



ROHDE & SCHWARZ

Test and Measurement

Division

Release Notes

3G FDD BTS/3GPP HSDPA BTS

Application Firmware R&S FS-K72/FS-K74

Release 4.10

for R&S FSP, FSU, FSQ, FMU Analyzer Firmware 4.1x

Release Note Revision: 2

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Contents

History	2
General Topics	3
Hardware Requirements	3
Compatibility of R&S FS-K72/K74.....	3
Firmware Update of R&S FS-K72/K74	4
Generation of an update disk set for R&S FS-K72/K74	4
Preparing installation via LAN or USB stick:.....	5
Performing the Application Firmware Update on the Instrument.....	5
Enabling the Application Firmware via License Key Code Entry.....	5
Modified Functions	6
Problems Eliminated with 4.10	8
Modifications to the Operating Manual.....	8
Modified Chapters for manual operation	8
Code Domain Power Menu – Overview	9
Measurement Menu – Overview.....	10
Signal Power Check – SPECTRUM EM MASK	11
Root Mean Square Error Vector Magnitude (EVM _{RMS}).....	13
Error Vector Magnitude (EVM _{chip}) versus chip	13
Explanation of displayed IQ impairments	19
Menu MEAS – SPECTRUM EM MASK.....	21
Modified Chapters for remote operation.....	22
Advanced channel type estimation (SCPICH).....	22
Define channel table using advanced channel types (SCPICH)	24
Activating Error Vector Magnitude versus chip measurements.....	24
Query result of Error Vector Magnitude versus chip	25
Query result of scrambled chip data for composite constellation display.....	25
Query result of Frequency Error vs Slot	25
Enabling of automatic peak search in spectrum emission mask measurement.....	26
Query result of peak search list in spectrum emission mask measurement	26
Appendix: Contact to our hotline	28

History

<u>Date</u>	<u>Rel Note Rev</u>	<u>Changes</u>
04 April 2007	1	First revision for R&S FS-K72/R&S FS-K74 version 4.10
22 August 2007	2	Chapter <i>Modifications to the Operating Manual</i> corrected. The extensions of version 4.00 SP1 were erroneously removed.

General Topics

Hardware Requirements

Please note that R&S FS-K72/K74 requires options R&S FSP-B15 and R&S FSP-B70 in order to run on an R&S FSP. If either of the required hardware options is not installed the unit will not accept the license key for the corresponding firmware application.

Compatibility of R&S FS-K72/K74

The following table shows the compatible versions of the basic analyzer firmware and the 3G FDD BTS Application Firmware R&S FS-K72 and 3GPP Application Firmware R&S FS-K74 (FS-K74 is supported since version 2.28/3.28):

Table of compatible versions:

R&S FS-K72/K74 Application Firmware	R&S FSP Basic Firmware	R&S FSU Basic Firmware	R&S FSQ Basic Firmware	R&S FSMR Basic Firmware	R&S FMU Basic Firmware
4.10	4.10	4.11	4.15	4.16	4.18
4.01	-	-	-	-	4.08
4.00	4.00	4.01	4.05	-	-
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	3.76 SP1	-
3.60	3.60	3.61	3.65	3.66 SP1	-
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	-	-
2.60	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	-	-
1.12	1.70	1.71	1.75	-	-
1.11	1.60	1.61	1.65	-	-
1.10	1.50	1.51	-	-	-
1.00	-	1.41	-	-	-

Application firmware versions 3.xx/4.xx are running on R&S FSPs with order # 1164.4391.xx or R&S FSU with order # 1166.1660.xx or R&S FSQ with operating system XP.

Application firmware version 2.xx are running on R&S FSPs with order # 1093.4495.xx or R&S FSU with order # 1129.9003.xx or R&S FSQ with operating system NT.

Firmware Update of R&S FS-K72/K74

The R&S FS-K72/K74 Application Firmware package is available with its own version number. This application firmware package requires an appropriate basic instrument firmware version. Compatible revisions are shown in the table above.

Please make sure to have the correct basic firmware version installed prior to installing the R&S FS-K72/K74 Application Firmware. Please refer to the basic firmware version release notes for firmware update information of the basic firmware.

Note: *R&S FS-K72/74 and R&S FS-K73 are using the same update set. It is therefore required to only update one of these applications.*

Generation of an update disk set for R&S FS-K72/K74

The files needed for the R&S FS-K72/K74 Application Firmware update are available in the FIRMWARE section of the Service Board on GLORIS (R&S FS-K72 and FS-K74 are included in the same disc).

If you already have the update disk set you can skip this paragraph.

They are grouped according to the disk contents:

Disk 1: disk1.bin (self-extracting ZIP file)

Disk 2: data3.cab (packed contents of disk 2, will be automatically unpacked by FW update)

The contents of disk 1 are packed in a self-extracting ZIP file and need to be unzipped. For this purpose the following steps are necessary:

1. Create a temporary directory on your local PC (e.g. MyTemp\Extensions\K72 on drive C:)
2. Copy disk1.bin into that directory and rename it to disk1.exe
3. Execute disk1.exe. Under Windows 95/98/NT/2000 this is done best using the following sequence:
 <CTRL><ESC> - RUN – C:\MyTemp\Extensions\K72\DISK1 - <ENTER> or
 <CTRL><ESC> - AUSFÜHREN – C:\MyTemp\Extensions\K72\DISK1 - <ENTER>for a German Windows version.

The files will be unzipped.

4. Delete disk1.exe from the temporary directory.

data1.cab	data1.hdr	data2.cab	ExecCtrl.exe	id.txt	ikernel.ex_
ISSetup.exe	layout.bin	RestInst.exe	Setup.exe	Setup.ini	setup.inx

Please make sure that all filenames exactly match with these printed above before you try to use them for the firmware update. Especially the trailing underscore ('_') as used in ikernel.ex_ or _inst32i.ex_ is essential for correct operation of the update program.

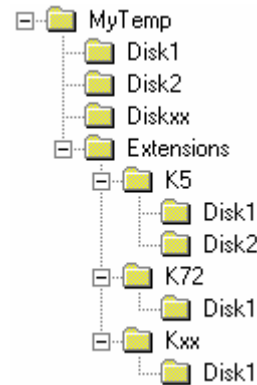
5. Copy the contents of the temporary directory onto update disk #1.

The content of the other disk is already packed in the format required by the firmware update program and need no further processing. The files only need to be copied onto disks #2, the number in the filename (minus 1) indicating the corresponding disk number (data3.cab => disk #2).

Preparing installation via LAN or USB stick:

If the installation shall be done via LAN or USB stick (XP only) please set up the following directory structure:

Copy all files as mentioned in the previous section in the directory ..\MyTemp\Extensions\K72\Disk1.



Performing the Application Firmware Update on the Instrument

The Application Firmware update process is performed in the following steps:

- Switch the instrument on and wait until the Analyzer has resumed operation.
- For updates from LAN or USB (XP only) use the SETUP | NEXT | FIRMWARE UPDATE | UPDATE PATH softkey to specify any path for the location of the Disk1 directory (e.g. F:\MyTemp\Extensions\K72). For floppy usage the default A:\ must not be changed
- Press SETUP → NEXT → FIRMWARE UPDATE
- Confirm the query "Do you really want to update the firmware?" with OK
- Insert update disk #1 (and #2 for version 3.xx/4.xx) as requested (for LAN or USB just confirm the copy process)
- The instrument will perform several automatic shutdowns, until the new firmware is installed properly.
Do not switch the instrument off until the update process has been finished completely.

After switching on the instrument for the first time after a successful firmware update it is necessary to execute the instrument's self alignment process by pressing CAL and softkey CAL TOTAL.

Note: R&S FS-K72/74 and R&S FS-K73 are using the same update set. It is therefore required to only update one of these applications.

A simplified update process is available if base system firmware 4.1x or newer is installed. More details are described in the release note of the base system firmware.

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-K72 3G FDD BTS and R&S FS-K74 HSDPA BTS 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.

- Each application firmware R&S FS-K72 3G FDD BTS and R&S FS-K74 HSDPA BTS has its own option key. The K72 3G FDD BTS is a prerequisite for installing the K74 HSDPA BTS application firmware!
- Installing FS-K72: option key for FS-K72 must be entered
- Installing FS-K74: option key for FS-K72 **and** option key for FS-K74 must be entered
- 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 and 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. [V1.11] New functions: Antenna Diversity, Sync Type CPICH / SCH
2. [V1.12] Carrier Frequency Error now determined on per slot basis
3. [V1.12] New result display types: Composite Constellation, Power vs. Symbol
4. [V1.12] New: Support for Compressed Mode signals
5. [V1.20] Margin check of xdB margin below Spectrum Emission Mask Limit Lines
6. [V3.20/V1.20] Output of frequency and response value if margin check failed
7. [V3.20/V1.21] Improved sensitivity for code channels with low SN ratio (6dB SNR of a code class 8 channel is sufficient to detect the channel in auto search mode)
8. [V3.20/V1.21] Pilot symbol check added.
9. [V3.20/V1.21] For signalling a detection of a pilot symbol that is different from that of the 3GPP standard the 5th Bit of the status register is used.
10. [V3.24/V2.24] Code Domain Error Power measurement is now available
11. [V3.24/V2.24] Improved Resolution of Trigger to Frame measurement
12. [V3.24/V2.24] Improved absolute accuracy of Trigger to Frame measurement
13. [V3.24/V2.24] Trace statistic available on result summary parameters (MIN Hold, MAX Hold, Averaging)
14. [V3.24/V2.24] Improved compressed mode handling
15. [V3.28/V2.28] Support of FS-K74 HSDPA BTS Test including automatic channel search
16. [V3.28/V2.28] Unit circle display in constellation diagrams
17. [V3.28] Option FS-K9 power sensor support for RF measurement
18. [V3.30/V2.30] New function: Multi-Frame Evaluation
19. [V3.30/V2.30] Detection of SCCPCH is now available
20. [V3.30/V2.30] Improved detection sensitivity for HSDPA channels
21. [V3.30/V2.30] Spectrum emission mask – IEC readout of worst fail position
22. [V3.30/V2.30] Auto channel detection of compressed mode channels
23. [V3.40/V2.40] IEC readout of frame bit-stream

24. [V3.40/V2.40] Slot power difference of power versus slot measurement
25. [V3.40/V2.40] Adjacent channel leakage power ratio (ACLR) for multi carrier signals
26. [V3.40/V2.40] Peak list evaluation of spectrum emission mask
27. [V3.40/V2.40] Advanced auto level adjust of multi carrier signals
28. [V3.40/V2.40] Autolevel Adjust for channel power measurement and statistic measurement
29. [V3.50/V2.60] Extended scrambling code range
30. [V3.50/V2.60] Advanced channel type estimation for compressed mode
31. [V3.50/V2.60] Display of slot format type A and type B
32. [V3.50/V2.60] Display of TPC Symbols in the first slot of a compressed gap
33. [V3.50/V2.60] Constellation re-arrangement for 16 QAM in dependence on constellation parameter B
34. [V3.50/V2.60] Absolute and relative slot power display and differential slot power display added
35. [V3.50/V2.60] Extended trigger range
36. [V3.50/V2.60] RF combination measurement (RF Combi)
37. [V3.60/V2.60] Display of frequency error versus slot, phase discontinuity versus slot, symbol magnitude error and symbol phase error
38. [V3.60/V2.60] Result Summary: added value RHO
39. [V3.60/V2.60] Scrambling code input in hex and also in decimal
40. [V3.60/V2.60] HSDPA mode can be switched OFF / ON
41. [V3.60/V2.60] Measurement of timing offset in predefined channel mode
42. [V3.60/V2.60] Multi carrier ACP measurement with independent inter carrier spacing support
43. [V3.60/V2.60] SEM: Extended range definition for peak list and adjustable transition frequency
44. [V3.60/V2.60] External trigger level adjustable from 0.5 to 3.5 V
45. [V3.60/V2.60] Carrier frequency step size softkey available
46. [V3.70/V2.80] Scrambling code auto search
47. [V3.70/V2.80] Channel table compare mode
48. [V3.70/V2.80] Remote command to read out total power versus slot
49. [V3.70/V2.80] ACLR/MCACLR: number of adjacent channels increased to 12, power mode to max hold the power results
50. [V3.70/V2.80] RF COMBI: noise correction mode
51. [V3.80/V2.80] Support for HSUPA within R&S FS-K74
52. [V3.80/V2.80] Trace view available within code domain analyzer
53. [V3.90] List result of scrambling code search
54. [V4.00] Vector error of Error Vector Magnitude (EVM) versus chip
55. [V4.00] Magnitude error of Error Vector Magnitude (EVM) versus chip
56. [V4.00] Phase error of Error Vector Magnitude (EVM) versus chip
57. [V4.00] Spectrum emission mask: List evaluation in lower screen now supported
58. [V4.00SP1] New remote command TRACe:DATA? ATRACE2
59. [V4.10] New remote command CALC:MARK:FUNC:WCDP:RES? PSYMBOL | AChannels

Problems Eliminated with 4.10

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

- 1. (K72/K74 V2.80/ V3.80) **Code domain error power display corrected.**
According to 3GPP specification the code domain error (CDE) measurement displays the chip error of the signal spread to the channels spreading factor 256. In previous versions the spreading factor of the CDE measurement has been varied by adjusting the spreading factor of the Peak Code Domain Error Power (PCDEP) measurement. According to 3GPP the spreading factor of CDE is fixed to 256 and only the spreading factor of PCDEP may be varied. The unwanted dependency of CDE spreading factor on PCDEP spreading factor has been eliminated within this version.
- 2. (K72/K74 V4.00) **Selectable number of pilot symbols in predefined channel table corrected.**
The correction only applies to compressed mode channels with increased data rate by 2 in predefined mode if a new channel is added to the channel table. In case of an increased data rate, the number of pilot symbols is doubled compared to standard DPCH channels. In the previous version it was not possible to select the correct number of pilot symbols for the following two channel types: CPR_SF2 and CPR_SF2_TPC.
- 3. (K72/K74 V4.00) Predefined Channel Table 3GB_2 corrected (more than 3 DPCH channels).

Modifications to the Operating Manual

The R&S FS-K72/K74 3G FDD BTS analyzer functions are included in a separate manual set. Please refer to the following order numbers:

- 1154.7023.44-03 German and English

Modified Chapters for manual operation

Code Domain Power Menu – Overview

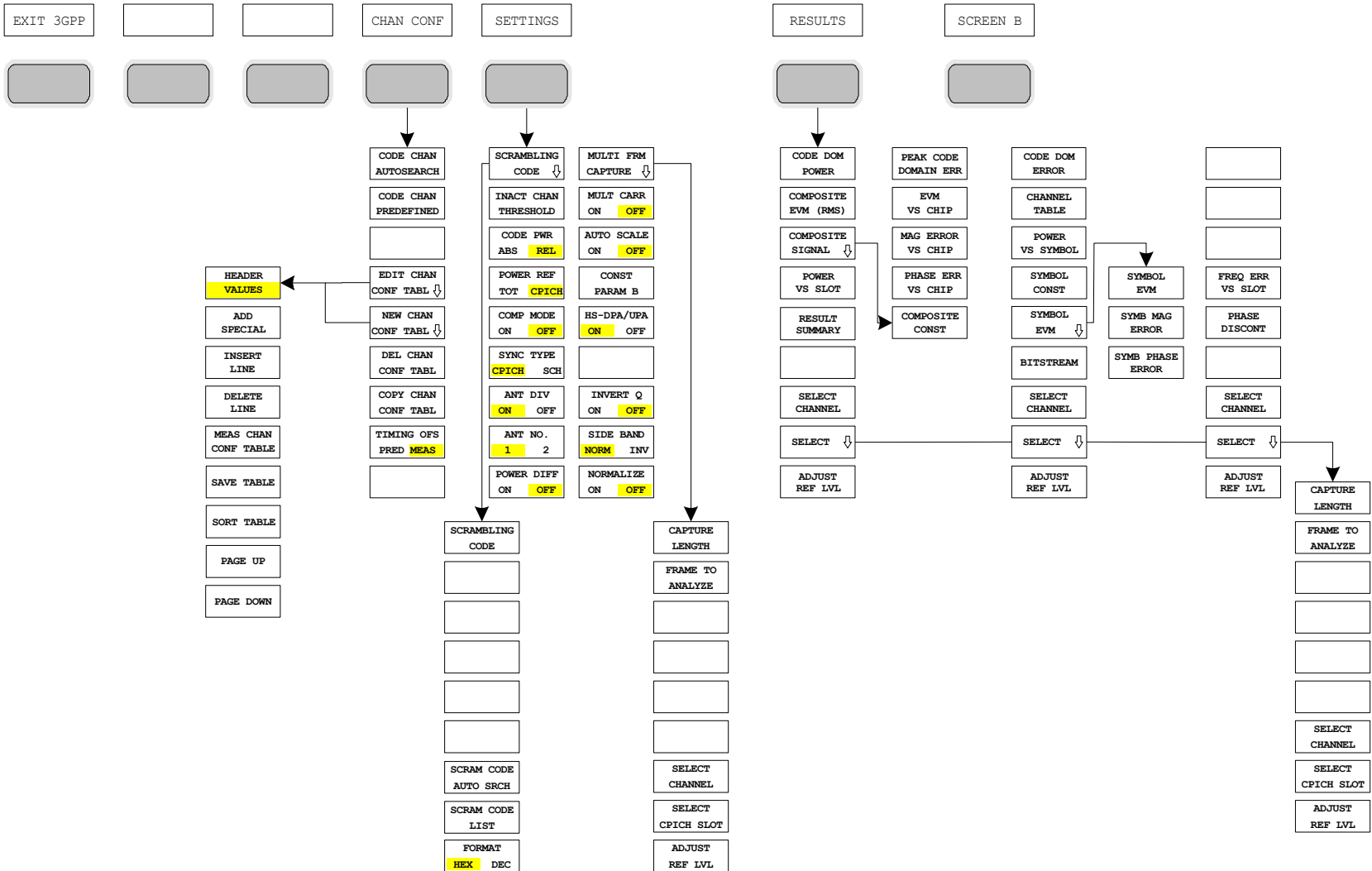


Figure 1: Code Domain Power Menu – Overview

Measurement Menu – Overview

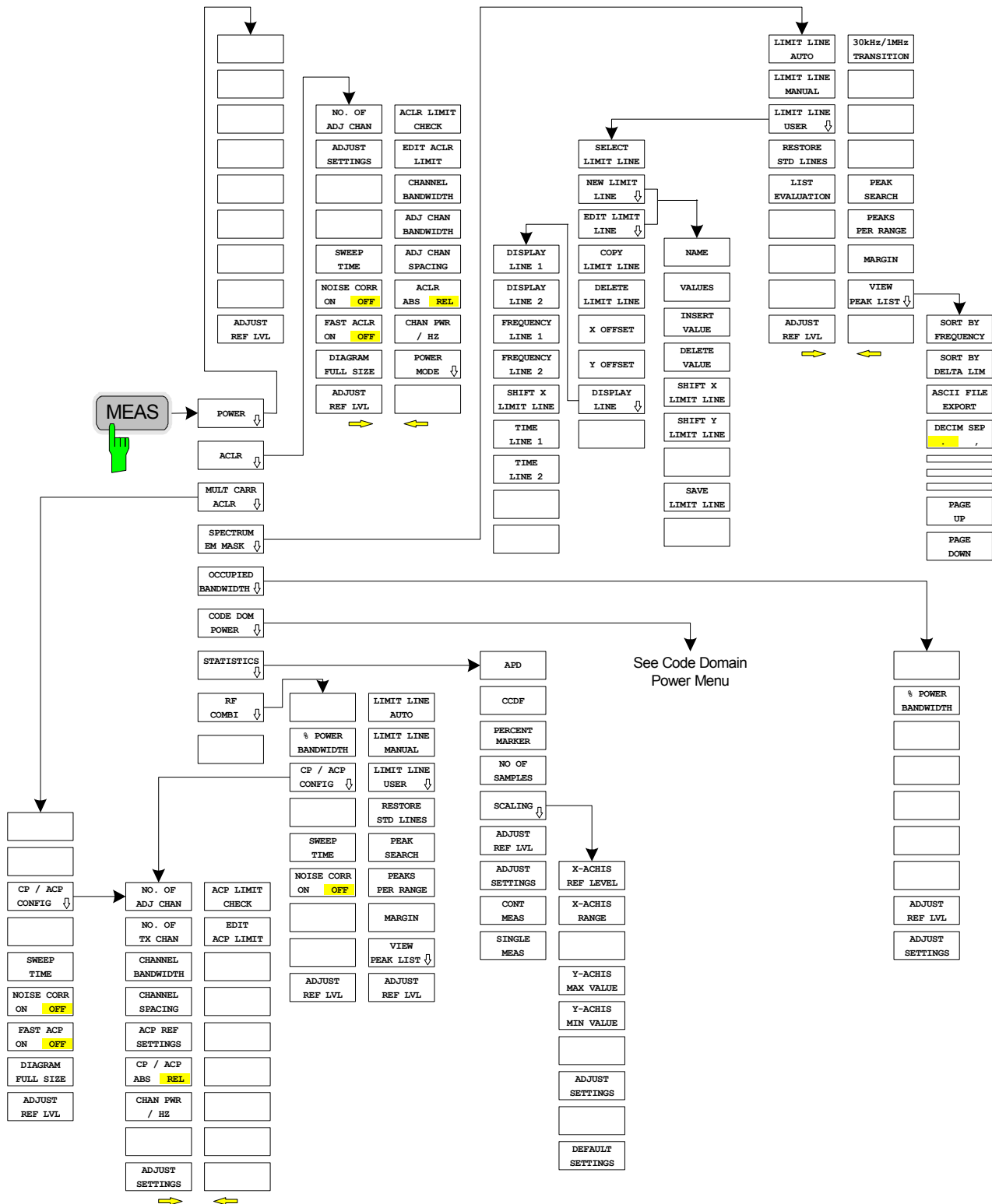


Figure 2: Overview of menus - measurements

Signal Power Check – SPECTRUM EM MASK

MEAS key

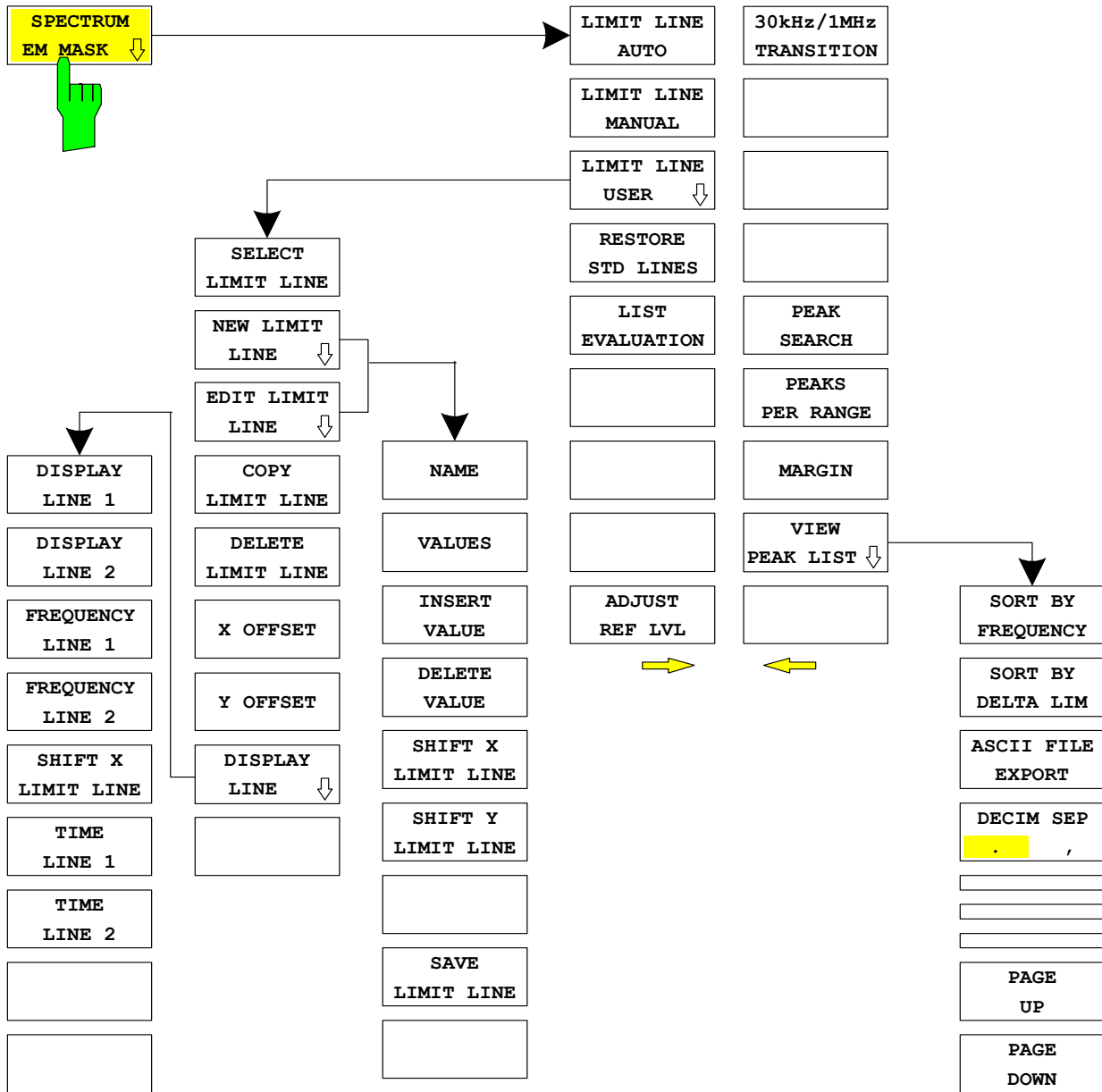


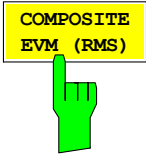
Figure 3: Spectrum emission mask measurement menu

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

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



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 referenced to the total signal) is determined. Thus, composite EVM is a measurement of the composite signal.

$$EVM_{RMS} = \sqrt{\frac{\sum_{n=0}^N |s_n - x_n|^2}{\sum_{n=0}^{N-1} |x_n|^2}} \cdot 100\% \quad | \quad N = 2560$$

- 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 - number of chips at each CPICH slot

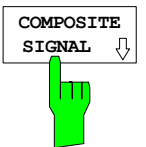
IEC/IEEE bus command: :CALC2:FEED "XTIM:CDP:MACC"

Query of result: :TRAC2:DATA? TRAC2

UNIT: [%]

Range: [0% ... 100%]

Error Vector Magnitude (EVM_{chip}) versus chip



- PEAK CODE DOMAIN ERR
- EVM VS CHIP
- MAG ERROR VS CHIP
- PHASE ERR VS CHIP
- COMPOSITE CONST

The *COMPOSITE SIGNAL* softkey opens a submenu for evaluation displays of the composite 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 ERR



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

EVM
VS CHIP



The EVM VS CHIP softkey activates the Error Vector Magnitude (EVM) versus chip display. The EVM is displayed for all chips of the selected 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.

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

- 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 4) 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%]

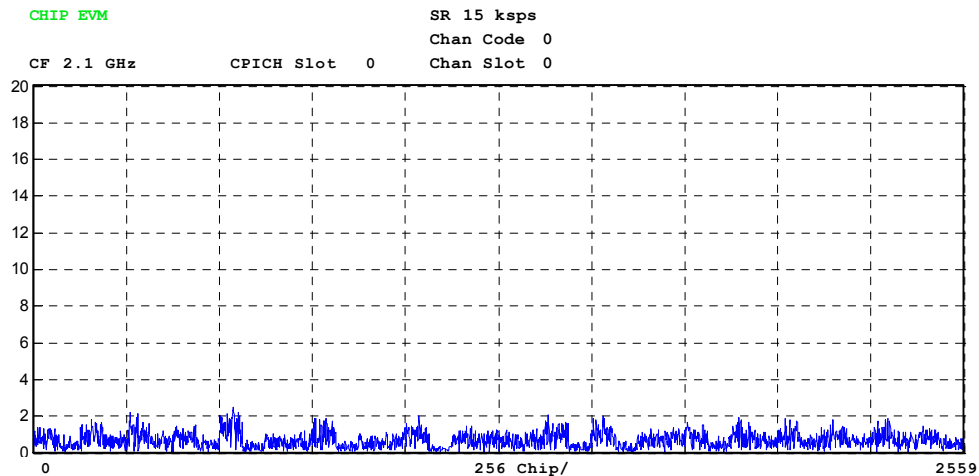
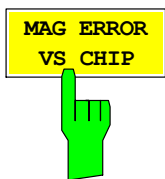


Figure 4: Display of vector error of the EVM versus chip measurement



The MAG ERROR VS CHIP softkey activates the Magnitude Error versus chip display. The magnitude error is displayed for all chips of the selected 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 6). 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.

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

- 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 5) 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%]

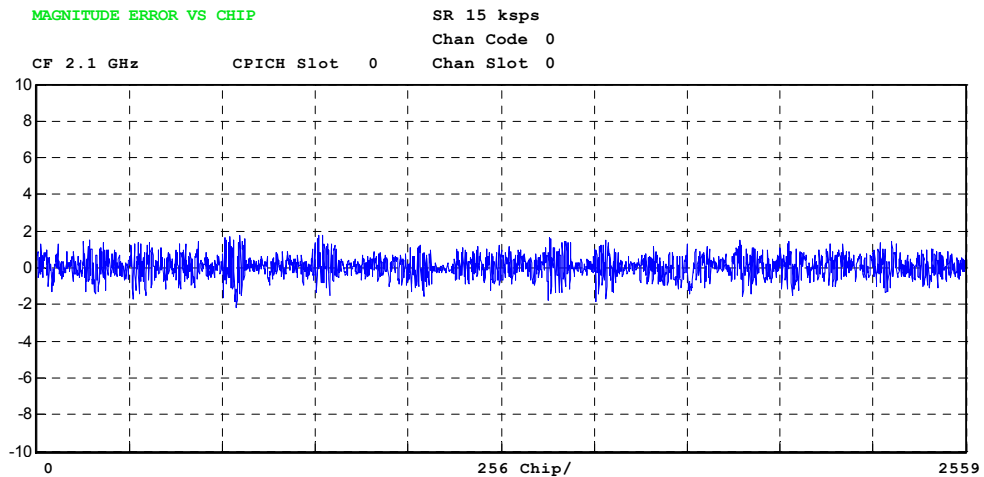
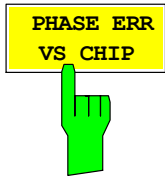


Figure 5: Display of magnitude error versus chip measurement



The PHASE ERROR VS CHIP softkey activates the Phase Error versus chip display. The phase error is displayed for all chips of the selected 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 6). 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°.

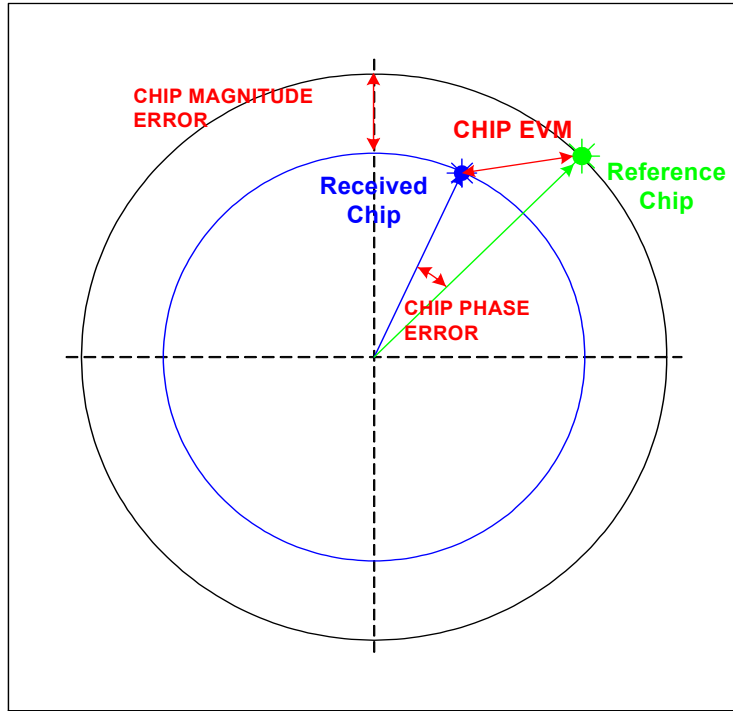


Figure 6: Schematic of reference signal chip and received signal chip to calculate the magnitude, phase and vector error.

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

- 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 7) 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°]

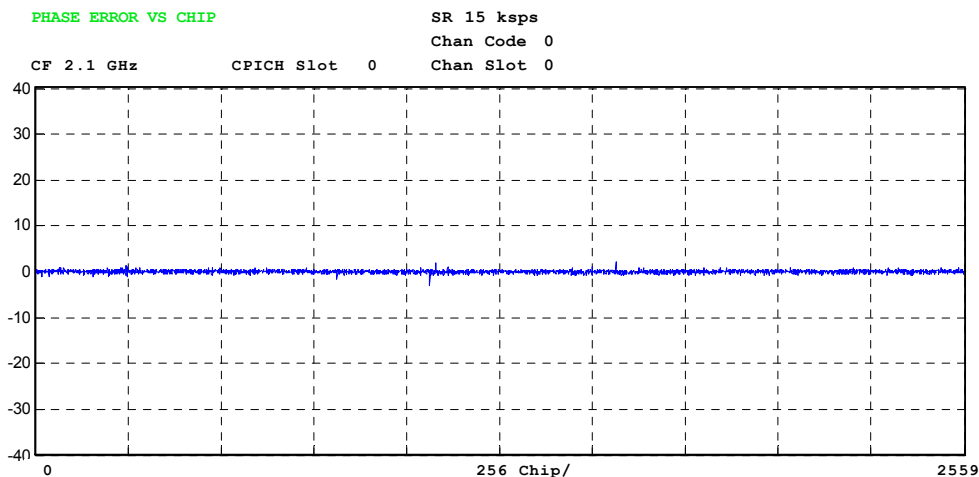
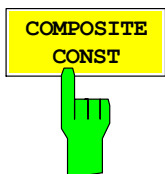


Figure 7: Display of phase error versus chip



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 8).

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: $Re_1, Im_1, Re_2, Im_2, \dots, Re_{2560}, Im_{2560}$
 Unit: [1]
 Quantity: 2560

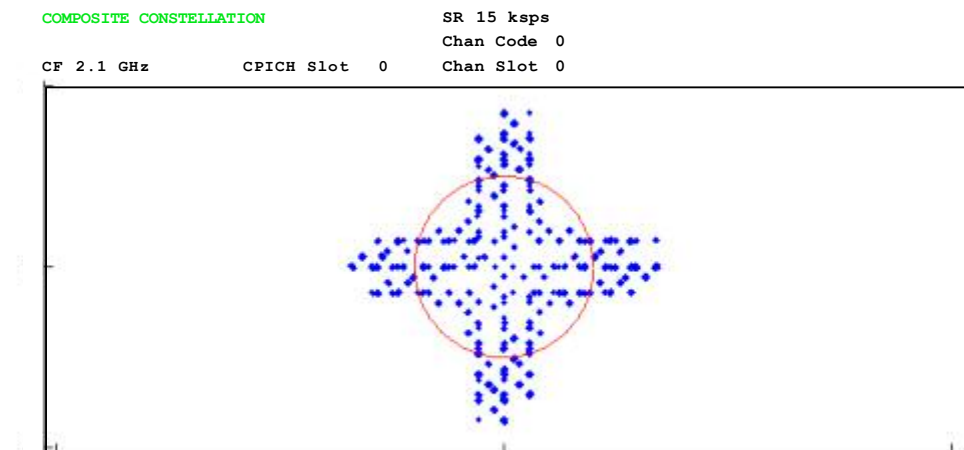


Figure 8: Composite Constellation diagram of received signal (scrambled chips)

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 $(r(t)=r_I(t)+j*r_Q(t))$ is shifted to a real high frequency signal $(s_{HF}(t))$. 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.

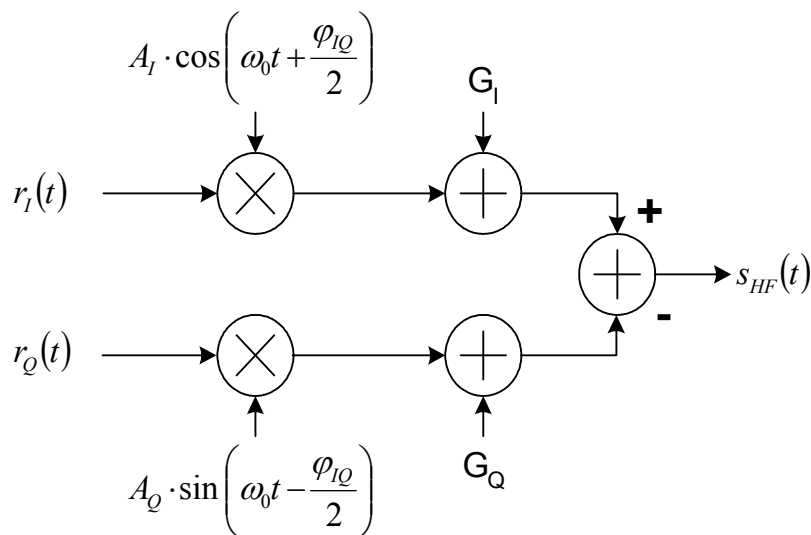


Figure 9: Basic model of possible IQ impairment parameters in complex up-converters.

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:

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

- 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=666 μs → 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(ω₀ t) and sin(ω₀ 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

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 emission defined by the standard the peak value is listed. For every peak value the frequency, the absolute 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	: absolute 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

Advanced channel type estimation (SCPICH)

:TRACe [:DATA] ? CWCDp

CWCDp For each channel, 10 values are transmitted. The range of channel type has been extended to 13.

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

No	Parameter	Range	Unit	Explanation
1)	<code class>	{2 ... 9}	[1]	Code class of the channel.
2)	<channel number>	{0 ... 511}	[1]	Code number of the channel.
3)	<absolute level>	{-∞ ... ∞}	[dBm]	Absolute level of the code channel at the selected channel slot. (The channel slot can be marked by the SELECTED CPICH slot.)
4)	< relative level >	{-∞ ... ∞}	[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.)
5)	<timing offset>	{0 ... 38400}	[chips]	Timing offset of the code channel to the frame start. The value is measured in chips. The step width is 256 chips in the case of code class 2 to 8, and 512 chips in the case of code class 9.
6)	<pilot length>	{0,2,4,8,16}	[symbols]	Pilot length of the code channel. According to the 3GPP standard, the pilot length range depends on the code class.
7)	<active flag>	{0,1}	[1]	Flag to indicate whether a channel is active 0 - channel not active 1 - channel active
8)	<channel type>	{0 ... 13}	[1]	Channel type indication
		0 - DPCH		D edicated P hysical C hannel of a standard frame
		1 - PICH		P aging I ndication C hannel
		2 - CPICH		C ommon P ilot C hannel
		3 - PSCH		P rimary S ynchronization C hannel
		4 - SSCH		S econdary S ynchronization C hannel
		5 - PCCPCH		P rimary C ommon C ontrol P hysical C hannel
		6 - SCCPCH		S econdary C ommon C ontrol P hysical C hannel
		7 - HS_SCCH		HSDPA: High Speed Shared Control Channel

		8 - HS_PDSCH	HSDPA: H igh S peed P hysical D ownlink S hared C hannel
		9 - CHAN	Channel without any pilot symbols (QPSK modulated)
		10 - CPRSD	Dedicated Physical Channel in compressed mode
		11 - CPR-TPC	Dedicated Physical Channel in compressed mode TPC symbols are sent in the first slot of the gap.
		12 - CPR-SF/2	Dedicated Physical Channel in compressed mode using half spreading factor (SF/2).
		13 - CPR-SF/2-TPC	Dedicated Physical Channel in compressed mode using half spreading factor (SF/2). TPC symbols are sent in the first slot of the gap.
		14 - EHICH-ERGCH	E-HICH: Enhanced HARQ Hybrid Acknowledgement Indicator Channel E-RGCH: Enhanced Relative Grant Channel
		15 - EAGCH	E-AGCH: Enhanced Absolute Grant Channel
		16 - SCPICH	SCPICH: Secondary Common Pilot Channel
9)	<modulation type>	{2,4,15}	[1] Modulation type of the code channel at the selected channel slot. (The channel slot can be marked by adjusting SELECT CPICH slot.)
		2 - QPSK	Modulation type QPSK.
		4 - 16QAM	Modulation type 16QAM.
		15 - NONE	There is no power in the selected channel slot [slot is switched OFF]. (According to 3GPP, the power of an HSDPA channel can be switched every 2 ms, i.e. 3 slots.)
10)	<reserved>	{0}	[1] Reserved for future functionality.

Define channel table using advanced channel types (SCPICH)

:CONFigure:WCDPower[:BTS]:CTABLE:DATA

<code class>,<code number>,<use TFCI>,<timing offset >,
<pilot length>,<pich>,<status>,<CDP relative [dB]>....

Code class: 2 to 9
 Code number: 0 to 511
 Use TFCI: 0: not used, 1: used
 Timing offset: 0 to 38400, for code class 9, the step width is 512; otherwise, 256
 Pilot length: code class 9: 4
 code class 8: 2, 4, 8
 code class 7: 4, 8
 code class 5/6: 8
 code class 2/3/4 16

Channel Type:

0:	<i>DPCH</i>	Dedicated Physical Channel of a standard WCDMA Frame
1:	<i>PICH</i>	Paging Indication Channel
2:	<i>SCCPCH</i>	Secondary Common Control Physical Channel
3:	<i>HS_SCCH</i>	HSDPA: High Speed Shared Control Channel
4:	<i>HS_PDSCH</i>	HSDPA: High Speed Physical Downlink Shared Channel
5:	<i>CHAN</i>	any other QPSK modulated channel without pilot symbols
10:	<i>CPRSD</i>	Dedicated Physical Channel (DPCH) in compressed mode
11:	<i>CPR-TPC</i>	DPCH in compressed mode TPC symbols are sent in the first slot of the gap.
12:	<i>CPR-SF/2</i>	DPCH in compressed mode using half spreading factor (SF/2).
13:	<i>CPR-SF/2-TPC</i>	DPCH in compressed mode using half spreading factor (SF/2). TPC symbols are sent in the first slot of the gap.
14:	<i>E-HICH:</i>	HSUPA: Enhanced HARQ Hybrid Acknowledgement Indicator Channel
	<i>E-RGCH:</i>	HSUPA: Enhanced Relative Grant Channel
15:	<i>EAGCH</i>	E-AGCH: Enhanced Absolute Grant Channel
16:	<i>SCPICH</i>	Secondary Common Pilot Channel

Status: 0: not active, 1: active

CDP relative: for setting commands any value, for query CDP relative value

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: VectError₀, VectError₁, ..., VectError₂₅₅₉
 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: MagError₀, MagError₁, ..., MagError₂₅₅₉
 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: PhaseError₀, PhaseError₁, ..., PhaseError₂₅₅₉
 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: Re₁, Im₁, Re₂, Im₂, ..., Re₂₅₆₀, Im₂₅₆₀
 Unit: [1]
 Quantity: 2560

Query result of Frequency Error vs Slot

:TRACe[:DATA]? ATRACE2

FREQUENCY ERROR VS SLOT (ATRACe2)

This command returns a list of slot number / absolute frequency error vs slot for all slots.

Output: List of slot number and absolute frequency error values of all slots
 Format: SlotNumber₀, FreqError₀, ..., SlotNumber₁₄, FreqError₁₄
 Unit: [Hz]
 Quantity: 15

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>:MARKer<1>:FUNCtion:WCDPower[:BTS]:RESult? PTOTal | FERRor | TFRame | TOFFset | MACCuracy | PCDerror | EVMRms | EVMPeak | CERRor | CSLot | SRATe | CHANnel | CDPabsolute | CDPRelative | IQOFFset | IQIMbalance | MTYPE | RHO | **PSYMBOL** | **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	TOFFset	timing offset
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	I/Q offset	IQIMbalance	I/Q imbalance
MTYPE	modulation type	PSYMBOL	Number of pilot bits
RHO	rho value for every slot	ACHannels	Number of active channels

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

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

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

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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)
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