# UE Fading Test with the CMW500 RF Tester and the SMW200A Application Note

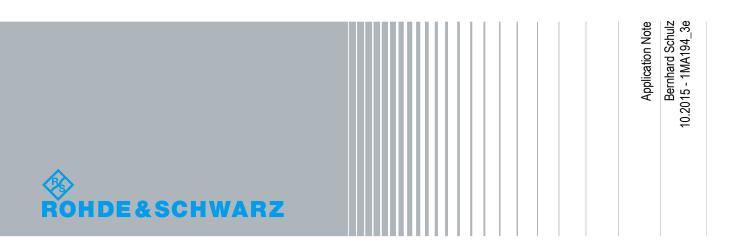
#### Products:

- R&S<sup>®</sup>CMW500
- I R&S<sup>®</sup>SMW200A

This application note shows how to perform user equipment (UE) receiver tests, such as block error rate (BLER) and throughput tests, under fading conditions with the R&S<sup>®</sup>CMW500 RF tester and the R&S<sup>®</sup>SMW200A vector signal generator in LTE(-A), W-CDMA (HSPA+), TD-SCDMA, GSM (GRPS and EGPRS(2)), CDMA2000 and 1xEV-DO.

#### Note:

Please find the most up-to-date document on our homepage http://www.rohde-schwarz.com/appnote/1MA194.



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## 1 Introduction

The R&S®CMW500 wideband radio communication tester can be used throughout all phases of UE device development. It supports different mobile standards, such as LTE(-A) (FDD and TDD), W-CDMA (HSPA+, TD-SCDMA), GSM (including GPRS, EDGE and EGPRS(2) and VAMOS), CDMA2000 and 1xEV-DO.

Testing under real propagation conditions is important for UE receiver sensitivity tests. The measurement type depends on the mobile standard, e.g. a bit-error rate (BER) or a block-error rate (BLER). The throughput can be calculated directly from the BLER.

The CMW offers internal fading for different standards as options:

LTE	(CMW-KE500)
W-CDMA	(CMW-KE400)
GSM	(CMW-KE200)
CDMA2000/1xEV-DO	(CMW-KE800)
AWGN	(CMW-KE100)
	W-CDMA GSM CDMA2000/1xEV-DO

Supported	d fading			
	Internal Fading	External Fading with SMW		
LTE (-A)		Predefined profiles acc. 3GPP.TS 36.101 Annex B		Ø
(FDD and	TDD)	Full user-defined fading settings		Ø
	W-CDMA	Predefined profiles acc. 3GPP.TS 25.101 Annex B	Ø	Ø
3GPP	W-CDIVIA	Full user-defined fading settings		
0011	TD-SCDMA	Predefined profiles acc. 3GPP.TS 25.101 Annex B		
		Full user-defined fading settings		
	CDMA2000	Predefined profiles acc. 3GPP2 C.S0011		
3GPP2	CDWA2000	Full user-defined fading settings		
30112	1xEV-DO	Predefined profiles acc. 3GPP2 C.S0033	V	
		Full user-defined fading settings		Ø
GSM		Predefined profiles acc. 3GPP.TS 45.005 Annex C	V	
		Full user-defined fading settings and hopping		

The combination of the CMW500 wideband radio communication tester as base station simulator and the SMW200A vector signal generator offers full user-defined channel simulation, including fading for SISO and MIMO scenarios, as well as noise.

This application note shows the test setups for external fading, explains the settings required for the various measurement configurations, such as Rx diversity and MIMO for LTE, W-CDMA, GSM and TD-SCDMA. In addition, it specifies the most important remote commands along the way.

The CMW is able to perform fading internally with predefined fading profiles. This application note also explains for every standard the internal fading settings briefly.

The AMU200A baseband and fading simulator can also be used to provide the external fading. Please note that the here shown screenshots and settings apply for the SMW200A. Possible differences are explained in the particular sections.

The following abbreviations are used in the following text for R&S<sup>®</sup> test equipment:

- The R&S<sup>®</sup>CMW500 wideband radio communication tester is referred to as CMW.
- The R&S<sup>®</sup>SMW200A vector signal generator is referred to as SMW.
- The R&S<sup>®</sup>AMU200A fading simulator is referred to as AMU.
- R&S<sup>®</sup> refers to Rohde & Schwarz GmbH und Co KG.

## 2 Measurement Setup

This chapter deals with the measurement setup for external fading with the SMW. For internal fading with the CMW only, no special setup is needed.

Fading and AWGN characteristics are applied in the SMW. To do this, it is necessary to feed the CMW's digital baseband signals through the SMW.

## 2.1.1 Fading Test Setup for One Baseband Signal

The following figure shows the setup for SISO-based measurements.

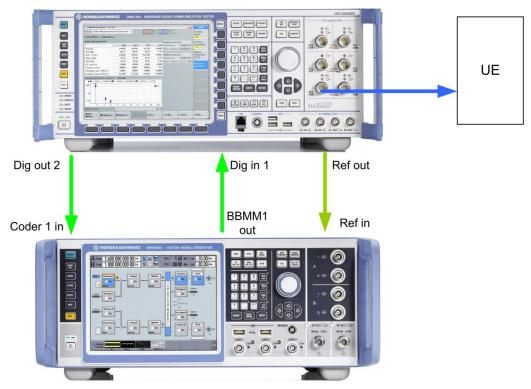


Fig. 2-1: Hardware configuration for UE terminal test under SISO fading conditions.

The SMW is connected to the CMW via the digital baseband Coder 1 in input and BBMM 1 output.

The AMU is connected to the CMW via the digital baseband input and output A.

## 2.1.2 Fading Test Setup for Two Basebands Signals

The following figure shows a setup with two baseband signals, which is required for scenarios using two basebands, such as MIMO or dual carrier. Please note that there are two possible configurations for the RF frontends available:

Two FE basic (FE1 basic (CMW-S590A) + FE2 basic (CMW-B590A))

Or

- ------OF STOP -NOR CORE WEINE [11] (CONTRA 7 💷 🔛 2.3 UE -1-1-1 BACK-SPACE SHIT LIKTLE 0 = -0 0 0 Dig in 3 Dig in 1 Dig out 2 Dig out 4 Ref out BBMM2 BBMM1 Ref in Coder 1 in Coder 2 in out out Ĉ 1 ----0.0 () (and a line of the line of 0
- One FE1 advanced (CMW-S590D)

Fig. 2-2: Hardware configuration for UE terminal test with two RF ports.

The SMW is connected to the CMW via two digital baseband Coder 1/2 inputs and BBMM 1/2 outputs.

The AMU is connected to the CMW via two digital baseband inputs and outputs A and B.

## 2.1.3 Fading Test Setup for Four Basebands Signals

The following figure shows a setup with four baseband signals, which is required for scenarios using four basebands, such as carrier aggregation with MIMO. Please note that here two FE1 advanced (CMW-S590D) and two Digital IQ Interfaces (CMW-B510F and CMW-B520F) are necessary in the CMW and one SMW is needed for the fading.

Dig IQ connectors at the CMW

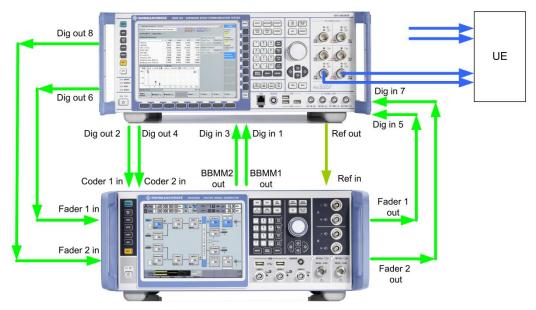


Fig. 2-3: Hardware configuration for UE terminal tests with four RF ports.

The SMW is connected to the CMW via two digital baseband Coder 1/2 inputs and BBMM 1/2 outputs and the Fader 1/2 inputs and outputs.

The AMU is connected to the CMW via two digital baseband inputs and outputs A and B. Two AMU's are needed.

## 2.1.4 Fading Test Setup for more than four Basebands Signals

The combination of one CMW and one SMW allows fading for up to 4 baseband signals, e.g. carrier aggregation with 2CC, both with 2x2 MIMO. If more than the four baseband signals are needed the CMWflexx solution allows to combine two or more CMW's, each with four basebands signals. In addition two or more SMW's provide the fading.

The test setup of 2.1.3 for four baseband signals is multiplied by the number of used CMW's.

A scenario with carrier aggregation with 4 CC's and 2x2 MIMO thus needs a CMWflexx setup with two CMW's and thus in addition two SMW's. The digital connections between the CMW and the corresponding SMW are needed twice.

To provide the signals to the UE, an additional RF combiner (e.g. CMW-Z24) may be needed.

## 2.2 Dig IQ connectors at the CMW

Here, a single or first signal is fed through DIG IQ OUT 2 via Baseband A and DIG IQ IN/OUT 1. A second signal is sent accordingly through DIG IQ OUT 4 via Baseband B and DIG IQ IN/OUT 3.

Fig. 2-4 shows the CMW digital baseband connection. A single signal (SISO tests or one carrier) needs input and output A, while using two signals (MIMO or dual carrier) requires input and output A and B.



Fig. 2-4: CMW: Digital In / Out.

If needed, the signals three and four are handled via DIG IQ OUT 6 and DIG IQ IN/OUT 5 respectively DIG IQ OUT 8 and DIG IQ IN/OUT 7.

Detailed configuration information for the SMW and CMW can be found at the end of this application note.

## 2.3 SMW Configuration

## 2.3.1 System Configuration / MIMO Settings

With tests that use MIMO, it is also necessary to fade the cross components between the antennas. For a 2x2 MIMO test, for example, it is necessary to simulate a total of four paths.

#### SMW

The SMW is able to handle up to four basebands and up to four RF paths. Thus a tool **System Configuration** handles the MIMO settings.

In the description of the scenarios special settings are described.

Fading	
Fading Settings.	
Signal Routing (non-M	11MO)
✓ A-►A	B <b>-</b> ► B
A–►A	B <b>−</b> ► A
<mark>A-</mark> ► B	B −► B
A → A and B	<mark>  </mark> B <b>−► (</b> open)
A –► (open)	B —▶ A and B
A → A and B	B —► A and B
Signal Routing (MIMO)	)
System Configu	ration

Fig. 2-5: Calling the System Configuration to handle MIMO settings

System Configuration					-	. ×
Fading/Baseband Config	I/Q Stream Mapper	External RF and I/	QOverview			
Set to Default				Basebands		Streams
Mode	Advanced		вв	_A	FAA → +	•
Entities (Users, Cells)	Basebands (Tx Antennas)	Streams (Rx Antennas)			FAB	
1 • X	2	X 2-				
			вв	в	<b>− Г</b> ВА)	
BB Source Config	Separate Sources	s			-FBB+	<u> </u>
			Entity 1			
	💽 ок					

Fig. 2-6: Setting basebands and MIMO routings in the System Configuration (example: 2x2 MIMO)

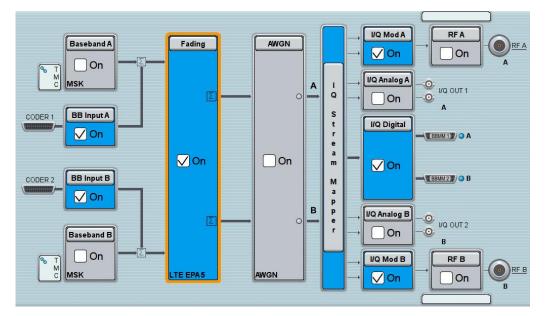


Fig. 2-7: Overview SMW 2x2 MIMO fading scenario.

#### Remote commands SMW:

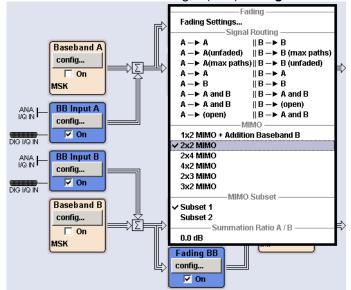
:SCONfiguration:MODE ADVanced :SCONfiguration:FADing MIMO2x2 // Advanced mode
// 2x2 MIMO

Select the desired fading standards in the LTE MIMO menu, e.g. *EPA 5 Hz Low* (Enhanced Pedestrian A, low correlation), or use individual settings.

Remote commands SMW:

SOURce1|2:FSIMulator:STANdard LMEPA5L

### AMU



Select 2x2 MIMO in the Fading A (or B) config... menu.

Fig. 2-8: 2x2 MIMO scenario AMU

Remote commands AMU:

SOUR:FSIM:ROUT FA1A2BFB1A2BM24

Select the desired fading standards in the LTE MIMO menu, e.g. *EPA 5 Hz Low* (Enhanced Pedestrian A, low correlation), or use individual settings.

Remote commands AMU:

SOURce1|2:FSIMulator:STANdard LMEPA5L

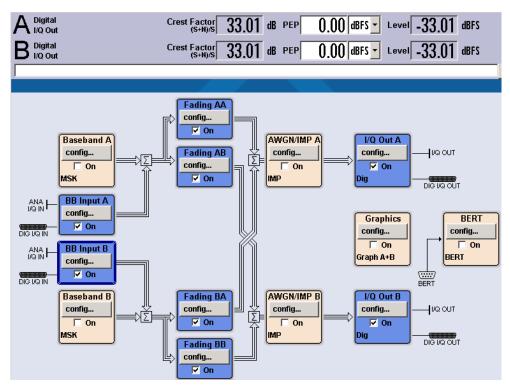


Fig. 2-9: Overview AMU 2x2 MIMO fading scenario.

<u>Note:</u> A setting change in one of the fading blocks (Fading AA, AB, BA or BB) also always applies to all other blocks.

## 2.3.2 External Reference

The SMW needs to be synchronized by connecting the CMW Ref1 Out to the SMW Ref In. The SMW must be set to external reference in the menu **Setup**.

Setup 🚬 🗙	RF Freq/Phase/Reference Freq/LO Coupling			
General 🗸	RF Frequency Phase Refer	ence Freq / LO Coupling		
System Configuration	Reference Frequency			
Global Connectors	Source	External -		
Reference Freq / LO Coupling	Deactivate RF Output (if external reference is missing)			
Internal Adjustments				
Baseband Powers	External Reference Frequency	10 MHz		
Remote Access	Synchronization Bandwidth	Wide		

Fig. 2-10: External reference.

## 2.3.3 Digital input

Two important criteria of the baseband signal are the crest factor and the PEP peak envelope power). The PEP of the digital LTE baseband signal coming from the CMW is defined as 0 dBFS (= dB Full Scale, the level ratio of the signal to the maximum possible voltage of I or Q, e.g. 0.5 Vp = 1 Vpp [peak to peak]). The crest factor is the ratio between the PEP and (RMS) Level.

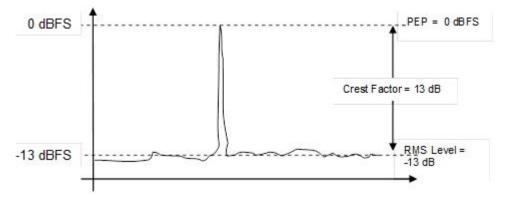


Fig. 2-11: PEP, RMS level and crest factor.

The signal at the CMW digital baseband output depends on the mobile standard and is shown in the SIGNALING application under IQ Settings | Crest Factor. In the example for LTE signaling in Fig. 2-12, it is 15 dB.

Du	plex Mode	FDD /				
Scenario		Standard Cell Fading Fading: External				
-IQ	able Data end to end Settings -IQ Out 	DIG IQ OUT 2 - 100 Msps				
		0.000 dBFS 15.00 dB				
<u> </u>	-IQ In Connector Sample Rate Baseband PEP Baseband Level	DIG IQ IN 1 100 Msps 0.000 dBFS -15.000 dBFS				

Fig. 2-12: The Crest factor depends on the mobile standard, and the CMW indicates its value.

The crest factor must be taken into account when adjusting the digital input to the SMW. The SMW BB Coder 1 (and Coder 2 for MIMO) must be set to 0 dBFS PEP, and the crest factor must be set as determined above (15 dB in this example).

Baseband Input Settings A	_ ×	Baseband Input	Settings A	Baseband Input Settings A		_ ×
General Sample Rate Input Level	Signal Monitor	General Sar	mple Rate Input Level Signal Monitor	General Sample Rate	nput Level Signal Mon	itor
State	Off On	Source	User Defined	DIG IQ Auto Setting		On
Source	CODER 1 IN	Value	100.000 000 000 MHz	Measurement Period	2 s	; .
Connected D cmw 500 (108691) dig ig out 2	evice			Auto Level Set		
				Crest Factor	15.00 c	яв -
				Peak Level	0.00 c	BFS ·
				Level	-15.00 c	BFS -

Fig. 2-13: SMW Baseband Input Settings.

Remote commands SMW:

SOURce1 2:BBIN:DIGital:SOURce CODER1	// Select Coder 1
SOURce1 2:BBIN:STATe ON	// Turn Input On
SOURce1 2:BBIN:MODE DIGital	// Digital Input Mode
SOURce1 2:BBIN:SRATe:SOURce USER	// Digital Input Mode
SOURce1 2:BBIN:SRAT 100MHz	// 100 MHz sample rate
SOURce1 2:BBIN:CFACtor 15.00	// Set 15 dB Crest Factor
SOURce1 2:BBIN:POWer:PEAK 0.00	// Set 0 dBFS PEP

#### Remote commands AMU:

SOURce1 2:BBIN:STATe ON	// Turn Baseband A B Inp. ON
SOURce1 2:BBIN:MODE DIGital	// Select Digital Input Mode
SOURce1 2:BBIN:SRATe:SOURce USER	// Select Digital Input Mode
SOURce1 2:BBIN:SRAT 100MHz	// 100 MHz sample rate
SOURce1 2:BBIN:CFACtor 15.00	// Set 15 dB Crest Factor
SOURce1 2:BBIN:POWer:PEAK 0.00	// Set 0 dBFS PEP

## 2.3.4 Digital output

The digital I/Q output BBMM1 (and BBMM2 for MIMO; A and B for the AMU) must be turned ON, and the PEP must be set to the same value as at the input (0.00 dBFS). Set the output sample rate to 100 MHz.

I/Q Digital Outpu	ts A 📃 🗙	I/Q Digital Outputs A	_ ×
OGeneral S	ignal Output Olmpairments	General Signal Output	mpairments
State	Off On	Set Level Via	Peak Level -
	Sample Rate	Peak Level	0.00 dBFS -
Source	User Defined ·		
Value	100.000 000 MHz ·	Level	0.00 dBFS -
	Connected Device		
cmw 500 (10	)8691) dig iq in 1		

Fig. 2-14: Digital I/Q Output Settings.

Remote commands SMW:

```
SOURce:IQ:OUTPut:DIGital:BBMM1|2:SRATe:SOURce USER
SOURce:IQ:OUTput:DIGital:BBMM1|2:SRAT 100MHz
SOURce:IQ:OUTPut:DIGital:BBMM1|2:POWer:VIA PEP
SOURce:IQ:OUTPut:DIGital:BBMM1|2:POWer:PEP 0 // PEP = 0 dBFS
SOURce:IQ:OUTPut:DIGital:BBMM1|2:STATE ON // BB ON
```

#### Remote commands AMU:

## 2.3.5 Display settings (AMU only)

In the I/Q OUT SETTINGS menu, select LEVEL DISPLAY SETTINGS... to easily read the output level.

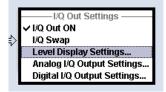


Fig. 2-15: Level Display Settings AMU

Set the **AUXILIARY INFORMATION** parameter in the **LEVEL DISPLAY SETTINGS A** (and B for MIMO) menu to **CREST FACTOR** ((S+N)/S). This crest factor indicates the ratio of the signal's peak value plus noise to the signal's RMS level without noise.

ngs A 🔤 🗆 🔯
Digital 💌
PEP 💌
n Crest Factor ((S+N)/S) 💌

Fig. 2-16: Level Display Settings AMU

Remote commands AMU:

SOURce1|2:IQ:OUTPut:DISPlay DIGItal SOURce1|2:IQ:OUTPut:DISPlay:AINFormation CFSN

## 2.3.6 Fading settings

In principle, up to two baseband signals can be subjected to fading and AWGN in the SMW. In addition, it is possible to select different MIMO configurations.

For the fading functionality, there are pre-defined scenarios in line with the specifications of the various wireless standards (for example, LTE EVA 5 Hz). In such cases, there is no need to configure any further settings. In addition, for tests that go beyond these requirements, it is also possible to set all of the fading parameters individually.

In the **Fading** block, configure the **Fading Settings**. You can either choose *Standard* to conveniently select predefined scenarios (Fig. 2-18 and Fig. 2-19) or choose *User* to modify the individual parameters by implementing custom settings.

Fading Fading Settings.	
Signal Routing (non-M	IIMO)
✓ A–►A	B <b>-</b> ► B
A–►A	II B −► A
A–► B	B <b>►</b> B
A –► A and B	B <b>-</b> ► (open)
A –► (open)	B → A and B
A –► A and B	B −► A and B
Signal Routing (MIMO)	)
System Configu	ration

Fig. 2-17: Block Fading: fading settings.

#### Remote command:

SOURce1|2:FSIMulator:STANdard xxx

Fading A						_	×
O General Standard/Fine Delay	Restart Auto	Insertion Loss Config. / Coupled Parameters	Path Table	Path Graph			
Off On					et To lefault 🕝 Reca	ul 🕒	Save
Standard	EPA 5	Hz	•				
Configuration	Standar	d/Fine Delay	- Fading C	lockrate	200 MHz		•
Signal Dedicated To	Baseba	nd Output	· Virtual RI	Ŧ	2.646 00	0 000 00	GHz -
Ignore RF Changes	< <mark>5</mark> %		On Frequen	cy Hopping Mo	ode Off		•

Fig. 2-18: The selection of pre-defined fading profiles.

CDMA GSM NADC PCN TETRA 3GPP WLAN DAB WIMAX WIMAX-MIMO LTE LTE-MIMO 1xEVDO WATTERSON 802.11n-MIMO	User	802.11ac-MIMO
NADC PCN TETRA 3GPP WLAN DAB WIMAX WIMAX-MIMO LTE LTE-MIMO 1xEVDO WATTERSON	CDMA	
PCN TETRA 3GPP WLAN DAB WIMAX WIMAX-MIMO LTE LTE-MIMO 1xEVDO WATTERSON	GSM	
TETRA 3GPP WLAN DAB WIMAX WIMAX-MIMO LTE LTE-MIMO 1xEVDO WATTERSON	NADC	
3GPP WLAN DAB WIMAX WIMAX-MIMO LTE LTE-MIMO 1xEVDO WATTERSON	PCN	
WLAN DAB WIMAX WIMAX-MIMO LTE LTE-MIMO 1xEVDO WATTERSON	TETRA	
DAB WIMAX WIMAX-MIMO LTE LTE-MIMO 1xEVDO WATTERSON	3GPP	
WIMAX WIMAX-MIMO LTE LTE-MIMO 1xEVDO WATTERSON	WLAN	
WIMAX-MIMO LTE LTE-MIMO 1xEVDO WATTERSON	DAB	
LTE LTE-MIMO 1xEVDO WATTERSON	WIMAX	
LTE-MIMO 1xEVDO WATTERSON	WIMAX-MIMO	
1xEVDO WATTERSON	LTE	
WATTERSON	LTE-MIMO	
	1xEVDO	
802.11n-MIMO	WATTERSON	
	802.11n-MIMO	

Fig. 2-19: Available pre-defined fading profiles ("standards")

	Restart Auto	Insertion Loss Config Coupled Parameters		h Graph	
Table Settings		Copy Path Group	1 T	o	2 👔 Copy
	Unit	1	1 2	1 3	1 4
State		On	On	On	On
Profile		Rayleigh	Rayleigh	Rayleigh	Rayleigh
Path Loss /dB		0.00	1.00	2.00	3
Basic Delay /µs	μs	0.000 000	0.000 000	0.000 000	0.000 (
Additional Delay /µs	μs	0.000 000	0.030 000	0.070 000	0.090 (
Resulting Delay /µs	μs	0.000 000	0.030 000	0.070 000	0.090 (

Fig. 2-20: Path Table: Detailed settings for multiple paths.

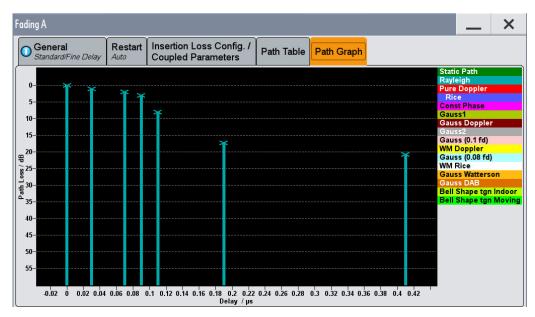


Fig. 2-21: Path Graph: Detailed graphically presentation.

If a second path is used, also configure the fading accordingly in Path B.

#### **RF Frequency**

The Fading Simulator needs to know the CMW's RF frequency in order to calculate Doppler-based fading standards correctly (e.g. 2.646 GHz). There are two possible ways:

Virtual RF

This case is used in the AMU and can be used in the SMW. In the SMW set **Signal Dedicated to Baseband Output**, then set the **Virtual RF** in the fading simulator.

Remote commands SMW:

```
SOURce1|2:FSIMulator:SDEStination BB // Destination Baseband
SOURce1|2:FSIMulator:FREQuency 2646MHz // Virtual RF
```

#### Remote commands AMU:

SOURce1|2:FSIMulator:FREQuency 2646MHz //Virtual RF

RF

ı

This case is used in the SMW only. Set **Signal Dedicated to RF**, then set the *general* **RF frequency** as usual.

Remote commands SMW:

```
SOURce1|2:FSIMulator:SDEStination RF // Destination RF SOURce1|2:FREQuency 2646MHz // general RF
```

#### **Enable Fading**

Turn fading ON.

Remote command:

SOURce1|2:FSIMulator:STATe ON

## 2.3.7 AWGN settings

Click on AWGN in the AWGN block.

In the AWGN menu, set the System Bandwidth (e.g. 10 MHz), the desired Signal/Noise Ratio (e.g. 0.00 dB) and turn the *State ON*.

AWGN Settings A		_	×
OGeneral Noise Power / Output Results			
State	Of	f	On
Mode	Additive Noise		-
System Bandwidth	10.000 (	MHz	
Min Noise/System Bandwidth Ratio			1.0
Fig. 2-22: AWGN settings general			
AWGN Settings A		_	×
OGeneral Noise Power / Output Results			
Show Powers For Output	RFA		·
Set Noise Power Via	CIN		•
Reference Mode	Carrier		•
Bit Rate	100.000 000	kbps	•
Carrier/Noise Ratio	0.00	dB	•
Eb/N0	20.00	dB	•
Carrier Power	-30.00	dB	•
Noise Power (System Bandwidth)	-30.00	dB	•



#### Remote commands:

SOURcel|2:AWGN:MODE ADD// Additive noiseSOURcel|2:AWGN:BWID 10 MHz// bandwidthSOURcel|2:AWGN:BWID:RAT 1.0// bandwidthSOURcel|2:AWGN:POWer:MODE SN// Power mode signal to noiseSOURcel|2:AWGN:SNR 0.0 dB// SNRSOURcel|2:AWGN ON// switch ON

### 2.3.8 Compensation of necessary attenuation

A faded signal has a higher crest factor than an unfaded signal has. In order to avoid distortion, the signal must be attenuated before entering the fading unit. The necessary attenuation depends on the fading standard and on the AWGN level and is calculated and displayed by the fading simulator.

The attenuation in the baseband must be compensated in the CMW. This can be done easily by setting the CMW IQ Input level to the calculated SMW IQ Output level.

Changing the input level or fading profile settings on the SMW affects the necessary attenuation, and this must be compensated on the CMW as shown in Fig. 2-26 **before** a throughput measurement or any other measurement is performed!

#### **Display SMW**

The SMW shows the calculated insertion loss in the fading block (Fig. 2-24).

Fading A						_	×
General Standard/Fine Delay	Restart Auto	Insertion Loss Config. / Coupled Parameters	Path Table	Path Graph			
		Insertion Lo	oss Configura	ation —			
Mode	Normal						•
Insertion Loss			10.0	) dB			
Clipped Samples			0.00	) %			•
1 1 1 1	1 I	1 1 1 1	I I	1 1	1 1 1 1	· 1	
0						100	.00 %
		Coupled Pa	arameters A =	⇒ B ——			
Speed Setting Cou	pled						On
Local Constant Cou	pled						On

Fig. 2-24: SMW displays the calculated insertion loss

#### Remote commands SMW:

SOURce1|2:FSIMulator:ILOSs? // read insertion loss

The complete baseband level to be entered in the CMW calculates via:

Level BB out SMW= Crest Factor In SMW - Insertion Loss

In our example:

Level BB <sub>out SMW</sub> = -15 dB - 10 dB = -25 dBFS

#### **Display AMU**

The AMU shows the calculated level in the main screen directly (Fig. 2-25)(for the Display configuration see 2.3.5).

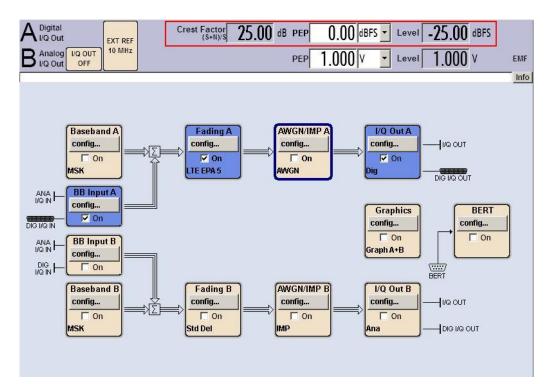


Fig. 2-25: AMU settings for SISO fading. The displayed level has to be entered in the CMW.

#### Remote commands AMU:

SOURce1|2:IQ:OUTPut:DIGital:POWer:LEVel? // read level

#### Compensation in the CMW

The baseband output level of the SMW has to be entered in the CMW as the input level.

🚸 LTE Signaling Configuration	
Path: IQ Settings/IQ In/Baseband Level	
-Duplex Mode	FDD 💌
Scenario	Standard Cell Fading 🔻 Fading: External 🔻
Enable Data end to end	
E IQ Settings	
E IQ Out	
Connector	DIG IQ OUT 2 🔻
	100 Msps
-Baseband PEP	0.000 dBFS
Crest Factor	15.00 dB
⊟-IQ In	
Connector	DIG IQ IN 1
Sample Rate	100 Msps
Baseband PEP	0.000 dBFS
Baseband Level	-25.000 dBFS

Fig. 2-26: Making allowance for the necessary attenuation from the SMW in the CMW. Here, the SMW signal's level (without AWGN) must be entered as the IQ In level.

**Note:** The fading profile and AWGN settings should not be changed during an active connection, since doing that affects the DL power, which may lead to a call drop. Always set the fading profile and AWGN before establishing the connection.

## 3 LTE(-A) Measurements

The CMW supports both FDD and TDD (TD-LTE) duplexing modes.

With the LTE standard, the UE receiver measurements include BLER, throughput and channel quality index (CQI). All measurements are summarized in the **Extended BLER** measurement application (see 3.1).

Before starting the LTE signaling, external fading must be selected as the scenario. Once signaling has begun, or once a connection has been established with the DUT, it is no longer possible to change scenarios.

Different antenna configurations (transmission modes, TM) are possible with LTE. The CMW supports following TM's:

LTE Tra	ansmission modes in the CMW
тм	Description
1	SISO, Rx Diversity
2	Tx Diversity
3	Open loop spatial multiplexing CCD
4	Closed loop spatial multiplexing
6	Closed loop spatial multiplexing, single layer
7	Single layer beamforming
8	Dual layer beamforming
9	Dual layer beamforming
Table 3-1	: TM's in the CMW

These transmission modes also require different ways of handling fading:

LTE Fading Scenarios				
CMW Configuration	тм	DCI	Description	Remark
1 Cell – Fading- 1 RF out	1	1A	SISO	Single Tx antenna port 0
2CC CA – Fading – 2 RF out (PCC and SCC1)	7	1	Single layer beamforming	Single Tx antenna port 5
1 Cell – Fading- 2 RF out	1	1A	Rx Diversity	SIMO, 1 x 2 (per CC)
	2	1A	Tx Diversity	MISO, 2 x 1 (per CC)
2CC CA – Fading – 4 RF out (PCC and SCC1)	3	1A 2A	Tx Diversity Open loop spatial multiplexing CCD	MISO, 2 x 1 (per CC) MIMO, 2 x 2 (per CC)
2CC CA – Fading – 4 RF out	4	2	Closed loop spatial multiplexing	MIMO, 2 x 2 (per CC)
distributed (PCC and SCC1)	6	1B	Closed loop spatial multiplexing single layer	MIMO, 2 x 2 (per CC)
3CC CA – Fading – 6 RF out	7	1	Single layer beamforming	Single Tx antenna port 5
(PCC, SCC1 and SCC2)	8	2B	Dual layer beamforming	Tx antenna ports 7 and 8
4CC CA – Fading – 8 RF out (PCC, SCC1, SCC2 and SCC3)	9	2C	Dual layer beamforming	Tx antenna ports 7 and 8
1 Cell 4x2 MIMO Fading 2 RF out	2, 3, 4, 6	ing in the	4x2 MIMO	

Table 3-2: LTE scenarios in the CMW.

UE Receiver Measurement in LTE: Extended BLER

This section describes the necessary steps to perform an LTE Rx measurement under several conditions, such as SISO or 2x2 MIMO fading.

For further information on LTE signaling and extended BLER measurements, refer to [5].

## 3.1 UE Receiver Measurement in LTE: Extended BLER

The CMW sends data to the UE via PDSCH subframes and determines the block error rate (BLER) from the positive ACKnowledgments (ACK) and negative ACKnowledgments (NACK) returned by the UE. Additional throughput results are calculated from the BLER results. The CQI indices reported by the UE are also evaluated.

Fig. 3-1 through Fig. 3-4 show examples of the different measurements under fading conditions.



Fig. 3-1: LTE Extended BLER: overview.

#### UE Receiver Measurement in LTE: Extended BLER

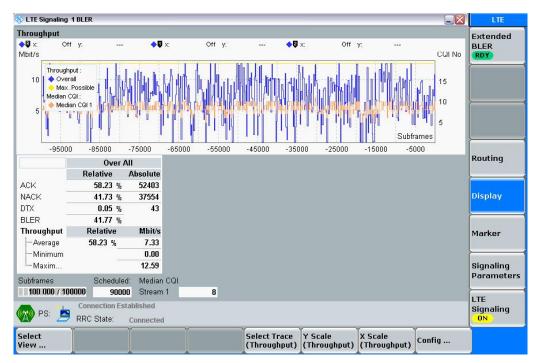


Fig. 3-2: LTE Extended BLER: Throughput

Results			Cell Setup				Extended
Over All	Relative	Absolute	Operating Band	Band 4	▼ FI	DD 🗸	BLER
ACK	58.23 %	52403		Davantinta			RDY
NACK	41.73 %	37554		Downlink	Up	link	
DTX _	0.05 %	43	Channel	2175 Ch	1	20175 Ch	
BLER	41.77 %		Frequency	2132.5 MHz	1	732.5 MHz	
Throughput	Relative	Mbit/s	Cell Bandwidth	10.0 MHz	- 10	.0 MHz	
Average	58.23 %	7.33				50 WITT2	
		0.00	RS EPRE	–90.0 dBm/15k	Hz		
		12.39	Full Cell BW Pow.	-62.2 dBm			
000 000 A00 000							
Subtrames 100 000	/ 100000 Scheduled:	90000	PUSCH Open Loo	p Nom.Power		–20 dBm	Routing
Supframes 100 000	7 100000 Scheduled:	90000	PUSCH Open Loo PUSCH Closed Lo		3	–20 dBm –20.0 dBm	Routing
Supirames <b>100 000</b>	/ 100000 Scheduled:	90000		op Target Power	2		
Subframes <b>100 000</b>	/ 100000 Scheduled:	90000	PUSCH Closed Lo	op Target Power P			Routing Display
Supirames 100 000	/ 100000 Scheduled:	90000	PUSCH Closed Lo Connection Setu Scheduling RMC	op Target Power P	-	-20.0 dBm	
subrames <b>100 000</b> .	/ 100000 Scheduled:	90000	PUSCH Closed Lo Connection Setu Scheduling RMC	op Target Power p	•	-20.0 dBm	Display
subrames <u>100 000</u>	/ 100000 Scheduled:	90000	PUSCH Closed Lo Connection Setu Scheduling RMC	op Target Power <b>p</b> Downlink	▼ Uplink	-20.0 dBm 12 <del>-</del>	Display
subrames <u>100 000</u>	/ 100000 Scheduled:	90000	PUSCH Closed Lo Connection Setu Scheduling RMC	op Target Power P Downlink 50 <del>~</del>	▼ Uplink	-20.0 dBm 12 <del>-</del>	Display
Subframes <b>100 000</b>	/ 100000 Scheduled:	90000	PUSCH Closed Lo Connection Setu Scheduling RMC #RB RB Pos./Start RB	op Target Power p Downlink 50 • high • 0	- Uplink	-20.0 dBm 12 <b>-</b>	Display
subrames <b>100 000</b>	/ 100000 Scheduled:	90000	PUSCH Closed Lo Connection Setu Scheduling RMC #RB RB Pos./Start RB Modulation	op Target Power p Downlink 50 • high • 0 16-QAM •	Vplink	-20.0 dBm 12 + v + QPSK +	Display Signaling Parameter
Com	/ TUUUUUU Scheduled:	90000	PUSCH Closed Lo Connection Setu Scheduling RMC # RB RB Pos /Start RB Modulation TBS Idx / Value	p Downlink 50 - high - 16-QAM - 14 - 14112	Vplink	-20.0 dBm 12 - v - QPSK - 022	Display

Fig. 3-3: LTE Extended BLER: BLER

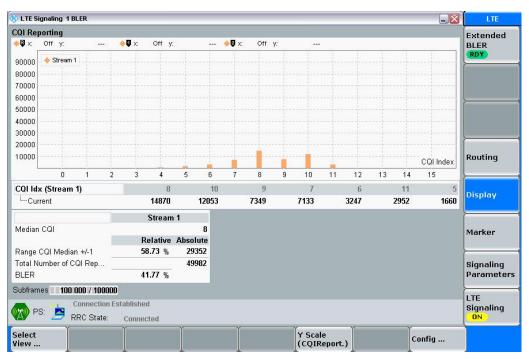


Fig. 3-4: LTE Extended BLER: CQI Reporting

Remote Command:

```
CONFigure:LTE:SIGN<i>:EBLer:SFRames 10000 // set 10000 frames
INITiate:LTE:SIGN<i>:EBLer // start measurement
FETCh:LTE:SIGN<i>:EBLer:ABSolute? // get results(abs.)
```

## 3.2 Scenarios for one cell

This section covers tests with one downlink carrier only. Different transmission modes require different fading paths. In the CMW these scenarios differ by the number of the used RF outputs.

## 3.2.1 "1 Cell – Fading – 1 RF Out" scenario (SISO)

This configuration uses only one data stream via one antenna. It covers tests for:

- I TM1 SISO
- I TM7 Single layer beamforming (port 5)

For this, it is necessary to fade one path only, and that can be done with one of the SMW channels.

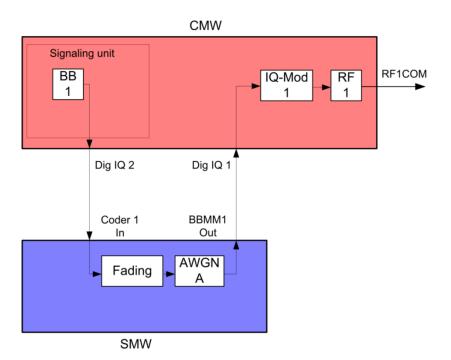


Fig. 3-5: Block diagram for the SISO test setup.

5. In the LTE Signaling Configuration, select the 1 Cell – Fading – 1 RF out Scenario (see Fig. 3-6). Set the Fading to *External*.

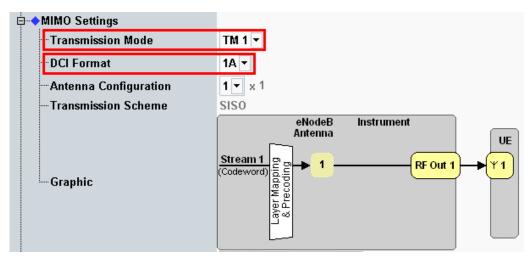
🚸 LTE Signalir	g Configuration					
PCC	♦SCC1					
Path: Scenari	0					
Duplex N	lode	FDD -				
- Scenario		1 Cell - Fading - 1 RF Out				
Fading		External 🔻				
1 1	peech Codec					
i □ IQ Settin						
	Jut					
-C	onnector	DIG IQ OUT 2 💌				
	ample Rate	100 Msps				
—В	aseband PEP	0.000 dBFS				
Ci	est Factor	15.00 dB				
	n					
-C	onnector	DIG IQ IN 1 🔽				
	ample Rate	100 Msps				
B	seband PEP	0.000 dBFS				
B	aseband Level	-15.000 dBFS				

Fig. 3-6: LTE scenario for SISO: Standard Cell Fading. The CMW indicates the crest factor, which is entered in the SMW's Dig IQ Input.

#### Remote commands:

```
// 1 Cell-Fading- 1 RF Out external via RF2COM and IQ2 Out
ROUTe:LTE:SIGN:SCENario:SCFading RF2C,RX1,RF2C,TX1,IQ2O
// read out information of IQ settings
SENSe:LTE:SIGN<i>:IQOut:PATH<n>?
```

- Take note of the Crest Factor under IQ Out and enter this value in the SMW under Baseband Input Level (see Fig. 2-13 in section 2.3).
- 7. Set a fading and switch on I/Q Out (BBMM1)(see section 2.3).
- In the CMW, enter the corresponding baseband level (Level BB <sub>out SMW</sub>= Crest Factor <sub>In SMW</sub> – Insertion Loss; example: -15 dB – 10 dB = -25 dBFS, see 2.3.8), which is indicated by the SMW (see Fig. 3-9). If you add noise to the signal, note the crest factor without noise.



9. Select a **TM** and a **DCI format** (see also Table 3-2)

Fig. 3-7: Transmission mode and DCI format. The CMW also shows the transmission scheme and a graphical representation.

#### Remote commands:

```
// set TM1
CONFigure:LTE:SIGN<i>:CONNection:TRANsmission TM1
// set DCI format 1A
CONFigure:LTE:SIGN<i>:CONNection:DCIFormat D1A
```

- 10. Use **CONNECT** to establish an LTE connection between the CMW and DUT.
- 11. If you modify the fading, remember to change the level accordingly in the CMW.

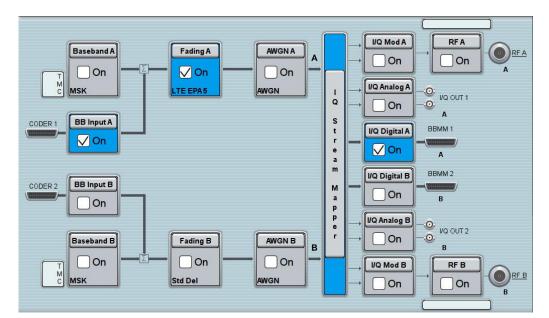


Fig. 3-8: Overview SMW settings for SISO fading.

Fading A						—	×
General Standard/Fine Dela	Restart Auto	Insertion Loss Config. / Coupled Parameters	Path Table	Path Graph			
		Insertion Lo	oss Configura	ation —			î
Mode	Normal						•
Insertion Loss	10.0 dB -						
Clipped Samples			0.00	) %			•

Fig. 3-9: The SMW shows the necessary insertion loss (example: 10 dB)

Subscription	
◆ PCC ◆ SCC1	
Path: IQ Settings/IQ In/Baseband Level	
	FDD -
Scenario	1 Cell - Fading - 1 RF Out
Fading	External -
-Enable Speech Codec	<b>v</b>
□ IQ Settings	
i international	
Connector	DIG IQ OUT 2 🔻
Sample Rate	100 Msps
-Baseband PEP	0.000 dBFS
Crest Factor	15.00 dB
⊟⊶◆IQ In	
Connector	DIG IQ IN 1 🔽
Sample Rate	100 Msps
Baseband PEP	0.000 dBFS
Baseband Level	-25.000 dBFS

Fig. 3-10: Making allowance for the necessary attenuation in the CMW. Here, the digital output level of the SMW signal is entered as the IQ In level.

#### Remote command:

// set IQ In to PEP 0 dBFS and Level -25 dBFS CONFigure:LTE:SIGN<i>:IQIN:PATH<n> 0.0, -25.0

12. Start the RX measurement using **Extended BLER** (see section 3.1). Fig. 3-11 shows an example of an SISO measurement in the overview.

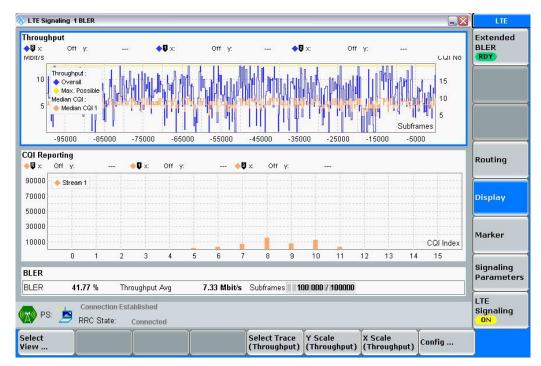


Fig. 3-11: LTE RX measurement for SISO.

### 3.2.2 "1 Cell – Fading – 2 RF Out" scenario (MIMO)

This section covers all scenarios with fading which need two RF output ports. The basic procedure for all the tests is the same, it is shown here once. Specials for single tests follow in the dedicated subsections:

1. In the LTE Signaling Configuration, select the 1 Cell – Fading – 2 RF Out Scenario (see Fig. 3-12). Set Fading to External.

🚸 LTE Signaling Configuration					
◆ PCC ◆ SCC1					
Path: IQ Settings/IQ Out/Crest Factor					
Duplex Mode	FDD 💌	FDD -			
Scenario	1 Cell - Fading - 2 RF Ou	t 💌			
Fading	External 💌	External 🕶			
Enable Speech Codec					
⊟ IQ Settings					
iq♦IQ Out	Path 1	Path 2			
Connector	DIG IQ OUT 2 🔻	DIG IQ OUT 4 🔻			
Sample Rate	100 Msps	100 Msps			
-Baseband PEP	0.000 dBFS	0.000 dBFS			
Crest Factor	15.00 dB	15.00 dB			
i⊒⊶ <b></b> ♦IQ In	Path 1	Path 2			
Connector	DIG IQ IN 1	DIG IQ IN 3 📃			
Sample Rate	100 Msps	100 Msps			
Baseband PEP	0.000 dBFS	0.000 dBFS			
Baseband Level	-15.000 dBFS	-15.000 dBFS			

Fig. 3-12: LTE Scenario for two RF out ports: 1 Cell – Fading – 2 *RF Out Ports*. The CMW indicates the crest factors, which are entered in the SMW's Dig IQ input.

#### Remote commands:

```
// 1 Cell-Fading-2 RF Out external: RF2C,IQ2Out, RF1C, IQ4Out
ROUTe:LTE:SIGN<i>:SCENario:TROFading
RF1C,RX1,RF1C,TX1,IQ2O,RF3C,TX2,IQ4O
// read out information of IQ settings
SENSe:LTE:SIGN<i>:IQOut:PATH1?
SENSe:LTE:SIGN<i>:IQOut:PATH2?
```

- Take note of both Crest Factors shown under IQ Out and enter the values in the SMW under Baseband Input Level (see Fig. 2-13 in section 2.3).
- 3. Set a fading for both paths and switch on **I/Q Out** (BBMM1|2)(see section 2.3).
- 4. In the CMW, enter both corresponding baseband levels (Level BB <sub>out SMW</sub> = Crest Factor <sub>In SMW</sub> Insertion Loss; example: -15 dB 10 dB = -25 dBFS, see 2.3.8), which are indicated by the SMW (see Fig. 3-14). If you add noise to the signal, note the crest factor without noise.
- 5. Select a **TM** and a **DCI format** (see also Table 3-2). The special settings are handled in the next subsections.
- 6. Use **CONNECT** to establish an LTE connection between the CMW and DUT.
- 7. If you modify the fading, remember to change the level accordingly in the CMW.

Fading A						_	×
General Standard/Fine Dela	Restart Auto	Insertion Loss Config. / Coupled Parameters	Path Table	Path Graph			
Insertion Loss Configuration							
Mode	Normal						-
Insertion Loss	10.0 dB -						
Clipped Samples			0.0	0 %			•

Fig. 3-13: The SMW shows the necessary insertion loss (example: 10 dB)

id⊢IQ Out	Path 1	Path 2	
Connector	DIG IQ OUT 2 🔻	DIG IQ OUT 4	
-Sample Rate	100 Msps	100 Msps	
-Baseband PEP	0.000 dBFS	0.000 dBFS	
Crest Factor	15.00 dB	15.00 dB	
– lQ In	Path 1	Path 2	
Connector	DIG IQ IN 1	DIG IQ IN 3	
-Sample Rate	100 Msps	100 Msps	
Baseband PEP	0.000 dBFS	0.000 dBFS	
Baseband Level	-25.000 dBFS	-25.000 dBFS	

Fig. 3-14: Compensating for the necessary attenuation in the CMW. Here, the levels of the SMW signals are entered as the IQ IN levels.

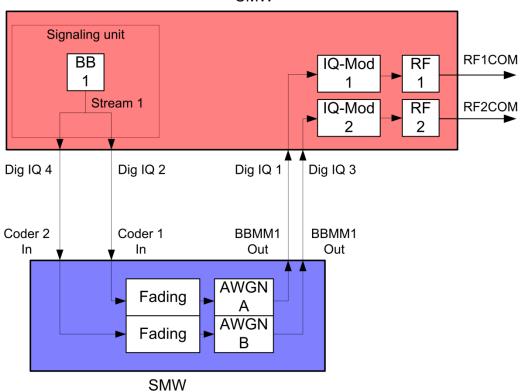
Remote commands:

```
// set IQ In to PEP 0 dBFS and Level -25 dBFS
CONFigure:LTE:SIGN<i>:IQIN:PATH1 0.0, -25.0
CONFigure:LTE:SIGN<i>:IQIN:PATH2 0.0, -25.0
```

8. Start the RX measurement using Extended BLER (see section 3.1)

## 3.2.2.1 Rx Diversity (1x2 SIMO) Configuration (TM1)

For Rx diversity, a signal sent from one antenna is received at the UE with two antennas. Consequently, it arrives via two different receive paths. No additional coding is employed on the transmitter side. TM1 is used. Therefore, in order to perform the measurement under fading conditions, it is necessary to simulate two receiving paths.



CMW

Fig. 3-15: Block diagram for the SIMO test setup. The two receive paths are simulated using the same stream.

1. Select a TM and a DCI format (see also Table 3-2). RX Diversity (SIMO 1x2) uses TM1 and DCI Format 1A.

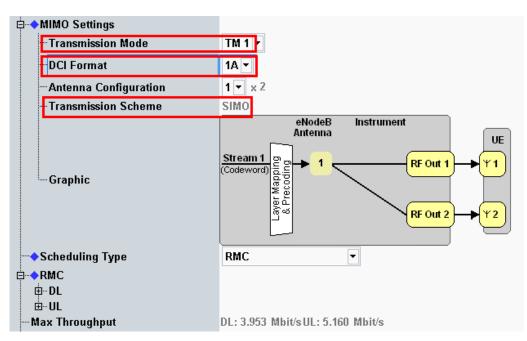


Fig. 3-16: Transmission mode and DCI format. The CMW also shows the transmission scheme and a graphical representation.

#### Remote commands:

```
// set TM1
CONFigure:LTE:SIGN<i>:CONNection:TRANsmission TM1
// set DCI format 1A
CONFigure:LTE:SIGN<i>:CONNection:DCIFormat D1A
```

- 2. Use **CONNECT** to establish an LTE connection between the CMW and DUT.
- 3. If you modify the fading, remember to change the level accordingly in the CMW.

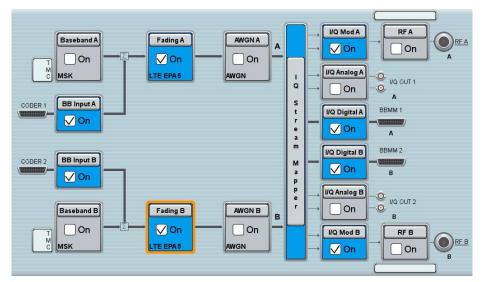


Fig. 3-17: SMW settings for fading two paths (SIMO and MISO).

4. Start the RX measurement using **Extended BLER** (see section 3.1). Fig. 3-11 shows an example of an SIMO measurement in the overview.

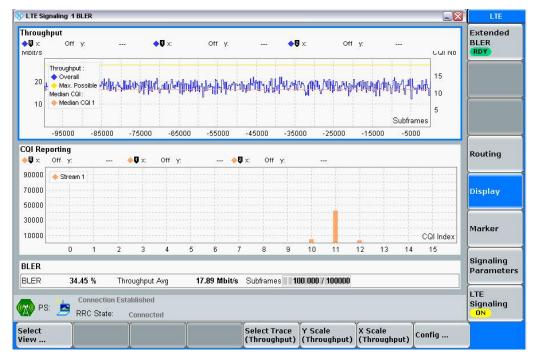


Fig. 3-18: LTE RX measurement for Rx Diversity (SIMO).

## 3.2.2.2 Tx Diversity (2x1 MISO) Configuration (TM2 or TM3)

To conduct the Tx diversity measurement, one signal is transmitted via two antennas using different coding in order to achieve greater robustness. Here, too, there are two different receive paths. Consequently, to take this measurement under fading conditions, it is necessary to simulate two different receive paths. Tx Diversity is a fall back mode in a couple of TM's. The CMW uses TM2 or TM3.

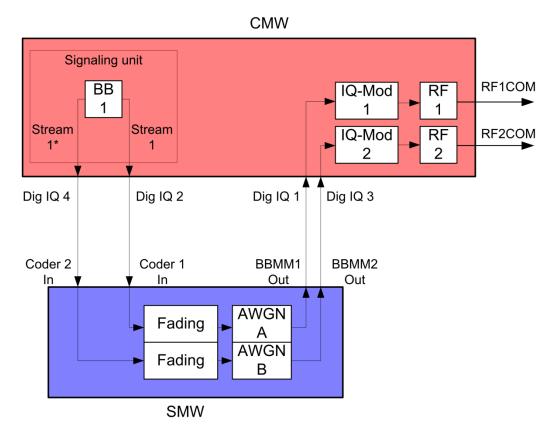


Fig. 3-19: Block diagram for the MISO test setup. Using different coding, one stream is transmitted via two antennas. Consequently, it is necessary to simulate two receive paths.

5. Select a TM and a DCI format (see also Table 3-2). Tx Diversity (MISO 2x1) uses TM2 or TM3 and DCI Format 1A.

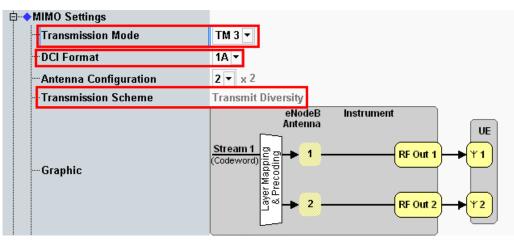


Fig. 3-20: Transmission mode and DCI format. The CMW also shows the transmission scheme and a graphical representation.

#### Remote commands:

```
// set TM3
CONFigure:LTE:SIGN<i>:CONNection:TRANsmission TM3
// set DCI format 1A
CONFigure:LTE:SIGN<i>:CONNection:DCIFormat D1A
```

- 6. Use **CONNECT** to establish an LTE connection between the CMW and DUT.
- 7. If you modify the fading, remember to change the level accordingly in the CMW.

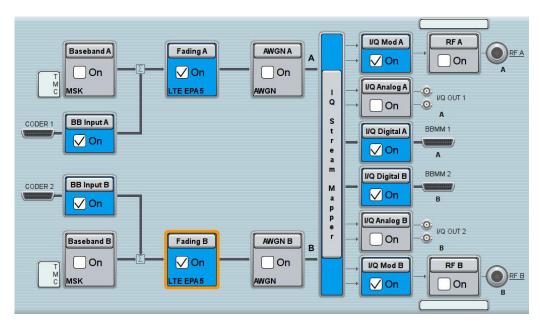


Fig. 3-21: SMW settings for fading two paths (SIMO and MISO).

8. Use **Extended BLER** to start the RX measurement (see section 3.1). Fig. 3-22 shows an example of an MISO measurement in the overview.



Fig. 3-22: LTE RX measurement for Tx diversity (MISO).

## 3.2.2.3 Spatial Multiplexing (2x2 MIMO) Configuration (TM3, TM4, TM6)

With spatial multiplexing, typically two different streams are transmitted via two antennas in order to boost the data throughput rate. For the simulation, it is also necessary to take the cross components into account; consequently, it is necessary to simulate a total of four receive paths.

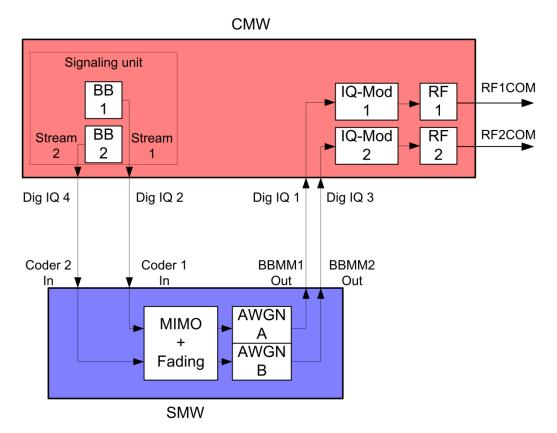


Fig. 3-23: Block diagram for the MIMO test setup. Two streams are transmitted via two antennas. Consequently, in order to also take the cross components into account, it is necessary to simulate four fading paths.

#### **Open Loop Spatial Multiplexing with CCD (TM3)**

5. Select TM3 and DCI format 2A (see also Table 3-2).

<b>.\</b>	MIMO Settings		
-	Transmission Mode	TM 3 🗸	
-	DCI Format	2A 🔻	
	Antenna Configuration	2 💌 x 2	
	Transmission Scheme	OL Spatial Multiplexing	
	Graphic	eNodeB Antenna Stream 1 (Codeword) Stream 2 Stream 2 2 2	Instrument UE RF Out 1 + Y 1 RF Out 2 + Y 2

Fig. 3-24: Transmission mode and DCI format for OL spatial multiplexing. The CMW also shows the transmission scheme and a graphical representation.

Remote commands:

```
// set TM3
CONFigure:LTE:SIGN<i>:CONNection:TRANsmission TM3
// set DCI format 1A
CONFigure:LTE:SIGN<i>:CONNection:DCIFormat D2A
```

#### **Closed Loop Spatial Multiplexing (TM4)**

5. Select TM4, DCI format 2 and a Precoding Matrix (see also Table 3-2).

MIMO Settings	
Transmission Mode	TM 4 🔽
- DCI Format	2 💌
Antenna Configuration	2 💌 x 2
Transmission Scheme	CL Spatial Multiplexing
Graphic	eNodeB Antenna Stream 1 (Codeword) Stream 2 Stream 2 End Stream 2 End Stream 1 (Codeword) Stream 2 End Stream 1 (Codeword) Stream 2 End Stream 1 (Codeword) Stream 2 End Stream 2 Stream 2 Strea
Precoding Matrix	PMIO -

Fig. 3-25: Transmission mode and DCI format for CL spatial multiplexing. The CMW also shows the transmission scheme and a graphical representation.

#### Remote commands:

```
// set TM4
CONFigure:LTE:SIGN<i>:CONNection:TRANsmission TM4
// set DCI format 2
CONFigure:LTE:SIGN<i>:CONNection:DCIFormat D2
// set the Precoding Matrix to PMI0
CONFigure:LTE:SIGN<i>:CONNection:PMATrix PMI0
```

### Closed Loop Spatial Multiplexing, single layer (TM6)

- ⊨ → MIMO Settings Transmission Mode TM 6 💌 1B 🔻 DCI Format Antenna Configuration 2 - x2 Transmission Scheme CL spatial multiplexing; single layer eNodeB Instrument Antenna UE Stream 1 RF Out 1 ť 1 (Codeword) -Graphic recod \_aver ñ RF Out 2 2 Precoding Matrix PMIO .
- 5. Select TM6, DCI format 1B and a Precoding Matrix (see also Table 3-2).

Fig. 3-26: Transmission mode and DCI format for CL spatial multiplexing with a single layer. The CMW also shows the transmission scheme and a graphical representation.

#### Remote commands:

```
// set TM6
CONFigure:LTE:SIGN<i>:CONNection:TRANsmission TM6
// set DCI format 1B
CONFigure:LTE:SIGN<i>:CONNection:DCIFormat D1B
// set the Precoding Matrix to PMI0
CONFigure:LTE:SIGN<i>:CONNection:PMATrix PMI0
```

- 6. Use **CONNECT** to establish an LTE connection between the CMW and DUT.
- 7. If you modify the fading, remember to change the level accordingly in the CMW.

#### **MIMO Correlation**

There are three correlation modes for EPA, EVA and ETU LTE fading settings in line with 3GPP specification TS36.101.

- Low = No correlation between path A and B faders. This results in the best throughput and BLER results.
- Medium = A and B are correlated to a certain degree, throughput decreases and BLER increases.
- High = Full correlation between A and B faders which annuls the improvement by MIMO.

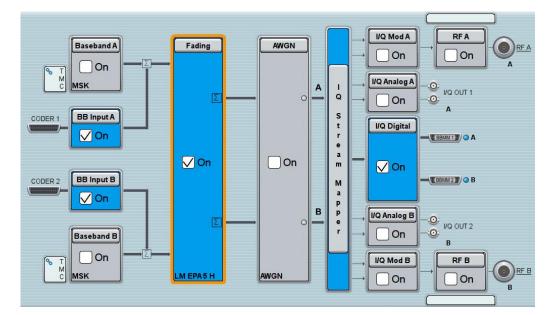


Fig. 3-27: SMW settings for fading four paths (2x2 MIMO).

8. Use **Extended BLER** to start the RX measurement (see section 3.1). Fig. 3-28 shows an example of an MIMO measurement in the overview.

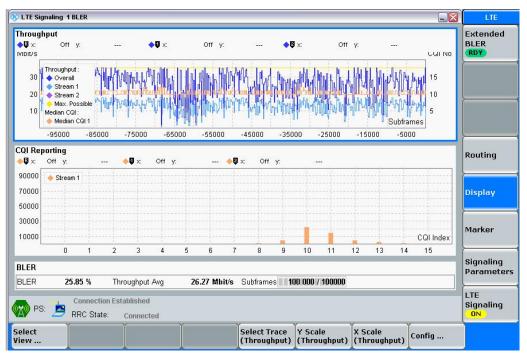


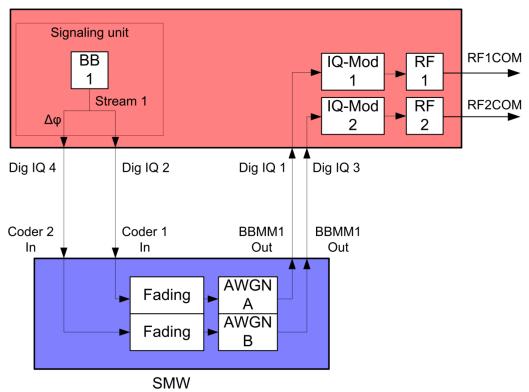
Fig. 3-28: LTE RX measurement for 2x2 MIMO. The measurements are adapted automatically for both streams individually as well as in the form of an overall assessment.

## 3.2.2.4 Beamforming (TM7 und TM 8)

#### Single layer Beamforming TM7

In TM7, the basestation may use an antenna array to transmit the signal. No matter how many antennas are used, the UE "sees" one virtual antenna port (port 5). This is similar to SISO (1x1).

The CMW supports TM7 with one transmit antenna (see 3.2.1), or here with two transmit antennas as an antenna array. Both antennas transmit the same stream, but with a different phase. Thus only two fading paths are necessary.



CMW

Fig. 3-29: Block diagram for the beamforming test in TM7. One stream is transmitted via two antennas with a different phase. Consequently, it is necessary to simulate two receive paths.

1. Select **TM7** and a **DCI format** 1(see also Table 3-2). Set the different phases.



Fig. 3-30: Transmission mode and DCI format. The CMW also shows the transmission scheme and a graphical representation.

Remote commands:

```
// set TM7
CONFigure:LTE:SIGN<i>:CONNection:TRANsmission TM7
// set DCI format 1
CONFigure:LTE:SIGN<i>:CONNection:DCIFormat D1
// set beamforming mode ON
CONFigure:LTE:SIGN<i>:CONNection:BEAMforming:MODE ON
// set beamforming matrix 0°, 30°
CONFigure:LTE:SIGN<i>:CONNection:BEAMforming:MATRix 0,30
```

- 2. Use **CONNECT** to establish an LTE connection between the CMW and DUT.
- 3. If you modify the fading, remember to change the level accordingly in the CMW.

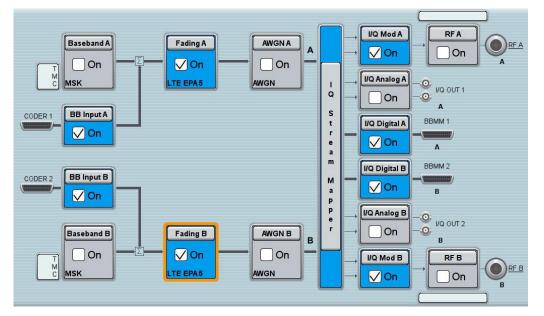


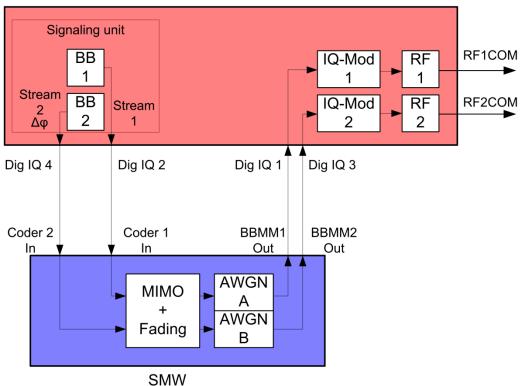
Fig. 3-31: SMW settings for fading two paths.

4. Use **Extended BLER** to start the RX measurement (see section 3.1).

#### **Dual layer Beamforming TM8**

In TM8, the basestation may use an antenna array to transmit the two layer signals. No matter how many antennas are used, the UE "sees" two virtual antenna ports (port 7 and 8;or in single layer mode just one port). This is similar to MIMO (2x2).

The CMW supports TM8 with two transmit antennas. Both antennas transmit different streams, an additional weighting in magnitude and phase can be applied. Thus four fading paths are necessary.



CMW

Fig. 3-32: Block diagram for the beamforming test in TM8. Two streams are transmitted via two antennas with a different phase. Consequently, it is necessary to simulate four receive paths.

1. Select **TM8** and a **DCI format 2B** (see also Table 3-2). Set the different weights in the matrix.

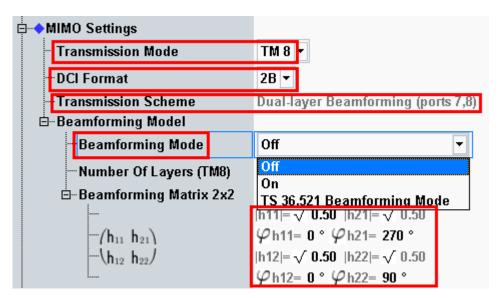


Fig. 3-33: Transmission mode and DCI format. The CMW also shows the transmission scheme and a graphical representation.

#### Remote commands:

```
// set TM8
CONFigure:LTE:SIGN<i>:CONNection:TRANsmission TM8
// set DCI format 2B
CONFigure:LTE:SIGN<i>:CONNection:DCIFormat D2B
// set beamforming mode ON
CONFigure:LTE:SIGN<i>:CONNection:BEAMforming:MODE ON
// set beamforming matrix h11phi,h12phi,h11abs,h12abs,h21phi,h22phi
CONFigure:LTE:SIGN<i>:CONNection:BEAMforming:MATRix
0,0,0.5,0.5,270,90
```

- 2. Use **CONNECT** to establish an LTE connection between the CMW and DUT.
- 3. If you modify the fading, remember to change the level accordingly in the CMW.

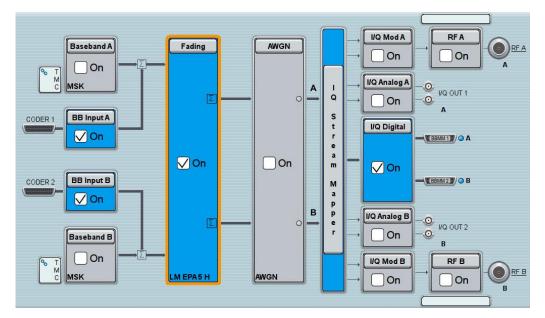


Fig. 3-34: SMW settings for fading four paths (2x2 MIMO).

4. Use **Extended BLER** to start the RX measurement (see section 3.1).

### 3.2.3 "1 Cell – Fading – MIMO 4x2 2 RF Out" scenario (4x2 MIMO)

This section covers all 4x2 MIMO scenarios with fading which need two RF output ports. These are:

- TM2 Tx Diversity
- I TM3 Open loop spatial multiplexing
- TM4 closed loop spatial multiplexing
- I TM6 closed loop spatial multiplexing, single layer

The setting for the **Antenna Configuration** is always 4x2. Please note that two SMWs are necessary to provide the fading paths. The CMW allows free routing of the two output connectors to meet the DUT's needs.

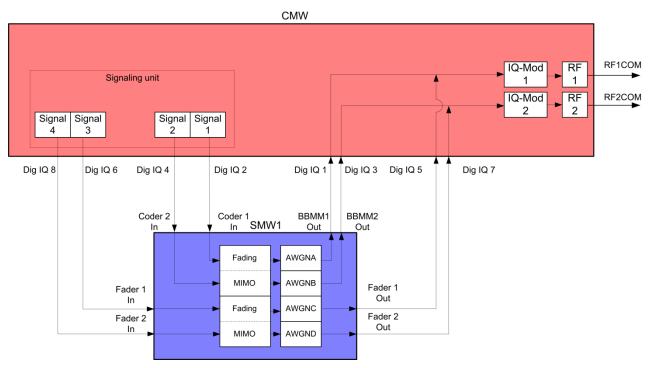


Fig. 3-35: Block diagram for the 4x2 MIMO test setup.

The basic procedure for all the tests is the same, only the MIMO settings differ (TMs):

1. In the LTE Signaling Configuration, select the *1 Cell – Fading – MIMO 4x2 – 2 RF Out* Scenario (see Fig. 3-48). Set Fading to *External*.

◆PCC ◆SCC1				
Path: Scenario				
Duplex Mode	FDD 🔻			
Scenario	1 Cell - Fading -	MIMO4x2 - 2 RF 0	ut 🔽	
–Fading External 💌				
-Enable Speech Codec				
⊡⊸IQ Settings ⊡⊸◆IQ Out	Path 1	Path 2	Path 3	Path 4
Connector	DIG IQ OUT 2 🔻	DIG IQ OUT 4 🔻	DIG IQ OUT 6 🔻	DIG IQ OUT 8
Sample Rate	100 Msps	100 Msps	100 Msps	100 Msps
Baseband PEP	0.000 dBFS	0.000 dBFS	0.000 dBFS	0.000 dBFS
- Crest Factor	15.00 dB	15.00 dB	15.00 dB	15.00 dB
⊡ -◆IQ In	Path 1	Path 2	Path 3	Path 4
Connector	DIG IQ IN 1 💎	DIG IQ IN 3 📃	DIG IQ IN 5 🛛 🔽	DIG IQ IN 7
Sample Rate	100 Msps	100 Msps	100 Msps	100 Msps
Baseband PEP	0.000 dBFS	0.000 dBFS	0.000 dBFS	0.000 dBFS
Baseband Level	-15.000 dBFS	-15.000 dBFS	-15.000 dBFS	-15.000 dBFS
□ RF Settings				
⊨ ◆RF Output (TX)	Out 1	1	Out 2	
Connector	RF1COM -		RF2COM -	
Converter	RFTX1 -		RFTX3 🔻	

Fig. 3-36: LTE Scenario for 4x2 MIMO and two RF out ports: 1 Cell – Fading – MIMO 4x2 - 2 *RF Out Ports*. The CMW indicates the crest factors, which are entered in the SMW's Dig IQ input.

#### Remote commands:

SENSe:LTE:SIGN<i>:IQOut:PATH2?

- 2. Take note of the four **Crest Factors** shown under **IQ Out** and enter the values in both SMWs under **Baseband Input Level** (see Fig. 2-13 in section 2.3).
- Set a MIMO fading for all paths and switch on I/Q Out (both SMWs: BBMM1|2)(see section 2.3).
- 4. In the CMW, enter both corresponding baseband levels (Level BB <sub>out SMW</sub> = Crest Factor <sub>In SMW</sub> Insertion Loss; example: -15 dB 10 dB = -25 dBFS, see 2.3.8), which are indicated by the SMWs (see Fig. 3-14). If you add noise to the signal, note the crest factor without noise.
- 5. Select a TM and a DCI format (see 3.2.2 and also Table 3-2 for details).

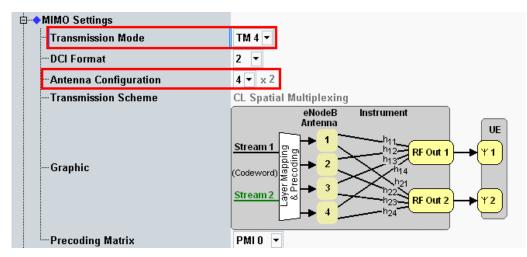


Fig. 3-37: Example for the 4x2 MIMO fading with TM4. The antenna configuration is fixed to 4x2.

- 6. Use **CONNECT** to establish an LTE connection between the CMW and DUT.
- 7. If you modify the fading, remember to change the level accordingly in the CMW.

General Standard/Fine Delay	Restart Auto	Insertion Loss Config. / Coupled Parameters	Path Table	Path Graph			
Insertion Loss Configuration							
Mode	lormal						
Insertion Loss			dB				
Clipped Samples			) %				
0	1 1	1 1 1 1	1 1	1 1	1 1	1 1	100.0

Fig. 3-38: The SMW shows the necessary insertion loss (example: 16 dB)

LTE Signaling Configuration						
◆ PCC ◆ SCC1						
Path: IQ Settings/IQ In/Baseband Level						
Duplex Mode	FDD 🔻					
Scenario	1 Cell - Fading -	MIM04x2 - 2 RF 0	ut 🔻			
Fading	External 💌	External 👻				
-Enable Speech Codec						
□ IQ Settings						
i⊒ •◆IQ Out	Path 1	Path 2	Path 3	Path 4		
Connector	DIG IQ OUT 2 🔻	DIG IQ OUT 4 🔻	DIG IQ OUT 6 🔻	DIG IQ OUT 8		
Sample Rate	100 Msps	100 Msps	100 Msps	100 Msps		
-Baseband PEP	0.000 dBFS	0.000 dBFS	0.000 dBFS	0.000 dBFS		
Crest Factor	15.00 dB	15.00 dB	15.00 dB	15.00 dB		
i di la	Path 1	Path 2	Path 3	Path 4		
Connector	DIG IQ IN 1 📃	DIG IQ IN 3 💎	DIG IQ IN 5 💎	DIG IQ IN 7		
Sample Rate	100 Msps	100 Msps	100 Msps	100 Msps		
Basehand PFP	0.000 dBES	0.000 dBES	0.000 dBES	0.000 dBES		
Baseband Level	-31.000 dBFS	-31.000 dBFS	-31.000 dBFS	-31.000 dBFS		
₽ RF Settings						
⊨ ◆RF Output (TX)	Out 1	1	Out 2			
Connector	RF1COM -		RF2COM 🔻			
Converter	RFTX1 -		RFTX3 🔻			

Fig. 3-39: Compensating for the necessary attenuation in the CMW. Here, the levels of the SMWs signals are entered as the IQ IN levels.

#### Remote commands:

```
// set IQ In to PEP 0 dBFS and Level -31 dBFS
CONFigure:LTE:SIGN<i>:IQIN:PATH1 0.0, -31.0
CONFigure:LTE:SIGN<i>:IQIN:PATH2 0.0, -31.0
CONFigure:LTE:SIGN<i>:IQIN:PATH1 0.0, -31.0
CONFigure:LTE:SIGN<i>:IQIN:PATH2 0.0, -31.0
```

8. Start the RX measurement using Extended BLER (see section 3.1)

## 3.3 Scenarios for Carrier Aggregation

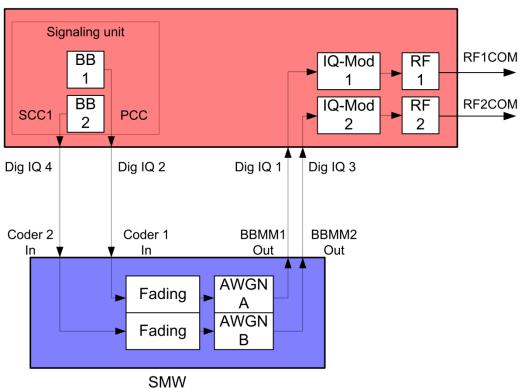
This section covers tests with carrier aggregation (CA) for two downlink component carriers (CC: Primary CC (PCC) and Secondary CC (SCC1). Different transmission modes require different fading paths. In the CMW these scenarios differ by the number of the used RF outputs. The CMW supports all possible frequency allocations in CA (intra-band contiguous, intra-band non- contiguous and inter-band). Both CCs can be set up independently of each other.

## 3.3.1 "2CC CA – Fading – 2 RF Out" scenario (CA with SISO)

This configuration uses only one data stream per CC via one antenna. Thus two RF connectors are needed. It covers tests for:

- I TM1 SISO
- TM7 Single layer beamforming (port 5)

For this, it is necessary to fade two paths independently, and that can be done with two SMW channels. The routing of the CCs to the RF connectors of the CMW can be done individually to according needs.



CMW

Fig. 3-40: Block diagram for the Carrier Aggregation SISO test setup.

1. In the LTE Signaling Configuration, select the 2CC CA- Fading – 2 RF out Scenario (see Fig. 3-6). Set the Fading to External.

PCC     SCC1		◆PCC ◆ SCC1	
ath: RF Settings/RF Output (TX)/Con	nector	Path: Scenario	
-Duplex Mode	FDD -	Duplex Mode	FDD <
Scenario	2CC CA - Fading - 2 RF Out	<ul> <li>Scenario</li> </ul>	2CC CA - Fading - 2 RF Out
Fading	External 💌	<mark>Fading</mark>	External 💌
Enable Speech Codec			Auto 💌
⊟⊸lQ Settings ⊟⊸◆lQ Out		Enable Speech Codec	
Connector	DIG IQ OUT 2 💌	⊨+IQ Out	
Sample Rate	100 Msps	Connector	DIG IQ OUT 4 💌
-Baseband PEP	0.000 dBFS		100 Msps
Crest Factor ⊟◆IQ In	15.00 dB	-Baseband PEP	0.000 dBFS
Connector	DIG IQ IN 1	Crest Factor ⊟♦IQ In	15.00 dB
Sample Rate	100 Msps	Connector	DIG IQ IN 3
Baseband PEP	0.000 dBFS	-Sample Rate	100 Msps
Baseband Level	-15.000 dBFS	Baseband PEP	0.000 dBFS
⊐-RF Settings		Baseband Level	-15.000 dBFS
RF Output (TX)			
Connector	RF1COM 💌	⊨◆RF Output (TX)	
Converter	RFTX1 🔻	Connector	RF3COM 🔻

Fig. 3-41: LTE scenario for Carrier Aggregation SISO: 2CC CA Fading. The CMW indicates the crest factors for both component carriers, which are entered in the SMW's Dig IQ Inputs.

#### Remote commands:

- Take note of the Crest Factors under IQ Out and enter the values in the SMW under Baseband Input Level (see Fig. 2-13 in section 2.3).
- 3. Set a fading and switch on both I/Q Out (BBMM1/2)(see section 2.3).
- 4. In the CMW, enter the corresponding baseband levels (Level BB <sub>out SMW</sub>= Crest Factor <sub>In SMW</sub> Insertion Loss; example: -15 dB 10 dB = -25 dBFS, see 2.3.8), which are indicated by the SMW (see Fig. 3-44). If you add noise to the signal, note the crest factors without noise.
- 5. Select a TM and a DCI format both for PCC and SCC (see also Table 3-2)

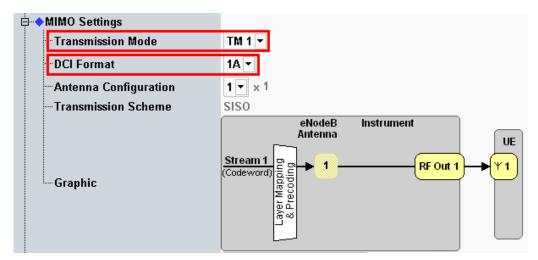


Fig. 3-42: Transmission mode and DCI format. The CMW also shows the transmission scheme and a graphical representation. Set both PCC and SCC.

#### Remote commands:

```
// set TM1
CONFigure:LTE:SIGN<i>:CONNection[:PCC]:TRANsmission TM1
CONFigure:LTE:SIGN<i>:CONNection:SCC:TRANsmission TM1
// set DCI format 1A
```

CONFigure:LTE:SIGN<i>:CONNection[:PCC]:DCIFormat D1A CONFigure:LTE:SIGN<i>:CONNection:DCIFormat D1A

- 6. Use **CONNECT** to establish an LTE connection between the CMW and DUT.
- 7. If you modify the fading, remember to change the level accordingly in the CMW.

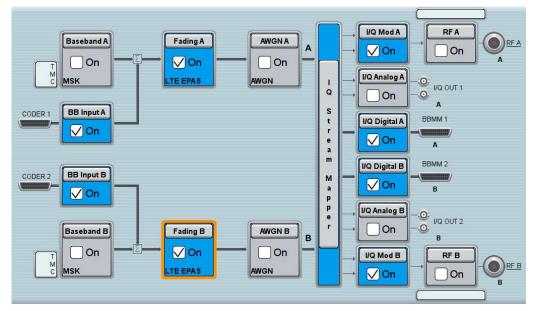


Fig. 3-43: Overview SMW settings for Carrier Aggregation SISO fading.

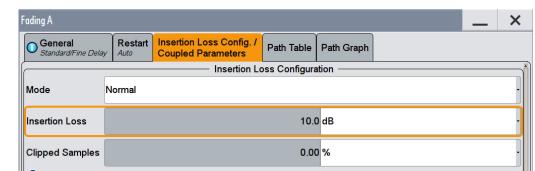


Fig. 3-44: The SMW shows the necessary insertion loss (example: 10 dB)

PCC     SCC1		PCC     SCC1	
ath: IQ Settings/IQ In/Baseband Le	vel	Path: IQ Settings/IQ In/Baseband Leve	9
Scenario	2CC CA - Fading - 2 RF Out	Scenario	2CC CA - Fading - 2 RF Out
Fading	External	Fading	External 🖂
Enable Speech Codec			Auto
🖻 IQ Settings			
⊨ ◆IQ Out		⊟IQ Settings	
Connector	DIG IQ OUT 2 🔻	dan ⇔lQ Out	
Sample Rate	100 Msps	Connector	DIG IQ OUT 4 🔻
-Baseband PEP	0.000 dBFS	Sample Rate	100 Msps
Crest Factor	15.00 dB	Baseband PEP	0.000 dBFS
i⊒⊸♦lQ In		Crest Factor	15.00 dB
Connector	DIG IQ IN 1 📝	⊟+lQ In	
	100 Msps	Connector	DIG IQ IN 3
-Baseband PEP	0.000 dBFS	-Sample Rate	100 Msps
-Baseband Level	-25.000 dBFS	Baseband PEP	0.000 dBFS
		Baseband Level	-25.000 dBFS

Fig. 3-45: Making allowance for the necessary attenuation in the CMW. Here, the digital output level of the SMW signal is entered as the IQ In level.

#### Remote command:

```
// set IQ In to PEP 0 dBFS and Level -25 dBFS
CONFigure:LTE:SIGN<i>:IQIN[:PCC]:PATH<n> 0.0, -25.0
CONFigure:LTE:SIGN<i>:IQIN:SCC:PATH<n> 0.0, -25.0
```

8. Start the RX measurement using **Extended BLER** (see section 3.1). Fig. 3-46 shows an example of a Carrier Aggregation SISO measurement in the overview.

#### LTE(-A) Measurements

#### Scenarios for Carrier Aggregation

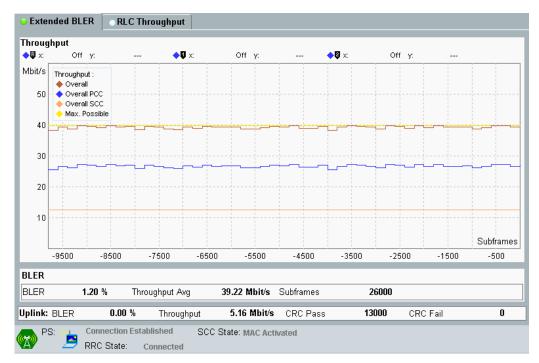


Fig. 3-46: LTE RX measurement for Carrier Aggregation SISO. The throughput for both CCs and the overall throughput are displayed.

## 3.3.2 "2CC CA – Fading – 4 RF Out" scenario (CA with MIMO)

This section covers all Carrier Aggregation scenarios with fading which need four RF output ports. These are:

- I TM1 Rx Diversity (1x2 SIMO)
- TM2 Tx Diversity
- TM3 Open loop spatial multiplexing
- TM4 closed loop spatial multiplexing
- TM6 closed loop spatial multiplexing, single layer
- TM7 Single layer beamforming (port 5)
- TM8 Dual layer beamforming (ports 7,8)

The settings for PCC and SCC may differ. Everything is doubled now because of the two downlink carriers in Carrier Aggregation (PCC and SCC1). The settings for each CC are similar to the scenarios with one cell (see 3.2.2).Please note that two SMWs are necessary to provide the fading paths. The CMW allows free routing of the four streams to the output connectors to meet the DUT's needs.

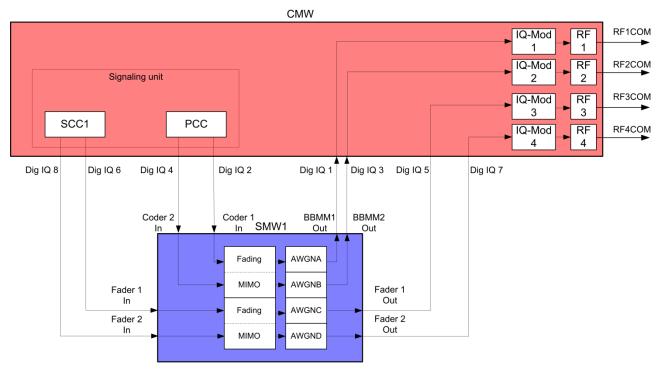


Fig. 3-47: Block diagram for the Carrier Aggregation MIMO test setup. The streams and the MIMO/Fading setup depend on the used transmission mode (TM)

The basic procedure for all the tests is the same, only the MIMO settings differ (TMs):

 In the LTE Signaling Configuration, select the 2CC CA – Fading – 4 RF Out Scenario (see Fig. 3-48). Set Fading to External.

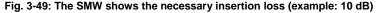
PCC     SCC1			◆PCC ▼SCC1				
ath: Scenario			Path: S	cenario			
	FDD /	D		olex Mode	FDD 🔽		
Scenario	2CC CA - Fading - 4 RF 0	2CC CA - Fading - 4 RF Out		enario	2CC CA - Fading - 4 RF	Out	
Fading	External 🔻		Fac	ling	External 💌		
-Enable Speech Codec			<b>-</b>	CC Activation Mode	Auto 💌		
🗗 IQ Settings			Enz	able Speech Codec			
⊨ ◆IQ Out	Path 1	Path 2	⊨ IQ S	Settings			
Connector	DIG IQ OUT 2 👻	DIG IQ OUT 4 🔻	¢	♦IQ Out	Path 1	Path 2	
	100 Msps	100 Msps		Connector	DIG IQ OUT 6 🔻	DIG IQ OUT 8 🔻	
-Baseband PEP	0.000 dBFS	0.000 dBFS		- Sample Rate	100 Msps	100 Msps	
- Crest Factor	15.00 dB	15.00 dB		-Baseband PEP	0.000 dBFS	0.000 dBFS	
ia	Path 1	Path 2		-Crest Factor	15.00 dB	15.00 dB	
Connector	DIG IQ IN 1	DIG IQ IN 3 💎	<u> </u>	♦ <mark>IQ In</mark>	Path 1	Path 2	
	100 Msps	100 Msps		Connector	DIG IQ IN 5 🕜	DIG IQ IN 7 📃	
Baseband PEP	0.000 dBFS	0.000 dBFS		-Sample Rate	100 Msps	100 Msps	
Baseband Level	-15.000 dBFS	-15.000 dBFS		Baseband PEP	0.000 dBFS	0.000 dBFS	
E RF Settings				Baseband Level	-15.000 dBFS	-15.000 dBFS	
RF Output (TX)	Out 1	Out 2	₽RF	Settings			
Connector	RF1COM 💌	RF2COM 🔻	¢	RF Output (TX)	Out 1	Out 2	
Converter	RFTX1 -	RFTX3 🔻		- Connector	RF3COM 🔫	RF4COM -	

Fig. 3-48: LTE Scenario for Carrier Aggregation with MIMO and four RF out ports: 2CC CA – Fading – 4 *RF Out Ports*. The CMW indicates the crest factors, which are entered in the SMW's Dig IQ input.

#### Remote commands:

- 2. Take note of the four **Crest Factors** shown under **IQ Out** and enter the values in both SMWs under **Baseband Input Level** (see Fig. 2-13 in section 2.3).
- 3. Set a fading for all paths and switch on **I/Q Out** (both SMWs: BBMM1|2)(see section 2.3).
- 4. In the CMW, enter both corresponding baseband levels (Level BB <sub>out SMW</sub> = Crest Factor <sub>In SMW</sub> Insertion Loss; example: -15 dB 10 dB = -25 dBFS, see 2.3.8), which are indicated by the SMWs (see Fig. 3-14). If you add noise to the signal, note the crest factor without noise.
- Select a TM and a DCI format both for PCC and SCC1 (see 3.2.2 and also Table 3-2 for details).
- 6. Use **CONNECT** to establish an LTE connection between the CMW and DUT.
- 7. If you modify the fading, remember to change the level accordingly in the CMW.

General Standard/Fine Dela	Auto	Insertion Loss Config. / Coupled Parameters	Path Table	Path Graph			
		Insertion Lo	oss Configura	ation —			
Mode	Normal						
Insertion Loss	10.0 dB -						
Clipped Samples	0.00 %						



◆ PCC ◆ SCC1			♦ PCC			
ath: IQ Settings/IQ In/Baseband Le	evel		Path: IQ Settings/IQ In/Baseband L	evel		
Duplex Mode	FDD -	FDD -		FDD 🔽		
Scenario 2CC CA - Fading - 4 RF Out		Scenario	2CC CA - Fading - 4 R	Out 🔻		
Fading	Fading External -		Fading	External 🔻	External -	
-Enable Speech Codec				Auto 💌		
∃-IQ Settings						
i da out	Path 1	Path 2	⊟-IQ Settings			
Connector	DIG IQ OUT 2 🔻	DIG IQ OUT 4 🔻	⊨+IQ Out	Path 1	Path 2	
Sample Rate	100 Msps	100 Msps	Connector	DIG IQ OUT 6 🔻	DIG IQ OUT 8	
-Baseband PEP	0.000 dBFS	0.000 dBFS	-Sample Rate	100 Msps	100 Msps	
Crest Factor	15.00 dB	15.00 dB	Baseband PEP	0.000 dBFS	0.000 dBFS	
⊟◆IQ In	Path 1	Path 2	Crest Factor	15.00 dB	15.00 dB	
Connector	DIG IQ IN 1 📝	DIG IQ IN 3 🛛 🗸	⊟+lQ In	Path 1	Path 2	
-Sample Rate	100 Msps	100 Msps	Connector	DIG IQ IN 5	DIG IQ IN 7	
-Baseband PEP	0.000 dBFS	0.000 dBFS	Sample Rate	100 Msps	100 Msps	
Baseband Level	-25.000 dBFS	-25.000 dBFS	Baseband PEP	0.000 dBFS	0.000 dBFS	
			Baseband Level	-25.000 dBFS	-25.000 dBFS	

Fig. 3-50: Compensating for the necessary attenuation in the CMW. Here, the levels of the SMWs signals are entered as the IQ IN levels.

#### Remote commands:

```
// set IQ In to PEP 0 dBFS and Level -25 dBFS
CONFigure:LTE:SIGN<i>:IQIN[:PCC]:PATH1 0.0, -25.0
CONFigure:LTE:SIGN<i>:IQIN[:PCC]:PATH2 0.0, -25.0
CONFigure:LTE:SIGN<i>:IQIN:SCC:PATH1 0.0, -25.0
CONFigure:LTE:SIGN<i>:IQIN:SCC:PATH2 0.0, -25.0
```

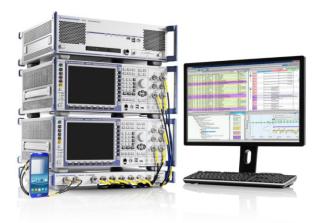


#### 8. Start the RX measurement using **Extended BLER** (see section 3.1)

Fig. 3-51: Example for a Throughput measurement with four RF output paths: a CA test with TM4 (2x2 MIMO) for each CC is used.

# 3.4 Scenarios for Carrier Aggregation with CMWflexx

This section covers tests with carrier aggregation (CA) for more than two downlink component carriers (CC: Primary CC (PCC) and Secondary CC (SCCx). Different transmission modes require different fading paths. In the CMW these scenarios differ by the number of the used RF outputs. The CMW supports all possible frequency allocations in CA (intra-band contiguous, intra-band non- contiguous and inter-band). All CCs can be set up independently of each other.



The CMWflexx provides more than 2 CC's with MIMO each, therefore more than one CMW is used. The CMW Controller (CMWC) allows easy manual and remote control, it acts like one CMW with extended RF hardware.

# 3.4.1 "2CC CA – Fading – 4 RF Out Distributed" scenario (CA with MIMO)

This scenario is the same like in 3.3.2, with the difference that both CMW's are used so the RF ports are distributed over the two CMW's.

The procedure is the same like in 3.3.2, only the scenario setting and the used RF ports differ:

1. In the LTE Signaling Configuration, select the 2CC CA – Fading – 4 RF Out-Distributed Scenario (see Fig. 3-48). Set Fading to External.

PCC	SCC1	SCC2	<ul> <li>SCC3</li> </ul>	
Path: Fading				
Duplex Me	ode	FI	D 🔻 Use Carri	ier Specific: 🔲
Scenario		20	CC CA - Fading	- 4 RF Out - Distributed 🔻
Fading		E	kternal 🔻	
IQ Setting	s			

Fig. 3-52: LTE Scenario for Carrier Aggregation with MIMO and four distributed RF out ports: 2CC CA – Fading – 4 *RF Out Distributed Ports*. The CMW sets the used RF out ports automatically

#### Remote commands:

```
// 2CC CA-Fading-4 RF Out distributed external: routing is done // automatically. Use query to ask settings
```

ROUTe:LTE:SIGN<i>:SCENario:BDFD:FIX

# 3.4.2 "3CC CA – Fading – 6 RF Out" scenario (CA with 3 CC's and MIMO)

This section covers all Carrier Aggregation scenarios with fading which need six RF output ports. These are:

- TM1 Rx Diversity (1x2 SIMO)
- TM2 Tx Diversity
- I TM3 Open loop spatial multiplexing
- TM4 closed loop spatial multiplexing
- I TM6 closed loop spatial multiplexing, single layer
- TM7 Single layer beamforming (port 5)
- **I** TM8 Dual layer beamforming (ports 7,8)
- **TM9** Dual layer beamforming (ports 7,8)

The settings for PCC, SCC1 and SCC2 may differ. Everything is tripled now because of the three downlink carriers in Carrier Aggregation (PCC, SCC1 and SCC2). The settings for each CC are similar to the scenarios with one cell (see 3.2.2).Please note that two SMWs are necessary to provide the fading paths.

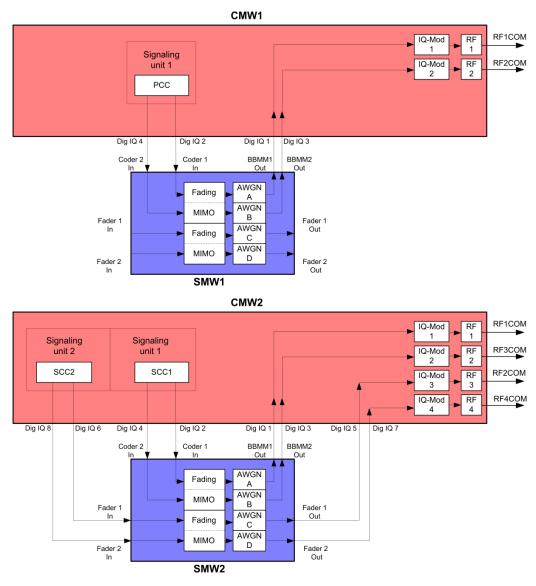


Fig. 3-53: Block diagram for the three Carrier Aggregation MIMO test setup. The streams and the MIMO/Fading setup depend on the used transmission mode (TM)

The basic procedure for all the tests is the same, only the MIMO settings differ (TMs):

 In the LTE Signaling Configuration, select the 3CC CA – Fading – 6 RF Out Scenario (see Fig. 3-48). Set Fading to External.

🚸 LTE Signaling 1 - Config	uration				
PCC SCC	1 🔸 SCC2	♦ SCC3			
Path: Scenario					
		FDD - Use Carrier Specific:			
Scenario		3CC CA - Fading - 6	RF Out		
Fading		External 🔻			
⊡ IQ Settings					
⊡ ◆IQ Out		Path 1	Path 2		
Connector		1.DIG IQ OUT 2 🔻	1.DIG IQ OUT 4		
Sample Rat		100 Msps	100 Msps		
Baseband P		0.000 dBFS	0.000 dBFS		
Crest Factor		15.00 dB	15.00 dB		
⊡·◆lQ In		Path 1	Path 2		
Connector		1.DIG IQ IN 1 🝸	1.DIG IQ IN 3 🝸		
Sample Rat		100 Msps	100 Msps		
Baseband P		0.000 dBFS	0.000 dBFS		
Baseband L	evel	-15.000 dBFS	-15.000 dBFS		
□ RF Settings		Out 1			
	⊡·•◆RF Output (TX) ··Connector		Out 2		
Connector			1.RF2COM		
•Converter		1.RFTX1	1.RFTX2		
External Att	enuation	0.00 dB	0.00 dB		
External De	ay Compensati	0 ns			

Fig. 3-54: LTE Scenario for Carrier Aggregation with MIMO and six RF out ports: 3CC CA – Fading – 6 *RF Out Ports*. The CMW indicates the crest factors, which are entered in the SMW's Dig IQ input.

#### Remote commands:

```
// 3CC CA-Fading-6 RF Out external: routing is done
// automatically. Use query to ask settings
```

ROUTe:LTE:SIGN<i>:SCENario:CFF:FIX

// read out information of IQ settings SENSe:LTE:SIGN<i>:IQOut[:PCC]:PATH1? SENSe:LTE:SIGN<i>:IQOut[:PCC]:PATH2? SENSe:LTE:SIGN<i>:IQOut:SCC1:PATH1? SENSe:LTE:SIGN<i>:IQOut:SCC1:PATH2? SENSe:LTE:SIGN<i>:IQOut:SCC2:PATH1? SENSe:LTE:SIGN<i>:IQOut:SCC2:PATH2?

- 3. Take note of the six **Crest Factors** shown under **IQ Out** and enter the values in both SMWs under **Baseband Input Level** (see Fig. 2-13 in section 2.3).
- Set a fading for all paths and switch on I/Q Out (both SMWs: BBMM1|2)(see section 2.3).

- In the CMW, enter all six corresponding baseband levels (Level BB <sub>out SMW</sub> = Crest Factor <sub>In SMW</sub> – Insertion Loss; example: -15 dB – 16 dB = -31 dBFS, see 2.3.8), which are indicated by the SMWs (see Fig. 3-14). If you add noise to the signal, note the crest factor without noise.
- 6. Select a **TM** and a **DCI format** for PCC, SCC1 and SCC2 (see 3.2.2 and also Table 3-2 for details).
- 7. Use **CONNECT** to establish an LTE connection between the CMW and DUT.
- 8. If you modify the fading, remember to change the level accordingly in the CMW.

Fading A							_	×
General Standard/Fine Delay	Restart Auto	Insertion Loss Config. / Coupled Parameters	Path Table	Path Graph				
Insertion Loss Configuration								
Mode	Normal							-
Insertion Loss	16.0 dB				·			
Clipped Samples			0.00	) %				•
0	1 1	1 1 1 1		1 1	1 1	1 1	100	.00 %

Fig. 3-55: The SMW shows the necessary insertion loss (example: 16 dB)

⊟ IQ Settings			
i⊐ ◆IQ Out	Path 1	Path 2	
Connector	1.DIG IQ OUT 2 🔽	1.DIG IQ OUT 4 🔽	
Sample Rate	100 Msps	100 Msps	
Baseband PEP	0.000 dBFS	0.000 dBFS	
Crest Factor	15.00 dB	15.00 dB	
i lQ In	Path 1	Path 2	
Connector	1.DIG IQ IN 1 🔽	1.DIG IQ IN 3 🔽	
Sample Rate	100 Msps	100 Msps	
Baseband PEP	0.000 dBFS	0.000 dBFS	
Baseband Level	-31.000 dBFS	–31.000 dBFS	

Fig. 3-56: Compensating for the necessary attenuation in the CMW. Here, the levels of the SMWs signals are entered as the IQ IN levels. Repeat this for all CC's.

#### Remote commands:

```
// set IQ In to PEP 0 dBFS and Level -31 dBFS
CONFigure:LTE:SIGN<i>:IQIN[:PCC]:PATH1 0.0, -315.0
CONFigure:LTE:SIGN<i>:IQIN[:PCC]:PATH2 0.0, -31.0
CONFigure:LTE:SIGN<i>:IQIN:SCC1:PATH1 0.0, -31.0
CONFigure:LTE:SIGN<i>:IQIN:SCC1:PATH2 0.0, -31.0
CONFigure:LTE:SIGN<i>:IQIN:SCC2:PATH1 0.0, -31.0
CONFigure:LTE:SIGN<i>:IQIN:SCC2:PATH2 0.0, -31.0
```

9. Start the RX measurement using Extended BLER (see section 3.1)

## 3.4.3 "4CC CA – Fading – 8 RF Out" scenario (CA with 4 CC's and MIMO)

This section covers all Carrier Aggregation scenarios with fading which need eight RF output ports. These are:

- TM1 Rx Diversity (1x2 SIMO)
- TM2 Tx Diversity
- I TM3 Open loop spatial multiplexing
- TM4 closed loop spatial multiplexing
- I TM6 closed loop spatial multiplexing, single layer
- TM7 Single layer beamforming (port 5)
- TM8 Dual layer beamforming (ports 7,8)
- TM9 Dual layer beamforming (ports 7,8)

The settings for PCC, SCC1, SCC2 and SCC3 may differ. Everything is four times available now because of the four downlink carriers in Carrier Aggregation (PCC, SCC1, SCC2 and SCC3). The settings for each CC are similar to the scenarios with one cell (see 3.2.2).Please note that two SMWs are necessary to provide the fading paths.

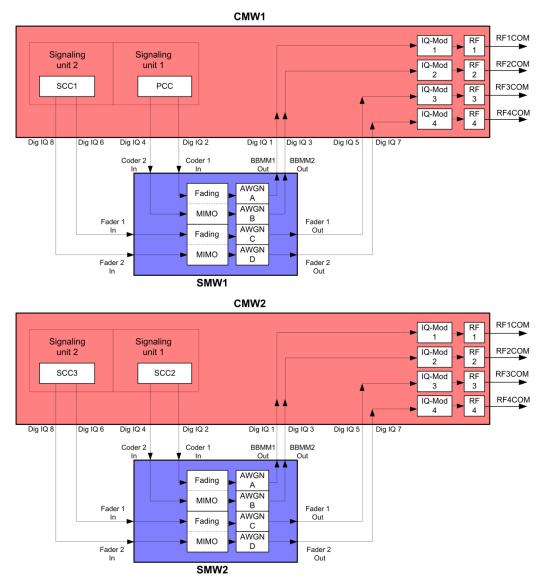


Fig. 3-57: Block diagram for the Carrier Aggregation MIMO test setup. The streams and the MIMO/Fading setup depend on the used transmission mode (TM)

The basic procedure for all the tests is the same, only the MIMO settings differ (TMs):

1. In the LTE Signaling Configuration, select the 4CC CA – Fading – 8 RF Out Scenario (see Fig. 3-48). Set Fading to External.

PCC SCC1 SCC2	SCC3			
Path: IQ Settings/IQ Out/Connector		_		
-Duplex Mode	FDD Vuse Carrier Specific			
Scenario	4CC CA - Fading - 8 RF Out	•		
••Fading	External 🔻			
⊞-Base Band				
l	1.SUW1 🔻			
🖻 IQ Settings				
i i out	Path 1	Path 2		
Connector	1.DIG IQ OUT 2 🔻	1.DIG IQ OUT 4 🔻		
Sample Rate	100 Msps	100 Msps		
Baseband PEP	0.000 dBFS	0.000 dBFS		
Crest Factor	15.00 dB	15.00 dB		
⊡-•IQ In —Connector	Path 1	Path 2		
	1.DIG IQ IN 1	1.DIG IQ IN 3 🔽		
Sample Rate Baseband PEP	100 Msps 0.000 dBES	100 Msps 0.000 dBFS		
Baseband Level	-15.000 dBFS	-15.000 dBFS		
⊡-RF Settings	-13.000 uDF3	-13.000 0053		
B RF Output (TX)	Out 1	Out 2		
Connector	1.RF1COM • 1.RF20			
Converter	1.RFTX1 • 1.RFT)			
	0.00 dB 0.00 dE			
External Delay Compensati		-		
□ ◆RF Input (RX)		In		
Connector	1.RF1COM 🔻			
Converter	1.RFRX1 🔻			

Fig. 3-58: LTE Scenario for Carrier Aggregation with MIMO and eight RF out ports: 4CC CA – Fading – 8 *RF Out Ports*. The CMW indicates the crest factors, which are entered in the SMW's Dig IQ input.

#### Remote commands:

// 4CC CA-Fading-8 RF Out external: routing is done
// automatically. Use query to ask settings

ROUTe:LTE:SIGN<i>:SCENario:DHF:FIX

```
// read out information of IQ settings
SENSe:LTE:SIGN<i>:IQOut[:PCC]:PATH1?
SENSe:LTE:SIGN<i>:IQOut[:PCC]:PATH2?
SENSe:LTE:SIGN<i>:IQOut:SCC1:PATH1?
SENSe:LTE:SIGN<i>:IQOut:SCC1:PATH2?
SENSe:LTE:SIGN<i>:IQOUt:SCC2:PATH1?
SENSe:LTE:SIGN<i>:IQOUt:SCC2:PATH2?
SENSe:LTE:SIGN<i>:IQOUt:SCC3:PATH1?
SENSe:LTE:SIGN<i>:IQOUt:SCC3:PATH2?
```

- 2. Take note of the eight **Crest Factors** shown under **IQ Out** and enter the values in both SMWs under **Baseband Input Level** (see Fig. 2-13 in section 2.3).
- 3. Set a fading for all paths and switch on **I/Q Out** (both SMWs: BBMM1|2)(see section 2.3).
- In the CMW, enter all eight corresponding baseband levels (Level BB <sub>out SMW</sub>= Crest Factor <sub>In SMW</sub> – Insertion Loss; example: -15 dB – 16 dB = -31 dBFS, see 2.3.8), which are indicated by the SMWs (see Fig. 3-14). If you add noise to the signal, note the crest factor without noise.
- 5. Select a **TM** and a **DCI format** for PCC, SCC1, SCC2 and SCC3 (see 3.2.2 and also Table 3-2 for details).
- 6. Use **CONNECT** to establish an LTE connection between the CMW and DUT.
- 7. If you modify the fading, remember to change the level accordingly in the CMW.

Fading A					_	-	×	
General Standard/Fine Delay	Restart Auto	Insertion Loss Config. / Coupled Parameters	Path Table	Path Graph				
Insertion Loss Configuration								
Mode	Normal							
Insertion Loss	16.0 dB -				·			
Clipped Samples	0.00 %							
0								

Fig. 3-59: The SMW shows the necessary insertion loss (example: 16 dB)

⊟ IQ Settings			
⊡ ••IQ Out	Path 1	Path 2	
Connector	1.DIG IQ OUT 2 🔽	1.DIG IQ OUT 4 🔽	
Sample Rate	100 Msps	100 Msps	
-Baseband PEP	0.000 dBFS	0.000 dBFS	
Crest Factor	15.00 dB	15.00 dB	
⊡ ◆IQ In	Path 1	Path 2	
Connector	1.DIG IQ IN 1 🔽	1.DIG IQ IN 3 🔽	
Sample Rate	100 Msps	100 Msps	
Baseband PEP	0.000 dBFS	0.000 dBFS	
Baseband Level	-31.000 dBFS	–31.000 dBFS	

Fig. 3-60: Compensating for the necessary attenuation in the CMW. Here, the levels of the SMWs signals are entered as the IQ IN levels. Repeat this for all CC's.

CMW Internal Fading for LTE(-A)

### Remote commands:

```
// set IQ In to PEP 0 dBFS and Level -31 dBFS
CONFigure:LTE:SIGN<i>:IQIN[:PCC]:PATH1 0.0, -31.0
CONFigure:LTE:SIGN<i>:IQIN[:PCC]:PATH2 0.0, -31.0
CONFigure:LTE:SIGN<i>:IQIN:SCC1:PATH1 0.0, -31.0
CONFigure:LTE:SIGN<i>:IQIN:SCC2:PATH2 0.0, -31.0
CONFigure:LTE:SIGN<i>:IQIN:SCC2:PATH1 0.0, -31.0
CONFigure:LTE:SIGN<i>:IQIN:SCC2:PATH2 0.0, -31.0
CONFigure:LTE:SIGN<i>:IQIN:SCC3:PATH2 0.0, -31.0
CONFigure:LTE:SIGN<i>:IQIN:SCC3:PATH1 0.0, -31.0
```

8. Start the RX measurement using **Extended BLER** (see section 3.1)

# 3.5 CMW Internal Fading for LTE(-A)

For all of the above Fading scenarios (see also Table 3-2):

- 1 Cell Fading- 1 RF out
- I Cell Fading- 2 RF out
- 1 Cell 4x2 MIMO Fading 2 RF out
- I 2CC CA Fading 2 RF out (PCC and SCC1)
- 2CC CA Fading 4 RF out (PCC and SCC1)
- 2CC CA Fading 4 RF out distributed (PCC and SCC1)
- 3CC CA Fading 6 RF out (PCC,SCC1 and SCC2)
- 4CC CA Fading 8 RF out (PCC, SCC1, SCC2 and SCC3)

the internal fading in the CMW can be used with the software option CMW-KE500. It allows the predefined fading settings:

- Delay profiles (3GPP TS 36.101, Annex B.2.)
  - EPA 5 Hz
  - EVA 5 Hz
  - EVA 70 Hz
  - ETA 30 Hz
  - ETA 70 Hz
  - ETA 300 Hz
  - For MIMO all with low, mid and high correlation
- High speed train profile (HST) (3GPP TS 36.101, Annex B.3.)
- Multi-path profile for CQI tests (3GPP TS 36.521-1, section 9.3.)

1. Set the wanted fading scenario and set Fading to Internal.

🚸 LTE Signalin	g Configuration		
PCC	♦SCC1		
Path: Fading			
-Duplex N	lode	FDD -	
- Scenario		1 Cell - Fading - 1 RF Out	-
Fading		Internal 🔻 Fader 1 💌	
Enable S	peech Codec		

Fig. 3-61: LTE scenario with internal fading

### Remote commands:

// 1 Cell-Fading- 1 RF Out internal via RF2COM ROUTe:LTE:SIGN:SCENario:SCFading:INTernal RF2C,RX1,RF2C,TX1 // 1 Cell-Fading-2 RF Out internal: RF2C, IQ2Out, RF1C ROUTe:LTE:SIGN<i>:SCENario:TROFading:INTernal RF1C, RX1, RF1C, TX1, RF3C, TX2, FAD1 // 1 Cell-Fading-MIMO 4x2 - 2 RF Out internal: ROUTe:LTE:SIGN<i>:SCENario:MTF:INTernal RF1C, RX1, RF1C, TX1, RF2C, TX3 // 2CC CA-Fading- 2 RF Out internal via RF1COM, RF3COM ROUTe:LTE:SIGN:SCENario:CATF:INTernal RF1C, RX1, RF1C, TX1, RF3C, TX2 // 2CC CA-Fading-4 RF Out internal: RF1C, RF2C, RF3C, RF4C ROUTe:LTE:SIGN<i>:SCENario:CAFF:INTernal RF1C, RX1, RF1C, TX1, RF2C, TX3, RF3C, TX2, RF4C, TX4 // 2CC CA-Fading-4 RF Out distributed external: routing is done // automatically. Use query to ask settings ROUTe:LTE:SIGN<i>:SCENario:BDFD:FIX:INTernal // 3CC CA-Fading-6 RF Out external: routing is done // automatically. Use query to ask settings ROUTe:LTE:SIGN<i>:SCENario:CFF:FIX:INTernal

// 4CC CA-Fading-8 RF Out external: routing is done
// automatically. Use query to ask settings
ROUTe:LTE:SIGN<i>:SCENario:DHF:FIX:INTernal

- 2. Select under Fading Simulator the wanted Profile (example EPA 5Hz Low)
- 3. Enable the Fading

CMW Internal Fading for LTE(-A)

rading returned Fading		
□ Fading Simulator	_	
- Enable		
- Profile	EPA 5Hz Low	-
	EPA 5Hz Low	•
	EPA 5Hz Medium EPA 5Hz High	
⊞Insertion Loss	EVA 5Hz Low	
Doppler Frequency Mode	EVA 5Hz Medium	
Doppler Frequency	EVA 5Hz High EVA 70Hz Low	
⊞ DL Settings	EVA 70Hz Medium	
⊞-Fading Module AWGN	EVA 70Hz High	
🖶 Downlink Power Levels	ETU 30Hz Low	-

Fig. 3-62: internal LTE fading profiles

Remote commands:

```
// Fading profile EPA 56 Hz low
CONFigure:LTE:SIGN<i>:FADing[:PCC]:FSIMulator:STANdard EP5Low
CONFigure:LTE:SIGN<i>:FADing:SCC:FSIMulator:STANdard EP5Low
```

```
// Switch on FAding
CONFigure:LTE:SIGN<i>[:PCC]:FADing:FSIMulator:ENABle ON
CONFigure:LTE:SIGN<i>:SCC:FADing:FSIMulator:ENABle ON
```

4. If wanted, apply AWGN by setting the Signal/Noise-ratio and enable the AWGN.

🖻 Fading Module AWGN	
Enable	$\checkmark$
-Min. Noise/System BW Ratio	1.5
Noise Bandwidth	10.00 MHz
Effective Signal BW	9.00 MHz
Signal/Noise Ratio	5.00 dB

Fig. 3-63: internal LTE AWGN section

Remote commands:

```
// Ratio 1.5
CONFigure:LTE:SIGN<i>:FADing[:PCC]:AWGN:BWIDth:RATio 1.5
CONFigure:LTE:SIGN<i>:FADing:SCC:AWGN:BWIDth:RATio 1.5
// Signal/Noise 5.0
CONFigure:LTE:SIGN<i>:FADing[:PCC]:AWGN:SNRatio 5.0
CONFigure:LTE:SIGN<i>:FADing:SCC]:AWGN:SNRatio 5.0
// Switch on AWGN
CONFigure:LTE:SIGN<i>:FADing[:PCC]:AWGN:ENABle ON
CONFigure:LTE:SIGN<i>:FADing:SCC:AWGN:ENABle ON
```

5. Start the measurement (see 3.1).

# 4 W-CDMA and HSPA(+) Measurements

With the W-CDMA standard, UE receiver measurements include different types of measurements depending on the release:

W-CDMA Rx measurements						
Release	Name		Measurement			
		DL / UL Carrier				
99	RMC	1/1	BER			
5	HSDPA	1/1	HSDPA ACK (BLER)			
6	HSUPA	1/1	E-HICH			
7	HSPA+	1/1	HSDPA ACK (BLER)			
8	Dual Cell HSDPA	2 /1	HSDPA ACK (BLER)			
_	DC-HSUPA	2/2	E-HICH			
9	Dual-Band HSDPA	2/1	HSDPA ACK (BLER)			
10	Four Carrier HSDPA	CMW: 3 / 2	HSDPA ACK (BLER)			

All measurements are summarized in the **WCDMA RX Meas** test and measurement applications (see 4.1).

Before the start of the W-CDMA signaling, external fading must be selected as the scenario. Once signaling has begun, or once a connection has been established with the DUT, it is no longer possible to change scenarios.

Different antenna configurations are possible with W-CDMA. They also require different ways of handling fading:

W-CDMA scenarios						
W-CDMA scenario	Purpose	Release	CMW configuration			
SISO	Standard	99/5/6/7	Standard cell fading			
SIMO	Rx Diversity	99/5/6/7	Standard cell Rx Diversity fading			
Dual Carrier	DC-HSPA+	5/7/8	Dual Carrier Fading			
DC – SIMO	DC-HSPA+ with RX Diversity	5/7/8	Dual Carrier Rx Diversity Fading			
Dual Band	DB-DC-HSDPA+	5/7/8/9	Dual Carrier / Dual Band Fading			
Dual Band - SIMO	DB-DC-HSDPA+ with RX Diversity	5/7/8/9	Dual Carrier / Dual Band Fading Rx Diversity			

Table 4-1: W-CDMA scenarios in the CMW.

This section describes the steps required to perform a W-CDMA Rx measurement under several different conditions, such as SISO or DC-HSPA+ fading.

For more information on W-CDMA signaling or on W-CDMA Rx measurements, refer to [6].

Important note: The CMW and the SMW use DigIQ connections to exchange the signals. The correct setting of the crest factor is essential for the fading and the correct RF level handling (see sections 4.2 to 4.5). The crest factor of the CMW depends on

UE Receiver Measurement in W-CDMA: Rx Meas

the settings of the channels and the connection state. Please check the crest factor settings after establishing the connections. Re-adjustments may be necessary.

For W-CDMA, the CMW offers "wizards". They make it very easy to configure the parameters for specific test cases. To do this, the CMW reads the UE report and sets the corresponding parameters – e.g. for maximum throughput (see Fig. 4-1).

🚸 CMW Wizard	×
Global Application Wiza	ards
	WCDMA UE Signaling Wizards HSDPA Max. Throughput HSUPA Max. Throughput HSPA Max. Throughput HSUPA Maximum Output Power Dual Carrier HSPA Innerloop Power Control HSUPA E-RGCH Measurement HSDPA CQI Measurement
	For best result, please register your phone!

Fig. 4-1: The WCDMA wizard

# 4.1 UE Receiver Measurement in W-CDMA: Rx Meas

The CMW sends data to the UE either via RMC or HSPA subframes and determines the block error rate (BLER) from the positive ACKnowledgments (ACK) and negative ACKnowledgments (NACK) returned by the UE. Additional throughput results are calculated from the BLER results. The CQI indices reported by the UE are also evaluated.

Fig. 4-2 through Fig. 4-4 show examples of the different measurements under fading conditions.

UE Receiver Measurement in W-CDMA: Rx Meas

_	_	•
_	_	

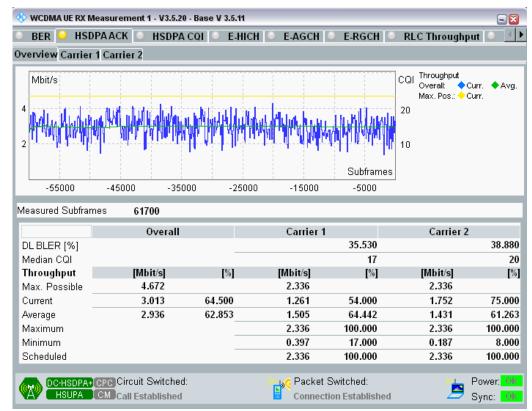
🚯 WCDMA UE RX Measurement 1 - X3.0.30.7						WCDMA
BER HSDPA ACK RLC Throughput E-HIC	H 📔 🔵 UL Loggin	g				BER
Connection Status	Cell Setup				2	RDY
Cell HSDPA	Band	Band 1	•			
Circuit Switched		Downlink		Uplink	755	
	Channel	10563	Ch	9613	Ch	
Packet Switched Attached	Frequency	2112.6	MHz	1922.6	MHz	
CMW Demod. Info Power in Range In Sync	Output Power	-80.00	dBm			
DL/UL Alignment 1019.63 Chip	Total Output	-80.00	dBm			
	Scrambling Code	0	hex	0	hex	
	P-CPICH -	-11.0	dB	Code	0	
	PS Domain	Reduced :	Signaling			
Results	Connection Setu	p				
BER 0.311 %	UE term. Connect	Test Mo	de			
BLER 0.000 %	Туре	RMC				
DBLER _ 2.000 %	RMC					
	Data Rate DL 1	2.2 kbps UL	12.2 kb	ps		
Lost Transp.Blocks 0	Test Mode Loop	Mode 1 RLC				Signaling
UL TFCI Faults NCAP						Parameter
FDR NCAP						
PN Discontinuity 1						WCDMA-UE Signaling
Transport Blocks 100 / 100						
Disconnect		iend MS	Handove	er Confi	g	

Fig. 4-2: W-CDMA BER Measurement on DCH (RMC) Rel 99. The UE loops back the data stream sent from the CMW. The CMW determines the bit error rate (BER) and from that also determines the block error rates.

## Remote commands:

```
CONFigure:WCDMa:SIGN<i>:BER:TBLocks 10000 // set 10000 blocks
INITiate:WCDMa:SIGN<i>:BER // start measurement
FETCh:WCDMa:SIGN<i>:BER? // get results
```

#### UE Receiver Measurement in W-CDMA: Rx Meas



# HSDPA ACK

Fig. 4-3: W-CDMA HSDPA ACK Measurement on HSPA channels. For each data block, the UE sends an ACK or NACK back to the CMW. The CMW counts the ACK/NACKs and calculates the block error rate (BLER) and, from that, the throughput.

#### Remote commands:

```
//set 10000 subframes
CONFigure:WCDMa:SIGN<i>:HACK:MSFRames 10000
// start measurement
INITiate:WCDMa:SIGN<i>:HACK
// get results
FETCh:WCDMa:SIGN<i>:HACK:TRACe:THRoughput:TOTal:CURRent?
```

# E-HICH

BER HSDPA AC	K OE-HICH	RLC Th	roughput	UL Log	ging		
12 Mbit/s 10 8 6 4 2 -18000 -16000	-14000 -12000	-10000 -80	00 -6000			Throughpu Overall Carrier 1: Carrier 2: Max, Pos.: Carrier 1: Carrier 1: Carrier 1: Carrier 1:	Curr.
	ent 11.484 Mbit/	s Average	11,484 Mb		2000		
Overall Throughput Curre	ent 11.484 Mbit/ Carrier 1	s Average Carrier 2	_	it/s		arrier 1	Carrie
Overall Throughput Curr Throughput [Mbit/s]			11.484 Mbi E-HICH R False	it/s		arrier 1 0	Carrie
Overall Throughput Curre Throughput [Mbit/s] Current	Carrier 1	Carrier 2	E-HICH R	it/s			Carrier 790
	Carrier 1 5.742	Carrier 2 5.742	E-HICH R False	it/s		0	
Dverall Throughput Curre Throughput [Mbit/s] Current Average Maximum	Carrier 1 5.742 5.742	Carrier 2 5.742 5.742	E-HICH R False Correct	it/s eception		0 7900	790
Dverall Throughput Curre Throughput [Mbit/s] Current Average Maximum Minimum	Carrier 1 5.742 5.742 5.742 5.742	Carrier 2 5.742 5.742 5.742 5.742	E-HICH R False Correct All Valid False Rati	it/s eception	G	0 7900 7900 0.000	790 790 0.00
Overall Throughput Curre Throughput [Mbit/s] Current Average Maximum Minimum Max. Possible	Carrier 1 5.742 5.742 5.742 5.742 5.742	Carrier 2 5.742 5.742 5.742 5.742 5.742	E-HICH R False Correct All Valid False Rati	it/s eception	G	0 7900 7900 0.000 arrier 1	790 790 0.00 Carrier
Dverall Throughput Curre Throughput [Mbit/s] Current Average	Carrier 1 5.742 5.742 5.742 5.742 5.742 5.742 5.742	Carrier 2 5.742 5.742 5.742 5.742 5.742 5.742 5.742	E-HICH R False Correct All Valid False Rati	it/s eception	G	0 7900 7900 0.000	790 790 0.00

Fig. 4-4: W-CDMA HSUPA E-HICH measurement on HSPA channels in line with Rel 6. On the uplink channels, the CMW measures the UE's reaction to the information in the downlink channels. The E-HICH measurement also supports DC-HSUPA with two carriers.

### Remote commands:

```
CONFigure:WCDMa:SIGN<i>:EHICh:MFRames 10000 //set 10000
subframes
INITiate:WCDMa:SIGN<i>:EHICh // start measurement
FETCh:WCDMa:SIGN<i>:EHICh? // get results
```

# 4.2 SISO Configuration

In this configuration, only one data stream is used via one antenna. For this, it is only necessary to fade one path. That can be done with one channel of the SMW.

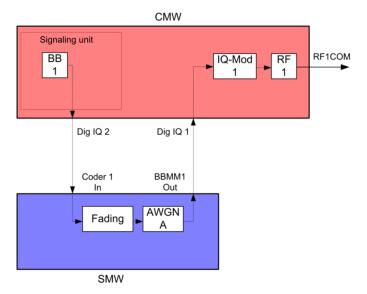


Fig. 4-5: Block diagram for the SISO test setup.

1. In the WCDMA **Signaling Configuration**, select the *Standard Cell Fading* **Scenario** (see Fig. 4-6). Set **Fading** to *External*.

🚸 WCDMA Signaling Configuration		
Path: Scenario		
Scenario	Standard Cell Fading	🔻 Fading: External 🝷
-Enable Data end to end	M	
-Enable Speech Codec		
i⊒-IQ Settings		
i lQ Out		
Connector	DIG IQ OUT 2 🔫	
Sample Rate	100 Msps	
Baseband PEP	0.00 dBES	
- Crest Factor	15.00 dB	
⊟-IQ In		
Connector	DIG IQ IN 1 🖂	
Sample Rate	100 Msps	
-Baseband PEP	0.00 dBFS	
Baseband Level	-15.00 dBFS	

Fig. 4-6: WCDMA scenario for SISO: Standard Cell Fading. The CMW indicates the crest factor that is entered in the SMW Dig IQ Input.

## Remote commands:

```
// Standard Cell Fading external with RF2C and IQ 2
ROUTe:WCDMa:SIGN:SCENario:SCFading RF2C,RX1,RF2C,TX1,IQ20
// read out IQ settings
SENSe:WCDMa:SIGN<i>:IQOut:CARRier<carrier>?
```

2. Take note of the **Crest Factor** under **IQ Out** and enter this value in the SMW under **Baseband Input Level** (see Fig. 2-13 in section 2.3).

- 3. Set a fading and switch on **I/Q Out** (BBMM1)(see section 2.3).
- In the CMW, enter the corresponding baseband level (Level BB <sub>out SMW</sub>= Crest Factor <sub>In SMW</sub> Insertion Loss; example: -15.0 dB 10 dB = -25.0 dBFS, see 2.3.8), which is indicated by the SMW (see Fig. 4-8). If you add noise to the signal, note the crest factor without noise.
- 5. Establish a W-CDMA connection between the CMW and DUT, e.g. using **CONNECT HSPA TM**.
- 6. If you modify the fading, remember to change the level accordingly in the CMW.

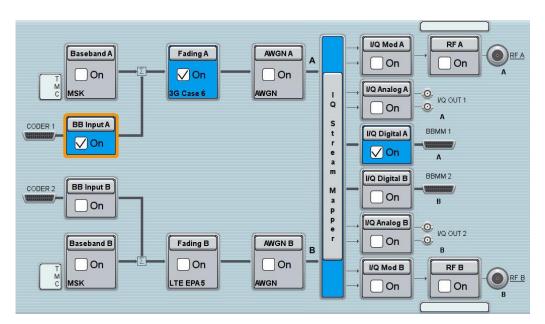


Fig. 4-7: SMW settings for SISO fading.

Fading A					—	×
General Standard/Fine Dela	Restart Auto	Insertion Loss Config. / Coupled Parameters	Path Table	Path Graph		
		Insertion Lo	oss Configura	ation		Ī
Mode	Normal	Normal ·				
Insertion Loss		10.0 dB -				
Clipped Samples			0.00	0 %		•



🚸 WCDMA Signaling Configuration	🚸 WCDMA Signaling Configuration						
Path: IQ Settings/IQ In/Baseband Level	Path: IQ Settings/IQ In/Baseband Level						
Scenario	Standard Cell Fading	▼ Fading: External ▼					
Enable Data end to end							
-Enable Speech Codec							
□ IQ Settings							
⊟ IQ Out							
Connector	DIG IQ OUT 2 🔻						
Sample Rate	100 Msps						
-Baseband PEP	0.00 dBFS						
Crest Factor	15.00 dB						
⊡IQ In							
Connector	DIG IQ IN 1 🕜						
Sample Rate	100 Msps						
Baseband PEP	0.00 dBFS						
Baseband Level	-25.00 dBFS						

Fig. 4-9: Compensating the necessary attenuation in the CMW. Here, the level of the SMW signal is entered as the IQ IN level.

#### Remote command:

// set IQ in to PEP 0 dBFS and Level to -26.77 dBFS CONFigure:WCDMa:SIGN<i>:IQIN:CARRier<carrier> 0, -26.77

7. Start the RX measurement via **WCDMA Rx Meas.** (see section 4.1). Fig. 4-10 shows an example of the SISO measurement in the overview.

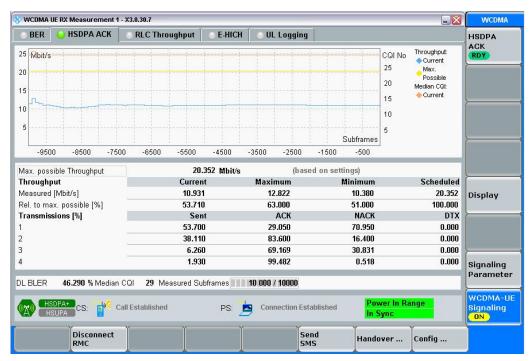


Fig. 4-10: WCDMA RX measurement for SISO.

Rx Diversity Configuration (SIMO)

# 4.3 Rx Diversity Configuration (SIMO)

Rx Diversity simulates the two different receiving paths of the UE. The second path is provided by the CMW via RFCOM2.

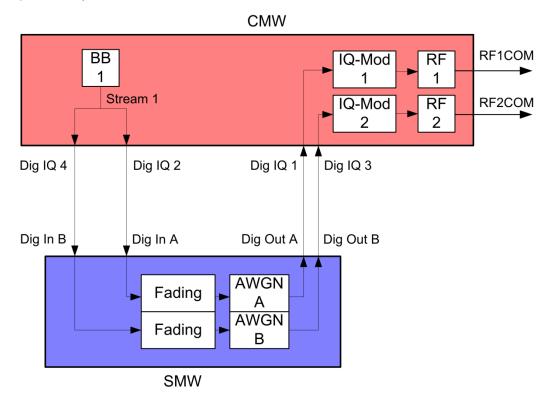


Fig. 4-11: Block diagram for the Rx Diversity test setup. One carrier is split up in two paths and transmitted via two antennas and with different fading.

1. In the **WCDMA Signaling Configuration**, select the *Standard Cell Rx Diversity Fading* **Scenario** (see Fig. 4-18). Set **Fading** to *External*. The CMW can accommodate different antenna configurations for the UE. Output for the second carrier can either be provided through the same RF port or through a separate one.

Rx Diversity Configuration (SIMO)

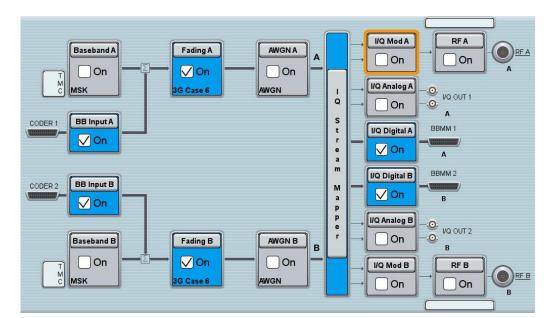
WCDMA Signaling Configuration		
ath: Scenario		
- Scenario	Standard Cell Rx Divers	sity Fading 💌 Fading: External 💌
Enable Data end to end	V	
-Enable Speech Codec		
i⊐ IQ Settings		
i lQ Out	Path 1	Path 2
Connector	DIG IQ OUT 2 🔻	DIG IQ OUT 4 🔻
Sample Rate	100 Msps	100 Msps
-Baseband PEP	0.00 dBFS	0.00 dBFS
-Crest Factor	15.00 dB	15.00 dB
id⊸lQ In	Path 1	Path 2
Connector	DIG IQ IN 1	DIG IQ IN 3 📃
Sample Rate	100 Msps	100 Msps
Baseband PEP	0.00 dBFS	0.00 dBFS
Baseband Level	-15.00 dBFS	-15.00 dBFS

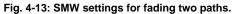
Fig. 4-12: WCDMA scenario for Rx Diversity: Standard Cell Rx Diversity Fading. The CMW indicates the crest factors that are entered in the SMW Dig IQ Input.

### Remote commands:

- 2. Take note of the **Crest Factors** under **IQ Out** and enter the values in the SMW under **Baseband Input Level** (see Fig. 2-13 in section 2.3).
- 3. Set a fading for both paths and switch on I/Q Out (BBMM1|2)(see section 2.3).
- In the CMW, enter the corresponding baseband level (Level BB <sub>out SMW</sub>= Crest Factor <sub>In SMW</sub> Insertion Loss; example: -15.0 dB 10 dB = -25.0 dBFS, see 2.3.8 ), which is indicated by the SMW (see Fig. 4-8). If you add noise to the signal, note the crest factor without noise.
- Establish a W-CDMA connection between the CMW and DUT, e.g. using CONNECT HSPA TM.
- 6. If you modify the fading, remember to change the level accordingly in the CMW.

Rx Diversity Configuration (SIMO)





Fading A						_	×
General Standard/Fine Dela	Restart Auto	Insertion Loss Config. / Coupled Parameters	Path Table	Path Graph			
		Insertion Lo	oss Configura	ation —			
Mode	Normal						-
Insertion Loss			10.0	) dB			·
Clipped Samples			0.0	) %			•

Fig. 4-14: The SMW shows the necessary insertion loss (example: 10 dB)

🚸 WCDMA Signaling Configuration		
Path: IQ Settings/IQ In/Baseband Level		
Scenario	Standard Cell Rx Diversity Fac	ling 🔻 Fading: External 💌
Enable Data end to end	V	
Enable Speech Codec		
⊟ IQ Settings		
E IQ Out	Path 1	Path 2
Connector	DIG IQ OUT 2 🔻	DIG IQ OUT 4 🔻
Sample Rate	100 Msps	100 Msps
-Baseband PEP	0.00 dBFS	0.00 dBFS
Crest Factor	15.00 dB	15.00 dB
⊡IQ In	Path 1	Path 2
Connector	DIG IQ IN 1 🔗	DIG IQ IN 3 🚽
-Sample Rate	100 Msps	100 Msps
Baseband PEP	0.00 dBFS	0.00 dBFS
Baseband Level	-25.00 dBFS	-25.00 dBFS

Fig. 4-15: Compensating for the necessary attenuation in the CMW. Here, the levels of the SMW signals are entered as the  $\rm IQ~In$  level.

#### Remote command:

```
// set IQ in to PEP 0 dBFS and Level to -25.0 dBFS
CONFigure:WCDMa:SIGN<i>:IQIN:CARRier1 0, -25.0
CONFigure:WCDMa:SIGN<i>:IQIN:CARRier2 0, -25.0
```

7. Start the RX measurement via WCDMA Rx Meas. (see section 4.1).

# 4.4 Dual-Carrier Configuration (DC-HSPA+)

With the DC-HSPA+ sceanrio, two different carriers are transmitted via two antennas in order to increase the data throughput. For the simulation, it is necessary to use two fading paths in this case. To enable two downlink carriers, use H-SETs with the suffix A, e.g H-SET 3A.

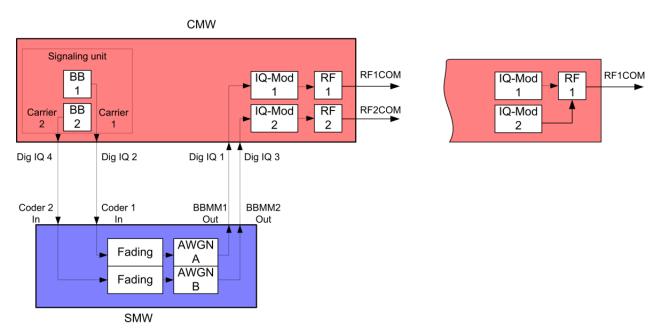
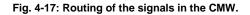


Fig. 4-16: Block diagram for the DC-HSPA test setup. Two carriers are transmitted via two antennas and with different fading. With the CMW, two different RF connectors can be used or the signal can be provided at one output port.

 In the WCDMA Signaling Configuration, select the Dual Carrier Fading Scenario (see Fig. 4-18). Set Fading to External. The CMW can accommodate different antenna configurations for the UE. Output for the second carrier can either be provided through the same RF port or through a separate one.

Scenario		uting utput)	1000000000	ernal Att. tput)	1000	utir Ipul
IQ In Connect	or:	DIG IQ IN 1	-	DIG IQ IN	3	•
IQ Out Conne	ctor:	DIG IQ OUT	2 -	DIG IQ O	UT 4	•
RF Converter:		RFTX1	•	RFTX2		•
RF Connector	;	RF1COM	•	RF1COM		-
		Carrier 1		Carrier 2		
🚯 Routing (Ou	(trugt					×



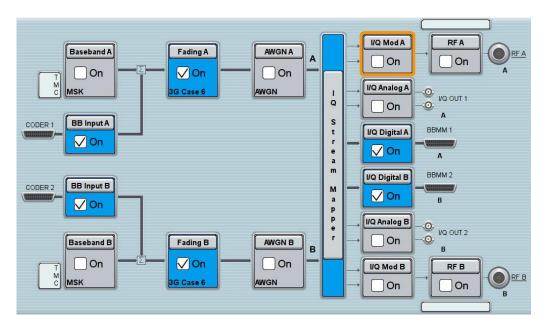
WCDMA Signaling Configuration		
Path: Scenario		
Scenario	Dual Carrier Fading	🔻 Fading: External 💌
-Enable Data end to end		
-Enable Speech Codec	<b>—</b>	
⊟ IQ Settings		
E IQ Out	Path 1 / Carrier 1	Path 2 / Carrier 2
Connector	DIG IQ OUT 2 💌	DIG IQ OUT 4 💌
	100 Msps	100 Msps
-Baseband PEP	0.00 dBFS	0.00 dBFS
Crest Factor	15.00 dB	7.10 dB
⊡⊸lQ In	Path 1 / Carrier 1	Path 2 / Carrier 2
Connector	DIG IQ IN 1 🔗	DIG IQ IN 3 🔗
Sample Rate	100 Msps	100 Msps
Baseband PEP	0.00 dBFS	0.00 dBFS
Baseband Level	-15.00 dBFS	-7.10 dBFS

Fig. 4-18: WCDMA scenario for two carriers: Dual-carrier fading. The CMW indicates the crest factors that are entered in the SMW Dig IQ Input.

#### Remote commands:

- Take note of the Crest Factors under IQ Out and enter the values in the SMW under Baseband Input Level (see Fig. 2-13 in section 2.3).
- 3. Set a fading for both paths and switch on I/Q Out (BBMM1|2)(see section 2.3).
- In the CMW, enter the corresponding baseband level (Level BB <sub>out SMW</sub>= Crest Factor <sub>In SMW</sub> Insertion Loss; example: -15.0 dB 10 dB = -25.0 dBFS, see 2.3.8 ), which is indicated by the SMW (see Fig. 4-8). If you add noise to the signal, note the crest factor without noise.

- 5. Establish a W-CDMA connection between the CMW and DUT, e.g. using **CONNECT HSPA TM**.
- 6. If you modify the fading, remember to change the level accordingly in the CMW.





Fading A						—	×
General Standard/Fine Dela	Restart Auto	Insertion Loss Config. / Coupled Parameters	Path Table	Path Graph			
		Insertion Lo	oss Configura	ation —	S		
Mode	Normal						
Insertion Loss			10.0	D dB			·
Clipped Samples			0.0	D %			•

Fig. 4-20: The SMW shows the necessary insertion loss (example: 10 dB)

🚸 WCDMA Signaling Configuration		
Path: IQ Settings/IQ In/Baseband Level		
Scenario	Dual Carrier Fading	▼ Fading: External ▼
-Enable Data end to end	V	
-Enable Speech Codec		
□ IQ Settings		
i lQ Out	Path 1 / Carrier 1	Path 2 / Carrier 2
- Connector	DIG IQ OUT 2 🔻	DIG IQ OUT 4 🔫
Sample Rate	100 Msps	100 Msps
-Baseband PEP	0.00 dBFS	0.00 dBFS
Crest Factor	15.00 dB	7.10 dB
i ⊡⊸lQ In	Path 1 / Carrier 1	Path 2 / Carrier 2
Connector	DIG IQ IN 1 🛛 🔽	DIG IQ IN 3 📝
Sample Rate	100 Msps	100 Msps
Baseband PEP	0.00 dBFS	0.00 dBFS
Baseband Level	-25.00 dBFS	-17.10 dBFS

Fig. 4-21: Compensating for the necessary attenuation in the CMW. Here, the levels of the SMW signals are entered as the IQ In level.

#### Remote command:

```
// set IQ in to PEP 0 dBFS and Level to -25.0 dBFS
CONFigure:WCDMa:SIGN<i>:IQIN:CARRier1 0, -25.0
CONFigure:WCDMa:SIGN<i>:IQIN:CARRier2 0, -17.1
```

7. Start the RX measurement via **WCDMA Rx Meas.** (see section 4.1). Fig. 4-22 shows an example of the DC-HSPA measurement in the overview.

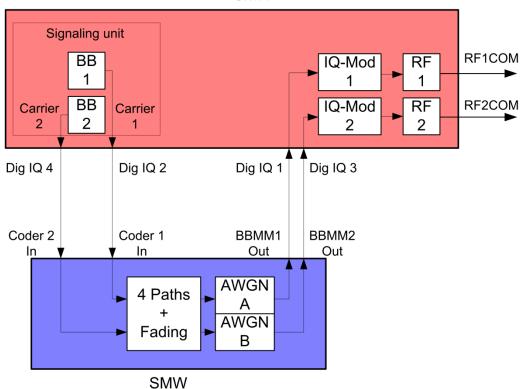
💿 BER [ 🕒 HSDPA ACK	🕘 RLC Throug	ghput 🚺 (	E-HICH	🕘 UL Logg	ing				HSDPA
40 Mbit/s							CarNo	roughput Curr. Overall Carrier 1	ACK RDY
								Carrier 2	
20								Max. Possible dian CQI Curr.	
						Subframes		Carrier 1 Carrier 2	
-9500 -8500 -750	0 -6500	-5500	-4500	-3500 -25	00 -1500	-500	-		
Max. possible Throughput	40.704	Mbit/s	(based on s	settings)	Overall Throu	ughput:	23	.486 Mbit/s	·
		1	Carrier 1			(	Carrier 2		
Throughput	Curr.	Max.	Min.	Sch'ed.	Curr.	Max.	Min.	Sch'ed.	
Measured [Mbit/s]	11.597	12.516	10.787	20.352	11.890	12.307	10.380	20.352	
Rel. to max. possible [%]	56.980	61.500	53.000	100.000	58.419	60.469	51.000	100.000	Display
Transmissions [%]	Sent	ACK	NACK	DTX	Sent	ACK	NACK	DTX	
1	57.050	38.265	61.735	0.000	58.440	43.309	56.691	0.000	
2	35.180	83.741	16.259	0.000	33.140	81.201	18.799	0.000	
3	5.730	64.398	35.602	0.000	6.230	64.848	35.152	0.000	
4	2.040	98.039	1.961	0.000	2.190	98.630	1.370	0.000	
Carrier 1: DL BLER 43.020	% Median CQI	<b>30</b> Mea	sured Subfr	ames 10	000 / 10000				Signaling Paramete
Carrier 2: DL BLER 41.580	∣% Median CQI	30							<u> </u>
DCHSDPA+ HSUPACS: CS	all Established		PS: 🛓	Connection	Established		ver in Rang ync	e	WCDMA-U Signaling ON
Repetition	Ŷ	Measu Subfra		lonitored -ARQ	Error Insertion	Y I	l.	onfiq	1

Fig. 4-22: WCDMA RX measurement for DC-HSPA. The measurements are adapted automatically for both streams individually and as an overall assessment.

DC-HSPA+ with Rx Diversity Configuration

# 4.5 DC-HSPA+ with Rx Diversity Configuration

With the DC-HSPA+ scenario, two different carriers are transmitted via two antennas in order to increase the data throughput. Here, too, it is possible to simulate the RX diversity reception. Since it is necessary to simulate two carriers for two antennas each, four fading paths are required in this case. The four paths are made available via the SMW's 2x2 MIMO function. However, this is NOT a MIMO function in W-CDMA! To enable two downlink carriers, use H-SETs with the suffix A, e.g H-SET 3A.



CMW

Fig. 4-23: Block diagram for the DC-HSPA test setup with RX diversity. Two carriers are transmitted via two antennas and with different fading. The UE's RX diversity antenna is operated via RF2COM.

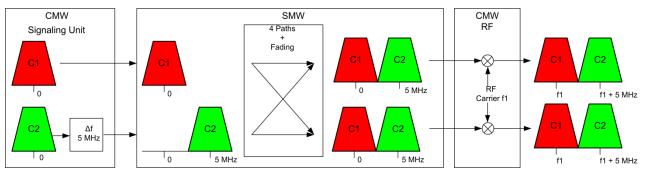


Fig. 4-24: Generating Rx diversity for dual carriers: Both carrier signals are generated in the CMW's baseband signaling unit (with a frequency of 0 Hz), the second signal is offset by 5 MHz in the baseband. Due to the cross components (MIMO function), both carrier signals are available on both of the SMW's paths. In the CMW, both paths are modulated to the carrier frequency f1.

DC-HSPA+ with Rx Diversity Configuration

 In the WCDMA Signaling Configuration, select the Dual Carrier Rx Diversity Fading Scenario (see Fig. 4-26) Set Fading to External. For the Rx-diversity reception, a second DUT antenna must be supplied with a signal. To do this, the CMW outputs a signal via a separate RF2COM RF Port.

Routing (Output)	P.	×
	Carrier 1	Carrier 2
RF Connector:	RF1COM -	RF2COM -
RF Converter:	RFTX1 -	RFTX2 -
IQ Out Connector:	DIG IQ OUT 2 🔻	DIG IQ OUT 4 🔻
IQ In Connector:	DIG IQ IN 1 🔹	DIG IQ IN 3 👻

Fig. 4-25: Routing of the signals in the CMW.

🥎 V	VCDMA Signaling Configuration		
Path	n: Scenario		
-	Scenario	Dual Carrier Rx Diversit	y Fading 🔻 Fading: External 🔻
	Enable Data end to end	M	
	Enable Speech Codec		
	IQ Settings		
	⊟ lQ Out	Path 1	Path 2
	Connector	DIG IQ OUT 2 🝷	DIG IQ OUT 4 💌
	-Sample Rate	100 Msps	100 Msps
	Baseband PEP	0.00 dBFS	0.00 dBFS
	Crest Factor	15.00 dB	15.00 dB
	⊟⊸IQ In	Path 1	Path 2
	Connector	DIG IQ IN 1	DIG IQ IN 3 🔽
	Sample Rate	100 Msps	100 Msps
	-Baseband PEP	0.00 dBFS	0.00 dBFS
	Baseband Level	-15.00 dBFS	-15.00 dBFS

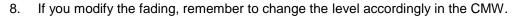
Fig. 4-26: WCDMA scenario for two carriers: Dual carrier fading. The CMW indicates the crest factors that are entered in the AMU *Dig IQ* inputs.

#### Remote commands:

- 2. Take note of the **Crest Factors** under **IQ Out** and enter the values in the SMW under **Baseband Input Level** (see Fig. 2-13 in section 2.3).
- 3. Switch I/Q Out (BBMM1|2) on (see section 2.3).

DC-HSPA+ with Rx Diversity Configuration

- 4. The four paths are realized using the SMW's 2x2-MIMO function. In addition, select the fading. This fading value is automatically used for all four paths. Set the virtual RF frequency to the mid-point between the two carriers. (Example: Carrier 1 at 2112.6 MHz and Carrier 2 at 2117.6 MHz -> Virtual frequency at 2115.1 MHz).
- 5. Set an offset of 5 MHz in the second path.
- In the CMW, enter the corresponding baseband level (Level BB <sub>out SMW</sub>= Crest Factor <sub>In SMW</sub> Insertion Loss; example: -15.0 dB 16 dB = -31.0 dBFS, see 2.3.8 ), which is indicated by the SMW (see Fig. 4-8). If you add noise to the signal, note the crest factor without noise.
- 7. Establish a W-CDMA connection between the CMW and DUT, e.g. using CONNECT HSPA TM.



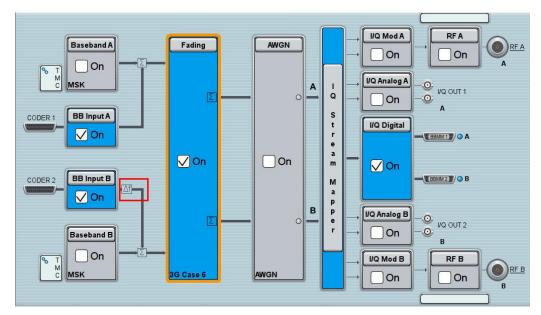


Fig. 4-27: SMW settings for dual carriers for Rx diversity: *Fading of four paths.* The second path must be offset by 5 MHz.

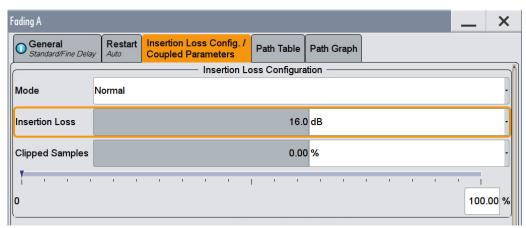


Fig. 4-28: The SMW shows the necessary insertion loss (example: 16 dB)

Remote command:

// set IQ in to PEP 0 dBFS and Level to -31.0 dBFS CONFigure:WCDMa:SIGN<i>:IQIN:CARRier<carrier> 0, -31.0

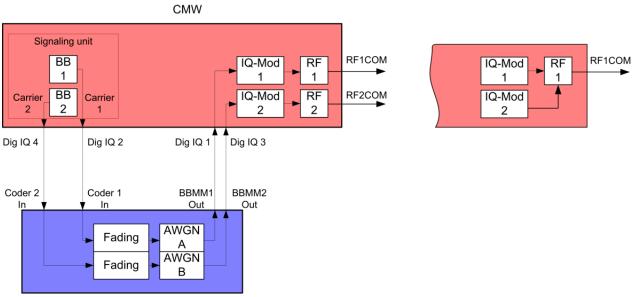
9. Use **WCDMA Rx Meas** to start the RX measurement (see section 4.1). Fig. 4-29 shows an example of a DC-HSPA measurement in the overview.

C	BER	STANDA AC	К 💿	E-HICH	RLC Th	roughput	UL Log	jing					HSDPA
40	Mbit/s									ଦ୍ୱୋ		nroughput Curr. Overall	ACK RDY
			_							20		Carrier 1 Carrier 2	
20										10	M	Max. Possible edian CQI Curr.	
									Subfra	mes		Carrier 1	<u>}</u>
	-950	0 -8500	-7500	-6500	-5500	-4500	-3500 -25	00 -1:	500 -50			Carrier 2	
Ma	ax. pos	sible Throughput		40.704	Mbit/s	(based on	settings)	Overall T	hroughput:		28	1.417 Mbit/s	<u> </u>
						Carrier 1				Carrie	er 2		
Th	rough	put		Curr.	Max.	Min	. Sch'ed.	Ci	urr. N	lax.	Min.	Sch'ed.	
M	easured	l [Mbit/s]		14.409	14.959	12.618	20.352	14.0	108 14.	.891 *	2.618	20.352	<u>}</u>
Re	el. to m	ax. possible [%]		70.799	73.500	62.000	100.000	68.8	29 73.	.167 (	62.000	100.000	Display
Tr	ansmis	sions [%]		Sent	ACK	NACK	C DTX	S	ent <i>i</i>	ACK	NACK	DTX	
1				70.780	61.543	38.457	0.000	68.0	350 57	.865 -	12.135	0.000	
2				27.240	93.025	6.975	0.000	28.9	90 92	.687	7.313	0.000	
3				1.900	95.789	4.211	0.000	2.1	120 98	.113	1.887	0.000	
4				0.080	100.000	0.000	0.000	0.0	)40 100	.000	0.000	0.000	
Ca	rrier 1:	DIBLER 2	9.200 % N	Aedian CQL	<b>30</b> Mea	asured Subfi	rames 10	000 / 100	nn				Signaling Paramete
a	rrier 2:	DL BLER 3	1.170 % N	Aedian CQI	30		The second second						<u></u>
œ		HSDPA+ CS:		stablished		PS: 📜	<b>Connectio</b>	n Establish	ed	Power Ir In Sync	Rang	e	WCDMA-U Signaling ON
-		Y	Y		Measu	Y	lonitored	Error	Y	in sync	Y		

Fig. 4-29: WCDMA RX measurement for DC-HSPA. The measurements are adapted automatically for both streams individually and for the overall assessment.

# 4.6 Dual-Band HSDPA Configuration (DB-DC-HSPA+)

With the Dual-Band-HSDPA configuration, two carriers in two different bands are transmitted via two antennas in order to increase the data throughput. For the simulation, it is necessary to use two fading paths in this case. To enable two downlink carriers, use H-SETs with the suffix A, e.g H-SET 3A.



SMW

Fig. 4-30: Block diagram for the Dual-Band-HSDPA test setup. Two carriers are transmitted via two antennas and with different fading. With the CMW, two different RF connectors can be used or the signal can be provided at one output port.

 In the WCDMA Signaling Configuration, select the Dual Carrier / Dual Band Fading Scenario (see Fig. 4-32). Set Fading to External. The CMW can accommodate different antenna configurations for the UE. Output for the second carrier can either be provided through the same RF port or through a separate one.

IG IQ OUT 2 IG IQ IN 1		dig iq oi dig iq in	
	2 +	DIG IQ OI	JT 4 🔻
FTX1	•	RFTX2	•
F1COM	•	RF1COM	-
arrier 1		Carrier 2	
	arrier 1 F1COM	F1COM 🝷	F1COM - RF1COM

Fig. 4-31: Routing of the signals in the CMW.

🚸 WCDMA Signaling Configuration						
Path: Scenario						
Scenario Dual Carrier / Dual Band Fading						
Fading	External 🔻					
i⊒ IQ Settings						
i⊒ IQ Out	Path 1 / Carrier 1Path 2 / Carrier 2					
Connector	DIG IQ OUT 2 🔻 DIG IQ OUT 4 🔻					
-Sample Rate	100 Msps 100 Msps					
Baseband PEP	0.00 dBFS 0.00 dBFS					
-Crest Factor	14.41 dB 13.23 dB					
🖻 IQ In	Path 1 / Carrier 1Path 2 / Carrier 2					
Connector	DIG IQ IN 1 🔻 DIG IQ IN 3 🔻					
-Sample Rate	100 Msps 100 Msps					
-Baseband PEP	nd PEP 0.00 dBFS 0.00 dBFS					
Baseband Level	-15.00 dBFS -15.00 dBFS					

Fig. 4-32: WCDMA scenario for two carriers: Dual-band fading. The CMW indicates the crest factors that are entered in the SMW Dig IQ Input.

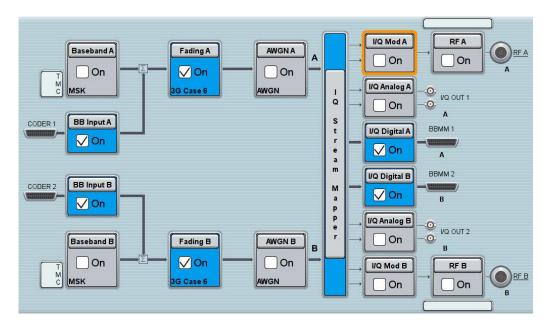
Path: RF Settings/RF Frequency/DB DC HSD	PA	
Converter	RFRX1 T	
Ext. Attenuation	0.0 dB	
Ext. Delay Comp.	0 ns	
B RF Frequency	Carrier 1	Carrier 2
-Operating Band	Band 1 🛛 🔻	Band 8 🔹 🔻
DL		
- Channel	10563 Ch	2937 Ch
- Frequency	2112.6 MHz	927.4 MHz
- Offset	0 Hz	0 Hz
UL		
- Channel	9613 Ch	
- Frequency	1922.6 MHz	
- Offset	0 Hz	
	190.0 MHz	
-Dual Carrier Separation	5.0 MHz	_
DB DC HSDPA	Configuration 1	<b>•</b>

Fig. 4-33: Enabling the Dual Band Configuration. The CMW sets the corresponding operating bands automatically.

## Remote commands:

```
CONFigure:WCDMa:SIGN<i>:RFSettings:DBDC ON,C1
```

- 2. Take note of the **Crest Factors** under **IQ Out** and enter the values in the SMW under **Baseband Input Level** (see Fig. 2-13 in section 2.3).
- 3. Set a fading for both paths and switch on I/Q Out (BBMM1|2)(see section 2.3).
- In the CMW, enter the corresponding baseband level (Level BB <sub>out SMW</sub>= Crest Factor <sub>In SMW</sub> Insertion Loss; example: -14.41 dB 10 dB = -24.41 dBFS, see 2.3.8 ), which is indicated by the SMW (see Fig. 4-8). If you add noise to the signal, note the crest factor without noise.
- 5. Establish a W-CDMA connection between the CMW and DUT, e.g. using **CONNECT HSPA TM**.
- 6. If you modify the fading, remember to change the level accordingly in the CMW.





ading A				_	×
General Standard/Fine Delay	Restart Auto	Insertion Loss Config. / Coupled Parameters	Path Table	Path Graph	
<u> </u>		Insertion Lo	oss Configura	ration	
Mode	Normal				•
Insertion Loss			10.0	.0 dB	•
Clipped Samples			0.00	00 %	•

Fig. 4-35: The SMW shows the necessary insertion loss (example: 10 dB)

WCDMA Signaling Configuration						
Path: IQ Settings/IQ In/Baseband Level						
Scenario	Dual Carrier / Dual Band Fading					
Fading	External 🔻					
⊟ IQ Settings						
i⊒ IQ Out	Path 1 / Carrier 1Path 2 / Carrier 2					
Connector	DIG IQ OUT 2 🔻 DIG IQ OUT 4 🔻					
Sample Rate	100 Msps 100 Msps					
-Baseband PEP	0.00 dBFS 0.00 dBFS					
Crest Factor	14.41 dB 13.23 dB					
⊡-lQ In	Path 1 / Carrier 1Path 2 / Carrier 2					
Connector	DIG IQ IN 1 🔻 DIG IQ IN 3 🔻					
Sample Rate	100 Msps 100 Msps					
-Baseband PEP	0.00 dBFS 0.00 dBFS					
Baseband Level	-24.41 dBFS -23.23 dBFS					

Fig. 4-36: Compensating for the necessary attenuation in the CMW. Here, the levels of the SMW signals are entered as the IQ In level.

Remote command:

```
// set IQ in to PEP 0 dBFS and Level to -24.41 dBFS
CONFigure:WCDMa:SIGN<i>:IQIN:CARRier1 0, -24.41
CONFigure:WCDMa:SIGN<i>:IQIN:CARRier2 0, -23.23
```

7. Start the RX measurement via **WCDMA Rx Meas.** (see section 4.1). Fig. 4-22 shows an example of the Dual-Band HSPSA measurement in the overview.

> WCDMA UE RX Me	asurement 1 - V3.5.20	- Base V 3.5.11				- 🛛
) BER 💛 HSDP	AACK 🔍 HSDPA	CQI 🔍 E-HIC	H 🕘 E-AGCH 🕻	E-RGCH 🕓	RLC Throughput	t 💿 🔳
verview Carrier 1	Carrier 2					
Mbit/s					CQI Throughput Overall: ◆Cur Max. Pos.: ◆Cur	
			M M M	AMANAMA	20	
				Subframes		
-55000	-45000 -350	00 -2500	0 -15000	-5000		
leasured Subframe	s 61700 Overall	_	Carrier 1		Carrier 2	_
DL BLER [%]	Overall		Carrier 1	35.530	Carrier 2	38.88
Median CQI				17		2
Throughput	[Mbit/s]	%	[Mbit/s]	[%]	[Mbit/s]	[%
Max. Possible	4.672		2.336	[*]	2.336	
Current	3.013	64.500	1.261	54.000	1.752	75.00
Average	2.936	62.853	1.505	64.442	1.431	61.26
Maximum			2.336	100.000	2.336	100.00
Minimum			0.397	17.000	0.187	8.00
Scheduled			2.336	100.000	2.336	100.00
					-	
	PC Circuit Switched			Switched:		ower: 이
AZ HSUPA IC	Call Established		Composti	on Established		ync: 🚺

Fig. 4-37: WCDMA RX measurement for Dual-Band-HSPDA. The measurements are adapted automatically for both streams individually and as an overall assessment.

Dual Band HSDPA with Rx Diversity Configuration (DB-DC-HSPA+ with Rx Diversity)

# 4.7 Dual Band HSDPA with Rx Diversity Configuration (DB-DC-HSPA+ with Rx Diversity)

With the Dual-Band HSPDA configuration, two different carriers are transmitted via two antennas in order to increase the data throughput. Here, too, it is possible to simulate the RX diversity reception. Since it is necessary to simulate two carriers for two antennas each, four fading paths are required in this case. The four paths are faded in the SMW. To enable two downlink carriers, use H-SETs with the suffix A, e.g H-SET 3A.

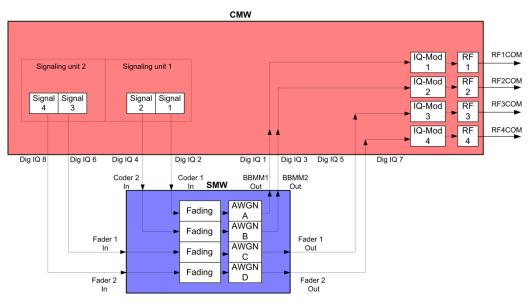


Fig. 4-38: Block diagram for the Dual-Band-HSDPA test setup with RX diversity. Two carriers are transmitted via two antennas and with different fading. The UE's RX diversity antenna is operated via RF2COM.

 In the WCDMA Signaling Configuration, select the Dual Carrier / Dual Band Rx Diversity Fading Scenario (see Fig. 4-40) Set Fading to External. For the Rxdiversity reception, a second DUT antenna must be supplied with the two carrier signals. To do this, the CMW allows flexible output routing.

🚸 Routing (Output)								
	Path 1		Path 2		Path 3		Path 4	
RF Connector:	RF1COM	▼	RF2COM	▼	RF3COM	▾	RF4COM	▼
RF Converter:	RFTX1	•	RFTX3	•	RFTX2	•	RFTX4	▼
IQ Out Connector:	DIG IQ OUT 2	•	DIG IQ OUT 4	▼	DIG IQ OUT 6	•	DIG IQ OUT 8	▼
IQ In Connector:	DIG IQ IN 1	•	DIG IQ IN 3	▼	DIG IQ IN 5	▼	DIG IQ IN 7	▼

Fig. 4-39: Routing of the signals in the CMW. In this case, RxDiv signal of carrier 1 is routed to RF3COM, RxDiv signal of carrier 2 is routed to RF4COM.

Dual Band HSDPA with Rx Diversity Configuration (DB-DC-HSPA+ with Rx Diversity)

🚸 WCDMA Signaling Configuration							
Path: Scenario							
Scenario	Dual Carrier / Dual Band Rx Diversity Fading 🔻						
<mark>Fading</mark>	External 🔻						
⊟-IQ Settings ⊟-IQ Out	Pa	th 1	Pa	ath 2	Pa	th 1	Path 2
Connector	DIG IQ	OUT 2 🔻	DIG IQ	OUT 4 🔻	DIG IQ	OUT 6 🔻	DIG IQ OUT
Sample Rate	100 Msp	s	100 Msp	)S	100 Msp	S	100 Msps
Baseband PFP	0.00	dBES	0.00	dBES	0.00	dBES	Ab 00.0
Crest Factor	15.00	dB	15.00	dB	7.10	dB	7.10 dB
⊡-lQ In	Pat	th 1	Pa	th 2	Pat	h 1	Path 2
Connector	DIG IQ I	N 1 🔽	DIG IQ I	IN 3 🛛 🔽	dig iq ii	15 🔽 [	DIG IQ IN 7
Sample Rate	100 Msp	s	100 Msp	s	100 Msps	: 1	00 Msps
-Baseband PEP	0.00 dBF	S	0.00 dBl	FS (	0.00 dBF	S 0	.00 dBFS
Baseband Level	-15.00 d	IBFS	-15.00 d	IBFS ·	-7.10 dB	FS –	7.10 dBFS

Fig. 4-40: WCDMA scenario for two carriers: Dual Band fading. The CMW indicates the crest factors that are entered in the SMW *Dig IQ* inputs.

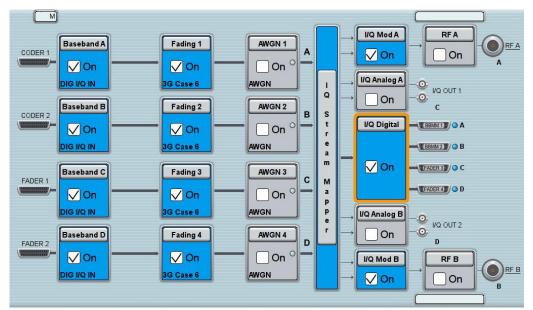
# Remote commands:

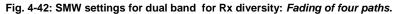
- 2. Take note of the **Crest Factors** under **IQ Out** and enter the values in the SMW under **Baseband Input Level** (see Fig. 2-13 in section 2.3).
- 3. Switch I/Q Out (BBMM1|2|FADER1|2) on (see section 2.3).
- 4. The four downlink paths are individually faded in the SMW. Set in the **System Configuration** Advanced mode a **4 x 1 x 1** configuration (Fig. 4-41 and Fig. 4-42).
- 5. In the CMW, enter the corresponding baseband level for all four paths (Level BB out SMW = Crest Factor In SMW Insertion Loss; example: -15.0 dB 10 dB = -25.0 dBFS, see 2.3.8), which is indicated by the SMW (see Fig. 4-8). If you add noise to the signal, note the crest factor without noise.
- 6. Establish a W-CDMA connection between the CMW and DUT, e.g. using **CONNECT HSPA TM**.
- 7. If you modify the fading, remember to change the level accordingly in the CMW.

Dual Band HSDPA with Rx Diversity Configuration (DB-DC-HSPA+ with Rx Diversity)

System Configuration				_ ×
Fading/Baseband Config	/Q Stream Mapper External RF and	I/Q Overview		
Set to Default			Basebands	Streams
Mode	Advanced -	BE	B A Fader -	Α,
Signal Outputs	Analog & Digital -	Entity 1		
Entities (Users, Cells)	Basebands Streams (Tx Antennas) (Rx Antennas)		1	
4 X BB Source Config	1 · X   1 ·     Separate Sources   ·	ВЕ	B D Fader -	D .
		Entity 4		
Apply	🐼 ок			

Fig. 4-41: Use 4 entities to enable 4 separated fading paths ( 4 x 1 x 1).





Fading A					_	×
General Standard/Fine Dela	Restart Auto	Insertion Loss Config. / Coupled Parameters	Path Table	Path Graph		
		Insertion Lo	oss Configura	ition		
Mode	Normal					-
Insertion Loss			10.0	) dB		
Clipped Samples			0.00	9 %		•

Fig. 4-43: The SMW shows the necessary insertion loss (example: 10 dB)

#### Remote command:

// set IQ in to PEP 0 dBFS and Level to -25.0 dBFS CONFigure:WCDMa:SIGN<i>:IQIN:CARRier<carrier> 0, -25.0

 Use WCDMA Rx Meas to start the RX measurement (see section 4.1). Fig. 4-29 shows an example of a DC-HSPA measurement in the overview.

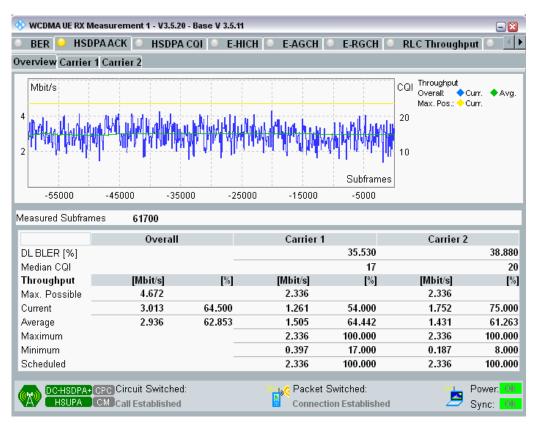


Fig. 4-44: WCDMA RX measurement for Dual-Band HSDPA. The measurements are adapted automatically for both streams individually and for the overall assessment.

# 4.8 CMW Internal Fading for W-CDMA and HSPA(+)

For all of the above Fading scenarios (see also Table 4-1):

- Standard cell fading
- Standard cell Rx Diversity fading
- Dual Carrier Fading
- Dual Carrier Rx Diversity Fading

- Dual Carrier / Dual Band Fading
- Dual Carrier / Dual Band Rx Diversity Fading

the internal fading in the CMW can be used with the software option CMW-KE400. It allows the predefined fading settings (3GPP TS 25.101, Annex B.2.):

- Multi-path profiles
  - Case 1 to 6
  - ITU pedestrian A/B with 3 km/h (PA3, PB3)
  - ITU vehicular A with 3 km/h, 30 km/h, 120 km/h (VA3, VA30, VA120)
- Moving propagation
- High speed train profile (HST)
- Birth-death propagation

# 1. Set the wanted Scenario and set Fading to Internal.

🚸 WCDMA Signaling Configuration	
Path: Fading	
Scenario	Standard Cell Fading
<mark>Fading</mark>	Internal 🔻 Fading: Fader 1 🛛 💌
tie RF Settings	

Fig. 4-45: WCDMA scenario with internal fading

# Remote commands:

<pre>// Standard Cell Fading internal ROUTe:WCDMa:SIGN:SCENario:SCFading:INTernal RF1C,RX1,RF1C,TX1 // Rx Diversity Fading internal ROUTe:WCDMa:SIGN:SCENario:SCFDiversity:INTernal RF1C,RX1,RF1C,TX1,RF2C,TX2</pre>
// Dual Carrier Fading internal
ROUTe:WCDMa:SIGN:SCENario:DCFading:INTernal
RF1C, RX1, RF1C, TX1, RF3C, TX2
<pre>// Dual Carrier Diversity Fading internal</pre>
ROUTe:WCDMa:SIGN:SCENario:DCFDiversity:INTernal
RF1C,RX1,RF1C,TX1,RF2C,TX2
// Dual Band Fading internal
ROUTe:WCDMa:SIGN:SCENario:DBFading:INTernal
RF1C, RX1, RF1C, TX1, RF3C, TX2
// Dual Band Diversity Fading internal
ROUTe:WCDMa:SIGN:SCENario:DBFDiversity:INTernal
RF1C,RX1,RF1C,TX1,RF3C,TX2,
RF2C, TX3, RF4C, TX4,

2. Select under Fading Simulator the wanted Profile (example Case 1)

n Internal Fading		
⊡-Internal Fading ⊟-Fading Simulator		
Enable		
Profile	Case 1	-
Restart Event	Case 1	
Start Seed	Case 2 Case 3	
Insertion Loss	Case 4	:
Clipped Samples	Case 5 Case 6	
Doppler Frequency	Case 8	
<b>⊡</b> • DL Settings	ITU PA3	
⊕ Fading Module AWGN	ITU PB3	
Physical Downlink Settings	ITU VA3	-

3. **Enable** the Fading

Fig. 4-46: internal W-CDMA fading profiles

### Remote commands:

```
// Fading profile Case1
CONFigure:WCDMa:SIGN<i>:FADing:FSIMulator:STANdard C1
// Switch on FAding
CONFigure:WCDMa:SIGN<i>:FADing:FSIMulator:ENABle ON
```

4. If wanted, apply AWGN by setting the **Noise** and enable the AWGN.

🗄 Fading Module AWGN	
- <mark>Enable</mark>	
Noise	-70.00 dBm
Signal/Noise Ratio	13.90 dB

Fig. 4-47: internal W-CDMA AWGN section

### Remote commands:

```
// Noise - 70 dBm
CONFigure:WCDMa:SIGN<i>:FADing:CARRier<c>:AWGN:NOISe - 70 dbm
// Switch on AWGN
CONFigure:WCDMa:SIGN<i>:FADing:CARRier<c>:AWGN:ENABle ON
```

5. Start the measurement (see 4.1).

# 5 GSM and (E)GPRS(2) Measurements

The original GSM standard has been developed in several releases to support higher data rates and increase capacity:

Landmarks in GSM evolution							
Release	Name	Feature					
Early 1990's	GSM	Circuit switched voice calls					
97	GPRS	Packet switched data calls Multi slot					
98	EDGE	8PSK modulation					
07	EDGE evolution	Higher order modulations (16QAM and 32QAM) DL Dual carrier Optional: increased symbol rate					
09	VAMOS	Double voice capacity with AQPSK modulation					

 Table 5-1: GSM evolution: All features before Rel. 07 are available in one option for the CMW called Rel. 6.

The MS receiver measurements include different types of measurements depending on the type of connection:

Circuit Switched connections (CS)

For circuit switched connections the CS BER is available.

GSM circuit switched BER								
CS BER	7	Traffic Mode		Test				
(measure mode)	Full rate (FR Vx)	Half Rate (HR)	AMR	Measurement on	Loop			
Burst by Burst	Ø	Ø	V	Burst	С			
BER	Ø	Ø	V	Speech frame	В			
RBER/FER	Ø	Ø	V	Speech frame	А			
FER FACCH	Ø	Ø	V	Frame	-			
FER SACCH	Ø	V	V	Blocks	-			
RBER/UFR		V		Speech frame	D			
AMR Inband FER			V	Speech frame	Ι			
Mean BEP <sup>1</sup>	Ø	Ø	V	Burst	С			
Signal Quality <sup>1</sup>	Ø	V	V	Burst	-			

 Table 5-2: Different measure modes in CS BER. Note 1: Mean BEP and Signal Quality need different settings of the enhanced measurement report, thus exclude each other.

🚸 GSM Signaling - V3.2.30								
Connection Status				Cell Setup BCCH				
				Channel / Band	62	GSM900	0	7
Circuit Switched	Synchronized			Level			-60.00	dBm
Packet Switched 📩	Attached			PMax (PCL)	5		33.00	dBm
RX Power -				PS Domain	V			
				TCH/PDCH Carrier 1	PDCH Car	rrier 2		
Event Log				Channel / Band	62	GSM900		
08:42:52 TBF Released			•		Downlink		Uplink	
08:42:28 () TBF Established 08:42:20 () TBF Released				Frequency	947.4	MHz	902.4	MHz
08:39:33 TBF Established				DL Reference Level	-60.00	dBm		
08:39:20 () TBF Released 08:36:55 () TBF Established 08:36:48 () TBF Released			-	Connection Setup Circuit Switched Slot Packet Switched Slot	DL: 000	••••	•	
MS Capabilities	<b>•</b>			<ul> <li>Circuit   Packet Sw.Slot</li> <li>OUL Measurement Slot</li> </ul>	UL:	0000		
		-		Auto Slot Config 🛛 🗖		Edit	t	
Ext. Dyn. Allocation GPRS	support			Circuit Switched P	acket Switc	hed		
LEGPRS Codec List	UMTS	GSM		Traffic Mode	FR V1			•
GSM FR GSM HR GSM EFR FR AMR		6314	T	PCL Timeslot	FR V1 FR V2 HR V1 AMR-NB FI AMR-NB H	R GMSK		
CS Connect		PS Connect		Send C	AMR-NB H AMR-WB F AMR-WB F AMR-WB H	R GMSK R 8PSK	ï	

Fig. 5-1: Traffic modes in circuit switched GSM connections

# Remote commands:

```
// Traffic Mode Full rate version 1
CONFigure:GSM:SIGN<i>:CONNection:CSWitched:TMODe FV1
// Test Loop B
CONFigure:GSM:SIGN<i>:CONNection:CSWitched:LOOP B
// connect in circuit switched
CALL:GSM:SIGN<i>:CSWitched:ACT CONNect
```

# Packet Switched connections (PS)

For packet switched connections three different measurements are available.

GSM Rx measurements packet switched						
Rx Measurement	Service (Test mode)				Comment	
	A B BLER SRB					
PS BER	V	V		V		
BLER			V			
RLC Throughput	$\mathbf{\nabla}$	$\mathbf{\nabla}$	$\mathbf{\nabla}$	V	And with DAU	

Table 5-3: The packet switched measurements possibilities depend on the test modes.

🚸 GSM Signaling - V3.2.30							
Connection Status				Cell Setup BCCH			
				Channel / Band	62	GSM900	~
Circuit Switched	Synchronized			Level			-60.00 dBm
Packet Switched 📩	Attached			PMax (PCL)	5		33.00 dBm
RX Power -				PS Domain			
				TCH/PDCH Carrier 1	PDCH C	arrier 2	
Event Log				Channel / Band	62	GSM900	
08:42:52 TBF Released 08:42:28 TBF Established			<b>^</b>		Downlink	U	plink
08:42:20 TBF Released				Frequency	947.4	MHz	902.4 MHz
08:39:33 👸 TBF Established	I			DL Reference Level	-60.00	dBm	
08:39:20 TBF Released 08:36:55 TBF Established 08:36:48 TBF Released MS Capabilities	·		•	Connection Setup Circuit Switched Slot Packet Switched Slot Circuit   Packet Sw.Slot OUL Measurement Slot	DL: 004 UL:	0000 0000	
Ext. Dyn. Allocation support				Auto Slot Config 🔲 Edit			
GPRS				Circuit Switched	Packet Swi	tched	
EGPRS				Service	SRB		-
Codec List GSM FR GSM HR GSM EFR FR AMR	UMTS	GSM	•	DL Dual Carrier Max Throughput	Test Mode Test Mode BLER SRB		kbit/s
CS Connect		PS Connec	t	Send	ся ямя		Config

Fig. 5-2: Services in packet switched GSM connections

### Remote commands:

```
// Service BLER
CONFigure:GSM:SIGN<i>:CONNection:PSWitched:SERVice BLER
// connect in packet switched
CALL:GSM:SIGN<i>:PSWitched:ACT CONNect
```

### Auto Slot Configuration: Wizard

To simplify the multi slot settings, the CMW offers the **Auto Slot Configuration** wizard. It reads the Multislot class information which the MS transmits during the synchronization/attaching process to the CMW and sets the multi slot configuration automatically according to the selected service.

### Mobile Station Receiver Measurement in GSM: Rx Meas

MS Capabilities	<b>•</b>	Connection Setup Circuit Switched Slot	
Multislot Class	10 (4 Dn/2 Up/5 Sum)	UL Measurement Slot	DL: 000000000000000000000000000000000000
-EGPRS	10 (4 Dn/2 Up/5 Sum)	Auto Slot Config 🛛 🔽	Edit
DTM EGPRS		Circuit Switched	Packet Switched
		Service	BLER / e2e:max DL 🔹
		DL Dual Carrier	Test Mode A / e2e:max UL Test Mode B / e2e:symmetric
		Max Throughput	BLER / e2e:max DL SRB / e2e:symmetric

Fig. 5-3: Auto Slot Configuration (in the example the MS supports 4 DL slots and 2 UL slots and in sum 5 slots. With the selected service BLER it set the maximum possible slots in the DL: 4 slots)

Remote command:

```
// use auto slot configuration
CONFigure:GSM:SIGN<i>:CONNection:ASConfig ON
```

# Measurements

All measurements are summarized in the **GSM RX Meas** test and measurement applications (see 5.1).

Before the start of the GSM signaling, external fading must be selected as the scenario. Once signaling has begun, or once a connection has been established with the DUT, it is no longer possible to change scenarios.

For further information on GSM signaling and Rx measurements, refer to [9].

# 5.1 Mobile Station Receiver Measurement in GSM: Rx Meas

# CS BER

This measurement calculates bit error rates in circuit switched connections. Typically the CMW transmits data which are looped back by the DUT. Different measure modes are available (see 5.1, detailed information is available in [9]).

Mobile Station Receiver Measurement in GSM: Rx Meas

• PS BER • PS BLER	OCS BER	<ul> <li>RLC Throughput</li> </ul>	CMR Performan	ce			
Results			Cell Setup				
@ Measure Mode	BER		BCCH				
Class II		0.00 %	Channel / Band	6	2 GSM900		2
Class Ib		0.00 %	Level			-60.00 dBm	
CRC Errors		0	PMax (PCL)		5	33.00 dBm	
peech Frames			PS Domain	~			
		318 / 100000	TCH/PDCH Carrier	1 PDCH	l Carrier 2		
			Channel / Band	6	2 GSM900		
			ĺ	Downlink		Uplink	
			Frequency	947	4 MHz	902.4 MHz	
			DL Reference Level	-60.0	0 dBm		
			Connection Setup Circuit Switched Slot Packet Switched Slot Circuit   Packet Sw.Slot OUL Measurement Slot		DL: 000• JL: 0	0000 00 <b>2</b> 0000	
			Traffic Mode	1	-R V1		•
			PCL		10	23.00 dBm	
			Timeslot		3		
			Data Source		PRBS 2E9-1		•
							-

## Remote commands:

```
//set measurement mode (example BER)
CONFigure:GSM:SIGN<i>:BER:CSWitched:MMODe BER
//set number of frames/bursts
CONFigure:GSM:SIGN<i>:BER:CSWitched:SCOUNT 100
INITiate:GSM:SIGN<i>:BER:CSWitched // start measurement
FETCh:GSM:SIGN<i>:BER:CSWitched? // get results
```

# **PS BER**

This measurement calculates bit error rates and data block error rates in packet switched connections. Typically the CMW transmits data which are looped back by the DUT (see 5.1, detailed information is available in []).

Mobile Station Receiver Measurement in GSM: Rx Meas

PS BER	• PS	BLER	• CS BER	RLC	C Throughp	out OC	MR Perfo	rmance				
Results								Cell Set	սթ			
a) Measure I	Mode							BCCH	(B) (			
		BER	DBLER	USF	False	Non	CRC	Channel	/ Band	62	GSM900	
∃- Carrier 1		[%]	[%]	BLER [%]	USF Det.[%]	Assign. USF	Errors	Level			-60.	00 dBr
-Slot0/	'nff	[//J	[/4] 	[/*] 	Dec[//j			PMax (P	CL)	5	33.	00 dBr
-Slot1/								PS Dom:	ain	V		
-Slot2/									CH Carrier			a 1
Slot3@		14.51	100.00	0.00			NCAP	TCH/PD	CH Carrier		CH Carrier	2
-Slot4/	_							Channel .	/ Band	62	GSM900	
-Slot5/	Off									Downlin	k Upl	ink
-Slot6/	Off							Frequenc	;y	947.4	MHz 902	2.4 MH:
-Slot7/	Off							DL Refer	ence Level	-60.00	dBm	
Over a	all	14.51	100.00	0.00			NCAP			00.00	abiii	
adio Blocks							10 / 100	●Circuit Sv ●Packet S <sup>v</sup> ●Circuit   P	tion Setup vitched Slot witched Slot acket Sw.Slot urement Slot	DL: OC	000000 00000 Edit	
											Ealt	
								Service		SRB		
								Data Sou	irce	PRBS 2	2E9-1	
🔊 cs: 🥍	Sy	nchronize	d	PS	S: 🔼 TE	3F Establis	hed		IL:000∎00		MCS-6 MCS-1	

Fig. 5-5: PS (packet switched) BER in GSM

## Remote commands:

```
//set measurement mode (example BER/DBLER)
CONFigure:GSM:SIGN<i>:BER:PSWitched:MMODe BDBLer
//set number of RLC blocks
CONFigure:GSM:SIGN<i>:BER:PSWitched:SCOUNT 100
INITiate:GSM:SIGN<i>:BER:PSWitched // start measurement
FETCh:GSM:SIGN<i>:BER:PSWitched? // get results
```

## **PS BLER**

This measurement calculates block error rates in packet switched connections. The CMW sends data to the MS and determines the block error rate (BLER) from the positive ACKnowledgments (ACK) and negative ACKnowledgments (NACK) returned by the MS. Additional the Data Rate is calculated from the BLER results (see 5.1).

# GSM and (E)GPRS(2) Measurements

Mobile Station Receiver Measurement in GSM: Rx Meas

• PS BER • PS BLER	CS BER ORL	C Throughput	• CMR Perfo	ormance			
Carrier 1	BLER [%]	RLC Data Blocks	Data rate [kBit/s]	Cell Setup BCCH			
-Slot0/Off				Channel / Band	20	GSM900	~
Slot1/Off				Level		-60.00	dBn
Slot2/Off				PMax (PCL)	5	33.00	dBn
Slot3@-60dBm	0.00	666	29.50	PS Domain			
Slot4@-60dBm	0.00	667	29.54 29.54	TCH/PDCH Carrier	1 pn/	CH Carrier 2	1
Slot5@-60dBm Slot6/Off							<u> </u>
Slot7/Off				Channel / Band		GSM900	
Over all	0.00	2000	88.59		Downlink		
Long-Term Throughput:				Frequency	947.4	MHz 902.4	MHz
Over All	88.59 kbit/s Per S	lot 29.4	53 kbit/s	DL Reference Level	-60.00	dBm	
RLC Data Blocks			10 / 2000	Connection Setup			
Corrupted Blocks				Circuit Switched Slot Packet Switched Slot			
False ACKed Blocks				Circuit   Packet Sw.Slot	DL: OC	00000	
				OUL Measurement Slot	UL:	000200	
						Edit	
				Service	BLER		
				DL Dual Carrier			
<b></b> )		254					
👷 CS: 🤁 Synchroniz	zed F	PS: 🔼 TBF Es	tablished	DL: 000000 UL: 00	00000	MCS-6 MCS-1	

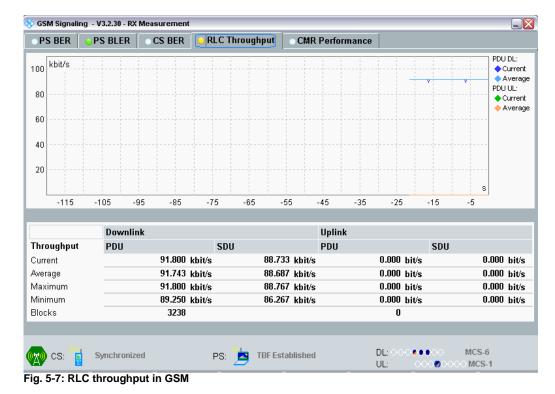
Fig. 5-6: PS (packet switched) BLER in GSM

# Remote commands:

```
//set measurement mode (example BER/DBLER)
CONFigure:GSM:SIGN<i>:BER:PSWitched:MMODe BDBLer
//set number of RLC blocks
CONFigure:GSM:SIGN<i>:BER:PSWitched:SCOUNT 100
```

```
INITiate:GSM:SIGN<i>:BER:PSWitched
FETCh:GSM:SIGN<i>:BER:PSWitched?
```

// start measurement
// get results



# **RLC Throughput**

# 5.2 Fading Scenario

In GSM fading on one path only is applied.

 In the GSM Signaling Configuration, select the Standard Cell Fading Scenario (see Fig. 3-6). Set the Fading to External. The crest factor depends on the used modulation (GMSK, 8PSK, AQPSK, 16QAM or 32QAM). In addition, the CMW uses a reserve, which depends on the connection state (Cell on, Call established, Dual carrier Call established) to the MS. This causes different crest factors displayed in the IQ out section. The CMW uses the following factors:

GSM used crest factors										
			Used crest factor							
Coding schemes		Modulation	Call established	Dual Carrier Call established						
Normal vo GPRS EGPRS	ice call (CS 14) (MCS 14)	GMSK	6.00 dB	9.54 dB						
EGPRS EGPRS2	(MCS 59) (DAS 57)	8PSK	9.23 dB	12.77 dB						
EGPRS2	(DAS 89)	16QAM	11.77 dB	15.31 dB						
EGPRS2	(DAS 1012)	32QAM	12.11 dB	15.65 dB						
VAMOS		AQPSK	9.39 dB	12.93 dB						

Table 5-4: CMW Crest factors in GSM

🚸 GSM Signaling Configuration					
Path: IQ Settings/IQ Out/Crest Factor					
Scenario	Standard Cell Fading				
Fading	External 🔽				
Enable Data end to end					
i⊐ IQ Settings					
i i Q Out					
Connector	DIG IQ OUT 2 🔻				
Sample Rate	100 Msps				
-Baseband PEP	0.0 dBFS				
Crest Factor	0.0 dB				
⊟-lQ In					
Connector	DIG IQ IN 1 🚽				
Sample Rate	100 Msps				
Baseband PEP	0.000 dBFS				
Baseband Level	0.000 dBFS				

Fig. 5-8: GSM scenario: Standard Cell Fading. The CMW indicates the crest factor, which is entered in the SMW's Dig IQ Input. As the crest factors depends on the used modulation and connection state, different factors may appear.

Remote commands:

// Standard Cell Fading external via RF2COM and IQ2 Out ROUTe:GSM:SIGN:SCENario:SCFading RF2C,RX1,RF2C,TX1,IQ20

// read out information of IQ settings
SENSe:GSM:SIGN<i>:IQOut:PATH<n>?

- 2. Take note of the **Crest Factor** under **IQ Out** or take it from Table 5-4 and enter this value in the SMW under **Baseband Input Level** (see Fig. 2-13 in section 2.3).
- 3. Set a fading and switch on I/Q Out (BBMM1)(see section 2.3).
- 4. In the CMW, enter the corresponding baseband level (Level BB <sub>out SMW</sub>= Crest Factor <sub>In SMW</sub> Insertion Loss; example: -6 dB 10 dB = -16 dBFS, see 2.3.8 ), which is indicated by the SMW (see Fig. 5-10). If you add noise to the signal, note the crest factor without noise.
- 5. Use **CS CONNECT** or **PS CONNECT** to establish a GSM connection between the CMW and DUT.
- 6. If you modify the fading, remember to change the level accordingly in the CMW.

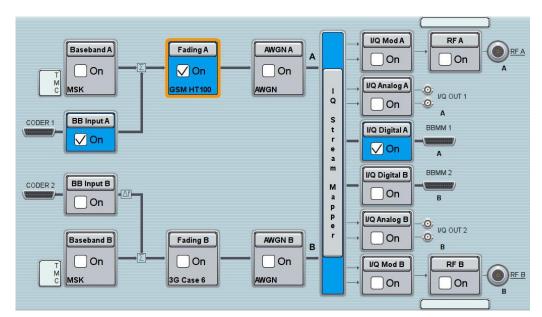


Fig. 5-9: Overview SMW settings for GSM.

ľ	ading A						_	×	
	General Standard/Fine Delay	Restart Auto	Insertion Loss Config. / Coupled Parameters	Path Table	Path Graph				
(	Insertion Loss Configuration								
	Mode Normal								
	Insertion Loss			10.0	) dB			·	
	Clipped Samples			0.00	) %			•	

Fig. 5-10: The SMW shows the necessary insertion loss (example: 10 dB)

🚸 GSM Signaling Configuration									
Path: IQ Settings/IQ In/Baseband Level									
Scenario	Standard Cell Fading 🔽								
Fading	External 🔽								
Enable Data end to end									
⊟IQ Settings ⊟IQ Out									
Connector	DIG IQ OUT 2 💌								
Sample Rate	100 Msps								
- Baseband PEP	0.0 dBFS								
Crest Factor	6.0 dB								
⊡…IQ In									
Connector	DIG IQ IN 1								
Sample Rate	100 Msps								
Baseband PEP	0.000 dBFS								
Baseband Level	-16.000 dBFS								

Fig. 5-11: Making allowance for the necessary attenuation in the CMW. Here, the digital output level of the SMW signal is entered as the IQ In level.

### Remote command:

```
// set IQ In to PEP 0 dBFS and Level -16 dBFS
CONFigure:GSM:SIGN<i>:IQIN:PATH<n> 0.0, -16.0
```

7. Start the RX measurement using **Rx MEAS** (see section 5.1). Fig. 3-11 shows an example.

🚸 GSM Signaling - V3.2.30 - RX Me	easurement					
• PS BER • PS BLER	CS BER RL	.C Throughput	• CMR Perfo	rmance		
Carrier 1	BLER [%]	RLC Data Blocks	Data rate [kBit/s]	Cell Setup BCCH		
Slot0/Off				Channel / Band	20 GSM90	0 🗸
Slot1/Off				Level	-6	0.00 dBm
Slot2/Off				PMax (PCL)	5 3	3.00 dBm
Slot3@-60dBm	12.46	666	25.86	PS Domain		
Slot4@-60dBm	11.54	667	26.17		-	
Slot5@-60dBm	11.69	667	26.13	TCH/PDCH Carrier	1 PDCH Carri	er Z
Slot6/Off				Channel / Band	62 GSM900	)
<sup>I</sup> Slot7/Off Over all	11.90	2000	78.15		Downlink U	plink
Over all	11.90	2000	70.13	Frequency	947.4 MHz 9	02.4 MHz
Long-Term Throughput:			_	DL Reference Level	-60.00 dBm	
Over All	78.02 kbit/s Per S		1 kbit/s	0 1 0 1		
RLC Data Blocks		2 00	0 / 2000	Connection Setup		
Corrupted Blocks			_	Packet Switched Slot	DL: 000000	
False ACKed Blocks			_	<ul> <li>Circuit   Packet Sw.Slot</li> <li>OUL Measurement Slot</li> </ul>		0000
					Edit.	
				Service	BLER	~
				DL Dual Carrier		
CS: Synchronized	F	PS: 🚬 TBF Est	ablished	DL:00000 UL: 00	●00 MCS-6	

Fig. 5-12: Example for a RX measurement in GSM: PS BLER on three downlink slots.

# 5.3 Fading with Hopping (single DL carrier)

The GSM standard also uses frequency hopping (FH) (3GPP TS 45.002). The CMW together with the SMW allows tests under fading conditions in combination with frequency hopping.

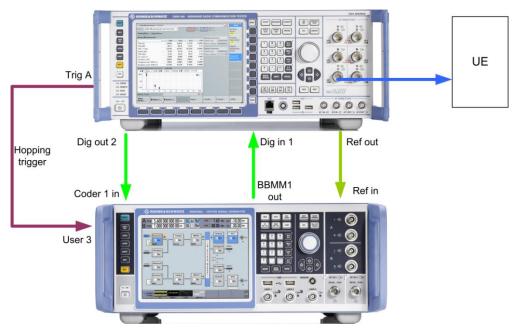
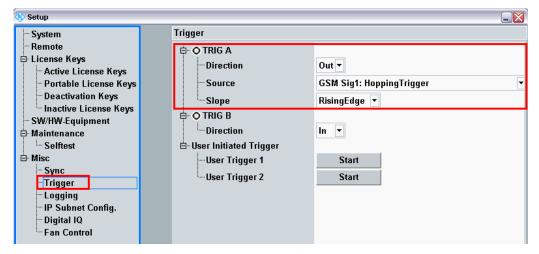
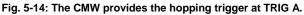


Fig. 5-13: Test setup GSM with hopping: the CMW provides the hopping trigger

To perform measurements with fading and hopping, use the same steps and settings like in 5.2. In addition following steps are necessary:

- 1. Connect CMW output **Trig A** to SMW input **USER 3**.
- 2. Make sure that the Hopping Trigger is output at TRIG A (SETUP|Misc|Trigger).





## Remote commands:

```
// Trigger A Output
TRIGger:BASE:EXTA:DIRection OUT
// Trigger A GSM1 Signalling Hopping
TRIGger:BASE:EXTA:SOURce "GSM Sig1: HoppingTrigger"
```

3. Create a **Hopping List** in the CMW.

⊨ TCH/PDCH					
- Carrier 1					
Channel	62				
DL Frequency	947.4 MHz				
UL Frequency	902.4 MHz				
DL Reference Level	-60.00 dBm				
- Hopping					
Enable					
MAIO	0				
-HSN	0				
Entry [ 0 - 2 ]	1 62 124				
Hopping List	[Hopping List]				

Fig. 5-15: Hopping settings in the CMW

Hopping Carrier 1									
Entry [ 0 - 4 ]	~	1		62		124		3	5
Entry [ 5 - 9 ]		7		9		11		13	15
Entry [ 10 - 14 ]		17		19		21		23	25
Entry [ 15 - 19 ]		27		29		31		33	35
Entry [ 20 - 24 ]		37		39		41		42	44
- Entry [ 25 - 29 ]		46		48		50	$\Box$	52	54
Entry [ 30 - 34 ]		56		58		60	$\Box$	64	66
Entry [ 35 - 39 ]		68		70		72	$\Box$	75	78
Entry [ 40 - 44 ]		80		82		84		86	88
Entry [ 45 - 49 ]		90		92		94		96	100
Entry [ 50 - 54 ]		102		105		108		109	111
Entry [ 55 - 59 ]		114		980		990		995	1001
Entry [ 60 - 63 ]		1005		1009		1011		1021	
	-								
Apply Undo Ok Cancel									

Fig. 5-16: The hoppling list in the CMW

Important note: Please note that the actual hopping sequence depends on the MAIO and HSN settings. The sequence may not start at the beginning of the list. In packet switched connections also the entire list may not be used (see Manual [9] and 45.002).

#### Remote commands:

```
// Hopping list entries channel 1,62, 124
CONFigure:GSM:SIGN<i>:RFSettings:HOPPing:SEQuence:TCH 1,62,124
// Set MAIO to 0
CONFigure:GSM:SIGN<i>:RFSettings:HOPPing:MAIO:TCH 0
// Set HSN to 0
CONFigure:GSM:SIGN<i>:RFSettings:HOPPing:HSN:TCH 0
```

 To use fading with hopping in the SMW, the fading must be dedicated to the RF output. Set the Frequency Hopping mode to In Band.

Fading A								_	×
		Insertion Loss Config Coupled Parameters		th Table	Path Graph				
Off On						et To efault	Recal		Save
Standard	GSM HT	100 (12Path)	•						
Configuration	Standard	I/Fine Delay	•	Fading C	lockrate	2	00 MHz		-
Signal Dedicated To	RF Outp	ut		Virtual R	F		947.400	000 00	MHz -
Ignore RF Changes <	< 5%	(	On	Frequen	cy Hopping M	ode Ir	Band		

Fig. 5-17: Fading settings with hopping. The signal must be dedicated to RF Output.

#### Remote commands SMW:

```
SOURce1|2:FSIMulator:SDEStination RF // Destination RF
SOURce1|2:FSIMulator:HOPPing:MODE IBANd // In band hopping
```

 Turn on the SMW RF A output ON to use the List Mode capability. Anyhow, the actual RF output is not used.

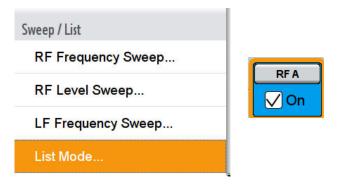


Fig. 5-18: For hopping the List mode is used in RF A.

6. Create or edit a list with the same entries like in the CMW (Convert the channels via the internal function in the CMW, the manual [9] or the iOS App *Wireless Communication Calculator).* Set the Mode to **Extern Step** and switch **ON**.

List Mode A			×
State	Off		On
Mode	Exte	rn Step	•
Reset			
Dwell Time		10.00	0 ms -
Current Index			0
List Mode Data		te	stgsm
Edit List Mode Data			
List Range In: [ 0;		2]	

Fig. 5-19: List mode settings in the SMW

Important note: Please note that the last entry of the CMW hopping sequence has to be entered as the first entry of the SMW list. In the example the CMW list 1, 62, 124 has to be entered in the SMW as 124, 1, 62 (Channel 1≡ 935.2 MHz).

Edit L	ist Mode Data A testgsm	_	×
	Frequency / Hz	Power / dBm	
1	959 800 000.000	-70.0	0
2	935 200 000.000	-70.0	0
3	947 400 000.000	-70.0	0

Fig. 5-20: List with three entries. The power settings are not used actually.

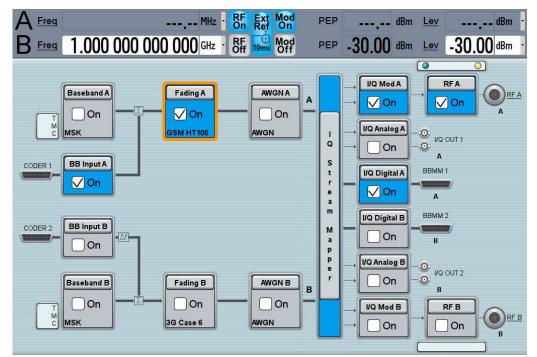


Fig. 5-21: Overview SMW for fading with hopping. The SMW uses the list mode in the RF.

#### Remote commands:

```
OUTPut1:STATE ON// Switch RF A OnSOURce1:FREQ:MODE LIST// Switch to List modeSOURce1:LIST:TRIGger EXT// Trigger ExternalSOURce1:LIST:MODE STEP// Step modeSOURCe1:LIST:POWer -70 dBm, -70 dBm, -70 dBmSOURce1:LIST:FREQuency 959.8 MHz, 935.2 MHz, 947.4 MHz
```

7. Establish a **Connection**, then enable the **Hopping**.

Fading with DL Dual Carrier

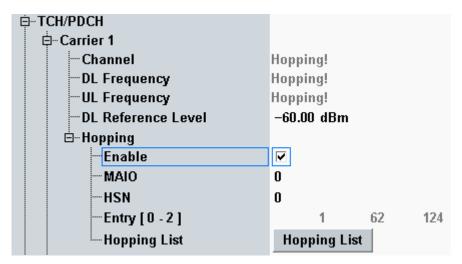


Fig. 5-22: Enabling the hopping in the CMW

```
// Enable Hopping
CONFigure:GSM:SIGN<i>:RFSettings:HOPPing:ENABle:TCH ON
```

8. Start a Measurement.

# 5.4 Fading with DL Dual Carrier

Since the introduction of EDGEevolution in Release 7 two downlink carriers can be dedicated to one MS. This feature is called DL Dual carrier. Both carriers are independent from each other. Typically there is a frequency gap between both carriers and both can use the whole GSM frequency band.

Connection Setup • Circuit Switched Slot • Packet Switched Slot • Circuit   Packet Sw.Slot OUL Measurement Slot Auto Slot Config		
Circuit Switched	Packet Switched	
Circuit Switched		
Service	BLER	-
DL Dual Carrier		
Max Throughput	Downlink 17.600 kbit/s	Uplink 8.800 kbit/s

Fig. 5-23: DL Dual Carrier mode

As both carriers are generated in one baseband in the CMW and thus routed in the fading scenario via only one Digital IQ output to the SMW, it is not possible to apply fading to both carriers independently.

Anyhow, fading is possible with the SMW.

CMW Internal Fading for GSM and (E)GPRS(2)

# Non hopping mode

If both carriers remain on fixed frequencies, just set the calculation frequency of the SMW in the middle of both carrier frequencies.

Example:

Fading Frequency			
Carrier	Channel	Frequency	Fading Frequency SMW
1	62	947.4 MHz	
2	72	949.4 MHz	948.4 MHz

# Hopping mode

In hopping mode both carriers may use completely independent hopping sequences. Even one carrier can hop and the other remains at one frequency. Again, set the calculation frequency of the SMW in the middle of all possible carrier frequencies.

Example:

Fading Frequency						
Carrier	Channel	Max Frequency range	Fading Frequency SMW			
1	1, 62, 124	Channel 1 and 124				
2	2, 72, 123	935.2 MHz and 959.8 MHz	947.5 MHz			

# 5.5 CMW Internal Fading for GSM and (E)GPRS(2)

For the GSM scenario:

Standard Cell Fading

the internal fading in the CMW can be used with the software option CMW-KE200. It allows the predefined fading settings (3GPP TS 45.005 annex C.3):

- Urban area (TU)
- Hilly terrain (HT)
- Rural area (RA)
- Equalization tests (EQ)
- Very small cell (TI)
- All models involve a movement of the MS. The speed of movement in km/h is indicated as part of the profile name, the number of propagation paths is also indicated. Example: "TU3 (6 path)" means urban area, MS moving with 3 km/h, 6 propagation paths.

CMW Internal Fading for GSM and (E)GPRS(2)

1. Set the wanted **Scenario** and set **Fading** to *Internal*.

🚸 GSM Signaling Configuration	
Path: Fading	
Scenario	Standard Cell Fading 🔻
Fading	Internal 🔻 Fader 1 💌
-Enable Speech Codec	

Fig. 5-24: GSM scenario with internal fading

#### Remote commands:

```
// Standard Cell Fading external via RF2COM
ROUTe:GSM:SIGN:SCENario:SCFading:INTernal RF2C,RX1,RF2C,TX1
```

- 2. Select under Fading Simulator the wanted Profile (example Case 1)
- 3. Enable the Fading

È−Internal Fading È−Fading Simulator Enable	
Profile	TU3 (6 path) 🔻
Restart EventStart SeedDoppler Frequency ModeDoppler Frequency	TI5 (2 path)       ▲         TU1.5 (6 path)       ■         TU3.6 (6 path)       ■         TU3.6 (6 path)       ■         TU6 (6 path)       ■         TU50 (6 path)       ■         TU50 (6 path)       ■         TU60 (6 path)       ■         TU60 (6 path)       ■         TU100 (6 path)       ■         TU100 (6 path)       ▼

Fig. 5-25: internal GSM fading profiles

## Remote commands:

```
// Fading profile TU3 6 paths
CONFigure:GSM:SIGN<i>:FADing:FSIMulator:STANdard T3P6
// Switch on FAding
CONFigure:GSM:SIGN<i>:FADing:FSIMulator:ENABle ON
```

4. If wanted, apply AWGN by setting the **Signal/Noise** and enable the AWGN.

CMW Internal Fading for GSM and (E)GPRS(2)

⊟…Fa	ading Module AWGN		
ŀ	- Enable		_
	Min. Noise/System BW Ratio	1.5	
ŀ	Noise Bandwidth	0.22	2 MHz
	Effective Signal BW	0.20	) MHz
Ļ	Signal/Noise Ratio	5.00	) dB

Fig. 5-26: internal GSM AWGN section

## Remote commands:

// Ratio 1.5 CONFigure:GSM:SIGN<i>:FADing:AWGN:BWIDth:RATio 1.5 // Signal/Noise 5.0 CONFigure:GSM:SIGN<i>:FADing:AWGN:SNRatio 5.0

// Switch on AWGN
CONFigure:GSM:SIGN<i>:FADing:AWGN:ENABle ON

5. Start the measurement (see 5.1).

Please note, that with internal fading, the fading with hopping is not calculated for every frequency. The full internal baseband frequency can be used for the hopping. The same applies in principle for Dual carrier setups.

UE Receiver Measurement in TD-SCDMA: Rx Meas

# 6 TD-SCDMA Measurements

With the TD-SCDMA (or 3GPP UTRA-TDD option) standard, the UE receiver measurements includes BER, BLER, DBLER and additional information. All measurements are summarized in the **TDSCDMA RX Meas** measurement application (see 6.1).

Before starting the TD-SCDMA signaling, external fading must be selected as the scenario. Once signaling has begun, or once a connection has been established with the DUT, it is no longer possible to change scenarios.

This section describes the necessary steps to perform a TD-SCDMA Rx measurement.

For further information on TD-SCDMA signaling and BER measurements, refer to [10].

# 6.1 UE Receiver Measurement in TD-SCDMA: Rx Meas

# BER

This measurement calculates bit error rates in test mode connections. Typically the CMW transmits data which are looped back by the DUT. Please note that the BER works in **Test Mode** connections only.

🚸 TDSCDMA UE RX Measurement 1 - V3.2.2	20						TDSCDMA
😑 BER							BER
Connection Status		Cell Setup				í	RDY
Cell 😡		Band:		A: 2010.8MH	z~2024.2MHz	•	
Circuit Switched Ca	II Established	Frequency:		2017.4000000	MHz		
	tached	Channel:		10087	Ch		
Packet Switched Att	lacheu	PCCPCH Power		-60.00	dBm		
		Scrambling Code		100			
		SCCPCH	•	0.0	dB		
		PS Domain		<b>V</b>			
		Connection Setu	p				
		UE term. Connect	Те	st Mode	2		
Results		Туре	F	RMC			
BER	0.000 %	RMC					
BLER	0.100 %	Data Rate [	DL 384 I	kbps 🗾 UL	144 kbps 🔽	i	
DBLER	0.000 %						
Lost Transp.Blocks	0						
UL TFCI Faults	NCAP	Test Mode	Loop Mo	de 2 🛛 🗸		i	
FDR	NCAP						Signaling
PN Discontinuity	1000						Parameter
Transport Blocks	1 001 / 1000					Ì	TDSCDMA
							Signaling ON
Repetition Stop Condition				Ĭ.	Config		

Fig. 6-1: Example for BER in TD-SCDMA

# Remote commands:

```
//set number of transport blocks
CONFigure:TDSCdma:SIGN<i>:BER:TBLocks 1000
INITiate:TDSCdma:SIGN<i>:BER // s
```

```
// start measurement
// get results
```

# 6.2 Fading Scenario

In TD-SCDMA fading on one path only is applied.

FETCh:TDSCdma:SIGN<i>:BER?

1. In the **TDSCDMA Signaling Configuration**, select the *Standard Cell Fading* **Scenario** (see Fig. 6-2). Set the **Fading** to *External*.

🚯 TDSCDMA Signaling Configuration							
Path: Connection Configuration/Test Mode/RMC/Data Rate							
- Scenario	Standard Cell Fading 💌 Fading: External 🗸						
-Enable Data end to end							
lo Settings							
IQ Out							
Connector	DIG IQ OUT 2 💌						
Sample Rate	100 Msps 0.00 dBFS						
Baseband PEP							
Crest Factor	6.02 dB						
⊡ IQ In							
Connector	DIG IQ IN 1 🕜						
Sample Rate	100 Msps						
Baseband PEP	0.00 dBFS						
Baseband Level	-6.02 dBFS						

Fig. 6-2: TD-SCDMA scenario: Standard Cell Fading. The CMW indicates the crest factor, which is entered in the SMW's Dig IQ Input.

Remote commands:

```
// Standard Cell Fading external via RF2COM and IQ2 Out
ROUTe:TDSCdma:SIGN:SCENario:SCFading RF2C,RX1,RF2C,TX1,IQ2O
// read out information of IQ settings
SENSe:TDSCdma:SIGN<i>:IQOut:PATH<n>?
```

- 2. Take note of the **Crest Factor** under **IQ Out** and enter this value in the SMW under **Baseband Input Level** (see Fig. 2-13 in section 2.3).
- 3. Set a fading and switch on **I/Q Out** (BBMM1)(see section 2.3).
- In the CMW, enter the corresponding baseband level (Level BB <sub>out SMW</sub> = Crest Factor <sub>In SMW</sub> Insertion Loss; example: -6.02 dB 10 dB = -16.02 dBFS, see 2.3.8 ), which is indicated by the SMW (see Fig. 6-4). If you add noise to the signal, note the crest factor without noise.

- 5. Use **CONNECT Test Mode** to establish a TD-SCDMA connection between the CMW and DUT.
- 6. If you modify the fading, remember to change the level accordingly in the CMW.

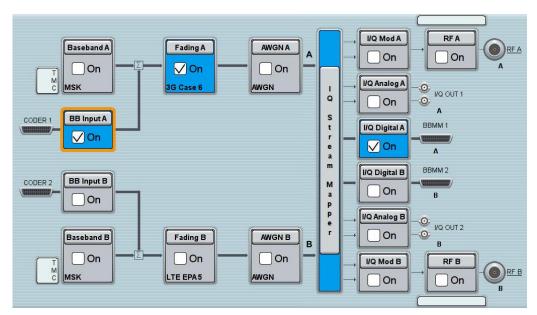


Fig. 6-3: Overview SMW settings for TD-SCDMA.

Fading A								_	×
General Standard/Fine Dela	Restart Auto	Insertion Loss Config. / Coupled Parameters	Path Table	Path Graph					
		Insertion Lo	oss Configura	ation —					
Mode	Normal	Normal -							
Insertion Loss		10.0 dB ·							
Clipped Samples	0.00 %							•	

Fig. 6-4: The SMW shows the necessary insertion loss (example: 10 dB)

Ė⊷IQ Settings Ė⊷IQ Out	
Connector	DIG IQ OUT 2 🔻
Sample Rate	100 Msps
-Baseband PEP	0.00 dBFS
Crest Factor	6.02 dB
⊟IQ In	
Connector	DIG IQ IN 1 🖂
Sample Rate	100 Msps
Baseband PEP	0.00 dBFS
Baseband Level	-16.02 dBFS

Fig. 6-5: Making allowance for the necessary attenuation in the CMW. Here, the digital output level of the SMW signal is entered as the IQ  $\ln$  level.

## Remote command:

// set IQ In to PEP 0 dBFS and Level -16.02 dBFS CONFigure:TDSCdma:SIGN<i>:IQIN:PATH<n> 0.0, -16.02

7. Start the RX measurement using **Rx MEAS** (see section 6.1). Fig. 6-6 shows an example.

O BER								
Connection Stat				Cell Setup				
	us 🦱			Band:		A. 2040 OMU	z~2024.2MHz	_
Cell				Danu.		A: 2010.0MH	2~2024.21112	
Circuit Switched	<sup>≫</sup> ≝»<	Call Established		Frequency:		2017.4000000	MHz	
Packet Switched		Attached		Channel:		10087	Ch	
1 dener omnened	<u>_</u>			PCCPCH Power		-65.00	dBm	
				Scrambling Code		100		
				SCCPCH	•	0.0	dB	
				PS Domain		M		
				Connection Set	սթ			
				UE term. Connect	Те	est Mode		
Results				Туре		RMC		
BER	<b>^</b>		2.216 %	RMC				
BLER	<b>^</b>		40.683 %	Data Rate	DL 384	kbps 🔽 UL	144 kbps 🔽	
DBLER	<b>^</b>		3.416 %					
Lost Transp.Block	s		0					
UL TFCI Faults			NCAP	Test Mode	Loop Mo	nde 2 💎 🔽		
FDR			NCAP					
PN Discontinuity			183					
Transport Blocks			322 / 1000					

Fig. 6-6: Example for a RX measurement in TD-SCDMA.

# 7 CDMA2000 and 1xEV-DO Measurements

With the 3G standards CDMA2000 and 1xEV-DO, 3GPP2 introduced a mixed voice and data standard CDMA/CDMA200 and a full IP data packet standard 1xEV-DO.

The CMW supports both standards as software options, in addition also a so called hybrid mode is available.

For further information on signaling and Rx measurements, refer to [11].

# 7.1 CDMA2000

With the CDMA2000 (3GPP2) standard, the UE receiver measurements includes a Frame Error Rate (FER), RLP, Pilot Strength and Speech measurements. All measurements are summarized in the **CDMA2000 RX Meas** measurement application (see 7.1.1).

Before starting the CDMA2000 signaling, external fading must be selected as the scenario. Once signaling has begun, or once a connection has been established with the DUT, it is no longer possible to change scenarios.

This section describes the necessary steps to perform a CDMA2000 Rx measurement.

Service Options							
Mode	Service Option	Data					
Speech	1, 3, 17, 68, 70, 73 and 0x8000	Voice					
Loopback	2, 9, and 55	Data					
Test Data	32	Data					
Packet Data	33	Data					

The CMW supports following service options (SO):

Please note that for SO33, packet data are provided by the DAU (see 8.5).

CDMA2000 defines different radio configurations (RC) with different modulations schemes and data rates,

Radio Configuration forward channel					
RC	Max Data rate Kbit / s	Modulation	Standard		
1	9.6				
2	14.4	O-QPSK	cdmaOne		
3	153.6				
4	307.2	H-PSK	CDMA2000		
5	230.4				

# 7.1.1 Mobile Station Receiver Measurement in CDMA2000: Rx Meas

Rx Meas in CDMA2000 provide different measurements, which also require different service options (SO):

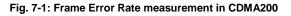
Service Options							
Mode	Service Option	Data					
Speech	1, 3, 17, 68, 70, 73 and 0x8000	Voice					
Loopback	2, 9, and 55	Data					
Test Data	32	Data					
Packet Data	33	Data					

Measurements				
Rx Measurement	1, 3, 17, 68, 70, 73, 0x8000 Speech	<b>2, 9, 55</b> Loopback	<b>32</b> Test Data	<b>33</b> Packet Data
FER FCH and FER SCH0		V	Ø	
RLP				V
Pilot Power	Ø	V	V	V
Speech	Ø			

# FER FCH and FER SCH0

Here the Frame Error Rate of the Fundamental Channel (FCH) and the Supplemental Channel 0 (SCH0) are determined. Views of both channels are analogical.

Current Service	e Option: <b>SO 55 (L</b>	oopback	()		
😑 FER FCH	⊖FER SCH0	RLP	Pilot Power	Speech	
FER FCH					
FER [%]					82.49
Confidence Le	evel [%]				69.62
Frame Errors					
Frames					2
Erased Frame	es				
Frames		Status	;		
	2 / 1000	ок			



# Remote commands:

```
INITiate:CDMA:SIGN<i>:RXQuality:TDATa:FERFch // start
measurement
FETCh:CDMA:SIGN<i>:RXQuality:FERFch? // get results
```

# RLP

This tab shows the RLP and IP statistics. This measurement requires an end-to-end data connection with the DAU and SO33.

Current Servic	Current Service Option: SO 33 (Packet Data)						
• FER FCH	• FER SCH	0 RLP	• Pil	ot Power	Spee	ech	
RLP & IP Sta	atistics						
RLP Messag	es	Rx		Rx Tota	I	Тх	Tx Total
Data (Unsegr	nented)		0		2	0	0
Data (Segme	nted)		0		112	0	0
Fill			6		762	0	9802
Idle			37		6065	0	0
NAK			0		0	0	34
SYNC			0		9	0	0
ACK			0		8	0	0
SYNCACK			0		0	0	9
B_Data			7		971	50	6861
C_Data			8		1904	400	55002
D_Data			8		1528	0	24
Reassembly			0		0	0	0
Blank			7		1011	0	0
Invalid			0		1	0	0
Summary			66	1	2680	450	73082
		Rx				Tx	
PPP Total By	rtes [kByte]		150			2595	
Data Rate [kB	Bit/s]		3.3			116.3	
	Statu	IS			_		
	OK						

Current Service Option: SO 33 (Packet Data)

Fig. 7-2: RLP and IP statistics

# **Pilot Strength**

The MS reports the total received power and the F-PICH power.

Current Service O	otion:SO 17 (Speec	h)		
• FER FCH	• FER SCH0	RLP	🕒 Pilot Strength	Speech
Pilot Strength				

# Fig. 7-3: Pilot strength

#### Remote commands:

SENSe:CDMA:SIGN<i>:RXQuality:RLP:SUMMary? // get results

# Speech

The speech measurement evaluates the traffic flow between DUT and CMW.

Current Service C	ption: SO 3 (Speec	h)				
FER FCH	FER SCHO	RLP	Pilot Powe	Speech		
Speech Acti	vitv					
	Forw	ard (T	x)	Re	verse (	Rx)
	[Frames]		[%]	[Frames]		[%]
Blanked	6	i i	0.3		0	0.0
Eighth	1850	)	82.6	18	43	82.7
Quarter	0	]	0.0		0	0.0
Half	25	Ĵ	1.1		26	1.2
Full	358	3	16.0	3	59	16.1
	[E	Bit/s]			[Bit/s]	
Throughput			799.0			799.0
Status OK						

#### Fig. 7-4: Speech statistics

# Remote commands:

SENSe:CDMA:SIGN<i>:RXQuality:SPEech:THRoughput? // get results

# 7.1.2 Fading Scenario

In CDMA2000 fading on one path only is applied.

1. In the **CDMA2000 Signaling Configuration**, select the *Standard Cell Fading* **Scenario** (see Fig. 6-2). Set the **Fading** to *External*.

SCDMA2000 Signaling Configuration	
Path: System/Physical Layer	
Scenario	Standard Cell Fading 🔻
"Fading	External 🔻
⊟-IQ Settings	
⊡-IQ Out	
Connector	DIG IQ OUT 2 🔻
Sample Rate	100 Msps
Baseband PEP	0.00 dBFS
Crest Factor	9.00 dB
⊡⊡	
Connector	DIG IQ IN 1
Sample Rate	100 Msps
-Baseband PEP	0.00 dBFS
-Baseband Level	-9.00 dBFS

Fig. 7-5: CDMA2000 scenario: Standard Cell Fading. The CMW indicates the crest factor, which is entered in the SMW's Dig IQ Input.

# Remote commands:

// Standard Cell Fading external via RF2COM and IQ2 Out ROUTe:CDMA:SIGN:SCENario:SCFading RF2C,RX1,RF2C,TX1,IQ2O // read out information of IQ settings SENSe:CDMA:SIGN<i>:IQOut:PATH<n>?

- Take note of the Crest Factor under IQ Out and enter this value in the SMW under Baseband Input Level (see Fig. 2-13 in section 2.3).
- 3. Set a fading and switch on **I/Q Out** (BBMM1)(see section 2.3).
- 4. In the CMW, enter the corresponding baseband level (Level BB <sub>out SMW</sub> = Crest Factor <sub>In SMW</sub> Insertion Loss; example: -9.0 dB 10 dB = -19.0 dBFS, see 2.3.8), which is indicated by the SMW (see Fig. 7-7). If you add noise to the signal, note the crest factor without noise.
- 5. Use **CONNECT 1<sup>st</sup> SO** to establish a CDMA2000 connection between the CMW and DUT.
- 6. If you modify the fading, remember to change the level accordingly in the CMW.

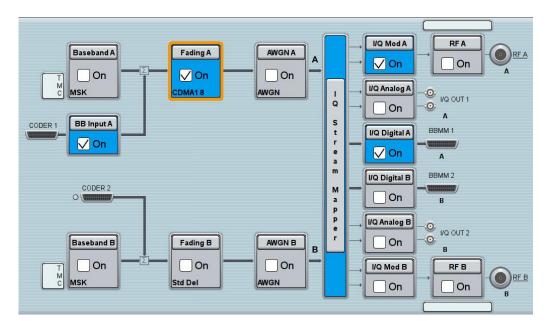


Fig. 7-6: Overview SMW settings for CDMA2000.

F	ading A							_	×
	O General Standard/Fine Delay	Restart Insertion Loss Config. / Auto Coupled Parameters Path Table Path Graph							
ſ			Insertion Lo	oss Configura	tion —				
	Mode	Normal .						-	
	Insertion Loss	10.0 dB •					·		
	Clipped Samples	0.00 %							

Fig. 7-7: The SMW shows the necessary insertion loss (example: 10 dB)

⊟-IQ Settings	
⊡-IQ Out Connector	DIG IQ OUT 2 🔻
Sample Rate	100 Msps
Baseband PEP	0.00 dBFS
Crest Factor	9.00 dB
⊡-10 In	
Connector	DIG IQ IN 1
Sample Rate	100 Msps
Baseband PEP	0.00 dBFS
-Baseband Level	-19.00 dBFS

Fig. 7-8: Making allowance for the necessary attenuation in the CMW. Here, the digital output level of the SMW signal is entered as the IQ In level.

Remote command:

```
// set IQ In to PEP 0 dBFS and Level -19.0 dBFS
CONFigure:CDMA:SIGN<i>:IQIN:PATH<n> 0.0, -19.0
```

- CDMA2000 CDMA2000 RX Measurement 1 - V3.5.11 - Base V 3.5.11 - 🛛 Current Service Option: SO 32 (Test Data) RX Meas 🕨 FER FCH 💿 FER SCHO RLP 🔍 Pilot Strength Speech FER FCH RUN FER FCH RF Settings FER [%] 1.28 Confidence Level [%] 0.23 Frame Errors 13 1018 Frames Erased Frames Frames 1018 / 1000 Status Warning: Test Data call connected Slow measurement updates Display Signaling Parameter CDMA2000 Mobile Station Connected 1st Service Option SO 32 (Test Data) RX Power Signaling Voice Coder ON External Frequency/ Channel ... RF Routing ... Power ... Config ... Attenuation
- 7. Start the RX measurement using **Rx MEAS** (see section 7.1.1). Fig. 7-9 shows an example.

Fig. 7-9: Example for a RX measurement in CDMA2000.

# 7.1.3 CMW Internal Fading for CDMA2000

For the CDMA200 scenario:

Standard Cell Fading

the internal fading in the CMW can be used with the software option CMW-KE800. It allows the predefined fading settings (3GPP2 C.S0032-C6.4.1 and C.S0011-C6.4.1): CDMA1 (8, 2 path)

- CDMA2 (30, 2 path)
- L CDMA3 (30, 2 path)
- CDMA4 (100, 2 path)
- CDMA5 (0, 2 path)
- CDMA6 (3, 2 path)
- All models involve a movement of the MS. The speed of movement in km/h is indicated as part of the profile name, the number of propagation paths is also

indicated. Example: "CDMA1 (8, 2 path)" means MS moving with 8 km/h, 2 propagation paths.

8. Set the wanted Scenario and set Fading to Internal.

To CDMA2000 Signaling Configuration	
Path: Fading	
Scenario	Standard Cell Fading 🔻
Fading	Internal 🔻

Fig. 7-10: CDMA200 scenario with internal fading

# Remote commands:

```
// Standard Cell Fading external via RF2COM
ROUTe:CDMA:SIGN:SCENario:SCFading:INTernal RF2C,RX1,RF2C,TX1
```

- 9. Select under Fading Simulator the wanted Profile (example Case 1)
- 10. Enable the Fading

🗄 Internal Fading	
⊟-Fading Simulator	
Enable	
Profile	CDMA1 💌
	CDMA1
Start Seed	CDMA2
	CDMA3
⊞ Insertion Loss	CDMA4
Doppler Frequency	CDMA5
⊞-Forward Link Settings	CDMA6
⊞-Fading Module AWGN	

Fig. 7-11: internal CDMA200 fading profiles

# Remote commands:

```
// Fading profile CDMA1 (P1)
CONFigure:CDMA:SIGN<i>:FADing:FSIMulator:STANdard P1
// Switch on FAding
CONFigure:CDMA:SIGN<i>:FADing:FSIMulator:ENABle ON
```

11. If wanted, apply AWGN by setting the **Signal/Noise** and enable the AWGN.

🖻 Fading Module AWGN	
Enable	<b>V</b>
Min. Noise/System BW Ratio	1.46
Noise Bandwidth	1.858660 MHz
Effective Signal BW	1.250000 MHz
Signal/Noise Ratio	3.00 dB

Fig. 7-12: internal CDMA2000 AWGN section

# Remote commands:

```
// Ratio 1.5
CONFigure:CDMA:SIGN<i>:FADing:AWGN:BWIDth:RATio 1.5
// Signal/Noise 5.0
CONFigure:CDMA:SIGN<i>:FADing:AWGN:SNRatio 5.0
// Switch on AWGN
CONFigure:CDMA:SIGN<i>:FADing:AWGN:ENABle ON
```

12. Start the measurement (see 7.1.1).

# 7.2 1xEV-DO

With the 1xEV-DO (3GPP2) standard, the AT receiver measurements includes a Frame Error Rate (FER), RLP, Pilot Strength and Speech measurements. All measurements are summarized in the **1xEV-DO RX Meas** measurement application (see 7.2.1).

Before starting the 1xEV-DO signaling, external fading must be selected as the scenario. Once signaling has begun, or once a connection has been established with the DUT, it is no longer possible to change scenarios.

This section describes the necessary steps to perform a 1xEV-DO Rx measurement.

Revisions			
Revision	PHY subtype	Max Data (Mbit/s) Forward Link	Comments
Release 0	0	2.4	
Revision A	1 and 2	3.1	
Revision B	1, 2 and 3	4.9 per carrier	CMW supports up to 3 carriers

The CMW supports all revisions of the standard:

1xEV-DO controls the data rate in the forward link by Data Rate Control (DRC). Please see [12] for more information and [11] how to set up the data rate in the CMW.

In Rev. B the CMW supports up to three carriers. As all carriers are generated in one baseband in the CMW and thus routed in the fading scenario via only one Digital IQ output to the SMW, it is not possible to apply fading to both carriers independently.

# 7.2.1 Access Terminal Receiver Measurement in 1xEV-DO: Rx Meas

# PER

Here the Packet Error Rate in the Forward Link is determined. Views of both channels are analogical.

For multi-carrier tests (revision B, physical layer subtype 3) PER statistics are collected and displayed both for the individual carriers and for all active carriers (column "Composite").

Physical Lay	yer: Subtype 3	Selected Ca	arrier: 2			
• PER	<ul> <li>Throughput</li> </ul>	Ctrl ChPER	●RLQ	Data	Overview	
Forward	Link PER					
						Composite
PER [%]					41.00	9.00
Confidence	ce Level [%]				17.00	22.00
Packet E	rrors				0	0
Test Packet	s Sent / <b>1</b> (	Status				
Composite <sup>-</sup>	Test Packets Sent / 10	UK				

Fig. 7-13: Packet Error rate measurement in 1xEV-DO

#### Remote commands:

```
INITiate:EVDO:SIGN<i>:RXQuality:FLPer // start measurement
FETCh:EVDO:SIGN<i>:RXQuality:FLPer? // get results
```

# Throughput

This tab shows the throughput on the MAC level.

PER Throughpur	CtrlChPER	●RLQ Data	Overview	
Forward Link Throug	hput			
Physical Packet Size	MAC Packets Received	Physical Packet Slots	Throughput vs Test Time [kBit/s]	Throughput vs Transmitted Slots [kBit/s]
128	92	44	65.40	362.3
256	71	86	640.50	529.9
512	46	93	318.70	142.1
1024	4	68	976.80	664.1
2048	74	84	45.90	314.9
3072	51	19	429.00	591.7
4096	97	24	316.80	2.7
5120	4	84	294.30	149.5
6144	74	49	377.40	931.4
7162	63	8	514.90	308.8
8192	57	47	498.20	823.8
Total	23	18	155.00	209.7
Composite			18.36	5.9
	Ct-tu-			
est Time	Status			

Fig. 7-14: Throughput measurements

# Remote commands:

```
INITiate:EVDO:SIGN<i>:RXQuality:FLPFormance // start
measurement
FETCh:EVDO:SIGN<i>:RXQuality: FLPFormance? // get results
```

# Data

This tab shows the RLP and IP statistics. This measurement requires an end-to-end data connection with the DAU.

RLP Messages	Rx	Rx Total	Tx	Tx Total
Reset	0	0	0	
Reset ACK	0	0	0	
NAK	0	1	0	
Summary	0	1	0	
	Rx		Тх	
PPP Total Bytes [kByte]	10177		59733	
Data Rate [kBit/s]	1087.5		2607.5	
Status				
OK				

Fig. 7-15: RLP and IP statistics

# Remote commands:

SENSe:EVDO:SIGN<i>:RXQuality:IPSTatistics:SUMMary?// get results

# 7.2.2 Fading Scenario

In 1xEV-DO fading on one path only is applied.

1. In the **1xEV-DO Signaling Configuration**, select the *Standard Cell Fading* **Scenario** (see Fig. 6-2). Set the **Fading** to *External*.

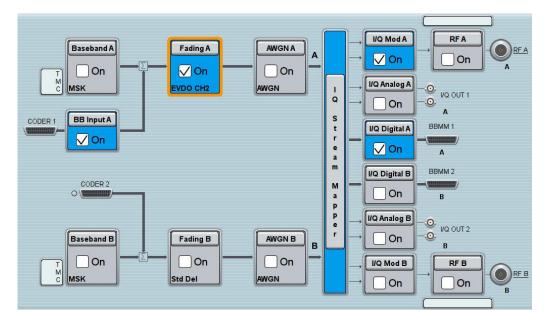
🚸 1xEV-DO Signaling Configuration	
Path: IQ Settings/IQ Out/Crest Factor	
Scenario	Standard Cell Fading 🔻
Fading	External 🔻
⊟-IQ Settings	
⊟-lQ Out	
Connector	DIG IQ OUT 2 🔻
-Sample Rate	100 Msps
Baseband PEP	0.00 dBFS
Crest Factor	9.00 dB
i⊡-lQ In	
Connector	DIG IQ IN 1
Sample Rate	100 Msps
-Baseband PEP	0.00 dBFS
Baseband Level	-9.00 dBFS

Fig. 7-16: 1xEV-DO scenario: Standard Cell Fading. The CMW indicates the crest factor, which is entered in the SMW's Dig IQ Input.

## Remote commands:

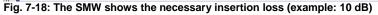
```
// Standard Cell Fading external via RF2COM and IQ2 Out
ROUTe:EVDO:SIGN:SCENario:SCFading RF2C,RX1,RF2C,TX1,IQ20
// read out information of IQ settings
SENSe:EVDO:SIGN<i>:IQOut:PATH<n>?
```

- Take note of the Crest Factor under IQ Out and enter this value in the SMW under Baseband Input Level (see Fig. 2-13 in section 2.3).
- 3. Set a fading and switch on I/Q Out (BBMM1)(see section 2.3).
- 4. In the CMW, enter the corresponding baseband level (Level BB <sub>out SMW</sub> = Crest Factor <sub>In SMW</sub> Insertion Loss; example: -9.0 dB 10 dB = -19.0 dBFS, see 2.3.8), which is indicated by the SMW (see Fig. 7-18). If you add noise to the signal, note the crest factor without noise.
- 5. Use **CONNECT** to establish a 1xEV-DO connection between the CMW and DUT.
- 6. If you modify the fading, remember to change the level accordingly in the CMW.





O General Standard/Fine Delay	Auto	Insertion Loss Config. / Coupled Parameters	Path Table	Path Graph	
Insertion Loss Configuration					
Mode	Normal				
Insertion Loss	10.0 dB				



İ⊡lQ Settings İ⊡lQ Out	
Connector	DIG IQ OUT 2 🔻
Sample Rate	100 Msps
Baseband PEP	0.00 dBFS
Crest Factor	9.00 dB
İ⊐-lQ İn	
Connector	DIG IQ IN 1 👻
Sample Rate	100 Msps
Baseband PEP	0.00 dBFS
-Baseband Level	-19.00 dBFS

Fig. 7-19: Making allowance for the necessary attenuation in the CMW. Here, the digital output level of the SMW signal is entered as the IQ In level.

# Remote command:

```
// set IQ In to PEP 0 dBFS and Level -19.0 dBFS
CONFigure:EVDO:SIGN<i>:IQIN:PATH<n> 0.0, -19.0
```

7. Start the RX measurement using **Rx MEAS** (see section 7.2.1). Fig. 7-20 shows an example.

🚸 1xEV-D0 RX Measurement - V3.5.11 - Base V 3.5.11		1xEV-DO
Physical Layer:Subtype 2 PER Throughput CtriChPER RLQ Data Overview Forward Link PER		RX Meas PER RUN
PER [%] Confidence Level [%] Packet Errors		RF Settings
Test Packets Sent Status 1070 / 1000 OK		
		Display Signaling Parameter
Access Connected PPP OFF RX Pow	ver <b>ein nangen</b>	1xEV-DO Signaling ON

Fig. 7-20: Example for a RX measurement in 1xEV-DO.

# 7.2.3 CMW Internal Fading for 1xEV-DO

For the 1xEV-DO scenario:

Standard Cell Fading

the internal fading in the CMW can be used with the software option CMW-KE800. It allows the predefined fading settings (3GPP2 C.S0032):

- EVDO1 (8, 2 path)
- EVDO 2 (3, 1 path)
- EVDO 3 (30, 1 path)
- EVDO 4 (100, 3 path)
- EVDO 5 (0, 2 path)
- All models involve a movement of the AT. The speed of movement in km/h is indicated as part of the profile name, the number of propagation paths is also indicated. Example: "EVDO1 (8, 2 path)" means AT moving with 8 km/h, 2 propagation paths.
- 8. Set the wanted **Scenario** and set **Fading** to *Internal*.

🚸 1xEV-DO Signaling Configuration	
Path: Fading	
Scenario	Standard Cell Fading 🔻
Fading	Internal 🔻

Fig. 7-21: CDMA200 scenario with internal fading

#### Remote commands:

// Standard Cell Fading external via RF2COM
ROUTe:EVDO:SIGN:SCENario:SCFading:INTernal RF2C,RX1,RF2C,TX1

- 9. Select under Fading Simulator the wanted *Profile* (example Case 1)
- 10. Enable the Fading

· ·	nal Fading a <u>ding Simulator</u>	
	Enable	V
	Profile	EVD01 💌
	Restart Event Start Seed	EVD01 EVD02 EVD03
	⊡Insertion Loss ™Doppler Frequency	EVDO4 EVDO5
	orward Link Settings ading Module AWGN	

Fig. 7-22: internal 1xEV-DO fading profiles

Remote commands:

```
// Fading profile EVDO1 2 paths
CONFigure:EVDO:SIGN<i>:FADing:FSIMulator:STANdard P1
// Switch on FAding
CONFigure:EVDO:SIGN<i>:FADing:FSIMulator:ENABle ON
```

11. If wanted, apply AWGN by setting the **Signal/Noise** and enable the AWGN.

🖻 Fading Module AWGN	
Enable	
-Min. Noise/System BW Ratio	1.46
Noise Bandwidth	1.858660 MHz
Effective Signal BW	1.250000 MHz
Signal/Noise Ratio	3.00 dB

Fig. 7-23: internal 1xEV-DO AWGN section

Remote commands:

```
// Ratio 1.5
CONFigure:EVDO:SIGN<i>:FADing:AWGN:BWIDth:RATio 1.5
// Signal/Noise 5.0
CONFigure:EVDO:SIGN<i>:FADing:AWGN:SNRatio 5.0
// Switch on AWGN
```

CONFigure:EVDO:SIGN<i>:FADing:AWGN:ENABle ON

12. Start the measurement (see 7.2.1).

## 8 Data Application Unit (DAU)

Applications with the DAU can also employ external fading. Doing this only requires taking a few steps beyond the steps described earlier in this document:

1. Enable end-to-end data connections in the individuals radio access networks (RANs).

🚸 WCDMA Signaling Configuration	
Path: Scenario	
Scenario	Standard Cell 🔻
Enable Data end to end	M

Fig. 8-1: *Enable Data end-to-end* must already be activated in the individual RANs (in this example, for WCDMA).

Note: Certain RANs do not show this setting in newer firmware versions. In this case the CMW starts Data end to end functionality automatically.

// ENABLE <STANDARD> END TO END, EXAMPLE: WCDMA
CONFigure:WCDMA:SIGN<i>:ETOE ON

- 2. Configure the DAU (see below).
- 3. From the UE, establish an end-to-end connection (no test mode).
- 4. Perform the measurements (e.g. directly in the device or with special end-to-endmeasurements) on the CMW.

For further information on operating the DAU, please refer to [7].

The DAU application **IPERF** sends data packages with a defined data rate to the UE. It is used for the following BLER and throughput measurement.

Press the MEASURE button on the CMW and check Data Appl. → Measurements
 1.

🚸 Measurement Controller	
RX Quality	
🕀 Data Appl.	
Measurements 1	
Measurements 2	

Fig. 8-2: Select DAU menu.

- 2. Press the DATA 1 MEAS software tab to enter the DAU Menu.
- 3. Select the iPerf menu tab.

- 4. Press ConFigure Services software key.
- 5. In the **DATA APPLICATION CONTROL** window, select the **IP CONFIG** tab and use following settings. Close the window.

🚸 Data Application Control		IP Config
DAU Unit ON		
Overview IP Config DNS FTP HTTP	IMS	
LAN DAU Status: Not connected  Current DAU IPv4 Settings IPv4 Address: 172.22.1.201 Subnet Mask: 255.255.0.0 Gateway IP: n/a IPv4 Address Configuration Automatic R&S CMW500 Network (standalone) Mobile IPv4 Addresses 172.22.1.100	Current DAU IPv6 Settings         IPv6 Address:       fc01:cafe::1/64         Default Router:       n/a         LAN(DAU) IPv6 Address Configuration         Automatic R&S CMW500 Network (standalone)         Automatic Mobile IPv6 Prefixes	
172.22.1.100 ▲ 172.22.1.101 172.22.1.102 172.22.1.103 172.22.1.103 172.22.1.104	fc01:abab:cdcd:efe0::/64 fc01:abab:cdcd:efe1::/64 fc01:abab:cdcd:efe2::/64 fc01:abab:cdcd:efe3::/64 fc01:abab:cdcd:efe4::/64	
	Routing Manual Routes Prefixes via Routers	
Select Network Applic Drive map	Close Config	DAU Unit ON

Fig. 8-3: The IP Config menu.

6. In the DATA APPLICATION MEASUREMENTS 1 window select IPERF and press the CONFIG... software key.

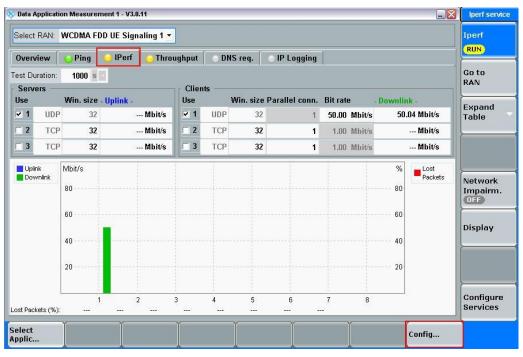


Fig. 8-4: Running IPERF.

7. In the IPERF CONFIG window, select CLIENT #1, UDP and BIT RATE = e.g. 50 Mbit/s (must be ≤ DL IP data rate). This sets the Downlink data rate. Press Ok to return to the DATA APPLICATION MEASUREMENTS 1 window.

Clients	Use	UDP or	тср	Port	UE IP Address	Win. size (in kByte)	Parallel Conn.	Bit ra	te
-1	•	UDP	-	5010	172.22.1.100	32	1	50.00	Mbit/
-2		тср	•	5002	172.22.1.100	32	1	1.00	Mbit/
-3		тср	•	5003	172.22.1.100	32	1	1.00	Mbit/
-4		тср	•	5004	172.22.1.100	32	1	1.00	Mbit/
-5		ТСР	•	5005	172.22.1.100	32	1	1.00	Mbit/
-6	-	тср	•	5006	172 22 1 100	32	1	1.00	Mhit/
							ок		Canc

#### Fig. 8-5: IPerf Config window.

8. Press the Iperf software key and press the ON/OFF button. The yellow RUN status message indicates that the data generator is running.



Fig. 8-6: Iperf is running.

#### Remote commands:

Configuration:

TEST DURATION - Time the test should last (in seconds). CONFigure:DATA:MEAS1:IPERf:TDURation 1000 PORT NUMBER - Data Application Unit (LAN DAU) port number for the connection. CONFigure:DATA:MEAS1:IPERf:CLIent1:PORT 5001 WINDOW SIZE - Size of the Negative Acknowledgement (NACK) window (in kbyte). CONFigure:DATA:MEAS1:IPERf:CLIent1:WSIZE 32 LISTEN PORT - UE's listen port number for the connection. CONFigure:DATA:MEAS1:IPERf:CLIent1:LPORt BITRATE - Maximum bit rate to be transferred (in kbps). CONFigure:DATA:MEAS1:IPERf:CLIent1:BITRate 56M PROTOCOL - Specifies the protocol used for data transfer for the client connection. CONFigure:DATA:MEAS1:IPERf:CLIent1:PROTocol UDP IPADDRESS - Specifies the IP address of an IPerf client.

CONFigure:DATA:MEAS1:IPERf:CLIent1:IPADdress 172.22.1.100 ENABLE - Activates an IPerf client instance. CONFigure:DATA:MEAS1:IPERf:CLIENT1:ENABLE ON

#### Start/Stop generating data:

INIT:DATA:MEAS1:IPERf
STOP:DATA:MEAS1:IPERf
ABORt:DATA:MEAS1:IPERf

9. Measure the throughput in the DAU application directly.

## 8.1 LTE

For LTE, there is one special setting for end-to-end tests.

Under Connection, the Type must be set to Data Application (Fig. 8-7).

🚸 LTE Signaling Configuration	
Path: Connection/Connection Type	
Duplex Mode	FDD -
Scenario	Standard Cell
<ul> <li>Enable Data end to end</li> <li>RF Settings</li> <li>Downlink Power Levels</li> <li>Uplink Power Control</li> <li>Physical Cell Setup</li> <li>Network</li> <li>Connection</li> </ul>	
—UE Category —Default Paging Cycle —Additional Spectrum Emission —UE Meas. Filter Coefficient	Manual: 5 Use Reported (if available): 🔽 #64 🔍 NS_01 🔍 FC4 🗸
Connection Type	Data Application 💌

Fig. 8-7: LTE special Settings for end-to-end tests: Data Application.

Remote command:

// SET CONNECTION TYPE TO DATA APPLICATION
CONFigure:LTE:SIGN<i>:CONNection:CTYPe DAPPlication

## 8.2 W-CDMA and with HSPA(+)

For W-CDMA, there are several special settings for end-to-end tests.

Under Packet Data, HSDPA or HSUPA should be entered under Data Rate (Fig. 8-8).

Here, too, the **WCDMA Wizard** is available for automatic setup using the UE capability (see Fig. 4-1on page 77).

W-CDMA and with HSPA(+)

ath: Scenario					
Scenario	Standard Cell 🔹				
Enable Data end to end RF Settings Physical Downlink Settings Physical Uplink Settings Connection Configuration	J.				
UE term. Connection	Test Mode 💌				
SRB Data Rate	DL 13.6 kbps - UL 13.6 kbps -				
<b>⊡</b> -Video					
⊕-Single SRB					
⊡Test Mode ⊡Packet Data					
Data Rate	DL HSDPA 💌 UL HSUPA 💌				
	Auto 🝷 2047				
T1 Release Timer	Auto 🔻 50 ms				

Fig. 8-8: W-CDMA special settings for end-to-end tests: Packet data.

Remote command:

```
// ENABLE WCDMA END TO END
CONFigure:WCDMa:SIGN<i>:ETOE ON
// SET PACKET DATA DATA RATE TO HSDPA AND HSUPA
CONFigure:WCDMa:SIGN<i>:CONNection:PACKet:DRATe HSDPa, HSUPa
```

The W-CDMA option offers an additional throughput measurement based on end-toend data connections (RLC throughput, see section 4.1). The HSDPA ACK and E-HICH receiver measurements for Layer1 (under RX Meas, see section 4.1) also work in the end-to-end configuration. Beyond this, all Tx tests can also be used with end-toend connections.

GSM and (E)GPRS(2)

BER	O HSI	OPA ACK	E-HICH	I 💽	RLC Throughp	ut	) UL Loggi	ing					RLC
400 200 100 400 200											s	PDU DL:	Throughpu RDY
-115	5 -1	05 -96	5 -85	-75	-65	-55	-45	-35	-25	-15	-5	-1	
		Downlin	(				Uplink						Display
Throughp	ut	Downlink PDU	¢	SE	)U		Uplink PDU			SDU			Display
Current	ut		790.000 ki	bit/s	798.933				1.000 bit/s			0.000 bit/s	Display
Current Average	ut		790.000 kl 790.000 kl	bit/s bit/s	798.933 784.623	kbit/s	PDU	0	1.000 bit/s		(	0.000 bit/s	Display
Current Average Maximum	ut		790.000 kl 790.000 kl 790.033 kl	bit/s bit/s bit/s	798.933 784.623 1.049	kbit/s Mbit/s	PDU	0	1.000 bit/s 1.000 bit/s		( (	0.000 bit/s 0.000 bit/s	
<b>Throughp</b> Current Average Maximum Minimum Plaako	ut		790.000 kl 790.000 kl 790.033 kl 789.967 kl	bit/s bit/s bit/s	798.933 784.623	kbit/s Mbit/s	PDU	0	1.000 bit/s 1.000 bit/s 1.000 bit/s		( (	0.000 bit/s	Signaling
Current Average Maximum	ut		790.000 kl 790.000 kl 790.033 kl	bit/s bit/s bit/s	798.933 784.623 1.049	kbit/s Mbit/s	PDU	0	1.000 bit/s 1.000 bit/s		( (	0.000 bit/s 0.000 bit/s	Signaling Parameter
Current Average Maximum Minimum Blocks		PDU	790.000 kl 790.000 kl 790.033 kl 789.967 kl	bit/s bit/s bit/s	798.933 784.623 1.049 499.333	kbit/s Mbit/s	PDU	000000000000000000000000000000000000000	1.000 bit/s 1.000 bit/s 1.000 bit/s 686		( ( ( In Rang	0.000 bit/s 0.000 bit/s 0.000 bit/s	Signaling

Fig. 8-9: RLC throughput measurements in WCDMA. Here, the throughput is measured directly in the end-to-end connection.

## 8.3 GSM and (E)GPRS(2)

For GSM, there is no special setting necessary for end-to-end tests.

Just enable Data end to end before starting GSM.

Scenario	Standard Cell Fading
Fading	External 🔻
-Enable Data end to end	V

Remote command:

```
// ENABLE GSM END TO END
CONFigure:GSM:SIGN<i>:ETOE ON
```

The GSM option offers an additional throughput measurement based on end-to-end data connections (RLC throughput, 5.1). Beyond this, all Tx tests can also be used with end-to-end connections.

## 8.4 TD-SCDMA

For TD-SCDMA, there are several special settings for end-to-end tests.

Under **Packet Data**, enter the wanted *Data Rate* (Fig. 8-10). Make sure that the Packet switched domain is enabled (Fig. 8-11).

Ē	- Connection Configuration							
	UE term. Connection	Te	st M	ode 🔻				
	SRB Data Rate	DL	2.5	kbps	- U	L 2.5	kbps	•
	⊕-Single SRB							
	🗄 Test Mode							_
	🖻 - Packet Data				_			
	Data Rate	DL	384	kbps 🔻	UL	128k	bps 🔻	

Fig. 8-10: TD-SCDMA special settings for end-to-end tests: Packet data.

Cell Setup	
Band:	A: 2010.8MHz~2024.2MHz 🔹
Frequency:	2017.4000000 MHz
Channel:	10087 Ch
PCCPCH Power	-65.00 dBm
Scrambling Code	100
SCCPCH	▼ 0.0 dB
PS Domain	

#### Fig. 8-11: PS domain

Remote command:

```
// ENABLE TD-SCDMA END TO END
CONFigure:TDSCdma:SIGN<i>:ETOE ON
// ENABLE PS DOMAIN
CONFigure: TDSCdma:SIGN<i>:CELL:PSDomain ON
// SET PACKET DATA DATA RATE
CONFigure: TDSCdma:SIGN<i>:CONNection:PACKet:DRATE R384,R128
```

Use the throughput measurement in the DAU (see 8). Beyond this, all Tx tests can also be used with end-to-end connections.

## 8.5 CDMA2000 and 1XEV-DO

#### CDMA2000

For CDMA2000, there are several special settings for end-to-end tests.

First, the **SO** has to be **SO33** (**Packet Data**). In Service Configuration, set **Accept Packet Calls** to **Accept** as the AT sets up the connection (Fig. 8-12).

CDMA2000 and 1XEV-DO

: System/RF Input (RX)	
-Baseband Level	-19.00 dBFS
System	
⊞ RF Output (TX)	
ங். <mark>RF Input (RX)</mark>	
⊞. RF Frequency	
⊞ RF Power	
🖻 Physical Layer	
-1st Service Option	SO 33 (Packet Data) 🔻
Radio Configuration (Fwd / Rev)	3/3 🔻
⊡-Code Channels	
FCH Frame Offset	0
⊞-SCH0	
⊡-°SCH	
±-QPCH	
⊞-Reverse Power Control	
⊡ Time	
Service Configuration	
-	Assent All Calls
-Accept Speech Calls	Accept All Calls
-Accept Packet Calls	Accept 🔻

Fig. 8-12: CDMA2000 special settings for end-to-end tests.

Remote command:

```
// SET SO 33
CONFigure:CDMA:SIGN<i>:PREConfiguration:LAYer:SOPTion:FIRSt SO33
// ACCEPT PACKET CALLS
CONFigure:CDMA:SIGN<i>:SCONfig:APCalls ACCept
```

Use the throughput measurement in the DAU (see 8). Beyond this, all Tx tests can also be used with end-to-end connections.

#### 1xEV-DO

For 1xEV-DO, there is one special setting for end-to-end tests.

Set the Application to Packet (Fig. 8-13).

CDMA2000 and 1XEV-DO

4 1xEV-DO Signaling Configuration	
Path: Layer/Application Layer/Application	
Scenario	Standard Cell Fading 🔻
Fading	External 🔻
⊡-IQ Settings	
⊞∝System	
⊟ Layer	Network Release A
⊟ Application Layer	
- Application	Packet 🔻
Preferred Packet Mode	eHRPD ▼

Fig. 8-13: 1xEV-DO special settings for end-to-end tests.

Remote command:

// SET APPLICATION PACKET
CONFigure:EVDO:SIGN<i>:APPlication:MODE PACKet

Use the throughput measurement in the DAU (see 8). Beyond this, all Tx tests can also be used with end-to-end connections.

# 9 Appendix

## 9.1 Literature

[1] Application Note 1MA111, UMTS Long Term Evolution (LTE) Technology Introduction

[2] Application Note 1MA142, Introduction to MIMO

[3] Application Note 1GP51 Guidelines for MIMO Test Setups - Part 2

- [4] Application Note 1SP11 WiMAX MIMO Multipath Performance Measurements
- [5] User Manual, R&S®CMW-KM5xx/-KS5xx LTE Firmware Applications
- [6] User Manual, R&S®CMW-KG4xx/-KM4xx/-KS4xx WCDMA Firmware Applications

[7] User Manual, R&S®CMW-B450A/-KM050 Data Application Units

[8] Application Note 1MA177 LTE Terminal Tests under Fading Conditions with R&S®CMW500 and R&S®AMU200A

[9] User Manual, R&S®CMW-KM2xx/-KS2xx GSM Firmware Applications

[10] User Manual, R&S®CMW-KM75x/-KS750/KS760 TD-SCDMA Firmware Applications

[11] User Manual, R&S®CMW-KM8xx/-KS8xx CDMA2000 1xRTT and 1xEV-DO Firmware Applications

[12] White Paper 1MA213 1xEV-DO Revision A + B

## 9.2 Additional Information

Please send your comments and suggestions regarding this application note to

TM-Applications@rohde-schwarz.com

## 9.3 Ordering Information

Ordering Information				
CMW Wideband Radio Communication Tester				
CMW500 RF Tester Hardware configuration				
Base Unit	CMW500	1201.0002K50		
CMW500 Mainframe 03	CMW-PS503	1208.7154.02		
Front Panel with Display H600B	CMW-S600B	1201.0102.03		
3B Flexible Link H550B	CMW-S550B	1202.4801.03		
RF Frontend (Basic) H590A	CMW-S590A	1202.5108.02		
<sup>nd</sup> RF Frontend (Basic) H590A	CMW-B590A	1202.8707.02		
Or		·		
F Frontend, dvanced functionality	CMW-S590D	1202.5108.03		
VI Interface	CMW-B620A	1202.5808.02		
Option Carrier H660A	CMW.B660A	1202.7000.02		
thernet Switch H661A	CMW-B661A	1202.7100.02		
CXO (Highly Stable) H690B	CMW-B690B	1202.6004.02		
ignaling Unit Wideband H300A	CMW-B300A	1202.8759.02		
gnaling Unit Universal B200A	CMW-B200A	1202.6104.02		
SM Signaling option	CMW-B210A	1202.6204.02		
tra RF Converter H570A	CMW-B570B	1202.8659.03		
ta Application Unit	CMW-B450A	1202.8759.02		
gital IQ 1 to 4	CMW-B510F	1202.8007.07		
gital IQ 5 to 8	CMW-B520F	1202.8107.07		
sic Fading and AWGN	CMW-KE100	1207.5506.02		
ftware LTE RF Tester				
E FDD Rel. 8, SISO, Basic signaling	CMW-KS500	1203.6108.02		
E Rel. 8, SISO, advanced signaling	CMW-KS510	1203.9859.02		
E MIMO 2x2 signaling	CMW-KS520	1207.3555.02		
E, user defined bands signaling	CMW-KS525	1207.4000.02		
E TDD Rel. 8, SISO, Basic signaling	CMW-KS550	1204.8904.02		
E FDD Rel. 8, TX measurement, uplink	CMW-KM500	1203.5501.02		
E TDD Rel. 8, TX measurement, uplink	CMW-KM550	1203.8952.02		
E FDD R10, CA, basic signaling	CMW-KS502	1208.6029.02		
E R10, CA, adv. signaling	CMW-KS512	1208.6041.02		
TE TDD R10, CA, basic signaling	CMW-KS552	1208.6087.02		
TE fading profiles MIMO 4x2	CMW-KE500	1207.5658.02		

### Appendix

### Ordering Information

LTE fading profiles MIMO 4x2	CMW-KE501	1208.6812.02
Software W-CDMA RF Tester		
WCDMA Rel. 99, Basic signaling	CMW-KS400	1203.0751.02
WCDMA Rel. 99, advanced signaling	CMW-KS410	1203.9807.02
WCDMA Rel. 5/6 HSPA, basic signaling	CMW-KS401	1203.9907.02
WCDMA Rel. 5/6 HSPA, advanced signaling	CMW-KS411	1207.3503.02
WCDMA Rel. 7 HSPA+, SISO, Basic signaling	CMW-KS403	1203.9959.02
WCDMA Rel. 7 HSPA+, SISO, adv. signaling	CMW-KS413	1207.3755.02
WCDMA Rel. 8 DC-HSDPA, Basic signaling	CMW-KS404	1207.6154.02
WCDMA Rel. 9 HSPA+, Basic signaling	CMW-KS405	1208.5980.02
WCDMA, user-defined bands,	CMW-KS425	1207.3955.02
WCDMA Rel. 99, TX measurement, uplink	CMW-KM400	1203.0700.02
WCDMA Rel. 5/6 HSPA, TX measurement, uplink	CMW-KM401	1203.2954.02
WCDMA Rel. 7 HSPA+, TX measurement, uplink	CMW-KM403	1203.9007.02
WCDMA fading profiles	CMW-KE400	1207.5606.02
Software GSM RF Tester		
GSM GPRS EDGE Rel. 6, Basic signaling	CMW-KS200	1203.0600.02
GSM GPRS EDGE Rel. 6, advanced signaling	CMW-KS210	1203.9759.02
GSM Rel.7, EDGEevo, Basic signaling	CMW-KS201	1204.8504.02
GSM Rel. 9, VAMOS	CMW-KS203	1207.2759.02
GSM GPRS EDGE Rel. 6 Tx measurement	CMW-KM200	1203.0551.02
GSM Rel. 7 EGPRS2-A Tx measurement	CMW-KM201	1204.8404.02
GSM fading profiles	CMW-KE200	1207.5558.02
Software TD-SCDMA RF Tester		
TD-SCDMA R4, basic signaling	CMW-KS750	1208.7854.02
TD-SCDMA R4, advanced signaling	CMW-KS760	1208.7854.02
TD-SCDMA, TX measurement	CMW-KM750	1203.2554.02
TD-SCDMA enhancement, TX measurement	CMW-KM751	1207.6102.02
Software CDMA2000 / 1xEV-DO RF Tester		
CDMA2000 <sup>®</sup> 1xRTT, basic signaling	CMW-KS800	1203.3109.02
CDMA2000 <sup>®</sup> 1xRTT, adv. Signaling	CMW-KS810	1207.3603.02
CDMA2000 <sup>®</sup> 1xEV-DO Rev. 0/A, basic signaling	CMW-KS880	1203.3209.02
CDMA2000 <sup>®</sup> 1xEV-DO Rev. B, basic signaling	CMW-KS881	1207.3655.02
CDMA2000 <sup>®</sup> 1xEV-DO Rev. 0/A, adv. signaling	CMW-KS890	1207.3703.02
CDMA2000 <sup>®</sup> 1xRTT, TX measurement	CMW-KM800	1203.2602.02
CDMA2000 <sup>®</sup> 1xEV-DO Rev. 0/A/B, TX meas.	CMW-KM880	1203.2854.02

Ordering Information

C2K and EVDO fading profiles	CMW-KE800	1208.6858.02
IP Test Extension		
Enabling of IP-Data Interface for IPV4	CMW-KA100	1207.2607.02
Extension of IP-Data Interface to IPv6	CMW-KA150	1207.2659.02
IP Based Measurements	CMW-KM050	1203.5901.02
Optional		·
Mini USIM LTE Rel. 8	CMW-Z03	1202.9503.02
RF Combiner		
Multibox RF set	CMW-Z24	1508.6150.02

Fading Simulator SMW200A Vector Signal Generator				
Baseband Main Module, two IQ paths	SMW-B13T	1413.3003.02		
Digital Baseband Outputs	SMW-B18	1413.3432.02		
ading Simulator	SMW-B14	1413.1500.02		
dditional White Gaussian Noise	SMW-K62	1413.3484.02		
Dynamic Fading	SMW-K71	1413.3532.02		
IIMO Fading	SMW-K74	1413.3632.02		

Note: The Rx measurements like BER/BLER/Throughput are included in the signaling options. Thus, the mentioned Tx measurements options are not necessary for the Rx tests.

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#### Sustainable product design

- Environmental compatibility and eco-footprint
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