begin}}^{N_{end}} |x_n|^2}} \cdot 100\% \quad | \quad \begin{matrix} N_{begin} \rightarrow \quad depends\ on\ SETTINGS \\ N_{end} \rightarrow \quad depends\ on\ SETTINGS \end{matrix}$$

where:

EVM_{RMS}	-	root mean square of the vector error of the composite signal
s_n	-	complex chip value of received signal
x_n	-	complex chip value of reference signal
n	-	index number for mean power calculation of received and reference signal.
N_{begin}	-	Chip index of the beginning of the measurement interval related to slot start. Possible range: [0 … 1280]
N_{end}	-	Chip index of the end of the measurement interval related to slot start. Possible range: [0 … 2559]

The size of the measurement interval ($N_{interval}$) depends on the measurement settings and the channel configuration of the applied signal.

$$N_{interval} = N_{end} - N_{begin} + 1 \quad | \quad \begin{matrix} N_{begin} \rightarrow \quad depends\ on\ SETTINGS \\ N_{end} \rightarrow \quad depends\ on\ SETTINGS \end{matrix}$$

Possible interval ranges:

$$0 \quad chips \le N_{begin} \le 1280\ chips \quad | \quad if\ N_{end} = 2559$$

$$1280\ chips \le N_{end} \le 2559\ chips \quad | \quad if\ N_{begin} = 0$$

$$1280\ chips \le N_{interval} \le 2560\ chips$$

The default value of measurement interval is 2560 chips, which corresponds to a full slot. The Interval can be reduced by 25µs to consider power transients of the DUT (refer to *ELIMINATE TAIL CHIPS*). In case of switched or large power controlled code channels with timing offset related to DPCCH, the measurement interval is determined by using that slot part of stable channel power (refer to *EVM MEAS INTERVAL*). The smallest possible size of measurement interval is a half slot, which corresponds to 1280 chips. If the 25µs transient elimination is activated, the measurement interval is further decreased by 96 chips (25µs → 96 chips). The determined measurement interval [N_{begin}:N_{end}] of each slot are displayed right of the second line of marker display. (Figure 5)

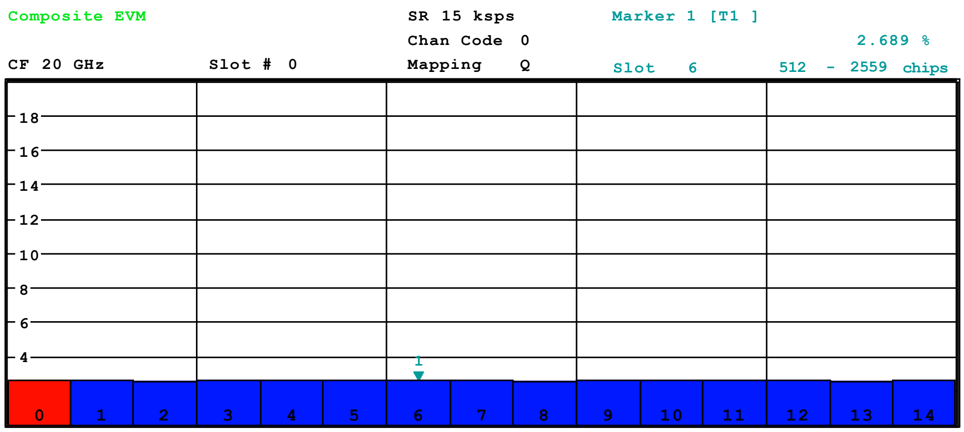
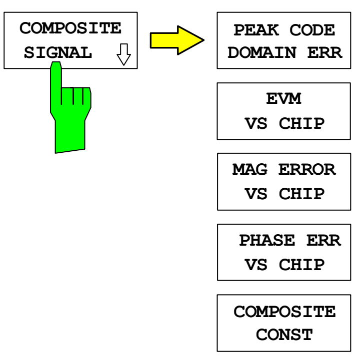


Figure 5: Display of composite EVM

The measurement result consists of one composite EVM measurement value per slot. The time reference for the start of slot 0 is the start of the 3GPP FDD frame. Within the slot not all chips are considered for root mean square calculation. The measurement interval depends on the channel configuration of the applied signal and the measurement Settings. The determined measurement interval [N_{begin}:N_{end}] of each slot are displayed right of the second line of marker display. (Figure 5)

Only the channels recognized as active are used to generate the ideal reference signal. If an assigned channel is not recognized, the difference between the measurement and reference signal and the composite EVM is very high.

Error Vector Magnitude (EVM_{chip}) versus chip



The *COMPOSITE SIGNAL* softkey opens a submenu for evaluation dispays of the compsite WCDMA signal versus time. Different measurements are supported:

PEAK CODE DOMAIN ERR:

Peak Code Domain Error

Projection of the error between the received signal and the ideal reference signal onto the spreading factor of code class 8 and subsequent averaging using the symbols of each slot of the difference signal. The maximum value of all codes is displayed versus the CPICH slot number [screen B].

EVM VS CHIP:

Error Vector Magnitude versus chip

Square root of square difference between received signal and reference signal at chip level, displayed for each chip.

MAG ERROR VS CHIP:

Magnitude Error versus chip

Difference between the amplitude of the received signal and the reference signal at chip level, displayed for each chip.

PHASE ERROR VS CHIP:

Phase Error versus chip

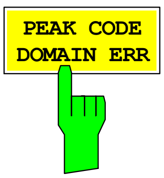
Phase difference between the received signal vector and the reference signal vector at chip level, displayed for each chip.

COMPOSITE CONST

Composite Constellation diagram

Constellation diagram of received signal (scrambled chips) [screen B].

Peak Code Domain Error Power versus slot

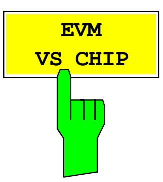


The *PEAK CODE DOMAIN ERR* softkey selects the peak code domain error display mode. In line with the 3GPP specifications, the error between the measurement signal and the ideal reference signal is projected onto the various spreading factors. The result consists of one numerical value per slot for the peak code domain error value. The measurement interval is the slot spacing of the CPICH (timing offset of 0 chips referenced to the beginning of the frame).

IEC/IEEE bus command: `:CALC2:FEED "XTIM:CDP:ERR:PCD`

Query of result: `:TRAC2:DATA? TRAC2`

Vector error versus chip of chip error vector magnitude



The EVM VS CHIP softkey activates the Error Vector Magnitude (EVM) versus chip display. The EVM is displayed for all chips of the slected slot. . The selected slot can be varied by the SELECT CPICH SLOT softkey. The EVM is calculated by the root of the square difference of received signal and reference signal. The reference signal is estimated from the channel configuration of .all active channels. The EVM is related to the square root of the mean power of reference signal and given in percent.

$$EVM_k = \sqrt{\frac{|s_k - x_k|^2}{\frac{1}{N}\sum_{n=0}^{N-1}|x_n|^2}} \cdot 100\% \quad | \quad N = 2560 \quad | \quad k \in [0 \ldots (N-1)]$$

where:

EVM_k	-	vector error of the chip EVM of chip number k
s_k	-	complex chip value of received signal
x_k	-	complex chip value of reference signal
k	-	index number of the evaluated chip
n	-	index number for mean power calculation of reference signal.
N	-	number of chips at each CPICH slot

The value are displayed as trace in screen B (Figure 6) and can be read by IEC bus command.

IEC/IEEE bus command: `:CALCulate1:FEED 'XTIMe:CDPower:CHIP:EVM'`

Query of result: `:TRACe1:DATA? TRACe2`

UNIT: [%]

Range: [0% … 100%]

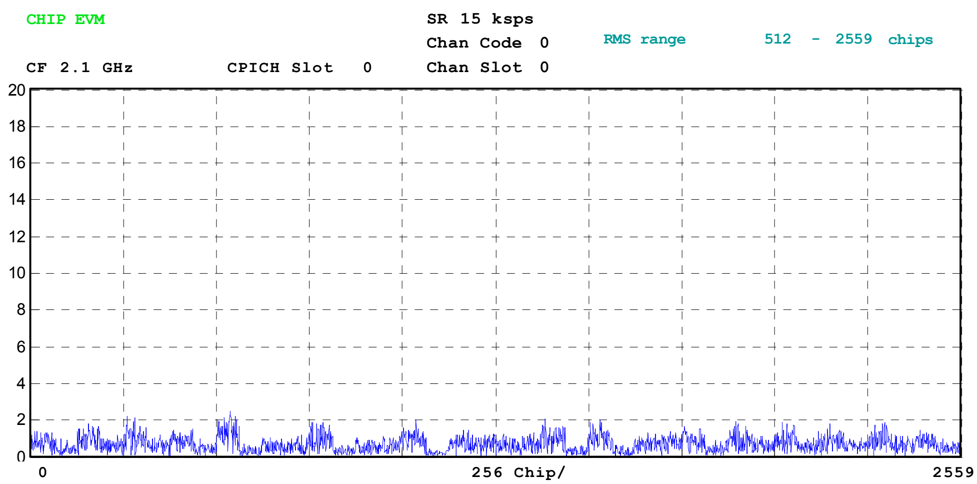
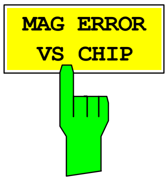


Figure 6: Display of vector error of the EVM versus chip measurement

Magnitude error versus chip of chip error vector magnitude



The MAG ERROR VS CHIP softkey activates the Magnitude Error versus chip display. The magnitude error is displayed for all chips of the slected slot. The selected slot can be varied by the SELECT CPICH SLOT softkey. The magnitude error is calculated by the difference of the magnitude of received signal and magnitude of reference signal (Figure). The reference signal is estimated from the channel configuration of .all active channels. The magnitude error is related to the square root of the mean power of reference signal and given in percent.

$$MAG_k = \frac{|s_k| - |x_k|}{\sqrt{\frac{1}{N}\sum_{n=0}^{N-1}|x_n|^2}} \cdot 100\% \quad | \quad N = 2560 \quad | \quad k \in [0 \ldots (N-1)]$$

where:

MAG_k	-	magnitude error of chip number k
s_k	-	complex chip value of received signal
x_k	-	complex chip value of reference signal
k	-	index number of the evaluated chip
n	-	index number for mean power calculation of reference signal
N	-	number of chips at each CPICH slot

The value are displayed as trace in screen B (Figure 7) and can be read by IEC bus command.

IEC/IEEE bus command: `:CALCulate1:FEED 'XTIMe:CDPower:CHIP:MAGNitude'`

Query of result: `:TRACe1:DATA? TRACe2`

UNIT: [%]

Range: [-100% … 100%]

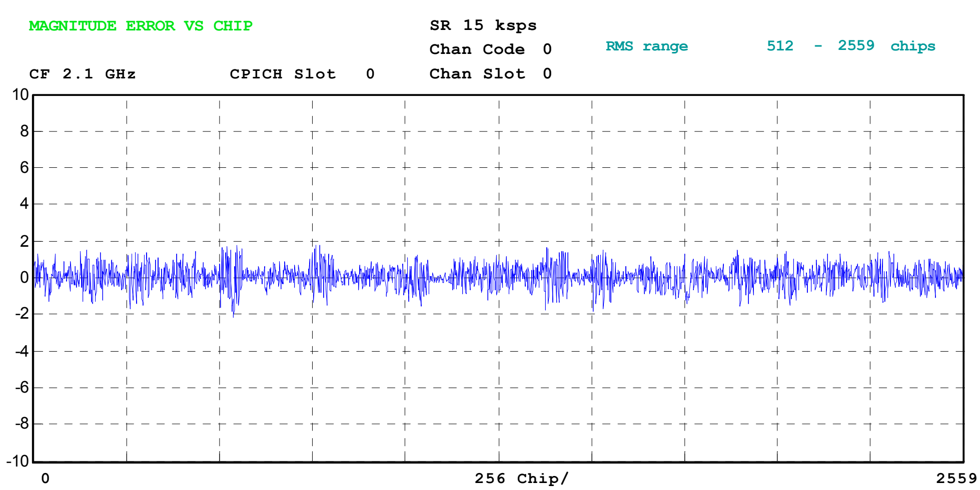
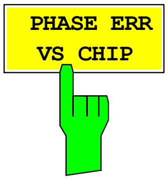


Figure 7: Display of magnitude error versus chip measurement

Phase error versus chip of chip error vector magnitude



The PHASE ERROR VS CHIP softkey activates the Phase Error versus chip display. The phase error is displayed for all chips of the slected slot. The selected slot can be varied by the SELECT CPICH SLOT softkey. The phase error is calculated by the difference of the phase of received signal and phase of reference signal (Figure 8). The reference signal is estimated from the channel configuration of .all active channels. The phase error is given in grad in a range of +/- 180°.

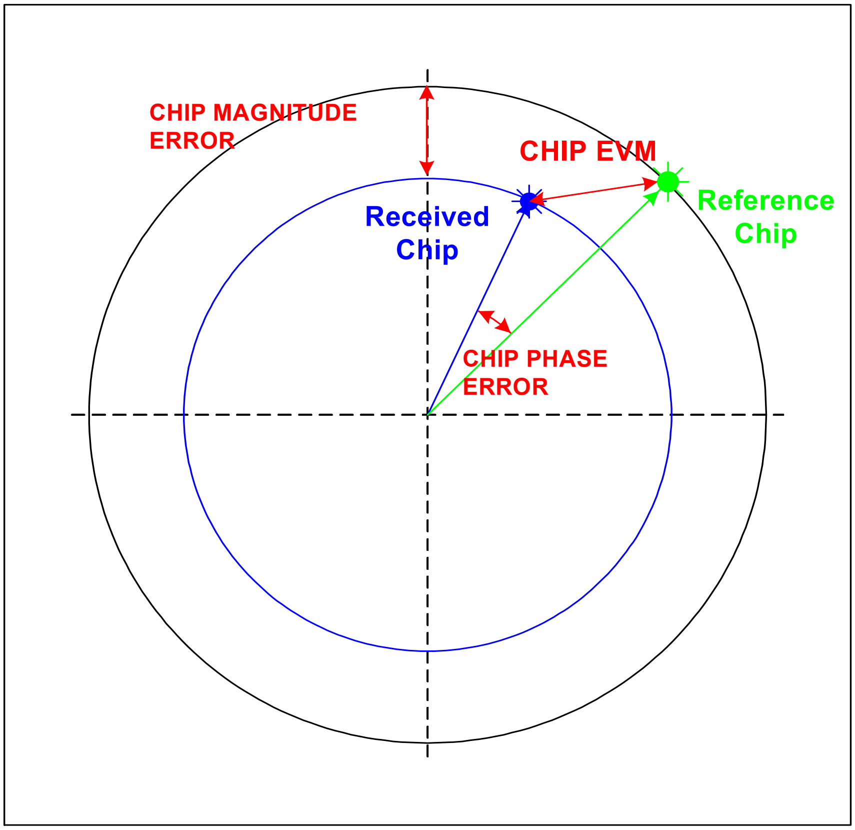


Figure 8: Schematic of reference signal chip and received signal chip to calculate the magnitude, phase and vector error.

$$PHI_k = \varphi(s_k) - \varphi(x_k) \quad | \quad N = 2560 \quad | \quad k \in [0 \ldots (N-1)]$$

where:

PHI_k	-	phase error of chip number k
s_k	-	complex chip value of received signal
x_k	-	complex chip value of reference signal
k	-	index number of the evaluated chip
N	-	number of chips at each CPICH slot
φ(x)	-	phase calculation of a complex value

The value are displayed in screen B (Figure 9) and can be read by IEC bus command.

IEC/IEEE bus command: `:CALCulate1:FEED :CALCulate1:FEED 'XTIMe:CDPower:CHIP:PHASe'`

Query of result: `:TRACe1:DATA? TRACe2`

UNIT: [°]

Range: [-180° … 180°]

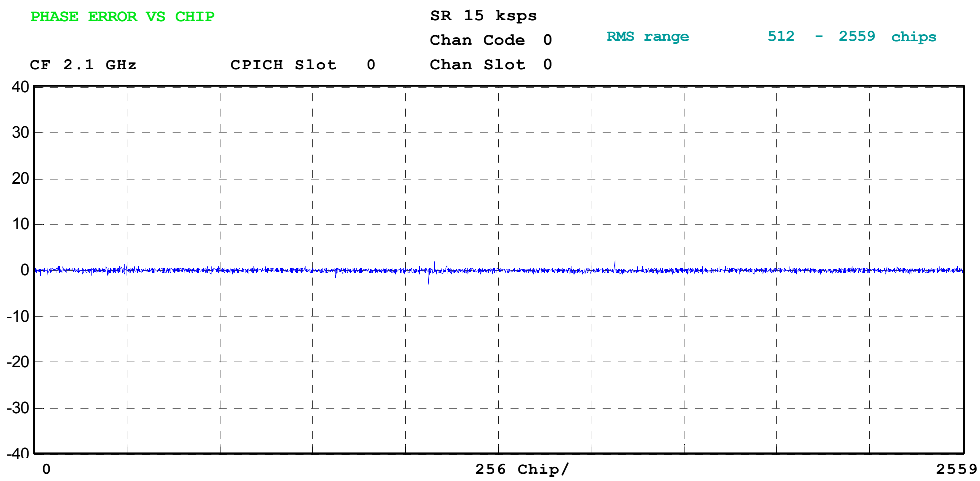
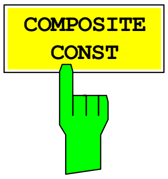


Figure 9: Display of phase error versus chip

Constellation diagram of composite signal at chip level



Display of constellation diagram for the chips of all channels. The displayed constellation points are normalized with the square root of the total power (Figure 10).

EC/IEEE bus command: `:CALC1:FEED "XTIM:CDP:COMP:CONS"`

Query of result: `:TRAC<1>:DATA? TRAC2`

Output: List of I/Q values of all chips per slot
Format: $Re_1, Im_1, Re_2, Im_2, ..., Re_{2560}, Im_{2560}$
Unit: [1]
Quantity: 2560

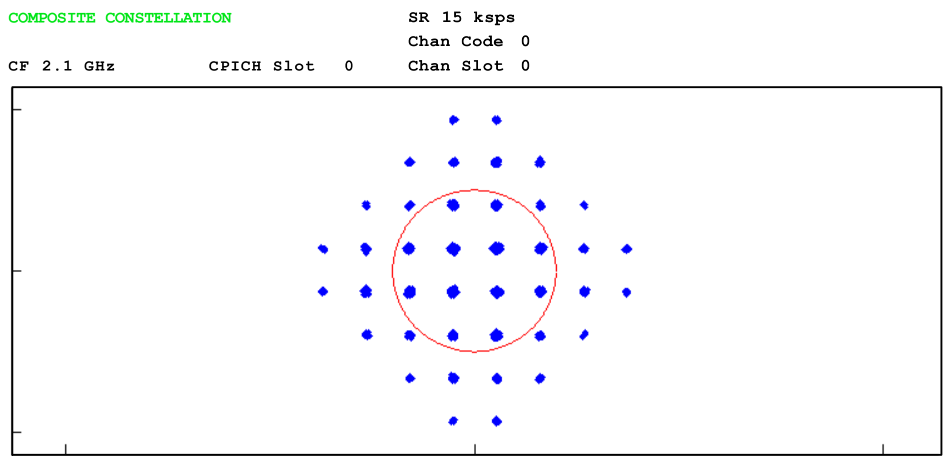


Figure 10: Composite Constellation diagram of received signal (scrambled chips)

Result Summary display

The *RESULT SUMMARY* softkey selects the numerical display of all results. The display is subdivided as follows:

Result Summary SR 15 ksps
Chan Code 0
CF 20 GHz Slot # 0 Mapping Q

GLOBAL RESULTS FOR FRAME 0:		Slot No	0
Total Power	-0.06 dBm	Carrier Freq Error	-58.06 Hz
Chip Rate Error	0.24 ppm	Trigger to Frame	640.017549 µs
IQ Offset	1.03 %	IQ Imbalance	0.13 %
Composite EVM	2.68 %	Pk CDE (480 ksps)	-42.71 dB
RMS range	512 - 2559 chips	No of Active Chan	7
CHANNEL RESULTS		RHO	0.99928
Symbol Rate	15.00 ksps	Timing Offset	0 Chips
Channel Code	0	Channel Mapping	Q
No of Pilot Bits	8	Modulation Type	BPSK-Q
Channel Power Rel	-8.46 dB	Channel Power Abs	-8.52 dBm
Symbol EVM	0.38 % rms	Symbol EVM	0.61 % Pk

Figure 5: Display of Result Summary

The upper part contains the results relating to the total signal:

|
|
|

Composite EVM: The composite EVM is the difference between the test signal and the ideal reference signal (see *COMPOSITE EVM* softkey). The composite EVM value for the selected slot is given in the *RESULT SUMMARY*. The measurement interval inside the selected slot is within the chips of the displayed "RMS range". It is determined by the value of the SETTING softkeys "*EVM INTERV SLOT / MEAS"* and "*ELIMINATE TAIL CHIPS".* (Please refer to the description of the mentioned softkeys)

|
|
|

RMS range: The RMS range gives the measurement interval of rot mean square averaged error vector magnitude inside the selected slot. It is determined by the value of the SETTING softkeys "*EVM INTERV SLOT / MEAS"* and "*ELIMINATE TAIL CHIPS".* (Please refer to the description of the mentioned softkeys)

|
|
|

Modulation type: This parameter shows the modulation type of the selected channel. Possible values are:

BPSK -I: The selected channel has BPSK modulation and is mapped to branch I

BPSK -Q: The selected channel has BPSK modulation and is mapped to branch Q

NONE: This value occurs if the selected channel is switched off and therefore no modulation type could be detected.

Explanation of displayed IQ impairments

Explanation of IQ impairment model

In RF devices including analog mixers such as up-converters, the analog complex baseband signal (r(t)=rI(t)+j*rQ(t)) is shifted to a real high frequency signal (sHF(t)). Each non-ideal complex mixer adds IQ impairments to the baseband signal. Two of them, the IQ offset and the IQ imbalance are estimated by the R&S FS-K72. Both values are given in the Result Summary display. The equations to explain these impairment parameters are described in the following paragraph. The estimation and display of IQ offset and IQ imbalance do NOT depend on the status of the NORMALIZE ON/OFF key. The key only controls an algorithm which compensates the IQ offset to normalize the constellation diagram to the origin.

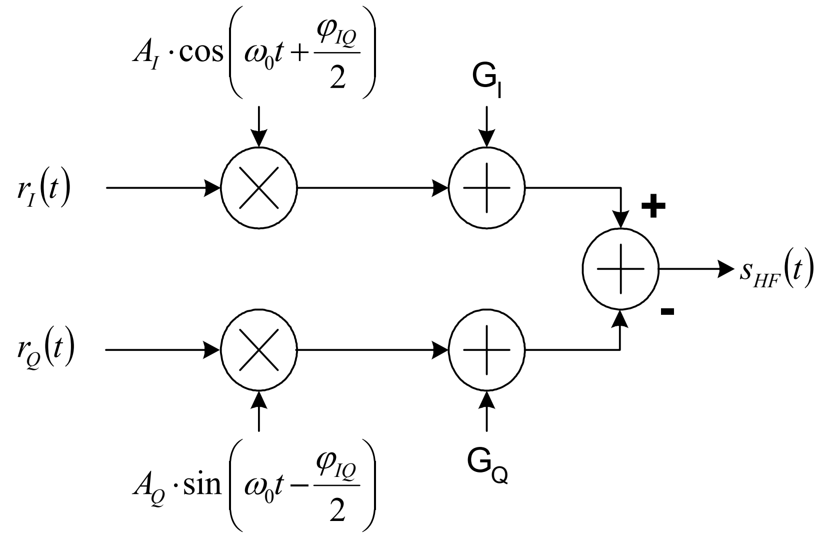


Fig. 0-1 Basic model of possible IQ impairment parameters in complex up-converters.

IQ-Offset

The IQ offset is given in the Result Summary display. It represents a complex offset which leads to a shifted composite constellation diagram. The value is given relative to the mean power of the signal. It is calculated as follows:

$$offset_{IQ} = |g| \cdot 100\% = \sqrt{\left|g_I + j \cdot g_Q\right|^2} \cdot 100\% = \sqrt{\frac{G_I^2 + G_Q^2}{\frac{1}{T}\int_0^T |r(t)|^2\,dt}} \cdot 100\%$$

where:	|g|	- magnitude of the relative IQ offset
	gI	- relative IQ offset of the real part
	gQ	- relative IQ offset of the imaginary part
	GI	- absolute IQ offset of the real part
	GQ	- absolute IQ offset of the imaginary part
	r(t)	- complex baseband signal (reference signal matching with optimum EVM assuming that AWGN is given)
	T	- evaluation time (T=666µs → 1 slot)
	offsetIQ	- IQ offset parameter

IQ-Imbalance

The IQ imbalance is given in the Result Summary display. It represents a complex gain error between the mixer gain in the I path and the mixer gain in the Q path. We assume that a baseband signal r(t) is multiplied by a complex analog oscillator with radian frequency $\omega_0 = 2\pi * f_0$. The complex signal r(t) can be split into a real part $\{r_I(t)\}$ and an imaginary part $\{r_Q(t)\}$. Using this assumption, an ideal complex local oscillator (LO_{ideal}) can also be described by two real sinusoidal signals with a phase offset of 90°. These signals are described as $\cos(\omega_0 t)$ and $\sin(\omega_0 t)$.

$$LO_{ideal} = A \cdot \exp(j\omega_0 t) = A \cdot \cos(\omega_0 t) + j \cdot A \cdot \sin(\omega_0 t)$$

The local oscillator is not ideal in an analog mixer. Normally, there are two different amplitude values (A_I and A_Q) in each path. Moreover, an unwanted phase shift (φ_{IQ}) between the real part and the imaginary part of the local oscillator ($LO_{impairment}$) may occur. Considering these impairments, a non-ideal LO can be described as follows:

$$LO_{impairment} = A_I \cdot \cos\left(\omega_0 t + \frac{\varphi_{IQ}}{2}\right) + j \cdot A_Q \cdot \sin\left(\omega_0 t - \frac{\varphi_{IQ}}{2}\right)$$

The IQ imbalance expresses the relative gain error of the mixer. It is calculated as follows:

$$imbalance_{IQ} = \sqrt{\frac{\left|A_I \cdot \exp\left(j\frac{\varphi_{IQ}}{2}\right) - A_Q \cdot \exp\left(-j\frac{\varphi_{IQ}}{2}\right)\right|^2}{\left|A_I \cdot \exp\left(j\frac{\varphi_{IQ}}{2}\right) + A_Q \cdot \exp\left(-j\frac{\varphi_{IQ}}{2}\right)\right|^2}} \cdot 100\%$$

where:

A_I	- amplitude mixer gain of the real part
A_Q	- amplitude mixer gain of the imaginary part
φ_{IQ}	- additional phase shift between real part and imaginary part
$imbalance_{IQ}$	- IQ imbalance parameter

Hint:

In 3GPP UPLINK signals, each code channel is BPSK-modulated. The BPSK symbols are sent to the I path or Q path. This is controlled by higher layer functionalities. In signals of lower data rates with only one data channel, IQ impairments may affect the detected code channel configuration. IQ impairments result in a power leakage from the I path to the Q branch and vice versa. This power leakage increases the channel power in the non-active channels and slightly decreases the power in the active channels. If the IQ impairments are enlarged, the leakage power is also enlarged and may cause a false detection of non-active channels in the code channel. If these leakage power code channels are detected as active channels, the displayed values of the IQ impairments and composite error vector magnitude (EVM) are decreased.

The displayed IQ impairments and the EVM value are calculated based on a comparison between an estimated ideal baseband signal and the received signal. The fact that it depends on the detected channel configuration can be explained as follows: the estimated ideal signal based on a channel configuration including these additionally detected leakage power channels matches far better with the received signal than the estimated ideal signal. This estimated ideal signal is based on a channel configuration of actually sent active channels.

A false detection of leakage power channels is indicated in the code domain power display (CDP) where all active channels are highlighted in yellow. All active channels are yellow. Yellow channels of low power and high data rate are most likely code channels. To suppress these channels, a PREDEFINED channel table can be used. A predefined channel table can be set via the CHAN CONF menu. This menu is selected by a softkey at the bottom of the screen.

Menu MEAS – SPECTRUM EM MASK

The softkey *LIST EVALUATION* reconfigures the SEM output to a split screen. In the upper half the trace with the limit line is shown. In the lower half the peak value list is shown. For every range of the spectrum emisison defined by the standard the peak value is listed. For every peak value the frequency, the absolut power, the relative power to the channel power and the delta limit to the limit line is shown. As long as the delta limit is negative, the peak value is below the limit line. A positive delta indicates a failed value. The results are then colored in red, and a star is indicated at the end of the row, for indicating the fail on a black and white printout.
If the list evaluation is active, the peak list function is not available.

IEC/IEEE-bus command:
`:CALCulate1:PEAKsearch:AUTO ON | OFF`

With this command the list evaluation which is by default for backwards compatibility reasons off can be turned on.

`TRACe1:DATA? LIST`
With this command the list evaluation results are queried in the following order:
<no>, <start>, <stop>, <rbw>, <freq>, <power abs>, <power rel>, <delta>, <limit check>, <unused1>, <unused2>
All results are float values.

no	: range number
start	: start frequency
stop	: stop frequency
rbw	: resolution bandwidth of range
freq	: frequency of peak
power abs	: absolut power in dBm of peak
power rel	: relative power in dBc (related to the channel power) of peak
delta	: distance to the limit line in dB (positive indicates value above the limit, fail)
limit check	: limit fail (pass = 0, fail =1)
unused1	: reserved (0.0)
unused2	: reserved (0.0)

Modified Chapters for remote operation

Control of root mean square average range of EVM_{rms} value

:[SENSe:]CDPower:EINTerval SLOT | MEAS

This command switches sets the mode of determining the average interval of the root mean square (RMS) calculation for error vector magnitude (EVM_{rms}) versus slot. The command influences the calculation of the composiet EVM (rms) values. [*COMPOSITE EVM* (RMS)]. According to 3GPP TS 34.121 version V7.1.0 chapter 5.13.1A "Error Vector Magnitude (EVM) with HS-DPCCH", the average interval for root mean square calculation of EVM_{rms} is not fixed to a full slot length. In signals containing power controlled channel unaligned to DPCCH slot timing, only an interval of constant channel power should be considered to calculate EVM_{rms}. The command decides wether unaligned power controlled channels should influence the average interval or not. The measurement interval is also influenced by the setting *ELIMINATE TAIL CHIPS* for details please refer to the command description of

MEAS: The measurement interval of EVM_{rms} is determined automatically considering the timing offset of HS-DPCCH and E-DPCCH channel of the received signal.

SLOT: The measurement interval of EVM_{rms} is set to a complete slot.

Example: `" SENS:CDP:EINT MEAS"`

Characteristics: *RST value: `SLOT`
SCPI: device-specific

Query of results: `:SENS:CDP:EINT?`

Result: `<SLOT | MEAS>`

:[SENSe:]CDPower:ETCHips ON|OFF

This command selects length of the measurement interval for calculation of error vector magnitude (EVM). In accordance with 3GPP specification Release 5, the EVM measurement interval is one slot (4096 chips) minus 25 µs at each end of the burst (3904 chips) if power changes are expected. If no power changes are expected, the evaluation length is one slot (4096 chips). In case of a reduced measurement length due to activated EVM interval reduction (refer to EVM INTERV SLOT/MEAS), the EVM measurement interval is also reduced by 25 µs. That results in an interval of less than one slot minus 25 µs (less than 3904 chips).

ON: Changes of power are expected. Therefore an EVM measurement interval of one slot minus 25 µs (3904 chips) is considered.

OFF: Changes of power are not expected. Therefore an EVM measurement interval of one slot (4096 chips) is considered

Example: `:SENS:CDP:ETCH ON`

Features: *RST value: OFF
SCPI: device-specific

Query of results: `:SENS:CDP:ETCH?`

Result: `<1|0>`

Query result of root mean square value of error vector magnitude with included measurement interval information.

:TRACe:DATA? CEVM

This command reads the root mean square (RMS) value of the error vector magnitude (EVM_{rms}). The measurement interval of the RMS value depends on analyzer settings and the channel configuration of the applied signal (refer to ":[SENSe:]CDPower:EINTerval" and ":[SENSe:]CDPower:ETCHips"). The information of the chip limits of the used measurement interval are given for each slot. Fifteen (15) groups of 6 values are always transferred.

Example: `:TRAC:DATA? CEVM`

Result: 15 groups with 6 values per group are returned:

<slot$_0$>,<EVM$_0$>, <BeginMeas$_0$>,<EndMeas$_0$>,<Reserved_A$_0$>,<Reserved_B$_0$>
<slot$_1$>,<EVM$_1$>, <BeginMeas$_1$>,<EndMeas$_1$>,<Reserved_A$_1$>,<Reserved_B$_1$>
| | | | | |
<slot$_{14}$>,<EVM$_{14}$>, <BeginMeas$_{14}$>,<EndMeas$_{14}$>,<Reserved_A$_{14}$>,<Reserved_B$_{14}$>

Where:	<field>	[unitf]	{range}	- explanation
	<slot$_n$>	[1]	{0 … 14}	- slot number
	<EVM$_n$>	[%]	{0 … 100}	- RMS value of error vector magnitude
	<BeginMeas$_n$>	[chip]	{0 … 1278}	- Begin of the measurement interval for EVM_{rms} value
	<EndMeas$_n$>	[chip]	{0 … 2559}	- End of the measurement interval for EVM_{rms} value
	< Reserved_A$_n$>	[]	{0}	- Reserved for possible additional information in future FW versions
	< Reserved_B$_n$>	[]	{0}	- Reserved for possible additional information in future FW versions

Query result of root mean square average interval

:CALCulate<1|2>:MARKer<1>:FUNCtion:WCDPower:MS:RESult?

PTOTal | FERRor | TFRame | MACCuracy | PCDerror | EVMRms | EVMPeak | CERRor | CSLot | SRATe | CHANnel | CDPabsolute | CDPRelative | IQOFfset | IQIMbalance | CMAPping | PSYMbol | RHO | TOFFset | EVMBegin | EVMend

This command queries the measured and calculated results of the 3GPP FDD code domain power measurement.

PTOTal	total power	[dBm]
FERRor	frequency error	[Hz]
TFRame	trigger to frame	[s]
MACCuracy	composite EVM (RMS)	[%]
PCDerror	peak code domain error	[dB]
EVMRms	symbol error vector magnitude RMS	[%]
EVMPeak	symbol error vector magnitude peak	[%]
CERRor	chip rate error	[ppm]
CSLot	channel slot number	[]
SRATe	symbol rate	[ksps]
CHANnel	channel number	[]
CDPabsolute	channel power absolute	[dBm]
CDPRelative	channel power relative	[dB]
IQOFfset	IQ offset	[%]
IQIMbalance	IQ imbalance	[%]
CMAPping	Channel component	[I | Q]
PSYMbol	Number of pilot bits	[]

RHO	Quality paramter rho for every slot	[]
TOFFset	Offset between the start of the first slot in the channel and the start of the analyzed 3GPP FDD frame.	[chip]
EVMBegin	Begin of the measurement interval to calculate EVM (RMS) value	[chip]
EVMend	End of the measurement interval to calculate EVM (RMS) value	[chip]

Example: `":CALC:MARK:FUNC:WCDP:RES?` EVMBegin"

Features: *RST value: -
SCPI: device-specific

Activating Error Vector Magnitude versus chip measurements

`:CALCulate<1|2>:FEED 'XTIMe:CDPower:CHIP:EVM'`
This command selects the vector error data to be displayed

`:CALCulate<1|2>:FEED 'XTIMe:CDPower:CHIP :MAGNitude'`
This command selects the magnitude error data to be displayed

`:CALCulate<1|2>:FEED 'XTIMe:CDPower:CHIP:PHASe'`
This command selects the phase error data to be displayed

`:CALCulate<1|2>:FEED 'XTIMe:CDPower:COMPosite:CONSt'`
This command selects the composite constellation data to be displayed

Query result of Error Vector Magnitude versus chip

`:TRACe[:DATA]? TRACE2`

EVM VS CHIP (TRACe2)

The square root of square difference between received signal and reference signal for each chip are transferred. The values are normalized to the square root of the average power at the selected slot:

Output:	List of vector error values of all chips at the selected slot
Format:	$VectError_0$, $VectError_1$, ..., $VectError_{2559}$
Unit:	[%]
Quantity:	2560

`:TRACe[:DATA]? TRACE2`

MAGNITUDE ERROR VS CHIP (TRACe2)

The magnitude difference between received signal and reference signal for each chip are transferred. The values are normalized to the square root of the average power at the selected slot:

Output:	List of magnitude error values of all chips at the selected slot
Format:	$MagError_0$, $MagError_1$, ..., $MagError_{2559}$
Unit:	[%]
Quantity:	2560

`:TRACe[:DATA]? TRACE2`

PHASE ERROR VS CHIP (TRACe2)

The phase differences between received signal and reference signal for each chip are transferred. The values are normalized to the square root of the average power at the selected slot:

Output:	List of magnitude error values of all chips at the selected slot
Format:	$PhaseError_0$, $PhaseError_1$, ..., $PhaseError_{2559}$
Unit:	[°]
Quantity:	2560

Query result of scrambled chip data for composite constellation display

`:TRACe[:DATA]? TRACE2`

COMPOSITE CONSTELLATION (TRACe2)

The real and the imaginary components of the received chip constellation at the selected slot are transferred. The values are normalized to the square root of the average power at the selected slot:

Output:	List of I/Q values of all chips per slot
Format:	Re_1, Im_1, Re_2, Im_2, ..., Re_{2560}, Im_{2560}
Unit:	[1]
Quantity:	2560

Enabling of automatic peak search in spectrum emission mask measurement

`CALCulate<1|2>:PEAKsearch:AUTO ON | OFF`

PEAK LIST OF SPECTRUM EMISSION MASK MEASUREMENT (SEM)

This command calculates a peak list of the spectrum emission mask measurement at each sweep. One peak value is determined for each range of the limit line. The command corresponds to the softkey 'LIST EVALUATION'

ON:	Enables automatic peak search
OFF:	Disables automatic peak search

Range: [ON | OFF]

Example: "CALC:PEAK:AUTO ON"

Default: OFF

Query result of peak search list in spectrum emission mask measurement

`TRACe<1|2>:DATA? LIST`

READ OUT RESULTS OF PEAK LIST EVALUATION

This command reads the peak list of the spectrum emission mask measurement list evaluation (refer to CALC:PEAK:AUTO ON | OFF). An array of values is returned for each range of the limit line. The arrays for each limit line range are following sequentially.

<value array of range 1>, <value array of range 2>, ….., <value array of range n>

The array of each range contains the following value list:

<No>, <Start>, <Stop>, <Rbw>, <Freq>, <Levelabs>, <Levelrel>, <Delta>, <Limitcheck>, <unused1>, <unused2>

where:

No	[]	: number of the limit line range
Start	[Hz]	: start frequency of the limit line range
Stop	[Hz]	: stop frequency of the limit line range
Rbw	[Hz]	: resolution band width of the limit line range
Freq	[Hz]	: frequency of the power peak with in the range
Levelabs	[dBm]	: absolute power of the peak with in the range
Levelrel	[dB]	: relative power of the peak with in the range related to channel power.
Delta	[dB]	: power difference to margin power
Limitcheck	[0 | 1]	: decision whether the power is below [0] or above [1] the limit line
Unused1	[]	: reserved (0.0)
Unused2	[]	: reserved (0.0)

Example: " TRAC:DATA? LIST" Reads the value list of automatic peaks search

Query result of result summary parameters

:CALCulate<1|2>:MARKer<1>:FUNCtion:WCDPower:MS:RESult?
PTOTal | FERRor | TFRame | MACCuracy | PCDerror | EVMRms | EVMPeak | CERRor | CSLot | SRATe | CHANnel | CDPabsolute | CDPRelative | IQOFfset | IQIMbalance | CMAPping | PSYMbol | RHO | TOFFset **| MTYPe | ACHannels**

This command queries the measured and calculated results of the 3GPP FDD code domain power measurement.

PTOTal	total power
FERRor	frequency error in Hz
TFRame	trigger to frame
MACCuracy	composite EVM
PCDerror	peak code domain error
EVMRms	error vector magnitude RMS
EVMPeak	error vector magnitude peak
CERRor	chip rate error
CSLot	channel slot number
SRATe	symbol rate
CHANnel	channel number
CDPabsolute	channel power absolute
CDPRelative	channel power relative
IQOFfset	IQ offset
IQIMbalance	IQ imbalance
CMAPping	Channel component
PSYMbol	Number of pilot bits
RHO	Quality paramter rho for every slot
TOFFset	Offset between the start of the first slot in the channel and the start of the analyzed 3GPP FDD frame.
MTYPe	**modulation type**
ACHannels	**Number of active channels**

Example: ":CALC:MARK:FUNC:WCDP:RES? PTOT"

Features: *RST value: -
SCPI: device-specific

Query results of channel table

:TRACe[:DATA]? TRACE1 | TRACE2 | ABITstream | CTABle | CWCDp | TPVSlot

This command transfers trace data from the controller to the instrument, the query reads trace data out of the instrument.

ABITstream can be set only if `CALC2:FEED "XTIM:CDP:BSTReam"` is selected (in the lower bitstream window). This command returns the bitstreams of all 15 slots one after the other, the output format may be REAL, UINT or ASCII.

The output format is equal to that of the ":TRACe1:DATa? TRACE2" command in case of an activated bitstream display. The only difference is the number of symbols which are evaluated. The ABITSTREAM command evaluates all symbols of one frame. One value is transferred per bit (range 0,1,). Each symbol contains of two (QPSK) consecutive bits. The number of symbols is not constant and may vary depending on the spreading factor of the selected channel. The bit stream may contain invalid (symbols without power). In this case the character '9' is read.

Unit:	[]
Range:	{0, 1, 7, 9}
Bits per symbol:	$N_{BitPerSymb} = 2$
Number of symbols:	$N_{Symb} = 150*2^{(8\text{-Code Class})}$
Number of bits:	$N_{Bit} = N_{Symb} * N_{BitPerSymb}$
Format:	$Bit_{00}, Bit_{01}, Bit_{10}, Bit_{11}, Bit_{20}, Bit_{21}, \ldots,$ $Bit_{NSymb\ 0}, Bit_{NSymb\ 1}$
Explanation:	0 – Low state of a transmitted bit 1 – High state of a transmitted bit 7 – Suppressed symbol of a HS-DPCCH slot 9 – Bit of an inactive channel

CTABle reads out the channel table: Seven values are transmitted for each channel, the sixth value (reserved for pilot length) being constantly 0:
< class>,<cannel number>,<absolute level>,<relative level>, <I/Q component>,0,<state>...

CWCDp can be set if CODE PWR ABSOLUTE / RELATIVE, CHANNEL TABLE is selected for trace 1. The pilot length, channel state, channel type, modulation type and a reserved value are transmitted in addition to the values transmitted for trace 1. For each channel, 11 values are transmitted

<code class>, <channel number>, <IQ component>, <absolute level>, <relative level>, <timing offset>, <pilot length>, <active flag>, <channel type>, <modulation type>, <reserved>...

No.	Parameter	Range	Unit	Explanation
1)	<code class>	{2 to 8}	[1]	Code class of the channel.
2)	<channel number>	{0 to 255}	[1]	Code number of the channel.
3)	<IQ component>	{0, 1}	[1]	IQ component of the channel.
		0 - Q component		Channel symbols (S_n) sent from **q**uadrate component; only imaginary part of S_n is used. [Re $\{S_n\} = 0$ Im $\{S_n\} \neq 0$]
		1 - I component		Channel symbols (S_n) sent from **I**n phase component; only real part of S_n is used. [Re $\{S_n\} \neq 0$ Im $\{S_n\} = 0$]
4)	<absolute level>	{-∞ to ∞}	[dBm]	Absolute level of the code channel at the selected channel slot. (The channel slot can be marked by the SELECTED CPICH slot.)
5)	< relative level >	{-∞to ∞}	[dB]	Relative level of the code channel at the selected channel slot referenced to CPICH or total power. (The channel slot can be marked by the SELECTED CPICH slot.)
6)	<timing offset>	{0 to 2560}	[chips]	Timing offset of the HS-DPCCH to the frame start. The value is measured in chips. The step width is 256 chips. For all other data channels, the timing offset is zero.
7)	<pilot length>	{0 to 8}	[symbols]	Pilot length of the DPCCH.
8)	<active flag>	{0,1}	[1]	Flag to indicate whether a channel is active 0 - channel not active 1 - channel active
9)	<channel type>	{0 ... 2}	[1]	Channel type indication
		0 - DPDCH		**D**edicated **P**hysical **D**ata **Ch**annel
		1 - DPCCH		**D**edicated **P**hysical **C**ontrol **Ch**annel
		2 – HS-DPCCH		**H**igh-**S**peed **D**edicated **P**hysical **C**ontrol **Ch**annel
		3 – E-DPCCH		***E**nhanced **D**edicated **P**hysical **C**ontrol **Ch**annel*
		4 - E-DPDCH		***E**nhanced **D**edicated **P**hysical **D**ata **Ch**annel*
10)	**<modulation type>**	**{0,1,15}**	**[1]**	**Modulation type of the code channel**
		0 - BPSK-I		**Modulation type BPSK I - Branch**
		1 – BPSK-Q		**Modulation type BPSK Q - Branch**
		15 – None		**no power within the channel slot**
11)	<reserved>	{0}	[1]	Reserved for future functionality.

For TRACE1 or TRACE2 the following measured values are transferred depending on the display mode:

Appendix: Contact to our hotline

Any questions or ideas concerning the instrument are welcome by our hotline:

USA & Canada

Monday to Friday (except US public holidays)

8:00 AM – 8:00 PM Eastern Standard Time (EST)

Tel. from USA	888-test-rsa (888-837-8772) (opt 2)
From outside USA	+1 410 910 7800 (opt 2)
Fax	+1 410 910 7801
E-mail	Customer.Support@rsa.rohde-schwarz.com

East Asia

Monday to Friday (except Singaporean public holidays)

8:30 AM – 6:00 PM Singapore Time (SGT)

Tel.	+65 6 513 0488
Fax	+65 6 846 1090
E-mail	Customersupport.asia@rohde-schwarz.com

Rest of the World

Monday to Friday (except German public holidays)

08:00 – 17:00 Central European Time (CET)

Tel. from Europe	+49 (0) 180 512 42 42
From outside Europe	+49 89 4129 13776
Fax	+49 (0) 89 41 29 637 78
E-mail	CustomerSupport@rohde-schwarz.com