# 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.



## **Table of Contents**

1	Introduction	5
2	Measurement Setup	7
2.1.1	Fading Test Setup for One Baseband Signal	7
2.1.2	Fading Test Setup for Two Basebands Signals	8
2.1.3	Fading Test Setup for Four Basebands Signals	8
2.1.4	Fading Test Setup for more than four Basebands Signals	9
2.2	Dig IQ connectors at the CMW	9
2.3	SMW Configuration	10
2.3.1	System Configuration / MIMO Settings	10
2.3.2	External Reference	14
2.3.3	Digital input	15
2.3.4	Digital output	16
2.3.5	Display settings (AMU only)	18
2.3.6	Fading settings	18
2.3.7	AWGN settings	22
2.3.8	Compensation of necessary attenuation	23
3	LTE(-A) Measurements	26
3.1	UE Receiver Measurement in LTE: Extended BLER	27
3.2	Scenarios for one cell	29
3.2.1	"1 Cell – Fading – 1 RF Out" scenario (SISO)	29
3.2.2	"1 Cell – Fading – 2 RF Out" scenario (MIMO)	34
3.2.3	"1 Cell – Fading –MIMO 4x2 2 RF Out" scenario (4x2 MIMO)	51
3.3	Scenarios for Carrier Aggregation	55
3.3.1	"2CC CA – Fading – 2 RF Out" scenario (CA with SISO)	55
3.3.2	"2CC CA – Fading – 4 RF Out" scenario (CA with MIMO)	60
3.4	Scenarios for Carrier Aggregation with CMWflexx	64
3.4.1	"2CC CA – Fading – 4 RF Out Distributed" scenario (CA with MIMO)	64
3.4.2	"3CC CA – Fading – 6 RF Out" scenario (CA with 3 CC's and MIMO)	65
3.4.3	"4CC CA – Fading – 8 RF Out" scenario (CA with 4 CC's and MIMO)	69
3.5	CMW Internal Fading for LTE(-A)	73
4	W-CDMA and HSPA(+) Measurements	

Dig IQ connectors at the CMW

4.1	UE Receiver Measurement in W-CDMA: Rx Meas77
4.2	SISO Configuration80
4.3	Rx Diversity Configuration (SIMO)84
4.4	Dual-Carrier Configuration (DC-HSPA+)87
4.5	DC-HSPA+ with Rx Diversity Configuration91
4.6	Dual-Band HSDPA Configuration (DB-DC-HSPA+)94
4.7	Dual Band HSDPA with Rx Diversity Configuration (DB-DC-HSPA+ with Rx Diversity)99
4.8	CMW Internal Fading for W-CDMA and HSPA(+)102
5	GSM and (E)GPRS(2) Measurements 105
5.1	Mobile Station Receiver Measurement in GSM: Rx Meas108
5.2	Fading Scenario112
5.3	Fading with Hopping (single DL carrier)116
5.4	Fading with DL Dual Carrier121
5.5	CMW Internal Fading for GSM and (E)GPRS(2)122
6	TD-SCDMA Measurements 125
6.1	UE Receiver Measurement in TD-SCDMA: Rx Meas125
6.2	Fading Scenario126
6.2 7	Fading Scenario
6.2 7 7.1	Fading Scenario    126      CDMA2000 and 1xEV-DO Measurements    129      CDMA2000    129
6.2 7 7.1	Fading Scenario       126         CDMA2000 and 1xEV-DO Measurements       129         CDMA2000       129         Mobile Station Receiver Measurement in CDMA2000: Rx Meas       130
<b>6.2</b> <b>7</b> <b>7.1</b> 7.1.1 7.1.2	Fading Scenario       126         CDMA2000 and 1xEV-DO Measurements       129         CDMA2000       129         Mobile Station Receiver Measurement in CDMA2000: Rx Meas       130         Fading Scenario       133
<ul> <li>6.2</li> <li>7</li> <li>7.1</li> <li>7.1.2</li> <li>7.1.3</li> </ul>	Fading Scenario       126         CDMA2000 and 1xEV-DO Measurements       129         CDMA2000       129         Mobile Station Receiver Measurement in CDMA2000: Rx Meas       130         Fading Scenario       133         CMW Internal Fading for CDMA2000       135
<ul> <li>6.2</li> <li>7</li> <li>7.1</li> <li>7.1.2</li> <li>7.1.3</li> <li>7.2</li> </ul>	Fading Scenario       126         CDMA2000 and 1xEV-DO Measurements       129         CDMA2000       129         Mobile Station Receiver Measurement in CDMA2000: Rx Meas       130         Fading Scenario       133         CMW Internal Fading for CDMA2000       135         1xEV-DO       137
<ul> <li>6.2</li> <li>7</li> <li>7.1.1</li> <li>7.1.2</li> <li>7.1.3</li> <li>7.2</li> <li>7.2.1</li> </ul>	Fading Scenario126CDMA2000 and 1xEV-DO Measurements129CDMA2000129Mobile Station Receiver Measurement in CDMA2000: Rx Meas130Fading Scenario133CMW Internal Fading for CDMA20001351xEV-DO137Access Terminal Receiver Measurement in 1xEV-DO: Rx Meas138
<ul> <li>6.2</li> <li>7</li> <li>7.1.1</li> <li>7.1.2</li> <li>7.1.3</li> <li>7.2</li> <li>7.2.1</li> <li>7.2.2</li> </ul>	Fading Scenario       126         CDMA2000 and 1xEV-DO Measurements       129         CDMA2000       129         Mobile Station Receiver Measurement in CDMA2000: Rx Meas       130         Fading Scenario       133         CMW Internal Fading for CDMA2000       135         1xEV-DO       137         Access Terminal Receiver Measurement in 1xEV-DO: Rx Meas       138         Fading Scenario       140
<ul> <li>6.2</li> <li>7</li> <li>7.1.1</li> <li>7.1.2</li> <li>7.1.3</li> <li>7.2</li> <li>7.2.1</li> <li>7.2.2</li> <li>7.2.3</li> </ul>	Fading Scenario       126         CDMA2000 and 1xEV-DO Measurements       129         CDMA2000       129         Mobile Station Receiver Measurement in CDMA2000: Rx Meas       130         Fading Scenario       133         CMW Internal Fading for CDMA2000       135         1xEV-DO       137         Access Terminal Receiver Measurement in 1xEV-DO: Rx Meas       138         Fading Scenario       140         CMW Internal Fading for 1xEV-DO       143
<ul> <li>6.2</li> <li>7</li> <li>7.1.1</li> <li>7.1.2</li> <li>7.1.3</li> <li>7.2</li> <li>7.2.1</li> <li>7.2.2</li> <li>7.2.3</li> <li>8</li> </ul>	Fading Scenario       126         CDMA2000 and 1xEV-DO Measurements       129         CDMA2000       129         Mobile Station Receiver Measurement in CDMA2000: Rx Meas       130         Fading Scenario       133         CMW Internal Fading for CDMA2000       135         1xEV-DO       137         Access Terminal Receiver Measurement in 1xEV-DO: Rx Meas       138         Fading Scenario       140         CMW Internal Fading for 1xEV-DO       143         Data Application Unit (DAU)       145
<ul> <li>6.2</li> <li>7</li> <li>7.1.1</li> <li>7.1.2</li> <li>7.1.3</li> <li>7.2</li> <li>7.2.1</li> <li>7.2.2</li> <li>7.2.3</li> <li>8</li> <li>8.1</li> </ul>	Fading Scenario       126         CDMA2000 and 1xEV-DO Measurements       129         CDMA2000       129         Mobile Station Receiver Measurement in CDMA2000: Rx Meas       130         Fading Scenario       133         CMW Internal Fading for CDMA2000       135         1xEV-DO       137         Access Terminal Receiver Measurement in 1xEV-DO: Rx Meas       138         Fading Scenario       140         CMW Internal Fading for 1xEV-DO       143         Data Application Unit (DAU)       145         LTE       148
<ul> <li>6.2</li> <li>7</li> <li>7.1.1</li> <li>7.1.2</li> <li>7.1.3</li> <li>7.2</li> <li>7.2.1</li> <li>7.2.2</li> <li>7.2.3</li> <li>8</li> <li>8.1</li> <li>8.2</li> </ul>	Fading Scenario       126         CDMA2000 and 1xEV-DO Measurements       129         CDMA2000       129         Mobile Station Receiver Measurement in CDMA2000: Rx Meas       130         Fading Scenario       133         CMW Internal Fading for CDMA2000       135         1xEV-DO       137         Access Terminal Receiver Measurement in 1xEV-DO: Rx Meas       138         Fading Scenario       140         CMW Internal Fading for 1xEV-DO       143         Data Application Unit (DAU)       145         LTE       148         W-CDMA and with HSPA(+)       148
<ul> <li>6.2</li> <li>7</li> <li>7.1</li> <li>7.1.2</li> <li>7.1.3</li> <li>7.2</li> <li>7.2.1</li> <li>7.2.2</li> <li>7.2.3</li> <li>8</li> <li>8.1</li> <li>8.2</li> <li>8.3</li> </ul>	Fading Scenario       126         CDMA2000 and 1xEV-DO Measurements       129         CDMA2000       129         Mobile Station Receiver Measurement in CDMA2000: Rx Meas       130         Fading Scenario       133         CMW Internal Fading for CDMA2000       135         1xEV-DO       137         Access Terminal Receiver Measurement in 1xEV-DO: Rx Meas       138         Fading Scenario       140         CMW Internal Fading for 1xEV-DO       143         Data Application Unit (DAU)       145         LTE       148         W-CDMA and with HSPA(+)       148         GSM and (E)GPRS(2)       150
<ul> <li>6.2</li> <li>7</li> <li>7.1.1</li> <li>7.1.2</li> <li>7.1.3</li> <li>7.2</li> <li>7.2.1</li> <li>7.2.2</li> <li>7.2.3</li> <li>8</li> <li>8.1</li> <li>8.2</li> <li>8.3</li> <li>8.4</li> </ul>	Fading Scenario       126         CDMA2000 and 1xEV-DO Measurements       129         CDMA2000       129         Mobile Station Receiver Measurement in CDMA2000: Rx Meas       130         Fading Scenario       133         CMW Internal Fading for CDMA2000       135         1xEV-DO       137         Access Terminal Receiver Measurement in 1xEV-DO: Rx Meas       138         Fading Scenario       140         CMW Internal Fading for 1xEV-DO       143         Data Application Unit (DAU)       145         LTE       148         W-CDMA and with HSPA(+)       148         GSM and (E)GPRS(2)       150         TD-SCDMA       150
<ul> <li>6.2</li> <li>7</li> <li>7.1</li> <li>7.1.2</li> <li>7.1.3</li> <li>7.2</li> <li>7.2.1</li> <li>7.2.2</li> <li>7.2.3</li> <li>8</li> <li>8.1</li> <li>8.2</li> <li>8.3</li> <li>8.4</li> <li>8.5</li> </ul>	Fading Scenario       126         CDMA2000 and 1xEV-DO Measurements       129         CDMA2000       129         Mobile Station Receiver Measurement in CDMA2000: Rx Meas       130         Fading Scenario       133         CMW Internal Fading for CDMA2000       135         1xEV-DO       137         Access Terminal Receiver Measurement in 1xEV-DO: Rx Meas       138         Fading Scenario       140         CMW Internal Fading for 1xEV-DO       143         Data Application Unit (DAU)       145         LTE       148         W-CDMA and with HSPA(+)       148         GSM and (E)GPRS(2)       150         TD-SCDMA       150         CDMA2000 and 1XEV-DO       151

Dig IQ connectors at the CMW

9.1	Literature	.154
9.2	Additional Information	.154
9.3	Ordering Information	.155

## 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:

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

Supported	l fading			
		Technology	Internal Fading	External Fading with SMW
LTE (-A)		Predefined profiles acc. 3GPP.TS 36.101 Annex B	V	Ø
(FDD and	TDD)	Full user-defined fading settings		
3GPP	W-CDMA	Predefined profiles acc. 3GPP.TS 25.101 Annex B	V	
		Full user-defined fading settings		
		Predefined profiles acc. 3GPP.TS 25.101 Annex B		
		Full user-defined fading settings		
		Predefined profiles acc. 3GPP2 C.S0011	V	
3GPP2	ODMA2000	Full user-defined fading settings		
	1xEV-DO	Predefined profiles acc. 3GPP2 C.S0033	V	
		Full user-defined fading settings		
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

-Sala (Salat (River) (151) CONTEN 1999 UE 22 \*\*\* \$ \$ 0 = = 00 00 Dig out 2 Dig in 1 Ref out BBMM1 Ref in Coder 1 in out 0 -1 0.0° 0

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



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 Settings.	
Signal Routing (non-M	IIMO)
✓ A-►A	B <b>→</b> B
A -► A	B <b>−</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. 2-5: Calling the System Configuration to handle MIMO settings

System Configuration					_	×
Fading/Baseband Config	I/Q Stream Mapper	External RF and	I/Q Overview			
Set to Default				Basebands	Stre	eams
Mode	Advanced	•	вв		AA + A	-
Entities (Users, Cells)	Basebands (Tx Antennas)	Streams (Rx Antennas)			AB	
1 · X	2-	X 2.			X	
			RR	в	BA	
BB Source Config	Separate Sources	5			BB + B	-
			Entity 1			
Apply	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 Ref	erence Freq / LO Coupling
System Configuration	Refer	ence Frequency
Global Connectors	Source	External +
Reference Freq / LO Coupling	Deactivate RF Output (if exte	rnal reference is missing)
Internal Adjustments		
Baseband Powers	External Reference Frequen	cy 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.

th: RF Settings/RF Frequency/UL Ch	annel/Frequency	
-Duplex Mode	FDD	
Scenario	Standard Cell Fading	Fading: External
─Enable Data end to end ⊃IQ Settings ĖIQ Out	T.	
Connector Sample Rate Baseband PFP	DIG IQ OUT 2 - 100 Msps 0.000 dBFS	
Crest Factor	15.00 dB	
E−IQ In -Connector -Sample Rate -Baseband PEP	DIG IQ IN 1 100 Msps 0.000 dBES	

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 Inj	put Settings A	Baseband Input Settings A	_ ×
General Sample Rate Input Level Sig	nal Monitor	General	Sample Rate Input Level Signal Monitor	General Sample Rate Input L	evel Signal Monitor
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 Devi	ce			Auto Level Set	
Criw 500 (106691) dig id out 2				Crest Factor	15.00 dB ·
				Peak Level	0.00 dBFS •
				Level	-15.00 dBFS -

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 Facto	r
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.

/Q Digital Outpu	uts A >	< I/Q Digital Outputs A	_ ×
General	Signal Output OImpairments	OGeneral Signal Output	Impairments
State	Off Of	On Set Level Via	Peak Level +
Source	User Defined	Peak Level	0.00 dBFS -
Value	100.000 000 000 MHz	Level	0.00 dBFS ·
	Connected Device		
cmw 500 (10	08691) 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.

📴 Level Display Sett	ings A 📃 🗆 🖸
Display I/Q Output	Digital 💌
Set Level Via	PEP 🔹
Auxiliary Informatio	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.

в
В
А
в
(open)
A and E
A and B

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

#### Remote command:

SOURce1|2:FSIMulator:STANdard xxx

Fading A			-	And the second	_		×
O General Standard/Fine Delay	Restart Auto	Insertion Loss Config. / Coupled Parameters	Path Table	Path Graph			
Off On				Set Defa	To ault 🕝 Rec	all 🕒	Save
Standard	EPA 5	Hz	·				
Configuration	Standar	d/Fine Delay	• Fading C	lockrate	200 MHz		
Signal Dedicated To	Baseba	nd Output	Virtual R	F	2.646 00	00 000 00	GHz -
Ignore RF Changes	< 5%		On Frequen	cy Hopping Mode	e Off		

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

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

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

General Standard/Fine Delay Table Settings	Restart Auto	Insertion Loss Config Coupled Parameters	g. / Path Table	Path Granh		
				r aut oraph		
	5	Copy Path Group		1 To		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	
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

// VII Cuui

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*.

VGN Settings A		_ >
General Noise Power / Output Res	sults	
State	Of	f
Mode	Additive Noise	
System Bandwidth	10.000 (	0 MHz
Vin Noise/System Bandwidth Ratio		1
g. 2-22: AWGN settings general		
VGN Settings A		_ >
OGeneral Noise Power / Output Res	ults	
Show Powers For Output	RFA	-
Set Noise Power Via	C/N	
Reference Mode	Carrier	
3it Rate	100.000 000	kbps
Carrier/Noise Ratio	0.00	dB
Carrier/Noise Ratio Eb/N0	0.00	dB dB
Carrier/Noise Ratio Eb/N0 Carrier Power	0.00	dB dB dB
Carrier/Noise Ratio Eb/N0 Carrier Power Joise Power (System Bandwidth)	0.00 20.00 -30.00 -30.00	dB dB dB 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				a		-	×	
General Standard/Fine Delay	Restart Auto	Insertion Loss Config. / Coupled Parameters	Path Table	Path Graph				
		Insertion Lo	oss Configura	ation				
Mode N	Normal .							
Insertion Loss			10.	0 dB		1		
Clipped Samples	d Samples 0.00 %							
0	i i	i i i	1 1 1	i i i	r r r	100.0	00 %	
	_	Coupled Pa	arameters A =	=> B			_	
Speed Setting Coup	led						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 <sub>out SMW</sub>= Crest Factor <sub>In SMW</sub> – Insertion Loss

In our example:

Level BB out SMW = -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	<b>v</b>
E-IQ Settings	
i⊐ IQ Out	
Connector	DIG IQ OUT 2 🔫
-Sample Rate	100 Msps
-Baseband PEP	0.000 dBFS
Crest Factor	15.00 dB
⊡-lQ 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	LTE Transmission 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		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

TTE Signaling 1 BLER								LTE
Results			Cell Setup					Extended
Over All	Relative	Absolute	Operating Band	Band 4	9	FDD	<u>.</u>	BLER
ACK	58.23 %	52403	<u> </u>	David		I In Roll.		RDY
NACK.	41.73 %	37554		Downlink		Uplink		
DTX	0.05 %	43	Channel	2175 (	Ch	2017	5 Ch	
BLER	41.77 %		Frequency	2132.5	AHz	1732.	5 MHz	
Throughput	Relative	Mbit/s	Call Danduidth	40.0 MU-		10.0 M		-
Average	58.23 %	7.33	Cell Bandwidth	10.0 14112		TO'D W	1112	
Minimum		0.00	RS EPRE	-90.0 c	IBm/15kHz	C		1
·Maximum		12.59	Full Cell BW Pow.	-62.2 vi	Bm			
Subframes 100 000	100000 Scheduled:	90000	PUSCH Open Loo	p Nom.Powe	er	-2	0 dBm	Routing
			PUSCH Closed Lo	op Target P	ower	-20.	0 dBm	
			Connection Setu	ıp				
			Scheduling RMC		•			Display
				Downlink	l	Jplink		-
			#RB		50 🕶		12 -	
			RB Pos./Start RB	high 🔻	0	low +	0	
			Modulation	16	QAM -	C	PSK -	Signaling
			TBS Idx / Value	14	14112	6	1224	Parameter
			Throughput	12.586	Mhit/s	1.224	Mbit/s	
Свил	ection Established			-		-		LTE Signaling
PS: 🤰 RRC	State: Connected							ON

Fig. 3-3: LTE Extended BLER: BLER

S LIE SI	gnaling	g 1 BL	ER		_		_	_	_		_	_	_	_		_		_		LIE
CQI Rep	orting	g	_									-2.12		_	_					Extended
● <b>U</b> x:	Off	y:	-		•0	X	Off	Υ:	-		<b>Q</b> X:	Off	Y:				_			BLER
90000	🔶 Str	ream 1												1-1-1-1-						RDT
80000																				1.000
70000																				
60000																				-
50000																				
40000																				
30000																				
20000																				
10000																	in sub-		COLIndex	Routing
L	-	0	1	2		3	4		5	3	7	8	9	10	11	12	13	14	15	
CQI Id:	x (Stre	eam 1	1					8		10		9		7		6		11	5	
LCur	rent						1487	0	120	53		7349		7133		3247		2952	1660	Display
						11	Strea	m 1	-											
Median	CQI								8											Marker
						R	elativ	e Al	solute											
Range	CQI M	ledian	+/-1			5	8.73 %	6	29352											
Total Number of CQI Rep			49982												Signaling					
BLER						4	1.77 %	6												Parameter
Subfram	ies 🔲	100 00	00 / 1	0000	0															
P:	s: 🟓		onnec RC St:	tion E ate:	Stabli Co	she	d ted													Signaling ON
Select View		1			T									Y Sca (CQIF	le Report	t.)		(	Config	

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 Signaling Configuration	
◆ PCC ◆SCC1	
Path: Scenario	
-Duplex Mode	FDD -
• Scenario	1 Cell - Fading - 1 RF Out
-Fading	External 💌
Enable Speech Codec □IQ Settings □◆IQ Out	
Connector	DIG IQ OUT 2 🔻
Sample Rate	100 Msps
-Baseband PEP	0.000 dBFS
-Crest Factor	15.00 dB
id⊶ <b>∳</b> IQ In	
Connector	DIG IQ IN 1
Sample Rate	100 Msps
-Baseband PEP	0.000 dBFS
Baseband 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>?
```

- 6. 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.

<sup>F</sup> ading 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						
Clipped Samples	0.00 %					

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

FDD -					
1 Cell - Fading - 1 RF Out					
External 💌					
DIG IQ OUT 2 -					
100 Msps					
0.000 dBFS					
15.00 dB					
DIG IQ IN 1 🔁					
100 Msps					
0.000 dBFS					
-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.

r						
🚸 LTE Signaling Configuration						
◆ PCC ◆SCC1						
Path: IQ Settings/IQ Out/Crest Factor						
Duplex Mode	FDD -					
Scenario	1 Cell - Fading - 2 RF Out	▼				
Fading	External 💌					
-Enable Speech Codec						
⊟IQ Settings						
⊨⊶◆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				
⊡⊶ <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.

ading A					-	×
O General Standard/Fine Dela	Restart Auto	Insertion Loss Config. / Coupled Parameters	Path Table	Path Graph		
		Insertion Lo	oss Configura	ation		
Mode	Normal					
Insertion Loss						
Clipped Samples	0.00 %					

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

E-IQ Settings			
ia-IQ Out	Path 1	Path 2	
Connector	DIG IQ OUT 2 🔻	DIG IQ OUT 4 + 100 Msps	
-Sample Rate	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	DIG ID 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  $\rm IQ~IN$  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.



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.

Chroud	hnut								_					Extender
VIDIT/S	Off y:		1	<b>◆</b> Ũ ×:		Off y:		<b>\$</b> 9 :	×	Off	y:	-		BLER
20	Throughput :	ala											15	
	Median CQI :		1000 m		-			unge under		-			10	ļ
10	🔶 Median CQI	1										Subframe	5 es	-
1	-95000	-85000	-750	00 -6	5000	-55000	-45000	-3500	0 -2	5000	-15000	-5000		-
QI Re	porting													Routing
🖗 x:	Off y:		🔶 🖗 >	: Off	у:		🕽 🗶 🖸 C	f y:						restring
<b>Q</b> x:	Off y:		•Q >	: Off	<b>у</b> :		lig x ⊂	f y:	····		·			
00000 70000	Off y:		•0 >	: Off	y:		Qix C	fy:	· · · · · · · · · · · · · · · · · · ·			· · · · · · · · · · · · · · · · · · ·		Display
© x: 90000 70000 50000	Off y:		•0	e Off	у:		∎x c	fy:		1				Display
90000 70000 50000 30000	Off y:		•0	c Off	γ:		¥ I I I I I I I I I I I I I I I I I I I	f y:						Display
90000 70000 50000 30000 10000	Off y:		<b>•</b> 0 >	c Off	y:		jų x: C	fy:					CQI Index	Display
90000 70000 50000 30000 10000	Off y: Stream 1		2 3	E Off	y:	6	<b>₿</b> ∞ C	f y: 9	10	11	12 1	3 14	CQI Index 15	Display
00000 00000 00000 00000 00000 LER	Off y: Stream 1	1	2 3	t 4	y:	6	<b>9</b> x: C	f y: 9	10	11	12 1	3 14	CQI Index 15	Display Marker Signaling Paramete
00000 70000 50000 30000 10000 LER	0ff y: Stream 1 0 0.38	1	<b>↓</b> ♥ > 2 3 Through	e Off	y: 5 1)	1 6 7.64 Mbit	<b>19</b> ×: ⊂ 7 8 ∕ <b>s</b> Subfra	9 9 nes <b>1100</b>	10	11	12 1	3 14	CQI Index 15	Display Marker Signaling Paramet

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	<b>OL Spatial Multiplexing</b>	
	Graphic	eNodeB Antenna Stream 1 (Codeword) Stream 2 Stream 2 2	Instrument UE RF Out 1 Y 1 PF 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 Instrument Antenna U Stream 1 (Codeword) Stream 2 Stream 2 RF Out 1 V V V V V V V V V V V V V V V V V V V
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 💌 DCI Format 1B 🔻 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.



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.



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.

## LTE(-A) Measurements

Scenarios for one cell



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							
Pa	th: Scenario								
	-Duplex Mod	e	FDD V						
	Scenario		1 Cell - Fading -	MIMO4x2 - 2 RF Ou	ıt 🔽				
	Fading		External 💌						
	-Enable Spee	ech Codec							
Ē	□ IQ Settings □ □ ◆ IQ Out		Path 1	Path 1 Path 2 Path 3					
	Conn	ector	DIG IQ OUT 2 👻	DIG IQ OUT 4 🔻	DIG IQ OUT 6 🔻	DIG IQ OUT 8			
	Samı	ole Rate	100 Msps	100 Msps	100 Msps	100 Msps			
	Base	band 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 d					
	⊨ -◆IQ In		Path 1	Path 2	Path 3	Path 4			
	Conn	ector	DIG IQ IN 1 🖂	DIG IQ IN 3 💎	DIG IQ IN 5 🛛 👻	DIG IQ IN 7			
	Samj	ole Rate	100 Msps	100 Msps	100 Msps	100 Msps			
	Base	band PEP	0.000 dBFS	0.000 dBFS	0.000 dBFS	0.000 dBFS			
	Base	band Level	-15.000 dBFS	-15.000 dBFS	-15.000 dBFS	-15.000 dBFS			
Ę	RF Settings								
	👌 🔶 RF Out	put (TX)	Out 1	(	Out 2				
	Conn	ector	RF1COM 🔻		RF2COM -				
	Conv	erter	RETX1 -		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	Restart	Insertion Loss Config. /	Dath Tabla	Dath Graph		
Standard/Fine Delay	Auto	Coupled Parameters	Paul Table	Paul Graph		
		Insertion Lo	oss Configura	ation		-
Mode N	lormal					
Insertion Loss			16.0	) dB		
Clipped Samples			0.00	0 %		•
1		1 ( J )	1 ( ) (	1 1 F F	1 I I	1
1		1 I I I	I I I	1 1 1 1	+ + +	1

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

🚸 LTE Signaling (	Configuration							
PCC	♦SCC1							
Path: IQ Settings	s/IQ In/Baseband Level							
-Duplex Mod	le	FDD V						
Scenario		1 Cell - Fading -	MIMO4x2 - 2 RF Ou	ıt 💌				
Fading		External 🔻						
-Enable Spe	ech Codec							
IQ Settings								
i di		Path 1	Path 2	Path 3	Path 4			
Coni	nector	DIG IQ OUT 2 🔻	DIG IQ OUT 4 🔻	DIG IQ OUT 6 🔻	DIG IQ OUT 8			
Sam	ple Rate	100 Msps	100 Msps	100 Msps	100 Msps			
Base	band PEP	0.000 dBFS	0.000 dBFS	0.000 dBFS	0.000 dBFS			
Cres	t Factor	15.00 dB	15.00 dB	15.00 dB	15.00 dB			
⊟ <b>◆</b> IQ In		Path 1	Path 2	Path 3	Path 4			
Con	rector	DIG IQ IN 1 🛛 🔽	DIG IQ IN 3 🛛 🔽	DIG IQ IN 5 💎	DIG IQ IN 7			
Sam	ple Rate	100 Msps	100 Msps	100 Msps	100 Msps			
Base	hand PFP	0.000 dBES	0.000 dBES	0.000 dBES	0.000 dBES			
Base	band Level	-31.000 dBFS	-31.000 dBFS	-31.000 dBFS	-31.000 dBFS			
⊨ ⊓RF Settings								
⊨◆RF Ou	tput (TX)	Out 1	(	Dut 2				
Coni	nector	RF1COM -		RF2COM -				
Com	verter	RETY1 -		RETY3 V				

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.



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.

L DCC			
		◆PCC ◆ SCC1	
Path: RF Settings/RF Output (TX)/Connector		Path: Scenario	
Duplex Mode	FDD -	Duplex Mode	FDD 🕜
Scenario	2CC CA - Fading - 2 RF Out	- Scenario	2CC CA - Fading - 2 RF Out 💌
Fading	External 💌	- Fading	External 💌
Enable Speech Codec		SCC Activation Mode	Auto 💌
⊟IQ Settings ⊟◆IQ Out		Enable Speech Codec D-IQ Settings	
Connector	DIG IQ OUT 2 🔻	⊨	
Sample Rate	100 Msps	Connector	DIG IQ OUT 4 🔻
Baseband PEP	0.000 dBFS	Sample Rate	100 Msps
	15.00 0.5	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		100 Msps
Baseband Level	-15.000 dBFS	-Baseband PEP	0.000 dBFS
BE Output (TX)		Baseband Level	-15.000 dBFS
	RE1COM		
Connector		□ → KF Output (IX)	
Converter	RFIX1 -	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		
Path: IQ Settings/IQ In/Baseband Level		Path: IQ 3	Settings/	IQ In/Baseband Le	evel	
Scenario	2CC CA - Fading - 2 RF Out	Scen	nario			2CC CA - Fading - 2 RF Out
Fading	External	Fadi	ng			External 🕜
-Enable Speech Codec		+sc	C Activa	tion Mode		Auto
□ IQ Settings		Enab	ole Spee	ch Codec		Γ
i ⊡		⊨⊟-lQ Se	ettings			
Connector	DIG IQ OUT 2 🔻	<b>∲</b> …••	IQ Out			
Sample Rate	100 Msps		Conne	ector		DIG IQ OUT 4 🔻
-Baseband PEP	0.000 dBFS		Samp	le Rate		100 Msps
Crest Factor	15.00 dB		Baseb	and PEP		0.000 dBFS
i⊒◆IQ In			Crest	Factor		15.00 dB
Connector	DIG IQ IN 1 📝	<u> </u>	IQ In			
-Sample Rate	100 Msps		Conne	ector		DIG IQ IN 3 🗾
-Baseband PEP	0.000 dBFS		Samp	le Rate		100 Msps
-Baseband Level	-25.000 dBFS		Baseb	and PEP		0.000 dBFS
			Baseb	and 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:

- 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.

## LTE(-A) Measurements

Scenarios for Carrier Aggregation



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					
Pa	th: Sce	enario			Pat	Path: Scenario					
	Dupl	ex Mode	FDD			Duple	ex Mode	FDD 🔽			
	Scenario		2CC CA - Fading - 4 RF	2CC CA - Fading - 4 RF Out		- <mark>Scenario</mark>		2CC CA - Fading - 4 RF C	)ut 💌		
	Fadi	ng	External 🔻			Fadir	ng	External 💌			
	- Enab	le Speech Codec				- <mark>+</mark> SC	C Activation Mode	Auto 💌			
¢	⊢IQ Se	ettings			-	- Enab	le Speech Codec				
	<b>↓</b> ♦	IQ Out	Path 1	Path 2	ļ	⊟ IQ Settings					
		Connector	DIG IQ OUT 2 💌	DIG IQ OUT 4 🔻		<b>.</b>	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 🚽		<u> </u>	IQ 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	-15.000 dBFS	-15.000 dBFS			Baseband PEP	0.000 dBFS	0.000 dBFS		
ļ	⊢RF S	ettings				I	Baseband Level	-15.000 dBFS	-15.000 dBFS		
	÷	RF Output (TX)	Out 1	Out 2	Ē	RFS	ettings				
		- Connector	RF1COM 🔻	RF2COM 🔻		<b>∳</b> ♦	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).
- 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.

ading A					_	×		
O General Standard/Fine Dela	y Auto	Insertion Loss Config. / Coupled Parameters	Path Table	Path Graph				
		Insertion Lo	oss Configura	ation		-		
Mode	Normal							
Insertion Loss			10.	0 dB		-		

Fig. 3-49: The SMW shows the necessary insertion loss (example: 10 dB)

◆ PCC ◆ SCC1			<b>♦</b> P	СС	♦ SCC1				
Path: IQ Settings/IQ In/Baseband Level			Path:	Path: IQ Settings/IQ In/Baseband Level					
-Duplex Mode	FDD -		-D	uplex Mo	de		FDD 🕜		
-Scenario 2CC CA - Fading - 4 RF Out		-s	Scenario		2CC CA - Fading - 4 RF Out		•		
──Fading External ▼		F	ading			External 🔻			
-Enable Speech Codec				SCC Activ	vation Mode		Auto 💌		
D-IQ Settings		Path 2	E	nable Spe	eech Codec				
Connector	DIG IQ OUT 2 -			J Settings ≒-+0 Ou	t		Path 1		Path 2
Sample Rate	100 Msps	100 Msps		-Con	nector		DIG IQ OUT 6 🔻		DIG IQ OUT 8 -
-Baseband PEP	0.000 dBFS	0.000 dBFS		San	nple Rate		100 Msps		100 Msps
Crest Factor	15.00 dB	15.00 dB		Bas	eband PEP		0.000 dBFS		0.000 dBFS
	Path 1	Path 2		L-Cres	st Factor		15.00 dB		15.00 dB
Connector	DIG IQ IN 1	DIG IQ IN 3 📝	E	∃+lQ In			Path 1		Path 2
Sample Rate	100 Msps	100 Msps		Con	nector		DIG IQ IN 5 💎		DIG IQ IN 7 📃
Baseband PEP	0.000 dBFS	0.000 dBFS		San	nple Rate		100 Msps		100 Msps
Baseband Level	-25.000 dBFS	-25.000 dBFS		Bas	eband PEP		0.000 dBFS		0.000 dBFS
				Bas	eband 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	♦ SCC3	
Path: Fading				
Duplex Mo	de	F	DD 🔻 Use Carr	ier Specific: 🔲
Scenario		2	CC CA - Fading	- 4 RF Out - Distributed 🔻
Fading		E	xternal 🔻	
IQ Settings	1			

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)
- **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 - Configuration								
٠	PCC	SCC1	SCC2	•	SCC3			
Pa	ath: Scer	nario						
	Duplex Mode			FDD ▼ Use Carrier Specific: □				
	<sup></sup> Scenario <sup></sup> Fading			3CC CA - Fading - 6 RF Out				
				External 1	•		-	
E	∃ IQ Se	ttings						
	d⊶◆IQ Out				Path 1			Path 2
		Connector		1.DIG IQ O	)UT 2 🔻	1.	DIG IQ O	UT 4 🔻
		Sample Rate		100 Msps		10	0 Msps	
		Baseband PEP		0.000 d	BFS	0.	000 dl	BFS
		-Crest Factor		15.00 dB	}	15	5.00 dB	
	⊡·.◆IQ In			Path 1			Path 2	
		Connector		1.DIG IQ I	N 1 🔽	1.	DIG IQ II	13 🔻
		Sample Rate		100 Msps		10	0 Msps	
	Baseband PEP		0.000 dBF	S	0.	000 dBFS	5	
	Į l	-Baseband Level		–15.000 dE	BES	-1	15.000 dE	<b>FS</b>
E	□ RF Settings							
			Ou	t1	Out	2		
		· Connector · Converter		1.RF1COI	V V	1.RF2COM	-	
				1.RFTX1	-	1.RFTX2		
		External Attenuati	on	0.00 dB		0.00 dB		
		External Delay Co	mpensati	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?

- 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.

O General Standard/Fine Delay	Auto	Insertion Loss Config. / Coupled Parameters	Path Table	Path Graph	
		Insertion L	oss Configura	tion	
Node	Normal	-			
nsertion Loss			16.0	) dB	
Clipped Samples			0.00	) %	
	- ( ) (	i i i i	I i i	1 F F F	· · · · · · · · · · · · · · · · · · ·

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	
⊡ ◆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. 3-56: 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		5003			
	0001	0002		0000			
Path: IQ Setting	s/IQ Out/Connecto	)r					
Duplex Mode			FDD 🔻 Use Carrier Specific: 🗌				
Scenario			4CC CA -	Fading	- 8 RF Out	•	
Fading			External <sup>•</sup>	-			
🖻 Base Band							
			1.SUW1	-			
IQ Settings	;						
🖻 🔶 IQ Ou	t			Path 1		Path 2	2
Con	nector		1.DIG IQ (	DUT 2 🔻		1.DIG IQ OUT 4	•
San	nple Rate		100 Msps			100 Msps	
Bas	eband PEP		d 000.0	BFS		0.000 dBFS	
<sup>L</sup> Cres	st Factor		15.00 dE	}		15.00 dB	
⊡·•◆IQ In			Path 1		Path 2	2	
Con	nector		1.DIG IQ I	N 1 🝸		1.DIG IQ IN 3 🔽	
San	nple Rate		100 Msps			100 Msps	
Bas	Baseband PEP		0.000 dBF	S		0.000 dBFS	
Bas	eband Level		–15.000 dE	BFS		-15.000 dBFS	
B RF Setting	S						
📄 🛉 RF Oເ	ıtput (TX)		Ou	it 1	0	ut 2	
Con	nector		1.RF1C0	M 🗖	1.RF2C0	)M 🔻	
Con	verter		1.RFTX1	-	1.RFTX3		
Exte	ernal Attenuation	I	0.00 dB		0.00 dB		
External Delay Compensati 0 ns							
□ ◆RF Input (RX)					1	In	
Con	nector		1.RF1C0	м 🔻			
Con	verter		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:SCC2: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:PATH1?
```

- 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.

General Standard/Fine Delay	Restart Auto	Insertion Loss Config. / Coupled Parameters	Path Table	Path Graph		
		Insertion Lo	oss Configura	ation —		
Mode N	Normal					
Insertion Loss	16.0 dB ~					
Clipped Samples			0.0	0 %		
	- ( - (	1 I I I	1 i i	1 F F F	+ + + - <u> </u>	

Fig. 3-59: 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	
⊡ ◆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
- 1 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 Signali	ng Configuration		
PCC	♦SCC1		
Path: Fading			
-Duplex I	Mode	FDD -	
Scenario	)	1 Cell - Fading - 1 RF Out	-
Fading		Internal 🔻 Fader 1 💌	
Enable S	Speech 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)

⊟⊸Internal Fading		
⊨ Fading Simulator		
- Enable		
- Profile	EPA 5Hz Low	-
	EPA 5Hz Low	-
Trester Event	EPA 5Hz Medium	
Start Seed	EPA 5Hz High	
insertion Loss	EVA 5Hz Low	
Donnler Frequency Mode	EVA 5Hz Medium	
	EVA 5Hz High	
Doppler Frequency	EVA 70Hz Low	
tian 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	
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).



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

### BER

🗞 WCDMA UE RX Measurement 1 - X3.0.30.7						WCDMA
BER HSDPA ACK RLC Throughput E-HIC	H UL Loggin	1				BER
Connection Status	Cell Setup					RDY
Cell HSDPA	Band	Band 1				
Circuit Switched		Downlink	1	Uplink	-	
	Channel	10563	l Ch	9613	Ch	
Packet Switched Attached	Frequency	2112.6	MHz	1922.6	MHz	
CMW Demod. Info	Output Power	-80.00	l dBm			
DDOL Aighment 1019.03 Cmp	Total Output	-80.00	) dBm			
	Scrambling Code	0	hex	D	hex	
	P-CPICH -	-11.0	dB	Code	Ũ	
	PS Domain	Reduced :	Signaling			
Results	Connection Setu	p				
BER 0.311 %	UE term. Connect	Test Mo	de			-
BLER 0.000 %	Туре	RMC			E	
DBLER 2.000 %	Data Rate DL 1.	.2 kbps UL	12.2 kbp	IS		
Lost Transp.Blocks 0	Test Mode Loop	Mode 1 BLC	1			
UL TFCI Faults NCAP	and the second					Signaling Parameter
FDR NCAP						
PN Discontinuity 1						WCDMA-UE Signaling
Transport Blocks 100 / 100						ON
Disconnect RMC	S	end MS	Handover	r 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.

```
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.

```
//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?
```

SISO Configuration

### E-HICH

, W	COMA UE	<b>RX Measurement</b>	1 - X3.2.60.39 - B	ase V 3.2.21	-			
C	BER	HSDPA ACK	E-HICH	RLC Th	roughput	UL Logging		
12 10 8 5 4 2	Mb#/s	8000 -16000 -1	4000 -12000	-10000 -80	00 -6000	Subfram -4000 -2000	Throughpu Overall Carrier 1: Carrier 2: Max. Pos. Carrier 1: Carrier 1: Carrier 1: Carrier 1: Carrier 1: Carrier 1:	t Curr.
Ove	erall Thr	oughput Current	11.484 Mbi	t/s Average	11.484 Mbit	5	-	
The	roughpu	nt [Mbit/s]	Carrier 1	Carrier 2	E-HICH Re	ception	Carrier 1	Carrier 2
Cus	ment	_	5.742	5./42	False	_	7000	7000
Ave	erage	_	5./42	5./42	Correct		7900	7900
Ma	ximum		5.742	5.742	All Valid	10/1	7900	7900
MIL	amum	-	5.742	5,742	Faise Ratio	[%]	0.000	0.000
Ma	K. POSSI	Die	5./42	5.742	CRC		Carrier 1	Carrier 2
EX	pected M	1ax.	5./42	5./42	Correct		7900	7900
					Error		0	0
Mea	asured Fi	rames		7900	BLER [%]		0.000	0.000
62	DICHS DICHS	OPA+CEC Circuit	l Switched Tered	1	Packet Swite	hed:	Power C Sync: C	

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.

### **SISO** Configuration



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							
Enable Speech Codec	<b>—</b>						
IQ Settings							
i iQ Out							
Connector	DIG IQ OUT 2 🔻						
Sample Rate	100 Msps						
Basehand 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.

ading A				-	-	×	
General Standard/Fine Dela	y 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 %						



SISO Configuration

🚯 WCDMA Signaling Configuration									
Path: IQ Settings/IQ In/Baseband Level	IQ Settings/IQ In/Baseband Level								
Scenario	Standard Cell Fading	▼ Fading: External ▼							
Enable Data end to end	V								
Enable Speech Codec									
i⊐-IQ Settings									
i 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.

WCDMA UE F	RX Measurement 1 - 3	K3.0.30.7	_								WCDMA
BER	HSDPA ACK	RLC Through	put	E-HICH	UL	Logging					HSDPA
25 Mbit/s 20 15									CQI No 25 20	Throughput: Current Max. Possible Median CQI:	ACK RDY
5								Subframes	15 10 5		
-9500	-8500 -7500	-6500 -6	5500	-4500	-3500	-2500	-1500	-500			
Max. possibl	e Throughput		20.3	852 Mbit/s		(bas	ed on set	tings)			ļ
Throughput		(	Current	t	Maxi	mum		Minimum		Scheduled	1
Measured (M	lbit/s]		10.931	-	14	2.822		10.380		20.352	Display
tel. IO max. Franceniccio	possible [%]		53./10 Sont		6.	3.000 ACK		DI.UUU NACK		100.000	
1	ns [/u]		53 700		20	ACA 9.050		70.950		0.000	
5			38 110		8	3 600		16 400	-	0.000	
3			6.260		6	9.169		30.831	_	0.000	L
4			1.930		99	9.482		0.518		0.000	Signaling
L BLER	46.290 % Median C	QI <b>29</b> Measu	red Sub	frames	10 000	/ 10000					Paramete
HSDP HSUF	A+ CS:	Established		PS: ]	Con	nection Es	lablished	Pov In S	ver in R. Sync	ange	WCDMA-L Signaling
	Disconnect	ſ		Ĩ		Se	end	Hande	ver	Config	

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		
Path: Scenario		
Scenario	Standard Cell Rx Dive	sity Fading 🔻 Fading: External 💌
─Enable Data end to end ─Enable Speech Codec ⊟~IQ Settings		
i⊐ IQ Out	Path 1	Path 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	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. 4-12: 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.

- 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.
- 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.

Rx Diversity Configuration (SIMO)





Fading A					_ ×
General Standard/Fine Dela	y Auto	Insertion Loss Config. / Coupled Parameters	Path Table	Path Graph	
		Insertion Lo	oss Configura	ation —	
Mode	Normal				-
Insertion Loss			10.	0 dB	÷
Clipped Samples	1		0.0	0 %	-

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

🚸 WCDMA Signaling Configuration						
Path: IQ Settings/IQ In/Baseband Level						
	Standard Cell Rx Diversity Fading 🔻 Fading: External 💌					
Enable Speech Codec						
p⊷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				
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	-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.

Routing (Or	utput)	Carrier 1	-	Carrier 2		×
RF Connector: RF Converter:		RF1COM ·		RF1COM		•
		RFTX1 -		RFTX2		
IQ Out Conne	ctor:	DIG IQ OUT	2 -	DIG IQ O	UT 4	•
IQ In Connect	or:	DIG IQ IN 1	•	DIG IQ IN	3	•
Scenario	Ro (O	uting utput)	Exte (Ou	ernal Att. tput)	Ro (Ir	utin Ipu



🚯 MCDW	IA Signaling Configuration		
Path: Sc	enario		
Scei	nario	Dual Carrier Fading	🔻 Fading: External 💌
Ena	ble Data end to end	V	
- Enal	ble Speech Codec		
⊟⊸IQ S	ettings		
<b>⊨</b> ⊡I	Q 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
<b>⊡</b> …	Q 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.

- 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.



Fig. 4-19: SMW settings for fading two paths.

<sup>F</sup> ading 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	0 %	•

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	M	
Enable Speech Codec		
IQ Settings		
D IQ 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
⊟IQ 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.

S WCDMA UE RX Measurement 1 - X3.0.30.7								WCDMA	
BER HSDPA ACK	RLC Throug	hput	E-HICH	UL Logg	ling				HSDPA
40 Mbit/s								overall	ACK RDY
							20	Carrier 1 Carrier 2	
20						1	10 M	Max. Possible edian CQI Curr.	
						Subframes		Carrier 1 Carrier 2	
-9500 -8500 -7500	-6500	-5500	-4500	-3500 -25	00 -1500	-500			
Max. possible Throughput	40.704	Mbit/s (l	ased on	settings)	Overall Throug	hput:	23	.486 Mbit/s	
		C	arrier 1			C	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	NACH	C DTX	Sent	ACK	NACK	DTX	
1	57.050	38.265	61.735	5 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	2 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	30 Meas	ured Subf	rames 10	000 / 10000	-		1	Signaling Parameter
Carrier 2: DL BLER 41.580 %	Median CQI	30							
	Established	17	PS:	Connection	rEstablished	Pow In S	ver In Rang ync	E	WCDMA-UE Signaling ON
Repetition		Measur Subfrar	e N nes H	4onitored 1-ARQ	Error Insertion		c	onfig	

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.



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

1. 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)						
	Carrier 1		Carrier 2			
RF Connector:	RF1COM	•	RF2COM	٠		
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.

🚸 WCDMA Signaling Configuration		
Path: Scenario		
Scenario	Dual Carrier Rx Diversity Fadin	ig 🔻 Fading: External 🔻
Enable Data end to end	V	
Enable Speech Codec		
□ □ IQ Settings		
i iQ Out	Path 1	Path 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	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.

- 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.
- Establish a W-CDMA connection between the CMW and DUT, e.g. using CONNECT HSPA TM.
- I/Q Mod A RFA Baseband A Fading AWGN On On On I/Q Analog A MSK A 0 I/Q OUT 1 à Σ On 0 A s BB Input A CODER 1 t I/Q Digital 🗸 On r e BBMM 1 a m V On On **⊘**On CODER 2 BB Input B BBMM 2 BBMM 2 м a V On ppe в I/Q Analog B :0: I/Q OUT 2 0 Baseband B On R On I/Q Mod B RF B RF B MSK G Case 6 AWGN On On
- 8. If you modify the fading, remember to change the level accordingly in the CMW.

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

	~					1		
General Standard/Fine Delay	Auto	Insertion Loss Config. / Coupled Parameters	Path Table	Path Graph				
		Insertion Lo	oss Configura	ation				
Mode	Normal					-		
Insertion Loss		16.0 dB						
Clipped Samples	0.00 %							
0	i i		1 1 1	у т. н. н.	1 1 1	0.00 %		

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.

WCDMA UE RX Measurement 1 - X	3.0.30.14	_								WCDMA	
BER HSDPA ACK	E-HICH	RLC Th	oughput	UL Log	ging					HSDPA	
40 Mbit/s								CQINo Throughput Curr.		ACK RDY	
L	-				_	-	-	20	<ul> <li>Carrier 1</li> <li>Carrier 2</li> </ul>		
20	1.1.1.1	1.000						10	Max. Possible Median CQI Curr.		
							Subframes		Carrier 1		
-9500 -8500 -7500	-6500	-5500	-4500	-3500 -25	500	-1500	-500	1	Carner 2		
Max. possible Throughput	40.704	Mbit/s (	based on	settings)	Over	all Throug	hput:		28.417 Mbit/s		
		(	Carrier 1				(	Carrier 2			
Throughput	Curr.	Max.	Min	. Sch'ed.		Curr.	Max.	Mi	n. Sch'ed.		
Measured [Mbit/s]	14.409	14.959	12.618	8 20.352		14.008	14.891	12.61	8 20.352	-	
Rel. to max. possible [%]	70.799	73.500	62.000	0 100.000		68.829	73.167	62.00	0 100.000	Display	
Transmissions [%]	Sent	ACK	NACI	K DTX		Sent	ACK	NAC	K DTX	and the second s	
1	70.780	61.543	38.457	7 0.000		68.850	57.865	42.13	85 0.000	1	
2	27.240	93.025	6.97	5 0.000		28.990	92.687	7.31	3 0.000		
3	1.900	95.789	4.21	1 0.000		2.120	98.113	1.88	87 0.000		
4	0.080	100.000	0.000	0 0.000		0.040	100.000	0.00	000.0 00	o and a line	
Carrier 1: DL BLER 29.200 %	Median CQI	30 Mea	sured Subf	frames 10	000 /	10000	_			Parameter	
Carrier 2: DL BLER 31.170 %	Median CQI	30									
CS: Call	Established		PS:	Connectio	n Esta	blished	Pow In S	ver In Rai ync	nge	WCDMA-U Signaling ON	
Repetition		Measu	mes	Monitored H-ARO	Erro	ertion		Ì	Config		

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.



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.

Scenario	Ro (O	uting utput)	Exte (Ou	ernal Att. tput)	Routin (Input
IQ In Connect	or:	DIG IQ IN 1	•	DIG IQ IN	3 \star
IQ Out Conne	ctor:	DIG IQ OUT	2 +	DIG IQ O	UT 4 🔻
RF Converter:		RFTX1		RFTX2	
RF Connector:		RF1COM	RF1COM TRF1CO		*
		Carrier 1		Carrier 2	
🚯 Routing (Ou	(truct)	6	_		8

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

🚸 WCDMA Signaling Configuration						
Path: Scenario						
Scenario	Dual Carrier / Dual Band Fading					
Fading	External 🔻					
⊟-IQ Settings						
⊟-lQ 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	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 HSDF	A	
Converter	RFRX1 🔻	
Ext. Attenuation	0.0 dB	
Ext. Delay Comp.	0 ns	
🖻 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.

```
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.



Fig. 4-34: SMW settings for fading two paths.

ading A				-	_	×
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			0.0	0 %		*

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 / Du	ual Band Fading
Fading	External 🔻	
🖻 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	14.41 dB	13.23 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	-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 Measurement 1 - V3.5.20 - Base V 3.5.11						- 🛛
🔍 BER 💛 HSDF	PAACK 💽 HSDPA	CQI 💽 E-HIC	H 🕘 E-AGCH 🤇	E-RGCH 🕓	RLC Throughpu	t 💽 🔳
Overview Carrier 1	Carrier 2					
4 2	Alexan Hala Alexandria	<b>\}<sup>\$</sup>\}#\}\}</b>		Subframes	CQ  Throughput Overali ∳ Cu Max. Pos: ∳ Cu 20	rr. ✦Avg. rr.
-55000	-45000 -350	00 -2500	0 -15000	-5000		
Measured Subframe	es 61700					
	Overall		Carrier 1		Carrier 2	
DL BLER [%]				35.530		38.880
Median CQI				17		20
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	75.000
Average	2.936	62.853	1.505	64.442	1.431	61.263
Maximum			2.336	100.000	2.336	100.000
Minimum			0.397	17.000	0.187	8.000
Scheduled			2.336	100.000	2.336	100.000
HSUPA	CPC Circuit Switched	:	)))) Connecti	Switched: on Established	🥭 s	ower: Ok ync: Ok

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 / D	ual Band Rx Dive	rsity Fading 🔻	1
Fading	External 🔻			
🖻 IQ Settings				
🖻 IQ Out	Path 1	Path 2	Path 1	Path 2
Connector	DIG IQ OUT 2 🔻	DIG IQ OUT 4 🔻	DIG IQ OUT 6 🔻	DIG IQ OUT
-Sample Rate	100 Msps	100 Msps	100 Msps	100 Msps
	0.00 dBES	0.00 dBES	0.00 dBES	0.00 dB
-Crest Factor	15.00 dB	15.00 dB	7.10 dB	7.10 dB
⊡-lQ In	Path 1	Path 2	Path 1	Path 2
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	0.00 dBFS	0.00 dBFS	D.00 dBFS	0.00 dBFS
Baseband Level	-15.00 dBFS	-15.00 dBFS	-7.10 dBFS	-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.

- 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).
- 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).
- 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.

### W-CDMA and HSPA(+) Measurements

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

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

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





Fading A					_ >
General Standard/Fine Dela	y Auto	Insertion Loss Config. / Coupled Parameters	Path Table	Path Graph	
		Insertion L	oss Configura	ation —	
Mode	Normal				
Insertion Loss			10.	0 dB	
Clipped Samples			0.0	0 %	

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

8. 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 🔹
⊞-RF Settings	

Fig. 4-45: WCDMA scenario with internal fading

### Remote commands:

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

⊡-Internal Fading ⊡-Fading Simulator		
Enable	V	
Profile	Case 1	-
	Case 1	
Restart Lyent	Case 2	
Start Seed	Case 3	
-Insertion Loss	Case 4	
	Case 5	
Copped Samples	Case 6	
Doppier Frequency	Case 8	
⊞ 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.

⊟…Fa	ding Module AWGN		
-	Enable		
-	Noise	-7	0.00 dBm
:		-	

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		Traffic Mode	Managementan	Test					
(measure mode)	Full rate (FR Vx)	Half Rate (HR)	AMR	Measurement on	гоор				
Burst by Burst	V	V	V	Burst	С				
BER	$\square$	$\overline{\mathbf{A}}$	V	Speech frame	В				
RBER/FER	$\mathbf{\nabla}$	$\overline{\mathbf{A}}$	V	Speech frame	А				
FER FACCH	$\square$	$\overline{\mathbf{A}}$	V	Frame	-				
FER SACCH	$\square$	$\overline{\mathbf{A}}$	V	Blocks	-				
RBER/UFR		$\overline{\mathbf{A}}$		Speech frame	D				
AMR Inband FER			V	Speech frame	Ι				
Mean BEP <sup>1</sup>	V	V	V	Burst	С				
Signal Quality <sup>1</sup>	$\checkmark$	$\checkmark$	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	62	CCM00		
Circuit Switchod	Synchronizod				Channel / Danu	bΖ	G2Wanr	J	×
	Synchronized				Level			-60.00	dBm
Packet Switched 🔼	Attached				PMax (PCL)	5		33.00	dBm
RX Power					PS Domain	V			
					TCH/PDCH Carrier 1	PDCH Ca	rrier 2		
Event Log					Channel / Band	62	GSM900		
08:42:52 () TBF Released				-		Downlink		Uplink	
08:42:28 TBF Established					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 Circuit   Packet Sw.Slot	DL: 000	•••••		
ws Capabilities	<u> </u>				Auto Slot Config	0L.	Edit		
Ext. Dyn. Allocation	support						Lun		
GPRS					Circuit Switched P	acket Swite	hed		
EGPRS	UNTE		COM		Traffic Mode	FR V1			•
GSM FR GSM HR GSM EFR			6310		PCL Timeslot	FR V1 FR V2 HR V1 AMR-NB FI	R GMSK		
CS Connect Connect			_	Send C	AMR-NB H AMR-NB H AMR-WB F AMR-WB F AMR-WB F	R GMSK R 8PSK R GMSK R 8PSK IR 8PSK			

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 (	Comment					
	Α	в	BLER	SRB	oonnen			
PS BER	V	V		V				
BLER			V					
RLC Throughput	V	V	V	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	Synchr	ronized			Level				-60.00	dBm
Packet Switched 📃	Attach	ed			PMax (PCL)		5		33.00	dBm
RX Power					PS Domain					
					TCH/PDCH Ca	rrier 1	PDCH C	arrier 2	]	
Event Log					Channel / Band		62	GSM900		
08:42:52 TBF Released	4			<b>^</b>			Downlink		Uplink	
08:42:20 TBF Released	4				Frequency		947.4	MHz	902.4	MHz
08:39:33 🛉 TBF Established	1				DL Reference L	evel	-60.00	dBm		
08:36:55 TBF Established 08:36:48 TBF Released	•		 	•	Connection Se Circuit Switched Packet Switched Circuit   Packet Sv OUL Measurement	etup Slot Slot w.Slot Slot	DL: 00 UL:	0000	00 00000	
Ext Dup Allocation		ort			Auto Slot Config	g 🗆		Ed	it	
GPRS	supp	UIL			Circuit Switch	ed F	acket Swi	tched		
EGPRS		MTC	CSM		Service		SRB		-	
GSM FR GSM HR GSM EFR FR AMR		14113	GSM	•	DL Dual Carrier Max Throughput	t	Test Mode Test Mode BLER SRB	e A e B		kbit/s
CS Connect	Ĭ		PS Connect			Send (	S SMS		Conf	ig

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 Multislot Class GPRS	✓ 10 (4 Dn/2 Up/5 Sum)	Connection Setup Circuit Switched Slot Packet Switched Slot Circuit   Packet Sw.Slot OUL Measurement Slot	DL: 000000000				
EGPRS 	10 (4 Dn/2 Up/5 Sum) 	Auto Slot Config 🔽	Edit Packet Switched				
		Service	BLER / e2e:max DL 🗸				
		DL Dual Carrier Max Throughput	Test Mode A / e2e:max UL Test Mode B / e2e:symmetric 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

Y				۲ <u>ــــــــــــــــــــــــــــــــــــ</u>	1					
• PS BER • PS BLER •	OCS BER	RLC Th	roughput	CMR Performa	nce					
Results				Cell Setup						
@ Measure Mode	BER			BCCH						
Class II			0.00 %	Channel / Band		62	GSM900			
Class Ib			0.00 %	Level				-60.00	dBm	
L-CRC Errors			0	PMax (PCL)		5		33.00	dBm	
peech Frames				PS Domain						
		318 /	/ 100000	TCH/PDCH Carrier	1 PD	CH (	Carrier 2	]		
				Channel / Band		62	CSM000			
					Downlink		030000	Uplink		
				Frequency	9	47.4	MHz	902.4	MHz	
				DL Reference Level	-6	).00	dBm			
				Connection Setup Circuit Switched Slot Packet Switched Slot Circuit   Packet Sw.Slot OUL Measurement Slot	t	DI UI	: 000• : 0	0000 00 <b>0</b> 0000		
				Traffic Mode		FF	L V1			•
				PCL			10	23.00 dB	m	
				Timeslot			3			
				Data Source		PF	RBS 2E9-1			•
un cs: 💥 Call Establish	ed	DQ.		hed	DL:		•0000	MCS-6		

#### 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 Through	put C	RLC Throughput     CMR Performance					
Results	- <b>1</b> - 1		-0					Cell Setup BCCH				
ay measure m ⊟Carrier 1	oae	BER	DBLER	USF BLER	False USF	Non Assign.	CRC Errors	Channel / Bar Level	nd	6 <mark>2</mark>	GSM900 -60.00	dBn
Slot0/0	ff	[70]	[%]	[%]	Dec[%]	03F		PMax (PCL)		5	33.00	dBr
-Slot1/O	uff –							PS Domain		V		
-Slot2/O	ff							TCH/PDCH (	Carrier (	1 Pnr	'H Carrier 2	1
-Slot3@	-6	14.51	100.00	0.00			NCAP		Junior	1.00	an Ganner z	-
Slot4/O	ff							Channel / Bar	ıd	62	GSM900	
-Slot5/O	ff									Downlink	: Uplink	(
-Slot6/O	ff							Frequency		947.4	MHz 902.4	MH
-Slot7/O	ff							DL Reference	Level	-60.00	dBm	
<sup>i</sup> Over all		14.51	100.00	0.00			NCAP	<i>c r</i>	<b>C</b> 4			
Radio Blocks 100 / 100 Circuit Switched Slot Circuit J Packet Sw.Slot Circuit J Packet Sw.Slo												
								Service		SRB		
								Data Source		PRBS 2	E9-1	
🔊 cs: 🚬	Syn	chronized	1	P	S: 🚬 T	BF Establis	hed	DL: O UL:		 >>>> •••>>>>>	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 ORLC	C Throughput	• CMR Perfe	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	dBm
Slot2/Off				PMax (PCL)	5	33.00	dBm
Slot3@-60dBm	0.00	666	29.50	PS Domain	<u>्</u>		d D m
Slot4@-60dBm	0.00	667	29.54	TOURDOULD			1
Slot5@-60dBm	0.00	667	29.54	TCH/PDCH Carrie	r 1   PD0	CH Carrier 2	
-Slot6/Off				Channel / Band	62	GSM900	
Slot7/Off					Downlin	k Uplink	:
Over all	0.00	2000	88.59	Frequency	947.4	MHz 902.4	MHz
Long-Term Throughput:				DL Reference Level	-60.00	dBm	
Over All	88.59 kbit/s Per Slo	ot 29.5	3 kbit/s				
RLC Data Blocks		2 00	D / 2000	Connection Setup			
Corrupted Blocks			_	Packet Switched Slot	ni oc	00000	
False ACKed Blocks			_	Circuit   Packet Sw.Slo OII Measurement Slot	t UL:	000000	
				Cor measurement slot		Edit	
						Luitin	_
				Service	BLER		7
				DL Dual Carrier			
CS: Synchronize	ed PS	S: TBF Est	ablished	DL: 000•	••••	MCS-6	

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							
Coding schemes			Used crest factor				
		Modulation	Call established	Dual Carrier Call established			
Normal voi	ce call						
GPRS	(CS 14)	GMSK	6.00 dB	9.54 dB			
EGPRS	(MCS 14)						
EGPRS	(MCS 59)	ODOK	0 22 dP	10.77 dP			
EGPRS2	(DAS 57)	oron	9.23 UB	12.77 UD			
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	🚸 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 lQ Out							
Connector	DIG IQ OUT 2 👻						
Sample Rate	100 Msps						
Baseband PEP	0.0 dBFS						
Crest Factor	0.0 dB						
⊡-IQ 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.

Fading A					_ >			
General Standard/Fine Dela	y 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	0 %				

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	
i⊐IQ Settings i⊐IQ Out	
Connector	DIG IQ OUT 2 🔻
Sample Rate	100 Msps
Baseband PEP	0.0 dBFS
Crest Factor	6.0 dB
i ⊡⊶lQ 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 M	easurement				
• PS BER • PS BLER	OCS BER ORLO	C Throughput	<ul> <li>CMR Performance</li> </ul>	rmance	
Carrier 1	BLER [%]	RLC Data Blocks	Data rate [kBit/s]	Cell Setup BCCH	
Slot0/Off				Channel / Band	20 GSM900 🗠
Slot1/Off				Level	-60.00 dBm
Slot2/Off				PMax (PCL)	5 33.00 dBm
Slot3@-60dBm	12.46	666	25.86	PS Domain	
Slot4@-60dBm	11.54	667	26.17	TCU/DDCU Coordoo 1	
Slot5@-60dBm	11.69	667	26.13	TCH/PDCH Carrier	PDCH Carrier 2
Slot6/Off				Channel / Band	62 GSM900
Over all			79.45		Downlink Uplink
Over all	11.90	2000	70.15	Frequency	947.4 MHz 902.4 MHz
Long-Term Throughput:			_	DL Reference Level	-60.00 dBm
Over All	78.02 kbit/s Per Sl	ot 26.0	1 kbit/s		
RLC Data Blocks		2 000	) / 2000	Connection Setup	
Corrupted Blocks			_	Packet Switched Slot	
False ACKed Blocks				Circuit   Packet Sw.Slot	
				OUL Measurement Slot	Edit
					Luit
				Service	BLER
				DL Dual Carrier	
)»ı		»L			MCS.6
Synchronized	PS	s: 🔼 IBFEst	ablished	UL: 00	00000 MCS-1

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				
	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	$\checkmark$	62	$\checkmark$	124	3	5
Entry [ 5 - 9 ]		7		9	$\Box$	11	13	15
Entry [ 10 - 14 ]		17		19	$\Box$	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	52	54
Entry [ 30 - 34 ]		56		58		60	64	66
- Entry [ 35 - 39 ]		68		70	$\Box$	72	75	78
Entry [ 40 - 44 ]		80		82	$\Box$	84	86	88
Entry [ 45 - 49 ]		90		92		94	96	100
Entry [ 50 - 54 ]		102		105	$\Box$	108	109	111
Entry [ 55 - 59 ]		114		980	$\Box$	990	995	1001
Entry [ 60 - 63 ]		1005		1009	$\Box$	1011	1021	
			Арр	ly	U	ndo	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						-	×
O General Standard/Fine Delay	Restart Auto	Insertion Loss Config. / Coupled Parameters	Path Table	Path Graph			
Off On				C Set Def	To ault 🕞 Reca	0	Save
Standard	GSM H	T 100 (12Path)	•				
Configuration	Standar	d/Fine Delay	- Fading C	Clockrate	200 MHz		
Signal Dedicated To	RF Out	put	- Virtual R	F	947.400	000 00	MHz
Ignore RF Changes	< 5%		On Frequen	cy Hopping Mod	le In 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
```

5. 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	Extern Step
Reset	
Dwell Time	10.000 ms -
Current Index	0
List Mode Data	testgsm
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	.00
2	935 200 000.000		-70	.00
3	947 400 000.000		-70	.00

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	DL2: 000 • 00 DL: 000 • 00 UL: 000	000 000 00000 dit
Circuit Switched	Packet Switched	
Circuit Switched	T deket Switcheu	
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	V

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

🛱 Internal Fading	
⊨Fading Simulator	
<mark>Enable</mark>	
Profile	TU3 (6 path) 🔻
	TI5 (2 path) 🔺
	TU1.5 (6 path) TU3 (6 path)
⊡-Insertion Loss	TU3.6 (6 path)
Doppler Frequency Mode	TU6 (6 path) 👘
Donnler Frequency	TU25 (6 path)
	TU50 (6 path)
	1060 (6 path)
⊞∾Fading Module AWGN	TU100 (6 path)
⊞Network	HT100 (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)

E-Fading Module AWGN		
Enable	~	
Min. Noise/System BW Ratio	1.5	
Noise Bandwidth	0.22	MHz
Effective Signal BW	0.20	MHz
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 - V3.2.20								TDSCDMA
e Ber								ого
Connection Status	Cell S	etup					í	
Cell	Band:			A: 201	0.8MHz	~2024.2MHz	-	KUT
Circuit Switched	Freque	ncy:		2017.40	00000	MHz		
Desilet Outlines	Channe	el:			10087	Ch		
Packet Switched	PCCPC	H Power			-60.00	dBm		
	Scramb	oling Code			100			
	SCCP	СН	•		0.0	dB		
	PS Dor	main		V				
	Conne	ction Set	սթ					
	UE term	n. Connect	Те	est Mod	е			
Results	Туре			RMC			2	
BER 0.00	0% RMC							
BLER 0.10	0 % Data Ra	ate	DL 384	kbps	UL 1	44 kbps		
DBLER 0.00	D %							
Lost Transp.Blocks	0							
UL TFCI Faults NCA	D Test M	ode	Loop Mo	ode 2				
FDR NCA	P							Signaling
PN Discontinuity 1	000							Parameter
Transport Blocks 1001 / 1	000							TROOPMA
								Signaling ON
Repetition Stop Condition		ľ		ľ		Conf	ig	

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 //
```

// 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*.

Note: The second state of								
Path: Connection Configuration/Test Mode/RMC/Data Rate								
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	0.00 dBFS							
Crest Factor	6.02 dB							
⊡…IQ In								
Connector	DIG IQ IN 1 💌							
Sample Rate	100 Msps							
Baseband PEP	0.00 dBFS							
Baseband Level	-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,IQ20
// read out information of IQ settings
SENSe:TDSCdma: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).
- 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.

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

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

⊐-lQ Settings	
⊨-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 In 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.

😑 BER								
Connection Stat	us			Cell Setup				
Cell	(m)			Band:		A: 2010.8MH	z~2024.2MHz	-
Circuit Switched	No.	Call Established		Frequency:		2017.4000000	MHz	
Packet Switched		Attached		Channel:		10087	Ch	
1 denor omnenied	2	integrited.		PCCPCH Power		-65.00	dBm	
				Scrambling Code		100		
				SCCPCH	•	0.0	dB	
				PS Domain		V		
				Connection Set	սթ			
				UE term. Connect	T	est Mode	2	
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 Me	ode 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		CDMA2000		
4	307.2	H-PSK			
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	V				
RLP				V			
Pilot Power	Ø	V	Ŋ	Ŋ			
Speech	V						

## 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 Option: SO 55 (Loopback)						
😑 FER FCH	GER 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	e Option: 50	55 (Packet L	Jala)					
• FER FCH	• FER SCI	HO RLP	Pil	ot Power	Spe	ech		
RLP & IP Sta	ntistics							
RLP Messag	es	Rx		Rx Tota	I	Т×		Tx Total
Data (Unsegn	nented)		0		2		0	0
Data (Segmer	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				Тx		
PPP Total By	tes [kByte]		150				2595	
Data Rate [kB	Bit/s]		3.3				116.3	
	Stat	us						
	0	<						

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.

urrent Service Op	lion:SO 17 (Speec	:h)		
FER FCH	FER SCHO	RLP	Pilot Strength	Speech
Pilot Strength				
Pilot Strength Pilot Strength				-7.5

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.

Contenic Service C	puon. So a (apeccin)			
FER FCH	FER SCH0 RI	LP Pilot Pow	er Speech	
Speech Activ	vitv			
	Forwa	rd (Tx)	Rev	verse (Rx)
	[Frames]	[%]	[Frames]	[%]
Blanked	6	0.3		0.0
Eighth	1850	82.6	18	43 82.7
Quarter	0	0.0		0.0
Half	25	1.1		26 1.2
Full	358	16.0	3	59 16.1
	[Bi	t/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

CDMA2000

## 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*.

🚸 CDMA2000 Signaling Configuration	
Path: System/Physical Layer	
Scenario	Standard Cell Fading 🔻
Fading	External 🔻
⊟-IQ Settings	
-Connector	
Sample Rate Baseband PEP	100 Msps
	9.00 dB
⊡-IQ <mark>In</mark>	
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>?

- 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).
- 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.

Fading A					_ ×
General Standard/Fine Dela	y 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	0 %	

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
⊡-lQ 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)
- 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.

🚸 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	V
Profile	CDMA1 💌
	CDMA1
	CDMA2
⊞-Insertion Loss	CDMA5 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	
-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)	Comments
		Forward Link	
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 La	ayer: Subtype 3	Selected Ca	irrier: 2	]		
• PER	Throughput	CtrlChPER	●RLQ	Data	Overview	
Forwar	d Link PER					
						Composite
PER [%	]				41.00	9.00
Confider	nde Level [%]				17.00	22.00
Packet B	Errors				0	0
Test Packe	ets Sent	Status				
	/ 10	00 OK				
Composite	e Test Packets Sent					
	/ 10	000				

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.

Physical	Layer: Subtype 3	Selected	Carrier: 3	2			
PER	• Throughput	• CtriChPER	RLO	Data	Overview		
Ferry	rd Link Through						
Forwa	ira Link Through	put					
Physic: Size	al Packet	MAC Packets Received	Physical F Slots	Packet	Throughput vs Test Time [kBit	t/s] Ti	hroughput vs ransmitted Slots [kBit/s]
128		92		44	6	5.40	362.30
256		71		86	64	0.50	529.90
512		46		93	31	8.70	142.10
1024		4		68	97	6.80	664.10
2048		74		84	4:	5.90	314.90
3072		51		19	42	9.00	591.70
4096		97		24	31	6.80	2.70
5120		4		84	29-	4.30	149.50
6144		74		49	37	7.40	931.40
7162		63		8	514	4.90	308.80
8192		57		47	49	8.20	823.80
Total		23		18	15	5.00	209.70
Compos	site				11	8.36	5.91
Test Time		Status					
	/	1000 OK					

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 & IP Statistics				
RLP Messages	Rx	Rx Total	Тх	Tx Total
Reset	0	0	0	0
Reset ACK	0	0	0	0
NAK	0	1	0	0
Summary	0	1	0	0
	Rx		Тх	
PPP Total Bytes [kByte]	10177		59733	
Data Rate [kBit/s]	1087.5		2607.5	
Statue				
Old				
UK				

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 🔻
ia⊡IQ Settings	
⊟-lQ Out	
Connector	DIG IQ OUT 2 🔻
-Sample Rate	100 Msps
Baseband PEP	0.00 dBFS
Crest Factor	9.00 dB
⊡-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>?
```

- 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).
- 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.





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	0 %	



⊟-lQ 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	-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	2.71 0.00 29	RF Settings
Test Packets Sent Status 1070 / 1000 OK		
		Display Signaling Parameter
Access Connected PPP Connection: OFF RX Pow	rer <b>ein nanger</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

⊡-Internal Fading ⊡-Fading Simulator	
Enable	<b>V</b>
Profile	EVD01 💌
	EVD01
	EVD02
⊞-Insertion Loss	EVD03
Doppler Frequency	EVD05
⊞ Forward Link Settings	
⊞-Fading 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	<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. 7-23: 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	w.

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 172.22.1.100 172.22.1.101 172.22.1.101 172.22.1.102 172.22.1.103 172.27.1.104	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         fc01:ababcdcdtefe0::/64         fc01:ababcdcdtefe2::/64         fc01:ababcdcdtefe3::/64         fc01:ababcdcdtefe3::/64         fc01:ababcdcdtefe3::/64         fc01:ababcdcdtefe3::/64	
	Routing Manual Routes Prefixes via Routers Close	DAU Unit ON
Select Network Applic Drive map	Config	



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



Fig. 8-4: Running IPERF.

 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	V	UDP	•	5010	172.22.1.100	32	1	50.00	Mbit/s
-2	F	тср	-	5002	172.22.1.100	32	1	1.00	Mbit/s
-3	Г	TCP	•	5003	172.22.1.100	32	1	1.00	Mbit/s
-4	Г	ТСР	-	5004	172.22.1.100	32	1	1.00	Mbit/s
-5	Г	ТСР	-	5005	172.22.1.100	32	1	1.00	Mbit/s
6	F	тср	Ţ	5006	172 22 1 100	72	1	1.00	Mhit/s
							OK		Cance

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 🔹
-Enable Data end to end	
RF Settings	
Downlink Power Levels	
Uplink Power Control	
Physical Cell Setup	
⊞-Network	
E Connection	
- UE Category	Manual: 5 Use Reported (if available): 🔽 🗕
Default Paging Cycle	#64 -
Additional Spectrum Emission	NS_01 -
-UE Meas. Filter Coefficient	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 E-RF Settings E-Physical Downlink Settings E-Physical Uplink Settings E-Connection Configuration	for			
UE term. Connection	Test Mode 🔻			
	DL 13.6 kbps - UL 13.6 kbps -			
🕀 Voice				
⊞Video				
Single SRB				
E-Test Mode				
Data Rate	DL HSUPA + UL HSUPA +			
-Receiving Window Size	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)

wcD	IMA UE	RX Measure	ment 1	- X3.0.30.	14										WCDMA
BE	R	HSDPA /	ACK	E-HI	СН	😶 RI	.C Throughp	ut	UL Log	ging					RLC
700 600 500 400 300 200	kbit/s													PDU DL: Current Average PDU UL: Current Average	Throughpu RDY
	-115	-105 Dov	-95 vnlink	-85	j	-75	-65	-55	-45 Uplink	-35	-25	-15	-5		Display
Throu Curren Averaj	ughput nt ge	PDL	1	790.000 790.000 790.033	kbit/s kbit/s	SDU S	798.933 784.623	kbit/s kbit/s Mbit/s	PDU		).000 bit/ ).000 bit/	SDU 's 's	(	0.000 bit/s 0.000 bit/s	
Minim Block	ium s	-		789.967 13766	kbit/s	5	499.333	kbit/s	-		).000 bit/ ).000 bit/ 686	s		1.000 bit/s	Signaling Parameter
	HSDR	PA+ PA	R	egistere	ł		PS:	6	Connectio	n Establi	shed	Power h In Sync	n Rang	je	WCDMA-U Signaling ON
		Ĩ				D	isconnect acket Data			Ĩ		Handover	c	onfig	

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).

Connection Configuration	
	Test Mode 💌
SRB Data Rate	DL 2.5 kbps 🔻 UL 2.5 kbps 🔻
⊕ Voice	
⊞Video	
⊕-Single SRB	
⊡Test Mode	
🖻 Packet Data	
Data Rate	DL 384kbps 🔻 UL 128kbps 💌

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

ath: System/RF Input (RX)		
Basenand Level System B RF Output (TX) B RF Input (RX) B RF Frequency B RF Power	-19.00 (BFS	
Physical Layer	CO 22 (Basket Bata)	
Radio Configuration (Fwd / Rev)	3/3 <b>*</b>	
B SCHO B PCH B OPCH		
Reverse Power Control     D Time     Sendee Configuration		
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

🚸 1xEV-DO Signaling Configuration	
Path: Layer/Application Layer/Application	
Scenario	Standard Cell Fading 🔻
Fading	External 🔻
⊞-IQ Settings	
⊞∼System	
⊡-Layer	Network Release A
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				
CMW500 Mainframe 03	CMW-PS503	1208.7154.02		
Front Panel with Display H600B	CMW-S600B	1201.0102.03		
BB Flexible Link H550B	CMW-S550B	1202.4801.03		
RF Frontend (Basic) H590A	CMW-S590A	1202.5108.02		
2 <sup>nd</sup> RF Frontend (Basic) H590A	CMW-B590A	1202.8707.02		
Or				
RF Frontend, advanced functionality	CMW-S590D	1202.5108.03		
DVI Interface	CMW-B620A	1202.5808.02		
Option Carrier H660A	CMW.B660A	1202.7000.02		
Ethernet Switch H661A	CMW-B661A	1202.7100.02		
OCXO (Highly Stable) H690B	CMW-B690B	1202.6004.02		
Signaling Unit Wideband H300A	CMW-B300A	1202.8759.02		
Signaling Unit Universal B200A	CMW-B200A	1202.6104.02		
GSM Signaling option	CMW-B210A	1202.6204.02		
Extra RF Converter H570A	CMW-B570B	1202.8659.03		
Data Application Unit	CMW-B450A	1202.8759.02		
Digital IQ 1 to 4	CMW-B510F	1202.8007.07		
Digital IQ 5 to 8	CMW-B520F	1202.8107.07		
Basic Fading and AWGN	CMW-KE100	1207.5506.02		
Software LTE RF Tester				
LTE FDD Rel. 8, SISO, Basic signaling	CMW-KS500	1203.6108.02		
LTE Rel. 8, SISO, advanced signaling	CMW-KS510	1203.9859.02		
LTE MIMO 2x2 signaling	CMW-KS520	1207.3555.02		
LTE, user defined bands signaling	CMW-KS525	1207.4000.02		
LTE TDD Rel. 8, SISO, Basic signaling	CMW-KS550	1204.8904.02		
LTE FDD Rel. 8, TX measurement, uplink	CMW-KM500	1203.5501.02		
LTE TDD Rel. 8, TX measurement, uplink	CMW-KM550	1203.8952.02		
LTE FDD R10, CA, basic signaling	CMW-KS502	1208.6029.02		
LTE R10, CA, adv. signaling	CMW-KS512	1208.6041.02		
LTE TDD R10, CA, basic signaling	CMW-KS552	1208.6087.02		
LTE 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

Ordering Information Fading Simulator SMW200A Vector Signal Generator							
					Base Unit	SMW200A	1412.0000.02
					Baseband Main Module, two IQ paths	SMW-B13T	1413.3003.02
Digital Baseband Outputs	SMW-B18	1413.3432.02					
Fading Simulator	SMW-B14	1413.1500.02					
Additional White Gaussian Noise	SMW-K62	1413.3484.02					
Dynamic Fading	SMW-K71	1413.3532.02					
MIMO 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.