LTE-A Base Station Performance Tests According to TS 36.141 Rel. 14 Application Note

Products:

- I R&S®SMW200A I R&
 - R&S®SGS100A
 - R&S[®]SGT100A

3GPP TS36.141 defines conformance tests for E-UTRA base stations (eNodeB). Release 14 (LTE-Advanced Pro) added several tests, such as those for enhanced Licensed Assisted Access (eLAA).

This application note describes how all required performance tests (TS36.141 Chapter 8) can be performed quickly and easily by using vector signal generators from Rohde & Schwarz.

Examples illustrate the manual operation. A free software program enables and demonstrates remote operation.

The LTE base station transmitter (Tx) tests (TS36.141 Chapter 6) are described in Application Note 1MA154.

The LTE base station receiver (Rx) tests (TS36.141 Chapter 7) are described in Application Note 1MA195.





Table of Contents

1	Introduction
2	General Performance Tests7
2.1	Note7
2.2	Performance Test setup7
2.3	Instruments and Software options9
3	Performance Tests (Chapter 8) 12
3.1	Basic operation12
3.1.1	Signal routing / MIMO settings13
3.1.2	General Uplink LTE settings16
3.1.3	General Fading settings21
3.1.4	General AWGN settings23
3.1.5	SMW: extension to four or eight RF paths25
3.1.6	Demo Program R&S TSrun27
3.2	Performance requirements for PUSCH (Clause 8.2)
3.2.1	Performance requirements of PUSCH in multipath fading propagation conditions transmission on single antenna port (Clause 8.2.1)
3.2.2	Performance requirements of PUSCH in multipath fading propagation conditions transmission on two antenna ports (Clause 8.2.1A)
3.2.3	Performance requirements for UL timing adjustment (Clause 8.2.2)
3.2.4	Performance requirements for HARQ-ACK multiplexed on PUSCH (Clause 8.2.3)73
3.2.5	Performance requirements for High Speed Train conditions (Clause 8.2.4)80
3.2.6	Performance requirements for PUSCH with TTI bundling and enhanced HARQ pattern (Clause 8.2.5)
3.2.7	Enhanced performance requirements type A of PUSCH in multipath fading propagation conditions with synchronous interference (Clause 8.2.6)
3.2.8	Enhanced performance requirements type A of PUSCH in multipath fading propagation conditions with asynchronous interference (Clause 8.2.6A)
3.2.9	Performance requirements of PUSCH in multipath fading propagation conditions transmission on single antenna port for coverage enhancement (Clause 8.2.7)85
3.2.10	Performance requirements of PUSCH with Frame structure type 3 (Clause 8.2.8)89
3.3	Performance requirements for PUCCH (Clause 8.3)90
3.3.1	ACK missed detection for single user PUCCH format 1a transmission on single antenna port (Clause 8.3.1)90
3.3.2	CQI performance requirements for PUCCH format 2 transmission on single antenna port (Clause 8.3.2)97
3.3.3	ACK missed detection for multi user PUCCH format 1a (Clause 8.3.3)101

3.3.4	ACK missed detection for PUCCH format 1b with Channel Selection (Clause 8.3.4)108
3.3.5	ACK missed detection for PUCCH format 3 (Clause 8.3.5)
3.3.6	NAK to ACK detection for PUCCH format 3 (Clause 8.3.6)
3.3.7	ACK missed detection for PUCCH format 1a transmission on two antenna ports (Clause 8.3.7)
3.3.8	CQI performance requirements for PUCCH format 2 transmission on two antenna ports (Clause 8.3.8)
3.3.9	CQI performance requirements for PUCCH format 2 with DTX detection (Clause 8.3.9)
3.3.10	ACK missed detection for PUCCH format 1a transmission on single antenna port for coverage enhancement (Clause 8.3.10)
3.3.11	CQI performance requirements for PUCCH format 2 transmission on single antenna port for coverage enhancement (Clause 8.3.11)
3.3.12	ACK missed detection for PUCCH format 4 (Clause 8.3.12)
3.3.13	ACK missed detection for PUCCH format 5 (Clause 8.3.13)164
3.4	Performance requirements for PRACH (Clause 8.4)171
3.4.1	PRACH false alarm probability and missed detection (Clause 8.4.1)171
3.5	Performance requirements for Narrowband IoT (Clause 8.5)
3.5.1	Performance requirements for NPUSCH format 1 (Clause 8.5.1)
3.5.2	ACK missed detection for NPUSCH format 2 (Clause 8.5.2)194
3.5.3	Performance requirements for NPRACH (Clause 8.5.3)
4	Appendix 204
4.1	R&S TSrun Program204
4.2	References
4.3	Additional Information210
4.4	Ordering Information211

The following abbreviations are used in this Application Note for Rohde & Schwarz test equipment:

- The R&S[®]SMW200A vector signal generator is referred to as the SMW.
- The software R&S[®]TSrun is referred to as the TSrun.

Note:

Please find the most up-to-date document on our homepage

http://www.rohde-schwarz.com/appnote/1MA162.

This document is complemented by software. The software may be updated even if the version of the document remains unchanged

1 Introduction

Long Term Evolution (LTE) networks or Evolved Universal Terrestrial Radio Access (E-UTRA) (from Releases 8 and 9) have long since been introduced into daily usage. As a next step, 3GPP has added several extensions in Release 12, known as LTE-Advanced (LTE-A). These include a contiguous and non-contiguous multicarrier and/or carrier aggregation (CA) option, changes to MIMO (up to 8x8 in the downlink and introduction of MIMO in the uplink). Release 13 (now called LTE advanced pro) introduces a 3GPP solution for the Internet of Things, called NB-IoT as a new physical layer and enhanced MTC. In Release 14, the new innovations are the enhanced Licensed Assisted Access (eLAA) in Unlicensed Spectrum, the support for Vehicle-to-Everything (V2x) services as well as 4-band and inter-band Carrier Aggregation (CA).

An overview of the technology behind LTE and LTE-Advanced is provided in Application Note 1MA111, 1MA232 and 1MA252. The white papers 1MA166 and the application note 1MA296 handle NB-IoT.

The LTE-A conformance tests for base stations (eNodeB) are defined in 3GPP TS 36.141 Release 12 [1] and include transmitter (Tx), receiver (Rx) and performance (Px) tests. T&M instruments from Rohde & Schwarz can be used to perform all tests easily and conveniently.

This application note describes the performance tests in line with TS36.141 Chapter 8. It explains the necessary steps in manual operation for vector signal generators. A free remote-operation software program is additionally provided. With this software, users can remotely control and demo tests on base stations quickly and easily. It also provides the SCPI commands required to implement each test in user-defined test programs.

The transmitter (Tx) tests (TS36.141 Chapter 6) are described in Application Note 1MA154 and the receiver (Rx) tests (TS36.141 Chapter 7) are covered in Application Note 1MA195.

Table 1-1 gives an overview of the performance tests defined in line with Chapter 8 ofTS36.141. All tests can be carried out using instruments from Rohde & Schwarz.These tests are individually described in this application note. Please note that one testwill be implemented in the SMW firmware later (marked in yellow).

Per	forman	ce Requirement (Chapter 8)
Chap	oter	Test
(TS3	6.141)	
8.2 F	Performar	nce requirements for PUSCH
	8.2.1	Performance requirements of PUSCH in multipath fading propagation conditions transmission on single antenna port
	8.2.1A	Performance requirements of PUSCH in multipath fading propagation conditions transmission on two antenna ports
	8.2.2	Performance requirements for UL timing adjustment
	8.2.3	Performance requirements for HARQ-ACK multiplexed on PUSCH
	8.2.4	Performance requirements for High Speed Train conditions
	8.2.5	Performance requirements for PUSCH with TTI bundling and enhanced HARQ pattern
	8.2.6	Enhanced performance requirements type A of PUSCH in multipath fading propagation conditions with synchronous interference
	8.2.6A	Enhanced performance requirements type A of PUSCH in multipath fading propagation conditions with asynchronous interference
	8.2.7	Performance requirements of PUSCH in multipath fading propagation conditions transmission on single antenna port for coverage enhancement
	8.2.8	Enhanced performance requirements type A of PUSCH in multipath fading propagation conditions with asynchronous interference
8.3 F	Performar	nce requirements for PUCCH
	8.3.1	ACK missed detection for single user PUCCH format 1a transmission on single antenna port
	8.3.2	CQI performance requirements for PUCCH format 2 transmission on single antenna port
	8.3.3	ACK missed detection for multi user PUCCH format 1a
	8.3.4	ACK missed detection for PUCCH format 1b with Channel Selection
	8.3.5	ACK missed detection for PUCCH format 3
	8.3.6	NAK to ACK detection for PUCCH format 3
	8.3.7	ACK missed detection for PUCCH format 1a transmission on two antenna ports
	8.3.8	CQI performance requirements for PUCCH format 2 transmission on two antenna ports
	8.3.9	CQI performance requirements for PUCCH format 2 with DTX detection
	8.3.10	ACK missed detection for PUCCH format 1a transmission on single antenna port for coverage enhancement
	8.3.11	CQI performance requirements for PUCCH format 2 transmission on single antenna port for coverage enhancement
	8.3.12	ACK missed detection for PUCCH format 4
	8.3.13	ACK missed detection for PUCCH format 5
8.4 F	Performar	nce requirements for PRACH
	8.4.1	PRACH false alarm probability and missed detection
8.5 F	Performar	nce requirements for Narrowband IoT
	8.5.1	Performance requirements for NPUSCH format 1
	8.5.2	ACK missed detection for NPUSCH format 2
	8.5.3	Performance requirements for NPRACH
T - 1. 1 -		

Table 1-1: Covered Tests, yellow is not implemented yet.

Ready for RED?

The new radio equipment directive RED 2014/53/EU adopted by the European Union replaces the previous directive RTTED 1999/5/EC, better known as R&TTE. With RED, not only radio transmitters, but also radio receivers have to meet minimum regulatory performance requirements and need to be tested. Article 3.2 contains fundamental technical requirements.

The Harmonised European Standard **ETSI EN 301 908 Part 14** covers essential requirements of article 3.2 for E-UTRA Base Stations. The tests refer to **ETSI TS 136 141**, which is the same as **3GPP TS36.141**.

The Harmonised European Standard **ETSI EN 301 908** covers essential requirements of article 3.2 for Mobile Communication On Board Aircraft (MCOBA) systems. Chapter 4.2. defines tests for E-UTRA-OBTS (Onboard Base Transceiver Station), which refer to **ETSI TS 136 141**, which is the same as **3GPP TS36.141**.

2 General Performance Tests

2.1 Note



Very high power occurs on base stations! Be sure to use suitable attenuators in order to prevent damage to the test equipment.

2.2 Performance Test setup

Fig. 2-1 shows the general test setup for performance tests. A SMW is used to perform the test. Some tests are for four or eight Rx antennas. One SMW with additional RF sources like the SGS can generate the necessary signals for four Rx antennas. To generate signals for eight Rx antennas, one SMW with additional six RF sources like SGS and SGT are needed. Some tests require special MIMO combining setups; these are described in the respective sections.

Note:

Tests with four Rx antennas can also be handled by two SMW. This is not described in this application note.

Tests with eight Rx antennas can also be handled by four SMW. This is not described in this application note.

Performance Test setup



Fig. 2-1: Px Test Setup; To generate signals for four Rx antennas, one SMW plus two SGS are necessary. To generate signals for eight Rx antennas, one SMW plus six SGx are necessary.

2.3 Instruments and Software options

The SMW vector signal generator can be used for the tests described here.

The **E-UTRA/LTE** software option is available for each of the listed generators. The following are needed for the Px tests:

- SMW-K55 EUTRA/LTE (for four paths)
- SMW-K84 EUTRA/LTE Release 9 (for four paths)
- SMW-K85 EUTRA/LTE Release 10 (for four paths)
- SMW-K115 Cellular IoT
- SMW-K119 EUTRA/LTE Release 13/14

The instruments need following options:

- SMW-B14 Fading
- SMW-K71 Dynamic Fading
- I SMW-K74 MIMO
- I SMW-K62 AWGN
- SMW-K69 LTE Closed Loop BS Tests

A couple of tests require four RF paths and/or four LTE signals. This can be handled with one SMW plus two external RF generators (e.g. SGS).

- 1 x SMW + 2 x SGS
- SMW-K16 Analog IQ

To generate signals for eight Rx antennas, one SMW with six external RF generators is used:

- 1 x SMW + 2 x SGS + 4 x SGT
- ∎ SMW-K18 Dig IQ

In the following sections, only the used SMW is mentioned again without stating the number of external RF generators. The generators are still needed, though.

Instruments and Software options

Γ			Instruments and options										
				2 antennas							4 Antennas		ennas
Number		weasurement		AWGN (K62)	Fading (B14)	MIMO (K74)	LTE (K55,K85, K119)	Cellular IoT (K115)	HARQ (K69)	SOS	Analog IQ (K16)	SGS + SGT	Dig IQ (K18)
8		Performance requirements											
Π	8.2	Performance requirements for PUSCH											
	8.2.1	PUSCH in multipath fading propagation conditions transmission (single antenna port)			2	-	1		M	2		2 + 4	V
	8.2.1A	PUSCH in multipath fading propagation conditions transmission (two antenna ports)		V	2		2		V	2		2 + 4	V
	8.2.2	8.2.2 UL timing adjustment		V	2		2		V				
	8.2.3	HARQ-ACK multiplexed on PUSCH		V	2	-	1						
	8.2.4	High Speed Train conditions		M	2	-	1		V				
	8.2.5	PUSCH with TTI Bundling and enhanced HARQ pattern					not i	implemer	nted				
	8.2.6	Enhanced performance requirements type A of PUSCH in multipath fading propagation conditions with synchronous interference	ICH not implemented										
Enhanced performance requirements type A of PUSCH in multipath fading propagation conditions with asynchronous interference							not i	implemer	nted				
	8.2.7	Performance requirements of PUSCH in multipath fading propagation conditions transmission on single antenna port for coverage enhancment		M	2		1	1		a			

Fig. 2-2 gives an overview of the required instruments and options.

Instruments and Software options

					I	Instrume	nts and	option	s			
			2	antenna	s				4 Ant	ennas	8 Ante	ennas
Number	Measurement	×WS	AWGN (K62)	Fading (B14)	MIMO (K74)	LTE (K55,K85, K119)	Cellular IoT (K115)	HARQ (K69)	SDS	Analog IQ (K16)	SGS + SGT	Dig IQ (K18)
8	Performance requirements											
8.3	Performance requirements for PUCCH											
8.3.1	ACK missed detection for single user PUCCH format 1a (single antenna port)			2	-	1			2		2 + 4	
8.3.2	CQI performance for PUCCH format 2 (single antenna port)			2	-	1						
8.3.3	ACK missed detection for multi user PUCCH format 1a			2		2			2	Ø	2 + 4	
8.3.4	ACK missed detection for PUCCH format 1b with Channel Selection		M	2	-	1			2	V	2 + 4	M
8.3.5	ACK missed detection for PUCCH format 3		M	2	-	1			2	V	2 + 4	Ŋ
8.3.6	NAK to ACK detection for PUCCH format 3	V	M	2	-	1			2	V	2 + 4	Ŋ
8.3.7	ACK missed detection for PUCCH format 1a (two antenna ports)			2		1			2	Ø	2 + 4	M
8.3.8	CQI performance requirements for PUCCH format 2 (two antenna ports)			2		1						
8.3.9	CQI performance requirements for PUCCH format 2 with DTX			2		1						
8.3.10	ACK missed detection for PUCCH format 1a transmission on single antenna port for coverage enhancement	M	M	2	M	1	1					
8.3.11	CQI performance requirements for PUCCH format 2 transmission on single antenna port for coverage enhancement	M	M	2	M	1	1					
8.3.12	ACK missed detection for PUCCH format 4			2		1			2		2 + 4	
8.3.13	ACK missed detection for PUCCH format 5	V	M	2	V	1			2	V	2 + 4	$\mathbf{\overline{N}}$
8.4	Performance requirements for PRACH											
8.4.1	PRACH false alarm probability and missed detection			2	-	1			2		2 + 4	V
8.5	Performance requirements for Narrowband IoT											
8.5.1	Performance requirements for NPUSCH format 1			2	V	1	1					
8.5.2	ACK missed detection for NPUSCH format 2			2	V	1	1					
8.5.3	Performance requirements for NPRACH			2		1	1					

needed for the measurement (exact this one)

--- not used

 \checkmark

Fig. 2-2: Overview needed instruments and options

3 Performance Tests (Chapter 8)

Performance tests are for the receiver of the base station. The base station typically measures the throughput (for PUSCH tests) or the ability to detect certain signal (PUCCH and PRACH) under multipath channel conditions.

Fixed Reference Channels (FRC)

For the performance tests, Fixed Reference Channels (FRC) are defined. They contain LTE channel parameters as modulation, code rate and allocated resource blocks etc. They are named according to [1], annex A and split in different subsets:

FRC A3: A3-1...A3-7 (QPSK for performance requirements)

FRC A4: A4-1...A4-8 (16QAM for performance requirements)

FRC A5: A5-1...A5-7 (64QAM for performance requirements)

FRC A7: A7-1...A7-6 (16QAM for UL timing adjustment)

FRC A8: A8-1...A8-6 (QPSK for UL timing adjustment)

FRC A12: A12-1...A12-6 (QPSK for performance requirements type A)

FRC A13: A13-1...A13-6 (16QAM for performance requirements type A)

FRC A16: A16-1...A16-5 (NB-IoT NPUSCH F1 performance requirements)

FRC A17: A17-1...A17-6 (256QAM for performance requirements)

FRC A18: A18-1...A18-6 (16QAM for PUSCH transmission)

FRC A19: A19-1...A19-6 (256QAM for PUSCH transmission)

For more details refer to [1], annex A.

All FRCs are implemented as predefined settings for FDD and TDD in the signal generator family SMW.

Channels

According to [1] the channels to be tested are at the bottom (B), in the middle (M) and at the top (T) of the supported frequency range of the base station.

3.1 Basic operation

For most of the following measurements, the first operating steps are the same. They are described only once.

The SMW simulates one or more LTE-UE's and the channel with fading and noise (if applicable). In the single tests, special settings are added. Before starting with the described steps, perform a preset of the device (green button in left upper corner). In principle, four main parts are necessary:

- Signal routing / MIMO settings
- LTE settings for one or more UE's in the baseband block(s)
- Channel simulation / Fading
- AWGN / SNR

3.1.1 Signal routing / MIMO settings

The test setups require a routing of the UE signals to the Rx antennas of the base station under test.

The SMW is able to handle up to four independent basebands and (with additional RF generators) up to eight RF paths. Routing is done via System configuration (simple settings can be done via routing in the baseband block).

Table 3-1 shows the routing settings for the different tests.

Heading			
Test	2 RX Antennas	4 RX Antennas	8 RX Antennas
8.2.1	1 x 1 x 2	1 x 1 x 4	1 x 1 x 8
8.2.1A	1 x 2 x 2	1 x 2 x 4	1 x 2 x 8
8.2.2	2 x 1 x 2		
8.2.3	1 x 1 x 1		
	1 x 1 x 2		
8.2.4	1 x 1 x 2		
8.2.5	1 x 1 x 2	1 x 1 x 4	1 x 1 x 8
8.2.6(A)			
8.2.7	1 x 1 x 2		
8.3.1	1 x 1 x 2	1 x 1 x 4	1 x 1 x 8
8.3.2	1 x 4 x 2		
8.3.3	1 x 1 x 2		
8.3.4	1 x 1 x 2	1 x 1 x 4	1 x 1 x 8
8.3.5	1 x 1 x 2	1 x 1 x 4	1 x 1 x 8
8.3.6	1 x 1 x 2	1 x 1 x 4	1 x 1 x 8
8.3.7	1 x 2 x 2	1 x 2 x 4	1 x 2 x 8
8.3.8	1 x 2 x 2		
8.3.9	1 x 1 x 2		
	1 x 2 x 2		
8.3.10	1 x 1 x 2		
8.3.11	1 x 1 x 2		
8.3.12	1 x 1 x 2	1 x 1 x 4	1 x 1 x 8
8.3.13	1 x 1 x 2	1 x 1 x 4	1 x 1 x 8
8.4.1	1 x 1 x 2	1 x 1 x 4	1 x 1 x 8
8.5.1	1 x 1 x 2		
8.5.2	1 x 1 x 2		
8.5.3	1 x 1 x 2		

Table 3-1: Signal routing / MIMO settings

Si	gnal Routing
	route to path A
	route to path B
\checkmark	route to path A and B

Fig. 3-1: Simple baseband routing

System Configuration SMW

You can reach the **System Configuration** via the soft button in the lower left area or by a click on *Fading*.

- 1. Set **Mode** to **Advanced**.
- 2. Set the wanted configuration according to Table 3-1.

System Configuration					_	. ×
Fading/Baseband Config	/Q Stream Mapper	External RF and I/	QOverview			
Set to Default				Basebands		Streams
Mode	Advanced		вв	A	FAA ++	A
Signal Outputs	Analog & Digital	-			FAB	
Entities (Users, Cells)	Basebands (Tx Antennas)	Streams (Rx Antennas)			X	
1 · X	2-	X 2-		B	FBA	
BB Source Config	Coupled Sources	•	BB		FBB ++	в
			Entity 1			
Apply	🕜 ок					

Fig. 3-2: System Configuration in the SMW

3.1.2 General Uplink LTE settings

3. In the block diagram, click the **Baseband** block (typically A). Select **EUTRA/LTE...**

TDMA Standards
GSM/EDGE
Bluetooth
TETRA
CDMA Standards
3GPP FDD
CDMA2000
TD-SCDMA
1xEV-DO
WLAN Standards
IEEE 802.11
Beyond 3G Standards
IEEE 802.16 WiMAX
EUTRA/LTE
Broadcast Standards
DVB

Fig. 3-3: Setting of LTE in the baseband

The EUTRA/LTE A dialog opens (Fig. 3-4)

EUTRA/LTE A			×
General Stop Trigger In Marker Clock Info		· · · · · · · · · · · · · · · · · · ·	
Off On Set To Default Recall Save	, 🥑	Gene	erate eform
Test Case Wizard			
Mode LTE/eMTC/NB-loT · Duplexing FDD			
Link Direction Uplink	(<mark>SC-</mark> F	DMA)	-
General Settings Frame Con	figurati	ion	
Filter/Clipping/ARB/TDW/Power	/ Clip C	Off / 1 F	rames

Fig. 3-4: EUTRA/LTE main dialog. Set Link Direction to Uplink.

4. Set Link Direction to Uplink (SC-FDMA). Select the Duplexing (FDD or TDD) (example: FDD).

5. When using **TDD** click **General UL Settings...** and set the **TDD UL/DL Configuration** and the **Special Subframe Config**.

EUTRA/LTE A: Gene	eral UL Set	tings								_	×	
Physical/TDD 10 MHz, UL/DL 1	Cell	Signals	PRACH	PUSCH	PUCCH							
Channel Bandw		10 M	Hz	Hz - Number of Resource Blocks per Slot								
FFT Size			1024	•	•							
Physical Resou	irce Bloc	k Bandwid	th	12 * 15	(Hz O	cupied B		9.00	0 MHz			
Sampling Rate				15.360 M	IHz Nu	mber of (Occupied	d Subcarriers			600	
Number of Left	Guard S	ubcarriers		2	212 Nu	Number of Right Guard Subcarriers						
TDD UL/DL Co	nfiguratio	n			1 ті	DD Specia	al Subfra	me Config			0	
D		U	U	D		D		U	U		D	

Fig. 3-5: Setting the TDD UL/DL Configuration in duplexing mode TDD (example: 1)

The 3GPP specification [3] defines seven different uplink-downlink configurations, i.e. the allowed combination of downlink, uplink and special slots. These seven configurations are shown in Table 3-2, with "D" denoting a subframe reserved for downlink, "U" for uplink, and "S" for the special subframe.

TDD Uplink / Downlink configurations											
UL/DL configuration				Second configurable subframe number							
	0	1	2	3	4	5	6	7	8	9	
0	D	S	U	U	U	D	S	U	U	U	3
1	D	S	U	U	D	D	S	U	U	D	3
2	D	S	U	D	D	D	S	U	D	D	7
3	D	S	U	U	U	D	D	D	D	D	3
4	D	S	U	U	D	D	D	D	D	D	3
5	D	S	U	D	D	D	D	D	D	D	2 (in second frame)
6	D	S	U	U	U	D	S	U	U	D	3

Table 3-2: Uplink-downlink configurations. Downlink in green, Uplink in blue

The SMW simplifies settings with the parameter **configurable subframes.** You just have to setup the needed subframes only. The SMW copies the settings to the other subframes automatically. In a couple of tests only every second subframe is used (e.g. to transmit certain patterns). Please note that in TDD mode the second uplink

subframe depends on the UL/DL configuration. Thus, the subframe number to set differs. The first subframe to set is number 2. The second subframe to set is mentioned in Table 3-2.

Cyclic Prefix

6. In the tab Cell, set the Cyclic Prefix (example: Normal).

EUTRA/LTE #	: General	UL Settings						_	X
Physical	Cell	Signals	PRACH	PUSCH	PUCCH		Normal		
Cell ID					150	Physical Cell ID Group	Extended User Defined		
Physical L	ayer ID				0	Cyclic Prefix	Normal		
						SFN Offset			0

Fig. 3-6: Setting the Cyclic Prefix

Filter/Clipping/ARB/TDW/Power settings

7. The SMW supports different filters, see Fig. 3-7.

Best ACP focusses an excellent ACP performance. **Narrow** additionally features a smoother shape in the frequency domain. **Best EVM** focusses an excellent EVM performance. **No upsampling** additionally features a small output waveform file size.

EUTRA/LTE	UTRA/LTE A: Filter/Clipping/ARB/TDW/Power Settings								
Filter LTE	O Clipping	ARB	O Time Domain Power Windowing						
Filter			EUtra/LTE -						
Optimiza	tion		Best EVM						
Roll Off	Factor			Best EVM					
0.4.0%			Best ACP						
Cut Off F	-requency Sh		Best ACP (Narrow)						
Sample	Rate Variation		Best EVM (no upsampling)						

Fig. 3-7: LTE Filter Settings

Power Settings

8. In the main dialog, select Filter/Clipping Select the Power tab and set the Power Reference to UE Burst RMS Power.

EUTRA/LTI	A: Filter/Clig/	'ARB/TD	W/	Power Settings	_	×
Filter LTE	Clipping	ARB		Time Domain Windowing	Pov	wer
Power F	Reference		U	E Burst RMS Pow	er	
Referer	nce UE					UE1
Referer	nce Subframe					0
Referer	nce Channel			PUSC	CH w/	o DRS

Fig. 3-8: LTE Power Settings

It defines the reference of the **Level** display in the SMW status bar. It is the power reference for all tests. In this mode, the RMS and PEP in the SMW status bar are displayed during a single subframe of the **Reference UE**. **UE Burst RMS Power** is required for setting the AWGN correctly (e.g. according to TS36.141), in case not every possible subframe is used by the simulated UE.

Trigger

In default mode, the SMW starts the LTE signal immediately.

 To align the start of the LTE signal to the base station under test, set Trigger In Mode to Armed Auto. (Fig. 3-9)

EUTRA/LTE A							_	×	
General	Trigger In Arm Auto	Marker	Clock Internal	Info					
	Trigge	r Settings	Commo	n to all Ba	sebands				
Mode			Arme	d Auto				-	
						Sto	opped	\leq	
Source			Exterr	al Global	Trigger	1		-	
Sync. Output	To Ext. Trigge	r	V On						
External Inhib	bit				0	Sampl	es	•	
External Dela	ıy Unit		Samp	les				•	
External Dela	ıy				0.00	Sampl	es	•	

Fig. 3-9: Trigger In settings. The SMW waits for an external trigger signal to align the LTE signal.

NB-IoT standalone

A couple of tests are for NB-IoT. In the performance tests, only the standalone mode is used.

1. To generate standalone NB-IoT signals, set the **Channel Bandwidth** to *200 kHz*. Thus, the SMW automatically uses standalone mode.

ľ	UTRA/LTE	A: General	UL Settings						_	×
	OCA	Physical 200 kHz	Cell	Signals	PRACH	PUSCH	РИССН			
	Channel	Bandwidtł	1		200 kHz	2		Number of Resource Blocks per Slo	ot	1
	FFT Size				512/128	3	·			

Fig. 3-10: NB-IoT standalone mode uses 200 kHz bandwidth

2. Click on UE1 to open further settings

EUTRA/LTE A: UL Frame C	onfiguration	
General Time Plan	Subframe Sf 0	
	UE1	UE2
	🗸 On	On
3GPP Release	e NB-loT -	NB-loT -

Fig. 3-11: UE1 transmits an NB-IoT signal

3. In the tab **FRC** choose the wanted **FRC** (A14....A15) and switch **on** the **FRC State**.

EUTRA/LTE A: User Equipment Config	guration (UE1)						_	×
Common CRealtime Feedback	FRC NPUSCH	NDRS	NB-loT Allocatior	1				
FRC State						Off		On
FRC			Г	rs 36.141: A14	l-1			·
Subcarrier Spacing				TS 36.141 🕨	A14 🕨	TS 36.1	41: A14	-1 z
Number of Allocated Subcarrie	ers		L	TS 36.521 ▶	A15 ►	TS 36.1	41: A14	-2 1
					A16 ►	TS 36.1	41: A14	-3
Modulation						TS 36.1	41: A14	-4

Fig. 3-12: FRCs for NB-IoT

4. The SMW automatically sets the parameters according to the wanted FRC. Click Adjust Length if the Current ARB Sequence Length differs from the Suggested length.

EUTRA	/LTE A: Us	er Equipme	ent Config	uratio	ו (UE1)							_	-	×
Oc	ommon	⊖ <mark>Realtir</mark> Feedb	ne ack	RC	NPU	ISCH	NDRS	NB-IoT Allocation							
Subc	arrier Sp	acing	15 kHz			•									
Reso	ource Blo	ck Index				0	Δft	to DC/MHz				0.000 (MHz		•
Mode	Ð		Standal	one		•	Nur	nber of Transmiss	ions						1
	NPUSCH Format	Modulation	Enhanced Settings	Start Subfr.	Start Slot	Repeti- tions	- Res. Units	Subcarr. Indication or ACK/NACK Res. Field	No. of Subc.	Slots	Starting Subcar.	Power /dB			
1	F1	π/2-BPSK	Config	0	0	1	2	0	1	16	0	0.000			
			_	(— AI	RB Se	quence Length -		_	ſ				
Sug	gested	2	Current		3 F	rames	; •	Adjust Len	gth			ARB	Settings.		

Fig. 3-13: Detailed FRC settings

3.1.3 General Fading settings

The SMW provides channels simulators in the baseband via the block **Fading**. It allows the fast and easy configuration with predefined settings according to the different mobile radio specifications (e.g. in LTE EVA 5 Hz). Additionally individual fading settings can be applied.

1. Click on the block Fading and Fading Settings (Fig. 3-14)

Fading	
Fading Settings.	
Signal Routing (non-M	IIMO)
✓ A-►A	B − ► B
A-►A	B − ► A
A-► B	B - ► B
A → A and B	<mark> B −► (</mark> open)
A − ► (open)	B —▶ A and B
A –► A and B	B —► A and B
Signal Routing (MIMO))
System Configu	ration
Summation Ratio A / E	3
0.0 dB	

Fig. 3-14: Fading Settings

2. Select a profile via **Standard** (e.g. EVA 5 Hz Low) (Fig. 3-15 and Fig. 3-16)

Fading A						_	×
O General Standard/Fine Delay	Restart Auto	Insertion Loss Config. / Coupled Parameters	Path Table	Path Graph			
Off On					et To efault Process		Save
Standard	EVA 5	Hz Low					
Configuration	Standar	d/Fine Delay	- Fading C	lockrate	200 MHz		·
Signal Dedicated To	RF Outp	but	- Virtual RI	Ŧ	1.000 000 0	00 000	GHz -
Ignore RF Changes <	< 5%		On Frequenc	cy Hopping Mo	de Off		•

3. Switch the fading block **On**. (Fig. 3-15)

Fig. 3-15: Overview General Fading settings. Select a predefined settings in Standard

User	EPA 5Hz Low	ETU 300Hz Medium
CDMA	EPA 5Hz Medium	ETU 300Hz High
GSM	EPA 5Hz High	HST 3 Tunnel Multi Antennas
NADC	EVA 5Hz Low	HST 3 Tunnel Multi Ant./DL+UL
PCN	EVA 5Hz Medium	
TETRA	EVA 5Hz High	
3GPP	EVA 70Hz Low	
WLAN	EVA 70Hz Medium	
DAB	EVA 70Hz High	
WIMAX	ETU 30Hz Low	
WIMAX-MIMO	ETU 30Hz Medium	
LTE	ETU 30Hz High	
LTE-MIMO	ETU 70Hz Low	
1xEVDO	ETU 70Hz Medium	
WATTERSON	ETU 70Hz High	
802.11n-MIMO	ETU 300Hz Low	

Fig. 3-16: Predefined Fading profiles for LTE-MIMO

- 4. Repeat the settings in other paths. If special MIMO modes are used, this is done automatically
- 5. The path settings are shown as a table and as graph. Individual settings can be handled in the tables. (Fig. 3-17 and Fig. 3-18)

ading A					_ :
General Standard/Fine Delay	Restart Auto	Insertion Loss Config Coupled Parameters	g. / Path Table Path	h Graph	
Table Settings		Copy Path Group	1	o	2 Copy
	Unit	1 1	1 2	1 3	1 4
State		On	On	On	On
Profile		Rayleigh	Rayleigh	Rayleigh	Rayleigh
Path Loss /dB		0.00	1.50	1.40	3
Basic Delay /µs	μs	0.000 000	0.000 000	0.000 000	0.000 (
Additional Delay /µs	μs	0.000 000	0.030 000	0.150 000	0.310 (
Resulting Delay /µs	μs	0.000 000	0.030 000	0.150 000	0.310 (
Power Ratio /dB					





Fig. 3-18: Fading Path graph

3.1.4 General AWGN settings

The SMW provides noise via the block AWGN. The power levels in [1] are always set via a noise power and a relative signal-to-noise (SNR) requirement. The noise bandwidth to set always refers to the system (occupied) bandwidth:

Occupied Bandwidths									
Channel- Bandwidth [MHz]	0.2	1.4	3	5	10	15	20		
Occupied Bandwidth [MHz]	0.180	1.08	2.7	4.5	9	13.5	18		

Table 3-3: Occupied Bandwidth (System Bandwidth)

- 1. Click on the block AWGN
- 2. Switch the state ON and set the Mode to Additive Noise. (Fig. 3-19, Fig. 3-20)
- Set the System Bandwidth according to Table 3-3 (e.g. BW_{channel} = 10 MHz -> BW_{system} = 9 MHz) (Fig. 3-19).
- 4. Set the **Ratio** to **1.5** (Fig. 3-19).

ļ	WGN Setting	s A			_	×
	General	Noise Power / Output Results				
	State			Off		On
	Mode		Additive Noise			•
	System Bandwidth		9.00	0 0	MHz	Ţ
	Min Noise/S	System Bandwidth Ratio				1.5

Fig. 3-19: General AWGN settings. The system bandwidth depends on the LTE channel bandwidth.

- 5. Set the **Reference Mode** to **Noise**.
- Set the Noise Power and the Carrier to Noise Ratio (SNR) (e.g. power = -80.5 dB, SNR = 4 dB) (Fig. 3-20). Please note that for certain test cases an additional SNR correction factor applies.
- 7. For the SMW the referenced RF port has to be set (e.g. RF A)

AWGN Settings A		—	×		
General Noise Power / Output Results					
Show Powers For Output	Show Powers For Output RFA				
Set Noise Power Via	C/N				
Reference Mode	Noise		•		
Bit Rate	100.000 000	kbps	•		
Carrier/Noise Ratio	-4.00	dB]		
Eb/N0	15.54	dB	•		
Carrier Power	-84.50	dB	·		
Noise Power (System Bandwidth)	-80.50	dB	_		
Noise Power (Total Bandwidth)	-76.99	dB			

Fig. 3-20: AWGN settings. Set the noise power and the SNR. The effective Carrier Power is shown.

3.1.5 SMW: extension to four or eight RF paths

The SMW is able to generate up to eight baseband signals. It supports two RF paths directly inside one instrument. To support four or eight RF channels, additional instruments like the SGS and the SGT can be connected via IQ to the SMW. The SMW then controls those external instruments and acts like one instrument with four or eight channels.

An example with a SGS connected via IQ OUT1 to the SMW is used to explain the settings.

- 1. Open the **System Configuration** (e.g. click on **I/Q Stream mapper**) and click on the tab **External RF and IQ**
- 2. Click in the row External Instrument in line I/Q OUT 1. (Fig. 3-21)

System Con	figuratio	n Y						-	_
Fading/B	aseban	d Config I/	Q Strear	n Mappo	er External RF and L	Q Overvie	W		
Display	/lapped	Connector	s	-	Conne	ect All Ren	note Dis	connect All R	emote
	Dir	External Instrument	I/Q Conn	Rem Conn	Instrument Name	RF Coup	RF Frequency /Hz	RF Level /dBm	RF State
CODER	1 In	Config							
CODER	2 In	Config							
BBMM 1	Out	Config	1						
BBMM 2	Out	Config							
	1 Out	Config							
	2 Out	Config	1						

Fig. 3-21: Configuring external instrument at IQ1 Out

- 3. Click on the button **SCAN**. The SMW searches for available instruments on the LAN.
- 4. Select the wanted instrument under **External Instrument**. Check the shown settings and click **Apply and Connect**. The reference path is RF A. (Fig. 3-22)

I/Q OUT 1: External Instrument Configuration	_ ×					
Remote Config Remote Control Find Connec	tor					
Detect Scan	Purge Clean All					
External Instrument	SGS (100014) -					
Symbolic Name	SGS (100014)					
Hardware Channel	LAN					
Name / IP Address	rssgs100a100014					
RF Path	Α .					
Apply	Apply and Connect					

Fig. 3-22: Choose an external instrument

 If RF Coup is marked, the instrument uses the same frequency, level and RF state like the SMW (e.g. RF A). Offsets can be entered relatively to the reference path. (Fig. 3-23)

Fading/B	asebar	d Config	Q Stream	n Mappe	er External RF and I/C	Overvie	W			
Display N	Mappeo	Connector	s	-	Connec	t All Rem	note	Discor	nect All R	emote
	Dir	External Instrument	I/Q Conn	Rem Conn	Instrument Name	RF Coup	RF Frequ /Hz	ency	RF Level /dBm	RF State
CODER	1 In	Config								
CODER	2 In	Config								
BBMM 1	Out	Config								
BBMM 2	Out	Config								
	1 Out	Config			SGS (100014)			Δ: 0.00	Δ: 0.00	On
I/Q OUT	2 Out	Config								

Fig. 3-23: External instrument is RF coupled to RF A. It uses the same frequency, level and RF state like RF A.

6. Switch **On** the used IQ Modulators.

The SGT can be connected the same way as the SGS to the SMW. The SGT uses DIG IQ connections e.g. via FADERx.

3.1.6 Demo Program R&S TSrun

This Application Note comes with a demonstration program module called **LTE BS Performance Tests** for the software TSrun, which is free of charge. The module covers all required tests (with the exceptions in Table 1-1).

The **LTE BS Performance Tests** module represents a so called test for the TSrun software. See Section 4.1 for some important points on the basic operation of TSrun.

Each test described in this application note can be executed quickly and easily using the module. Additional individual settings can be applied.

The program offers a straightforward user interface, and SCPI remote command sequence export functions for integrating the necessary SCPI commands into any user-specific test environment. A measurement report will be generated on each run. It can be saved to a file in different formats including PDF and HTML.

Following SCPI resources are needed:

I SMx

Getting started

This section describes only the module for the LTE BS Rx tests. Double-click the test to open the window for entering parameters.

Basic operation

The test consists of two independent test cases:



I The test case ResetAll resets all instruments (SMx).

The test case **Measurement** is the main part.

LTE BS Performance Tests								
ROHDE&SCHWA	RZ					Help		
Performance Test: 8.2.1 General Frequency:	PUSCH in Multipath Fading	g Conditions (Sing (8.5) IHz (8.2)	le Antenna Port) NB-loT Additional Se PUSCH (8.3) PUCCH	▼ ttings (8.4) PRACH	Reset Devices Comments:	✓ External Reference		
Bandwidth: Duplex Mode: UL/DL Configuration: Special Subframe: Trigger Mode: Real-Time Feedback Feedback Mode: Feedback Connector:	andwidth: 10 • MHz uplex Mode: FDD • L/DL Configuration: 0 • pecial Subframe: 0 • rigger Mode: Armed Auto (Ext.) • Real-Time Feedback Feedback Mode: Binary ACK/NACK • Feedback Connector: T/M 3 •		PUSCH (1 AP): 4 Antennas 2nd CC: BW: Offset: A PUSCH (2 AP): 4 Antennas UL Timing: HARQ-ACK MPX:	Normal, EPA 5Hz, A B Antennas NHz KRC A3-x, EPA 5Hz, A B Antennas C CW Scenario 1, FRC A7-x SRS Normal, EVA 5Hz, A	8.2.1 PUSCH in Multin Antenna Port): Generates PUSCH Si different FRCs under Conditions. HARQ-Fe Note: For 4 or 8 Ante equipped SMW.	bath Fading (Single gnals of 1 UE with different Fading edback is necessary. nnas use one fully		
Additional User Delay: Fading Cyclic Prefix: Propagation Conditions Propagation Frequency Fading Profile:	0.00 ★ St Normal EPA C 5 H Low	ubfr. 8.2.4 8.2.7 Iz	High Speed: PUSCH for CE:	1 Antenna, HST 3, 30% V PUCCH CE Mode A, A3-2 V	General Test Setup:	UE		
						OK Cancel		

Fig. 3-24: Full overview: setting parameters for the LTE BS Performance tests.

General settings

The basic parameters are set at the top right:

- Reset Devices: Sends a reset command to all connected instruments
- I External Reference.

The tabulator **Addittional Settings** is used to enter compensations for external path attenuations.

(8.2) PUSCH (8.3) PUCCH (8.4) PRACH (8.5) NB-IoT Additional Settings										
Generator Attenuation:										
Path 1:	0	dB	Path 2:	0	dB					
Path 3:	0	dB	Path 4:	0	dB					
Path 5:	0	dB	Path 6:	0	dB					
Path 7:	0	dB	Path 8:	0	dB					

Fig. 3-25: Attenuation settings.

Test cases

This is the main parameter. Select the wanted test case here. All other remaining parameters in the window are grayed out or set active based on the requirements for the selected test case. These parameters are described in detail in the individual sections below.

Fig. 3-26: Available test cases.

Based on the selected test case, helpful hints are provided in the Comments section and an illustration of the basic test setup is displayed.



Fig. 3-27: Brief notes are provided in the Comments section (top right) based on the selected test case.



Fig. 3-28: The Test Setup section (bottom right) displays a basic setup for the selected test case.

General settings for the signal

Use this section to define the basic parameters for the LTE signal:

- Frequency for the center frequency
- Bandwidth: channel bandwidth
- I Duplex Mode
 - For TDD: UL/DL Configuration and Special Subframe
- Trigger Mode: typically External trigger provided by the base station under test
- The section Feedback defines the real time feedback handling for certain PUSCH tests
- The section Fading shows the fading settings

More advanced settings for specific tests cases are described in the corresponding sections below.

General							
Frequency:	1920	MHz					
Bandwidth:	10 -	MHz					
Duplex Mode:	FDD -]					
UL/DL Configuration:	1]					
Special Subframe:	0						
Trigger Mode: External (Armed A -							
Real Time Feedback:	Binary ACK/NACK 🗸						
Feedback Connector:	User1 -						
Additional User Delay:	0.00	Subfr.					
Fading							
Cyclic Prefix:	Normal -]					
Propagation Conditions	EPA -						
Propagation Frequency	5 👻	Hz					
Fading Profile:	Low]					

Fig. 3-29: Main parameter settings.

3.2 Performance requirements for PUSCH (Clause 8.2)

The physical uplink shared channels (PUSCH) carries user data, it is dynamically shared among different users in a cell.

Special issues for single PUSCH tests are described in the related subchapters.

All tests in this subclause are performed for a given SNR where the AWGN power level is given in Table 3-4.

AWGN power level for PUSCH tests							
Channel bandwidth [MHz]	AWGN power level						
1.4	-92.7dBm / 1.08MHz						
3	-88.7dBm / 2.7MHz						
5	-86.5dBm / 4.5MHz						
10	-83.5dBm / 9MHz						
15	-81.7dBm / 13.5MHz						
20	-80.4dBm / 18MHz						

Table 3-4: AWGN power level for PUSCH tests

Hybrid Automatic Repeat Request (HARQ)-Feedback

Some PUSCH tests require a feedback signal from the base station under test to provide feedback for HARQ and/or uplink timing control information. The signal generator automatically adjusts the transmitted signal based on the feedback. Software option SMW-K69 Closed Loop BS Tests is needed to perform tests with base station feedback.

The Realtime Feedback Configuration is enabled only for UE1 in instruments. It supports three different modes (Fig. 3-30). You can find the settings under **Frame Configuration** in **UE1**.

E	UTRA/LTE A: U	_	×						
	OCommon	OFRC		back	PUSCH	DRS	OSRS		
	Realtime Feedback Mode			Off					
				Off					
				Binary ACK/NACK					
				Ser	al				
				Ser	al 3x8				

Fig. 3-30: The three supported mode in option SMW-K69

Please note that for NB-IoT and eMTC only the serial modes are available.

Select the supported Realtime Feedback Mode (example: Binary ACK/NACK). The default parameter of Redundancy Version Sequence and the Max. Number of Transmissions fits to the needed settings already (Fig. 3-31).

EUTRA/LTE A: User Equipment Configurati	on (UE1) 🚬 🗙						
	pack PUSCH DRS OSRS						
Realtime Feedback Mode	Binary ACK/NACK						
Redundancy Version Sequence	0,2,3,1						
Max. Number of Transmissions	4						
Initial Timing Advance	0 16 T_S -						
ACK Definition	High						
Connector	Local						
	Local Connector Settings						
-Distanco Modo	3CDD						



You can configure the feedback line as required with the button Local Connector Settings (example: set Connector T/M 3 Direction to Input and Connector T/M 3 Signal to Feedback).

EUTRA/LTE A: User Equipment Configuration (UE1)									
OCommon OFRC ORT Feedback PUSCH DRS OSRS									
Realtime Feedback Mo	ode	Serial							
Redundancy Version S	equence	0,2,3,1							
Max. Number of Transmissions 4									
Assume ACK Until First Received ACK Command									
Initial Timing Advance 0 16 T_S							·		
Connector		Local							
		Loc	al Conn	ector S	etting	<u>as</u>			
	Local Connect	ors A				_	×		
Additional User Delay	Connector	Direction Signal							
	T/M/C 1			Output	•	Symbol C	lock A		
System VNC	T/M 2		•	Output		Marker A1	· •		
Config.	T/M 3			Input		Feedback	۰ -		

Fig. 3-32: Settings for using a serial feedback line from the BS to SMW. The HARQ-feedback line from the BS is connected with Local Connector T/M3 at the SMW rear panel.

Signals and connectors for PUSCH tests						
Signal	HARQ feedback (from	Frame Trigger				
	63)	(DL timing from BS)				
Connector	ТМЗ	USER3				
@ SMW	(rear panel)	(front panel)				

Table 3-5: Feedback and trigger inputs

SNR Correction Factor

For FRC's with not all RB's allocated (A3-1, A4-1, A4-2 and A5-1) a special SNR correction factor has to be applied by the user.

 $SNR\Delta = 10 \log (allocated RB's / full possible RB's per slot)$

Example: For FRC A4-1 in 5 MHz bandwidth only one RB is allocated. 25 RBs per slot can be allocated acc. to [2]. Thus $SNR\Delta = 10 \log (1 / 25) = -13.98 \text{ dB}$. This factor depends on the bandwidth, see Table 3-6.

SNR Correction factor PUSCH						
Bandwidth in MHz Factor in dB						
1.4	-7.78					
3	-11.76					
5	-13.98					
10	-16.99					
15	- 18.75					
20	- 20.00					

Table 3-6: SNR correction factor for PUSCH tests with 1RB allocated.

3.2.1 Performance requirements of PUSCH in multipath fading propagation conditions transmission on single antenna port (Clause 8.2.1)

The test verifies the achieved throughput of a receiver under multipath fading conditions at a given SNR. The throughput is measured by the base station under test. The required throughput is expressed as a fraction of maximum throughput for the FRC's. HARQ re-transmission is assumed.

Test parameters 8.2.1						
Parameter	Value					
Maximum number of HARQ transmissions	4					
Redundancy version (RV) sequence	0, 2, 3, 1, 0, 2, 3, 1					
Uplink-downlink allocation for TDD	Configuration 1 (2 DL:2 UL)					

Table 3-7: Parameters for PUSCH test 8.2.1

Carrier Aggregation

This test is applicable for Carrier Aggregation if the tested BS supports it. Only the CC combination with the largest aggregated bandwidth and the largest number of CCs has to be tested. For this CC combination, the tests using full PRB allocation FRC are conducted on per CC basis and measured by the required SNR levels corresponding to the bandwidths used on the different CCs.

CA can be tested by using a further baseband. The bandwidth then is limited to the bandwidth of the I/Q block. Further limitation may appear if for the other baseband a frequency shall be used which is too far off from the other used frequencies or where no resource is available. Also, see application note 1MA166 and 1GP92.

Base station categories

This test is applicable for all categories of BS. Tests with the fading profiles ETU 70Hz Low and ETU 300Hz Low are not applicable for Local Area and Home Area BS (marked yellow in the tables below).

Test requirements

The following tables show the test requirements for all bandwidths and all applicable number of RX antennas (2, 4 and 8). They include AWGN, SNR, SNR correction factor and the resulting carrier power level. For the given parameters, the fraction of the maximum throughput has to be achieved. All tables are in [1] section 8.2.1.

Test requirements 8.2.1, 1.4 MHz Bandwidth, 2 RX antennas, AWGN -92.7 dBm							
Cyclic prefix	Propagation conditions	FRC	Fraction of max. throughput	SNR [dB]	Add. SNR Corr. Factor -7,78 [dB]	Offset VRB	Resulting LTE Carrier Level [dBm]
Normal	EPA 5Hz	A3-2	30%	-3.5			-96.2
			70%	0.7			-92.0
		A4-3	70%	11.2			-81.5
		A5-2	70%	18.3			-74.4
		A17-1	70%	22.0			-70.7
		A18-1	70%	8.0			-84.7
		A19-1	70%	18.7			-74.0
	EVA 5Hz	A3-1	30%	-2.1	х	2	-102.58
			70%	2.4	х	2	-98.08
		A4-1	30%	5.0	х	2	-95.48
			70%	11.9	х	2	-88.58
		A5-1	70%	19.2	х	2	-81.28
	EVA 70Hz	A3-2	30%	-3.3			-96
			70%	1.3			-91.4
		A4-3	30%	4.6			-88.1
			70%	12.5			-80.2
	ETU 70Hz	A3-1	30%	-1.8	х	2	-102.28
			70%	3.0	х	2	-97.48
	ETU 300Hz	A3-1	30%	-1.6	Х	2	-102.08
			70%	3.5	x	2	-96.98
Extended	ETU 70Hz	A4-2	30%	5.4	x	2	-95.08
			70%	14.1	х	2	-86.38

Note: Not applicable for Local Area and Home Area BS. Table 3-8: Test requirements for test 8.2.1, 1.4MHz Bandwidth, 2RX antennas, AWGN -92.7dBm

Test requirements 8.2.1, 1.4 MHz Bandwidth, 4 RX antennas, AWGN -92.7 dBm							
Cyclic prefix	Propagation conditions	FRC	Fraction of max. throughput	SNR [dB]	add SNR Corr. Factor -7,78 [dB]	Offset VRB	LTE Carrier Level [dBm]
Normal	EPA 5Hz	A3-2	30%	-6.0			-98.7
			70%	-2.5			-95.2
		A4-3	70%	7.7			-85
		A5-2	70%	15.0			-77.7
		A17-1	70%	18.8			-73.9
		A18-1	70%	4.7			-88.0
		A19-1	70%	15.3			-77.4
	EVA 5Hz	A3-1	30%	-4.4	х	2	-104.88
			70%	-0.7	х	2	-101.18
		A4-1	30%	1.9	х	2	-98.58
			70%	8.4	х	2	-92.08
		A5-1	70%	16.0	х	2	-84.48
	EVA 70Hz	A3-2	30%	-5.7			-98.4
			70%	-2.1			-94.8
		A4-3	30%	1.4			-91.3
			70%	8.9			-83.8
	ETU 70Hz	A3-1	30%	-4.2	х	2	-104.68
			70%	-0.4	х	2	-100.88
	ETU 300Hz	A3-1	30%	-4.0	х	2	-104.48
			70%	0.0	х	2	-100.48
	ETU 600Hz	A13-1	30%	-0.3			-93.0
			70%	6.7			-86.0
Extended	ETU 70Hz	A4-2	30%	2.2	х	2	-98.28
			70%	10.5	Х	2	-89.98

Note: Not applicable for Local Area and Home Area BS.

Table 3-9: Test requirements for test 8.2.1, 1.4 MHz Bandwidth, 4 RX antennas, AWGN-92.7dBm
Test requi	Test requirements 8.2.1. 1.4 MHz Bandwidth. 8 RX antennas. AWGN -92.7 dBm									
Cyclic prefix	Propagation conditions	FRC	Fraction of max. throughput	SNR [dB]	add SNR Corr. Factor -7,78 [dB]	Offset VRB	LTE Carrier Level [dBm]			
Normal	EPA 5Hz	A3-2	30%	-8.8			-101.5			
		A4 2	70%	-5.0			99.1			
		Δ5-2	70%	11.5			-81.2			
		A17-1	70%	15.7			-77.0			
		A18-1	70%	1.7			-91.0			
		A19-1	70%	12.2			-80.5			
	EVA 5Hz	A3-1	30%	-6.6	х	2	-107.08			
			70%	-3.2	х	2	-103.68			
		A4-1	30%	-1.1	х	2	-101.58			
			70%	5.2	х	2	-95.28			
		A5-1	70%	12.3	Х	2	-88.18			
	EVA 70Hz	A3-2	30%	-8.4			-101.1			
			70%	-5.2			-97.9			
		A4-3	30%	-1.9			-94.6			
			70%	5.4			-87.3			
	ETU 70Hz	A3-1	30%	-6.2	х	2	-106.68			
ETU 30			70%	-3.0	х	2	-103.48			
	ETU 300Hz	A3-1	30%	-6.1	Х	2	-106.58			
			70%	-2.7	х	2	-103.18			
Extended	ETU 70Hz	A4-2	30%	-0.5	Х	2	-100.98			
			70%	7.0	x	2	-93.48			

Performance requirements for PUSCH (Clause 8.2)

Note: Not applicable for Local Area and Home Area BS. Table 3-10: Test requirements for test 8.2.1, 1.4 MHz Bandwidth, 8 RX antennas, AWGN-92.7dBm

Test requi	rements 8.2.1, 3	3 MHz Bai	ndwidth, 2 RX	antenna	s, AWGN -88.	7 dBm	
Cyclic prefix	Propagation conditions	FRC	Fraction of max. throughput	SNR [dB]	add SNR Correct. Factor -11,76 [dB]	Offset VRB	LTE Carrier Power Level [dBm]
Normal	EPA 5Hz	A3-3	30%	-3.5			-92.2
			70%	0.7			-88.0
		A4-4	70%	11.5			-77.2
		A5-3	70%	18.7			-70.0
		A17-2	70%	22.6			-66.1
		A18-2	70%	8.0			-80.7
		A19-2	70%	18.5			-70.2
	EVA 5Hz	A3-1	30%	-2.2	х	7	-102.66
			70%	2.4	х	7	-98.06
		A4-1	30%	4.9	х	7	-95.56
			70%	12.1	х	7	-88.36
		A5-1	70%	19.4	х	7	-81.06
	EVA 70Hz	A3-3	30%	-3.4			-92.1
			70%	1.2			-87.5
		A4-4	30%	5.3			-83.4
			70%	13.1			-75.6
	ETU 70Hz	A3-1	30%	-1.9	х	7	-102.36
			70%	3.0	х	7	-97.46
	ETU 300Hz	A3-1	30%	-1.6	Х	7	-102.06
			70%	3.5	х	7	-96.96
Extended	ETU 70Hz	A4-2	30%	5.3	x	7	-95.16
			70%	14.1	Х	7	-86.36

Performance requirements for PUSCH (Clause 8.2)

Note: Not applicable for Local Area and Home Area BS. Table 3-11: Test requirements for test 8.2.1, 3 MHz Bandwidth, 2 RX antennas, AWGN-88.7dBm

Test requirements 8.2.1, 3 MHz Bandwidth, 4 RX antennas, AWGN -88.7 dBm									
Cyclic prefix	Propagation conditions	FRC	Fraction of max. throughput	SNR [dB]	add SNR Correct. Factor -11,76 [dB]	Offset VRB	LTE Carrier Level [dBm]		
Normal	EPA 5Hz	A3-3	30%	-6.2			-94.9		
			70%	-2.8			-91.5		
		A4-4	70%	8.3			-80.4		
		A5-3	70%	15.0			-73.7		
		A17-2	70%	19.3			-69.4		
		A18-2	70%	4.6			-84.1		
		A19-2	70%	14.6			-74.1		
	EVA 5Hz	A3-1	30%	-4.4	х	7	-104.86		
			70%	-0.7	х	7	-101.16		
		A4-1	30%	1.8	х	7	-98.66		
			70%	8.4	х	7	-92.06		
		A5-1	70%	16.0	х	7	-84.46		
	EVA 70Hz	A3-3	30%	-5.9			-94.6		
			70%	-2.3			-91.0		
		A4-4	30%	2.2			-86.5		
			70%	9.3			-79.4		
	ETU 70Hz	A3-1	30%	-4.2	х	7	-104.66		
			70%	-0.3	х	7	-100.76		
ETU 300H	ETU 300Hz	A3-1	30%	-4.0	х	7	-104.46		
			70%	0.0	х	7	-100.46		
	ETU 600Hz	A13-2	30%	-0.5			-89.2		
			70%	6.4			-82.3		
Extended	ETU 70Hz	A4-2	30%	2.1	X	7	-98.36		
			70%	10.5	Х	7	-89.96		

Performance requirements for PUSCH (Clause 8.2)

Note: Not applicable for Local Area and Home Area BS.

Table 3-12: Test requirements for test 8.2.1, 3 MHz Bandwidth, 4 RX antennas, AWGN-88.7dBm

Test requirements 8.2.1, 3 MHz Bandwidth, 8 RX antennas, AWGN -88.7 dBm									
Cyclic prefix	Propagation conditions	FRC	Fraction of max. throughput	SNR [dB]	add SNR Correct. Factor -11,76 [dB]	Offset VRB	LTE Carrier Level [dBm]		
Normal	EPA 5Hz	A3-3	30%	-9.0			-97.7		
			70%	-6.0			-94.7		
		A4-4	70%	4.7			-84.0		
		A5-3	70%	11.7			-77		
		A17-2	70%	16.2			-72.5		
		A18-2	70%	1.9			-86.8		
		A19-2	70%	11.6			-77.1		
-	EVA 5Hz	A3-1	30%	-6.5	х	7	-106.96		
			70%	-3.4	х	7	-103.86		
		A4-1	30%	-1.0	х	7	-101.46		
			70%	5.0	х	7	-95.46		
		A5-1	70%	12.3	х	7	-88.16		
	EVA 70Hz	A3-3	30%	-8.7			-97.4		
			70%	-5.3			-94.0		
		A4-4	30%	-2.2			-90.9		
			70%	5.4			-83.3		
	ETU 70Hz	A3-1	30%	-6.4	Х	7	-106.86		
			70%	-3.1	Х	7	-103.56		
	ETU 300Hz	A3-1	30%	-6.2	Х	7	-106.66		
			70%	-2.7	Х	7	-103.16		
Extended	ETU 70Hz	A4-2	30%	-0.6	х	7	-101.06		
			70%	7.1	X	7	-93.36		

Performance requirements for PUSCH (Clause 8.2)

Note: Not applicable for Local Area and Home Area BS. Table 3-13: Test requirements for test 8.2.1, 3 MHz Bandwidth, 8 RX antennas, AWGN -88.7dBm

Test requirements 8.2.1, 5 MHz Bandwidth, 2 RX antennas, AWGN -86.5 dBm										
Cyclic prefix	Propagation conditions	FRC	Fraction of max. throughput	SNR [dB]	add SNR Correct. Factor -13.98 [dB]	Offset VRB	LTE Carrier Level [dBm]			
Normal	EPA 5Hz	A3-4	30%	-4.1			-90.60			
			70%	-0.1			-86.60			
		A4-5	70%	11.0			-75.50			
		A5-4	70%	18.6			-67.90			
		A17-3	70%	22.5			-64.0			
		A18-3	70%	8.9			-77.6			
		A19-3	70%	20.0			-66.5			
EV	EVA 5Hz	A3-1	30%	-2.1	х	12	-102.58			
			70%	2.4	х	12	-98.08			
		A4-1	30%	4.9	х	12	-95.58			
			70%	12.1	х	12	-88.38			
		A5-1	70%	19.2	х	12	-81.28			
	EVA 70Hz	A3-4	30%	-3.9			-90.40			
			70%	0.5			-86.00			
		A4-5	30%	4.9			-81.60			
			70%	12.9			-73.60			
ЕТU 70	ETU 70Hz	A3-1	30%	-1.9	Х	12	-102.38			
			70%	3.0	Х	12	-97.48			
	ETU 300Hz	A3-1	30%	-1.6	Х	12	-102.08			
			70%	3.5	Х	12	-96.98			
Extended	ETU 70Hz	A4-2	30%	5.4	Х	12	-95.08			
			70%	14.1	Х	12	-86.38			

Note: Not applicable for Local Area and Home Area BS. Table 3-14: Test requirements for test 8.2.1, 5 MHz Bandwidth, 2 RX antennas, AWGN-86.5dBm

Special properties Frequency properties Fraction of max. through-put withough-put withough-	Test requir	Test requirements 8.2.1, 5 MHz Bandwidth, 4 RX antennas, AWGN -86.5 dBm									
Normal FPA 5Hz A3-4 30% -6.5 International organizational organizationex organizational organizational organizationex organ	Cyclic prefix	Propagation conditions	FRC	Fraction of max. through-put	SNR [dB]	add SNR Correct. Factor -13.98 [dB]	Offset VRB	LTE Carrier Level [dBm]			
$ 70% - 3.2 $ $ -89.70 $ $ A4-5 $ $ 70% - 8.2 $ $ -78.30 $ $ A5-4 $ $ 70% - 15.0 $ $ -71.50 $ $ A17-3 $ $ 70% - 19.1 $ $ -67.40 $ $ A18-3 $ $ 70% - 5.7 $ $ -67.40 $ $ A18-3 $ $ 70% - 5.7 $ $ -6.3 $ $ A19-3 $ $ 70% - 4.5 $ $ 70.10 $ $ EVA 5Hz $ $ A3-1 $ $ 30% - 4.5 $ $ X. $ $ A4-1 $ $ 30% - 4.5 $ $ X. $ $ 12 $ $ A17.3 $ $ 30% - 4.5 $ $ X. $ $ 12 $ $ A19.3 $ $ 70% - 0.8 $ $ X. $ $ 12 $ $ A4-1 $ $ 30% - 6.3 $ $ X. $ $ 12 $ $ B5.7 $ $ R4.38 $ $ 92.80 $ $ R4.5 $ $ 30% - 2.7 $ $ R8.20 $ $ R4.5 $ $ 30% - 2.7 $ $ R8.20 $ </td <td>Normal</td> <td>EPA 5Hz</td> <td>A3-4</td> <td>30%</td> <td>-6.5</td> <td></td> <td></td> <td>-93.00</td>	Normal	EPA 5Hz	A3-4	30%	-6.5			-93.00			
$ \begin{array}{ c c c c c c } \hline \begin{tabular}{ c c c c } \hline 4.5 & 70\% & 8.2 & 1 & 1 & -78.30 \\ \hline $A5-4$ & 70\% & 15.0 & 1 & -71.50 \\ \hline $A17-3$ & 70\% & 19.1 & 1 & -67.40 \\ \hline $A17-3$ & 70\% & 5.7 & 1 & -80.80 \\ \hline $A18-3$ & 70\% & 16.4 & 1 & -70.10 \\ \hline $A19-3$ & 70\% & 16.4 & 1 & -70.10 \\ \hline $A19-3$ & 70\% & 16.4 & 1 & -70.10 \\ \hline $A19-3$ & 70\% & -4.5 & X & 12 & -104.98 \\ \hline $70\% & -0.8 & X & 12 & -101.28 \\ \hline $70\% & -0.8 & X & 12 & -101.28 \\ \hline $70\% & -0.8 & X & 12 & -101.28 \\ \hline $70\% & 8.5 & X & 12 & -98.68 \\ \hline $70\% & 8.5 & X & 12 & -91.98 \\ \hline $A5-1$ & 70\% & 16.1 & X & 12 & -91.98 \\ \hline $A5-1$ & 70\% & 16.1 & X & 12 & -91.98 \\ \hline $A5-1$ & 70\% & -6.3 & 1 & -92.80 \\ \hline $70\% & -2.7$ & 1 & -84.38 \\ \hline $P2.80 & -77.60 \\ \hline \\ \hline $PU 70Hz$ & $A3-1$ & $30\% & -4.2 & X & 12 & -104.68 \\ \hline $70\% & -0.3 & X & 12 & -100.78 \\ \hline \end{tabular}$				70%	-3.2			-89.70			
$ \begin{array}{ c c c c c c } \hline \begin{tabular}{ c c c c } \hline $A5-4$ & 70% & 15.0 & 16.4 & -71.50 \\ \hline $A17-3$ & 70% & 19.1 & 16.4 & 67.40 \\ \hline $A18-3$ & 70% & 5.7 & 10 & 80.80 \\ \hline $A19-3$ & 70% & 16.4 & 10 & -70.10 \\ \hline $A19-3$ & 70% & 16.4 & 12 & -70.10 \\ \hline $A19-3$ & 70% & -4.5 & X & 12 & -104.98 \\ \hline $A19-3$ & 70% & -0.8 & X & 12 & -101.28 \\ \hline $A19-3$ & 70% & -0.8 & X & 12 & -101.28 \\ \hline $A19-3$ & 70% & 1.8 & X & 12 & -98.68 \\ \hline $A19-3$ & 70% & 8.5 & X & 12 & -98.68 \\ \hline $A19-3$ & 70% & 8.5 & X & 12 & -91.98 \\ \hline $A5-1$ & 70% & 8.5 & X & 12 & -91.98 \\ \hline $A5-1$ & 70% & 16.1 & X & 12 & -91.98 \\ \hline $A5-1$ & 70% & 6.3 & 12 & -92.80 \\ \hline $A19-3$ & 1.8 & 12 & -92.80 \\ \hline $A19-3$ & 1.8 & 1.8 & 12 & -89.20 \\ \hline $A4-5$ & 30% & -2.7 & 1.6 & 1.8 & -89.20 \\ \hline $A4-5$ & 30% & 1.8 & 1.8 & -89.20 \\ \hline $A4-5$ & 30% & 1.8 & 1.8 & -89.20 \\ \hline $A4-5$ & 30% & 1.8 & 1.8 & -77.60 \\ \hline $ETU 70Hz$ & $A3-1$ & 30% & -4.2 & X & 12 & -104.68 \\ \hline $A19-4$ & -77.60 \\ \hline $ETU 70Hz$ & $A3-1$ & 30% & -4.2 & X & 12 & -100.78 \\ \hline $A19-5$ & 70% & -0.3 & X & 12 & -100.78 \\ \hline $A19-5$ & 70% & -0.3 & X & 12 & -100.78 \\ \hline $A19-5$ & 70% & -1.3 & -12 & -100.78 \\ \hline $A19-5$ &$			A4-5	70%	8.2			-78.30			
$ \begin{array}{ c c c c c c } \hline \mbox{A17-3} & 70\% & 19.1 & & & & -67.40 \\ \hline \mbox{A18-3} & 70\% & 5.7 & & & -80.80 \\ \hline \mbox{A19-3} & 70\% & 16.4 & & -70.10 \\ \hline \mbox{A19-3} & 70\% & -4.5 & X & 12 & -104.98 \\ \hline \mbox{A19-3} & 70\% & -0.8 & X & 12 & -101.28 \\ \hline \mbox{A31} & 70\% & -0.8 & X & 12 & -101.28 \\ \hline \mbox{A4-1} & 30\% & 1.8 & X & 12 & -98.68 \\ \hline \mbox{A4-1} & 30\% & 1.8 & X & 12 & -98.68 \\ \hline \mbox{A5-1} & 70\% & 8.5 & X & 12 & -91.98 \\ \hline \mbox{A5-1} & 70\% & 16.1 & X & 12 & -91.98 \\ \hline \mbox{A5-1} & 70\% & -6.3 & & -92.80 \\ \hline \mbox{A5-1} & 70\% & -2.7 & & -89.20 \\ \hline \mbox{A5-1} & 70\% & 1.8 & & -84.70 \\ \hline \mbox{A4-5} & 30\% & -2.7 & & & -84.70 \\ \hline \mbox{A4-5} & 30\% & 1.8 & & -77.60 \\ \hline \mbox{ETU 70Hz} & A3-4 & 30\% & -4.2 & X & 12 & -104.68 \\ \hline \mbox{A5-1} & 70\% & -0.3 & X & 12 & -100.78 \\ \hline \end{tabular}$			A5-4	70%	15.0			-71.50			
$ \begin{array}{ c c c c c c } \hline \mbox{A18-3} & 70\% & 5.7 & $			A17-3	70%	19.1			-67.40			
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $			A18-3	70%	5.7			-80.80			
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$			A19-3	70%	16.4			-70.10			
$ \begin{array}{ c c c c c c c } \hline & & & & & & & & & & & & & & & & & & $		EVA 5Hz	A3-1	30%	-4.5	х	12	-104.98			
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$				70%	-0.8	х	12	-101.28			
$ \begin{array}{ c c c c c c c } \hline & & & & & & & & & & & & & & & & & & $			A4-1	30%	1.8	х	12	-98.68			
A5-1 70% 16.1 X 12 -84.38 EVA 70Hz A3-4 30% -6.3 Image: Compare the system of the sy				70%	8.5	х	12	-91.98			
EVA 70Hz A3-4 30% -6.3			A5-1	70%	16.1	х	12	-84.38			
Image: Problem in the		EVA 70Hz	A3-4	30%	-6.3			-92.80			
A4-5 30% 1.8				70%	-2.7			-89.20			
FTU 70Hz A3-1 30% -4.2 X 12 -104.68 70% -0.3 X 12 -100.78			A4-5	30%	1.8			-84.70			
ETU 70Hz A3-1 30% -4.2 X 12 -104.68 70% -0.3 X 12 -100.78				70%	8.9			-77.60			
70% -0.3 X 12 -100.78		ETU 70Hz	A3-1	30%	-4.2	х	12	-104.68			
				70%	-0.3	х	12	-100.78			
ETU 300Hz A3-1 30% -4.0 X 12 -104.48	E	ETU 300Hz	A3-1	30%	-4.0	х	12	-104.48			
70% 0.0 X 12 -100.48				70%	0.0	х	12	-100.48			
ETU 600Hz A13-3 30% -0.3 -86.8		ETU 600Hz	A13-3	30%	-0.3			-86.8			
70% 6.7 -79.8				70%	6.7			-79.8			
Extended ETU 70Hz A4-2 30% 2.2 X 12 -98.28	Extended	ETU 70Hz	A4-2	30%	2.2	х	12	-98.28			
70% 10.5 X 12 -89.98				70%	10.5	х	12	-89.98			

Performance requirements for PUSCH (Clause 8.2)

Note: Not applicable for Local Area and Home Area BS.

Table 3-15: Test requirements for test 8.2.1, 5 MHz Bandwidth, 4 RX antennas, AWGN -86.5 dBm

Test requi	Test requirements 8.2.1, 5 MHz Bandwidth, 8 RX antennas, AWGN -86.5 dBm										
Cyclic prefix	Propagation conditions	FRC	Fraction of max. through-put	SNR [dB]	add SNR Correct. Factor -13.98 [dB]	Offset VRB	LTE Carrier Level [dBm]				
Normal	EPA 5Hz	A3-4	30%	-9.5			-96.0				
			70%	-6.6			-93.1				
		A4-5	70%	4.9			-81.6				
		A5-4	70%	11.9			-74.6				
		A17-3	70%	15.9			-70.6				
		A18-3	70%	2.6			-83.9				
		A19-3	70%	13.1			73.4				
EVA 5Hz	EVA 5Hz	A 5Hz A3-1	30%	-6.5	x	12	-106.98				
			70%	-3.3	x	12	-103.78				
		A4-1	30%	-1.3	x	12	-101.78				
			70%	5.0	x	12	-95.48				
		A5-1	70%	12.3	х	12	-88.18				
	EVA 70Hz	A3-4	30%	-9.3			-95.8				
			70%	-6.1			-92.6				
		A4-5	30%	-1.9			-88.4				
			70%	5.2			-81.3				
	ETU 70Hz	A3-1	30%	-6.3	х	12	-106.78				
			70%	-2.8	х	12	-103.28				
	ETU 300Hz	A3-1	30%	-6.3	Х	12	-106.78				
			70%	-2.7	Х	12	-103.18				
Extended	ETU 70Hz	A4-2	30%	-0.6	х	12	-101.08				
			70%	7.0	X	12	-93.48				

Note: Not applicable for Local Area and Home Area BS. Table 3-16: Test requirements for test 8.2.1, 5 MHz Bandwidth, 8 RX antennas, AWGN -86.5 dBm

Test requi	Test requirements 8.2.1, 10 MHz Bandwidth, 2 RX antennas, AWGN -83.5 dBm									
Cyclic prefix	Propagation conditions	FRC	Fraction of max. throughput	SNR [dB]	add SNR Correct. Factor -16.99 [dB]	Offset VRB	LTE Carrier Level [dBm]			
Normal	EPA 5Hz	A3-5	30%	-3.6			-87.10			
			70%	0.2			-83.30			
		A4-6	70%	11.4			-72.10			
		A5-5	70%	18.9			-64.60			
		A17-4	70%	23.2			-60.3			
		A18-4	70%	9.1			-74.4			
		A19-4	70%	20.1			-63.4			
EV	EVA 5Hz	A3-1	30%	-2.1	х	24	-102.59			
			70%	2.5	х	24	-97.99			
		A4-1	30%	4.9	х	24	-95.59			
			70%	12.0	х	24	-88.49			
		A5-1	70%	19.4	x	24	-81.09			
	EVA 70Hz	A3-5	30%	-3.5			-87.00			
			70%	0.7			-82.80			
		A4-6	30%	5.1			-78.40			
			70%	13.2			-70.30			
	ETU 70Hz	A3-1	30%	-1.9	х	24	-102.39			
			70%	3.0	х	24	-97.49			
	ETU 300Hz	A3-1	30%	-1.6	х	24	-102.09			
			70%	3.5	х	24	-96.99			
Extended	ETU 70Hz	A4-2	30%	5.4	x	24	-95.09			
			70%	14.2	х	24	-86.29			

Note: Not applicable for Local Area and Home Area BS.

Table 3-17: Test requirements for test 8.2.1, 10 MHz Bandwidth, 2 RX antennas, AWGN -83.5 dBm

Test requirements 8.2.1, 10 MHz Bandwidth, 4 RX antennas, AWGN -83.5 dBm										
Cyclic prefix	Propagation conditions	FRC	Fraction of max. throughput	SNR [dB]	add SNR Correct. Factor -16.99 [dB]	Offset VRB	LTE Carrier Level [dBm]			
Normal	EPA 5Hz	A3-5	30%	-6.2			-89.70			
			70%	-2.9			-86.40			
		A4-6	70%	8.1			-75.40			
		A5-5	70%	15.3			-68.20			
		A17-4	70%	19.8			-63.7			
		A18-4	70%	5.9			-77.6			
		A19-4	70%	16.4			-67.1			
EVA 5Hz	EVA 5Hz	A3-1	30%	-4.4	x	24	-104.89			
			70%	-0.6	х	24	-101.09			
		A4-1	30%	1.8	x	24	-98.69			
			70%	8.5	x	24	-91.99			
		A5-1	70%	16.1	х	24	-84.39			
	EVA 70Hz	A3-5	30%	-6.1			-89.60			
			70%	-2.3			-85.80			
		A4-6	30%	1.3			-82.20			
			70%	8.6			-74.90			
	ETU 70Hz	A3-1	30%	-4.2	х	24	-104.69			
			70%	-0.3	х	24	-100.79			
ETU 300Hz	ETU 300Hz	A3-1	30%	-4.0	х	24	-104.49			
			70%	0.0	Х	24	-100.49			
	ETU 600Hz	A13-4	30%	-0.4			-83.10			
			70%	6.8			-76.7			
Extended	ETU 70Hz	A4-2	30%	2.3	Х	24	-98.19			
			70%	10.9	X	24	-89.59			

Note: Not applicable for Local Area and Home Area BS. Table 3-18: Test requirements for test 8.2.1, 10 MHz Bandwidth, 4 RX antennas, AWGN -83.5 dBm

Test requirements 8.2.1, 10 MHz Bandwidth, 8 RX antennas, AWGN -83.5 dBm									
Cyclic prefix	Propagation conditions	FRC	Fraction of max. throughput	SNR [dB]	add SNR Correct. Factor -16.99 [dB]	Offset VRB	LTE Carrier Level [dBm]		
Normal	EPA 5Hz	A3-5	30%	-9.2			-92.7		
			70%	-6.1			-89.6		
		A4-6	70%	4.8			-78.7		
		A5-5	70%	12.1			-71.4		
		A17-4	70%	19.8			-63.7		
		A18-4	70%	2.7			-80.8		
		A19-4	70%	13.1			-70.4		
	EVA 5Hz	A3-1	30%	-6.3	х	24	-106.79		
			70%	-3.2	х	24	-103.69		
		A4-1	30%	-1.1	х	24	-101.59		
			70%	5.1	х	24	-95.39		
		A5-1	70%	12.5	х	24	-87.99		
	EVA 70Hz	A3-5	30%	-9.1			-92.6		
			70%	-5.6			-89.1		
		A4-6	30%	-2.0			-85.5		
			70%	5.3			-78.2		
ET	ETU 70Hz	A3-1	30%	-6.2	х	24	-106.69		
			70%	-3.0	х	24	-103.49		
	ETU 300Hz	A3-1	30%	-6.2	X	24	-106.69		
			70%	-2.7	X	24	-103.19		
Extended	ETU 70Hz	A4-2	30%	-0.5	х	24	-100.99		
			70%	7.1	х	24	-93.39		

Performance requirements for PUSCH (Clause 8.2)

Note: Not applicable for Local Area and Home Area BS. Table 3-19: Test requirements for test 8.2.1, 10 MHz Bandwidth, 8 RX antennas, AWGN -83.5 dBm

Test requ	uirements 8.2.1	, 15 MHz I	Bandwidth, 2	RX anten	nas, AWGN -	81.7 dB	m
Cyclic prefix	Propagation conditions	FRC	Fraction of max. throughput	SNR [dB]	add SNR Correct. Factor -18.75 [dB]	Offset VRB	LTE Carrier Level [dBm]
Normal	EPA 5Hz	A3-6	30%	-3.9			-85.60
			70%	-0.2			-81.90
		A4-7	70%	11.9			-69.80
		A5-6	70%	19.4			-62.30
		A17-5	70%	23.4			-58.3
		A18-5	70%	10.0			-71.7
		A19-5	70%	22.0			-59.7
EVA 5H	EVA 5Hz	A3-1	30%	-2.2	x	37	-102.65
			70%	2.4	x	37	-98.05
		A4-1	30%	4.8	x	37	-95.65
			70%	12.0	x	37	-88.45
		A5-1	70%	19.3	x	37	-81.15
	EVA 70Hz	A3-6	30%	-3.9			-85.60
			70%	0.3			-81.40
		A4-7	30%	4.8			-76.90
ETU 70Hz			70%	13.5			-68.20
	ETU 70Hz	A3-1	30%	-1.9	х	37	-102.35
			70%	3.0	х	37	-97.45
	ETU 300Hz	A3-1	30%	-1.6	х	37	-102.05
			70%	3.5	х	37	-96.95
Extended	ETU 70Hz	A4-2	30%	5.5	x	37	-94.95
			70%	14.2	Х	37	-86.25

Note: Not applicable for Local Area and Home Area BS. Table 3-20: Test requirements for test 8.2.1, 15 MHz Bandwidth, 2 RX antennas, AWGN -81.7 dBm

Test requi	rements 8.2.1,	15 MHz B	andwidth, 4 R	X antenn	as, AWGN -81	.7 dBm	
Cyclic prefix	Propagation conditions	FRC	Fraction of max. throughput	SNR [dB]	add SNR Correct. Factor -18.75 [dB]	Offset VRB	LTE Carrier Level [dBm]
Normal	EPA 5Hz	A3-6	30%	-6.6			-88.30
			70%	-3.2			-84.90
		A4-7	70%	8.2			-73.50
		A5-6	70%	15.6			-66.10
		A17-5	70%	19.5			-62.20
		A18-5	70%	6.5			-75.20
		A19-5	70%	17.7			-64.00
	EVA 5Hz	A3-1	30%	-4.4	х	37	-104.85
			70%	-0.6	х	37	-101.05
		A4-1	30%	1.8	х	37	-98.65
			70%	8.5	х	37	-91.95
		A5-1	70%	16.3	х	37	-84.15
	EVA 70Hz	A3-6	30%	-6.4			-88.10
			70%	-2.7			-84.40
		A4-7	30%	1.3			-80.40
			70%	9.1			-72.60
	ETU 70Hz	A3-1	30%	-4.2	х	37	-104.65
			70%	-0.4	х	37	-100.85
ETU 300Hz	ETU 300Hz	A3-1	30%	-4.0	х	37	-104.45
			70%	0.0	х	37	-100.45
	ETU 600Hz	A13-5	30%	-0.3			
			70%	7.0			
Extended	ETU 70Hz	A4-2	30%	2.2	х	37	-98.25
			70%	10.7	Х	37	-89.75

Performance requirements for PUSCH (Clause 8.2)

Note: Not applicable for Local Area and Home Area BS.

Table 3-21: Test requirements for test 8.2.1, 15 MHz Bandwidth, 4 RX antennas, AWGN -81.7 dBm

Test requi	rements 8.2.1,	15 MHz Ba	andwidth, 8 R	X antenna	as, AWGN -81	.7 dBm	
Cyclic prefix	Propagation conditions	FRC	Fraction of max. throughput	SNR [dB]	add SNR Correct. Factor -18.75 [dB]	Offset VRB	LTE Carrier Level [dBm]
Normal	EPA 5Hz	A3-6	30%	-9.8			-91.5
			70%	-6.7			-88.4
		A4-7	70%	5.0			-76.7
		A5-6	70%	12.4			-69.3
-		A17-5	70%	16.1			-65.6
		A18-5	70%	3.4			-78.3
		A19-5	70%	14.4			-67.3
	EVA 5Hz	A3-1	30%	-6.5	Х	37	-106.95
			70%	-3.4	х	37	-103.85
		A4-1	30%	-1.1	х	37	-101.55
			70%	5.0	х	37	-95.45
		A5-1	70%	12.3	х	37	-88.15
	EVA 70Hz	A3-6	30%	-9.5			-91.2
			70%	-6.2			-87.9
		A4-7	30%	-1.9			-83.6
			70%	5.6			-76.1
	ETU 70Hz	A3-1	30%	-6.4	х	37	-106.85
			70%	-3.0	х	37	-103.45
	ETU 300Hz	A3-1	30%	-6.3	Х	37	-106.75
			70%	-2.7	х	37	-103.15
Extended	ETU 70Hz	A4-2	30%	-0.5	х	37	-100.95
			70%	7.3	Х	37	-93.15

Performance requirements for PUSCH (Clause 8.2)

Note: Not applicable for Local Area and Home Area BS. Table 3-22: Test requirements for test 8.2.1, 15 MHz Bandwidth, 8 RX antennas, AWGN -81.7 dBm

Test requi	rements 8.2.1, 3	20 MHz B	andwidth, 2 R	X antenn	as, AWGN -80).4 dBm	
Cyclic prefix	Propagation conditions	FRC	Fraction of max. throughput	SNR [dB]	add SNR Correct. Factor -20 [dB]	Offset VRB	LTE Carrier Level [dBm]
Normal	EPA 5Hz	A3-7	30%	-3.6			-84.00
			70%	0.2			-80.20
		A4-8	70%	12.1			-68.30
		A5-7	70%	20.3			-60.10
		A17-6	70%	24.3			-56.10
		A18-6	70%	9.9			-70.50
		A19-6	70%	21.6			-58.80
	EVA 5Hz	A3-1	30%	-2.1	х	49	-102.50
			70%	2.4	х	49	-98.00
		A4-1	30%	4.9	х	49	-95.50
			70%	12.1	х	49	-88.30
		A5-1	70%	19.3	х	49	-81.10
	EVA 70Hz	A3-7	30%	-3.5			-83.90
			70%	0.8			-79.60
		A4-8	30%	4.8			-75.60
			70%	13.6			-66.80
	ETU 70Hz	A3-1	30%	-1.8	х	49	-102.20
			70%	3.0	х	49	-97.40
	ETU 300Hz	A3-1	30%	-1.5	х	49	-101.90
			70%	3.5	х	49	-96.90
Extended	ETU 70Hz	A4-2	30%	5.3	х	49	-95.10
			70%	14.2	х	49	-86.20

Note: Not applicable for Local Area and Home Area BS. Table 3-23: Test requirements for test 8.2.1, 20 MHz Bandwidth, 2 RX antennas, AWGN -80.4 dBm

Test requi	rements 8.2.1, 2	20 MHz Ba	andwidth, 4 R	X antenn	as, AWGN -80	.4 dBm	
Cyclic prefix	Propagation conditions	FRC	Fraction of max. throughput	SNR [dB]	add SNR Correct. Factor -20 [dB]	Offset VRB	LTE Carrier Level [dBm]
Normal	EPA 5Hz	A3-7	30%	-6.2			-86.60
			70%	-2.9			-83.30
		A4-8	70%	8.1			-72.30
		A5-7	70%	16.5			-63.90
		A17-6	70%	20.4			-60.00
		A18-6	70%	6.3			-74.10
		A19-6	70%	17.3			-63.10
	EVA 5Hz	A3-1	30%	-4.5	х	49	-104.90
			70%	-0.7	х	49	-101.10
		A4-1	30%	1.8	х	49	-98.60
			70%	8.5	х	49	-91.90
		A5-1	70%	16.2	х	49	-84.20
	EVA 70Hz	A3-7	30%	-6.1			-86.50
			70%	-2.3			-82.70
		A4-8	30%	1.3			-79.10
			70%	9.2			-71.20
	ETU 70Hz	A3-1	30%	-3.8	х	49	-104.20
			70%	-0.3	х	49	-100.70
	ETU 300Hz	A3-1	30%	-4.0	х	49	-104.40
			70%	-0.1	х	49	-100.50
	ETU 600Hz	A13-6	30%	-0.3			-80.7
			70%	7.0			-73.4
Extended	ETU 70Hz	A4-2	30%	2.2	х	49	-98.20
			70%	10.6	Х	49	-89.80

Performance requirements for PUSCH (Clause 8.2)

Note: Not applicable for Local Area and Home Area BS.

Table 3-24: Test requirements for test 8.2.1, 20 MHz Bandwidth, 4 RX antennas, AWGN -80.4 dBm

Test requi	rements 8.2.1,	20 MHz B	andwidth, 8 F	RX antenn	as, AWGN -80).4 dBm	l
Cyclic prefix	Propagation conditions	FRC	Fraction of max. throughput	SNR [dB]	add SNR Correct. Factor -20 [dB]	Offset VRB	LTE Carrier Level [dBm]
Normal	EPA 5Hz	A3-7	30%	-9.1			-89.5
			70%	-6.1			-86.5
		A4-8	70%	4.9			-75.5
		A5-7	70%	13.1			-67.3
		A17-6	70%	16.9			-63.5
		A18-6	70%	3.2			-77.2
		A19-6	70%	13.8			-66.6
	EVA 5Hz	A3-1	30%	-6.4	х	49	-106.8
			70%	-3.3	х	49	-103.7
		A4-1	30%	-1.1	х	49	-101.5
			70%	5.2	х	49	-95.2
		A5-1	70%	12.6	х	49	-87.8
	EVA 70Hz	A3-7	30%	-9.1			-89.5
			70%	-5.5			-85.9
		A4-8	30%	-1.6			-82.0
			70%	5.5			-74.9
	ETU 70Hz	A3-1	30%	-6.3	х	49	-106.7
			70%	-2.9	х	49	-103.3
	ETU 300Hz	A3-1	30%	-6.2	х	49	-106.6
			70%	-2.7	X	49	-103.1
Extended	ETU 70Hz	A4-2	30%	-0.6	х	49	-81.0
			70%	7.1	х	49	-73.3

Note: Not applicable for Local Area and Home Area BS.

Table 3-25: Test requirements for test 8.2.1, 20 MHz Bandwidth, 8 RX antennas, AWGN -80.4 dBm

Test setup

Fig. 3-33 to Fig. 3-35 show the test setup.

The wanted signal generated by SMW baseband A is split up in two paths. Multipath fading is simulated in the channel simulators, AWGN is added.

For four RX antennas, the test can be done with just one SMW (suitable options required). For eight RX antennas, the test can be also done with just one SMW.

The SMW needs an external trigger at USER3. A HARQ-Feedback signal from the base station is required.







Fig. 3-34: Test setup for PUSCH test 8.2.1 for 4 antennas with one SMW

Base Station Under Test SMW Path A RF A Channel Rx 1 AWGN Simulato TM3 (Rear Panel) UE Path B RF B Channel Rx 2 AWGN Simulator Frame Trigger Signal USER 3 REF IN 10MHz Reference (Rear Panel) Path C I IN I OUT 1 Channel Stream C OUT SGS AWGN Rx 3 Simulator Q OUT 1 QIN REF IN Path D REF I IN I OUT 2 Channel OUT AWGN SGS Rx 4 Stream D Simulator Q OUT 2 REF IN Q IN Path E REF Stream E OUT Channel Rx 5 AWGN SGT Simulato FAD 3 REF IN Path F REF OUT Channel - OUT AWGN SGT Rx 6 Simulator FAD 4 REF IN Path G REF OUT Channel · out AWGN SGT Rx 7 Simulato FAD 1 REF IN Path H REF OUT Channel AWGN Stream OUT SGT Rx 8 Simulato FAD 2 REF REF IN OUT (Rear Panel) 10MHz Refe Тх HARQ Feedback

Performance requirements for PUSCH (Clause 8.2)

Fig. 3-35: Test setup for PUSCH test 8.2.1 for 8 antennas with one SMW

Test Procedure

As an example, the settings for two RX antennas, normal prefix, EVA 5 Hz, 10 MHz, FRC A3-1 and fraction 30% throughput are shown. The PUSCH is transmitted continuously in every subframe.

- 1. Set the **routing** to 1x1x2 (see 3.1.1), thus one baseband block is routed to two paths.
- 2. For the basic LTE steps see section 3.1.2.

- 3. Click Frame Configuration.
- 4. Set **No of PUSCH Config** to 1 (Fig. 3-36). In this case, only one subframe has to be configured. The configuration is automatically copied to all other subframes.

EUTRA/LTE A	A: Frame Confi	guration	
General	Time Plan	Subframe	
		U	E1
			On
30	SPP Release	LTE-Ac	Ivanced
No. of PU	CCH Config	•	1
No. of PU	SCH Config	·	1

Fig. 3-36: Set one configurable PUSCH subframe. The SMW copies the setting to the other subframes automatically.

- 5. Open the User Equipment Configuration (UE1) dialog by double clicking UE1.
- In the tab FRC, activate FRCState. Set the FRC according to the test requirements tables (Table 3-8 to Table 3-25, example: FRC A3-1). With the FRC automatically all FRC parameters (e.g. the allocated RBs) are set.

FRCs with one RB only

The FRCs A3-1, A4-1, A4-2 and A5-1 use one resource block only. For these FRCs, the RB in the middle of the channel bandwidth shall be used. In case the number of resource blocks in the channel bandwidth are even, the one in the middle with lower number is to be used for testing. To perform this adjustment, shift the used RBs by setting **Offset VRB** according to the tables (example: 24) as shown in Fig. 3-37.

EUTRA/LTE A: User Equipment Configuration (UE1)					×
Common OFRC ORT Feedback	USCH	DRS	OSRS	5		
FRC State			Off			On
FRC	тѕ	36.141:	A3-1			·
Allocated Resource Blocks	Т	S 36.14	1 ► А	.1 ▶		1
Modulation	Т	S 36.52	1 ► A	2 🕨	G	PSK
Payload Size	TS 36	.141: A3	-1 A	.3 ▶		104
Physical Bits per Subframe (Unshortened	TS 36	.141: A3	-2 7 -3 A	.5 ▶		288
Offset VRB	TS 36	.141: A3	-4 A	7 🕨		24
n(2) DMRS	TS 36	.141: A3	-5 A	8 🕨		

Fig. 3-37: Setting the FRC and the Offset VRB for UE1.

HARQ-Feedback

 Set the needed Feedback Mode. Set the Redundancy Version Sequence to 0,2,3,1 and the Max. Number of Transmissions to 4 (Fig. 3-31).

AWGN and Fading

- Set Fading according to Table 3-8 to Table 3-25 (see 3.1.3) (example EVA 5 Hz Low)
- Set noise power and SNR. For FRC's with one RB only, take in account the SNR correction factor (see 3.1.4)(example: Noise = -83.5 dBm; SNR = SNR + Correction = -2.1 dB -16.99 dB = -19.09 dB)

Demo Program

Fig. 3-38 shows the parameters of the test. You can select the test in the section **8.2 PUSCH.** Select one test under **8.2.1 Multipath Fading**. The tests are listed by their cyclic prefix and fading profile. When selecting a particular test all settings are default according to the specification. The setting of the SNR depends on the fading profile and the channel bandwidth. For FRC's using 1 resource block the RB in the middle of the channel bandwidth is used and the special SNR correction factor is applied. The fading settings are displayed in the section **Fading**. There also select the correlation matrix (default: Low). **4 Antennas** enables the test for four antennas. **8 Antennas** enables the test for eight antennas. To simulate Carrier Aggregation, enable **2nd CC** and the corresponding parameters. Please note that this is handled via a second carrier inside the same baseband of the SMW.



Fig. 3-38: Parameter for PUSCH test 8.2.1

Fig. 3-39 shows the report.



Fig. 3-39: Report 8.2.1

3.2.2 Performance requirements of PUSCH in multipath fading propagation conditions transmission on two antenna ports (Clause 8.2.1A)

The test verifies the achieved throughput of a receiver under multipath fading conditions at a given SNR. The throughput is measured by the base station under test. The required throughput is expressed as a fraction of maximum throughput for the FRC's. HARQ re-transmission is assumed.

The test is similar to the test 8.2.1 (see 3.2.1) but uses two antenna ports (UL-MIMO with ports 200 and 201). The test is done with two code words (CW).

Please note that at the moment HARQ feedback via K69 is not supported for this test.

Test parameters 8.2.1A						
Parameter	Value					
Maximum number of HARQ transmissions	4					
Redundancy version (RV) sequence	0, 2, 3, 1, 0, 2, 3, 1					
Uplink-downlink allocation for TDD	Configuration 1 (2 DL:2 UL)					

Table 3-26: Parameters for PUSCH test 8.2.1A

Test requirements

The following tables show the test requirements for all bandwidths and all applicable number of RX antennas (2, 4 and 8). They include AWGN, SNR and the resulting carrier power level. For the given parameters, the fraction of the maximum throughput has to be achieved. A3-x represents FRC's with QPSK modulation, A4-x with 16QAM modulation.

Test req	uirements	s 8.2.1A, 2	2 RX antennas	s					
Number of TX antennas	Number of RX antennas	Cyclic prefix	Propagation conditions	Fraction of max. throughput	Channel Bandwidth [MHz]	AWGN [dBm]	FRC	SNR [dB]	Resulting LTE Carrier Level [dBm]
						00.7	A3-2	5.4	-87.3
			EPA 5Hz		1.4	-92.7	A4-3	18.5	-74.2
					3 -88	00.7	A3-3	5.2	-83.5
						-00.7	A4-4	18.4	-70.3
					5	-86.5	A3-4	4.5	-82.0
							A4-5	19.0	-67.5
2	2	Normai	low	70%	10	00.5	A3-5	5.0	-78.5
					10	-83.5	A4-6	19.4	-64.1
					45	04.7	A3-6	4.5	-77.2
					15	-81.7	A4-7	20.2	-61.5
							A3-7	5.2	-75.2
					20	-80.4	A4-8	20.5	-59.9

Table 3-27: Test requirements for test 8.2.1A, 2 RX antennas

Test req	uirements	s 8.2.1A, 4	RX antenna	s					
Number of TX antennas	Number of RX antennas	Cyclic prefix	Propagation conditions	Fraction of max. throughput	Channel Bandwidth [MHz]	AWGN [dBm]	FRC	SNR [dB]	Resulting LTE Carrier Level [dBm]
						-92.7	A3-2	0.7	-92.0
			EPA 5Hz		1.4		A4-3	12.7	-80.0
						00.7	A3-3	1.1	-87.6
					3	-88.7	A4-4	12.6	-76.1
					F	5 -86.5	A3-4	0.3	-86.2
0					5		A4-5	12.7	-73.8
2	4	Normai	low	70%	10	00.5	A3-5	1.0	-82.5
					10	-83.5	A4-6	12.8	-70.7
					45	04.7	A3-6	0.6	-81.1
					15	-81.7	A4-7	13.5	-68.2
							A3-7	1.3	-79.1
					20	-00.4	A4-8	13.5	-66.9

Table 3-28: Test requirements for test 8.2.1A, 4 RX antennas

Test req	uirements	s 8.2.1A, 8	RX antennas	6					
Number of TX antennas	Number of RX antennas	Cyclic prefix	Propagation conditions	Fraction of max. throughput	Channel Bandwidth [MHz]	AWGN [dBm]	FRC	SNR [dB]	Resulting LTE Carrier Level [dBm]
						00.7	A3-2	-2.2	-94.9
			EPA 5Hz		1.4	-92.7	A4-3	8.3	-84.4
				700/	3	-88.7	A3-3	-2.3	-91.0
							A4-4	8.4	-80.3
					5	-86.5	A3-4	-3.1	-89.6
2							A4-5	8.4	-78.1
2	0	Normai	low	70%	10	00.5	A3-5	-2.5	-86.0
					10	-83.5	A4-6	8.7	-74.8
					45	04.7	A3-6	-3.0	-84.7
					15	-81.7	A4-7	9.1	-72.6
					20	00.4	A3-7	-2.6	-83.0
					20	-60.4	A4-8	9.1	-71.3

Table 3-29: Test requirements for test 8.2.1A, 8 RX antennas

Test setup

Fig. 3-40 to Fig. 3-42 show the test setup.

The wanted signal generated by SMW basebands A and B uses a 2x2 MIMO configuration. Multipath fading is simulated in the channel simulators, AWGN is added.

For four RX antennas the test can be done with just one SMW (suitable options required). For eight RX antennas, the test can be also done with just one SMW.

The SMW needs an external trigger at USER3. A HARQ-Feedback signal from the base station is required.



Fig. 3-40: Test setup for PUSCH test 8.2.1A for 2 antennas



Fig. 3-41: Test setup for PUSCH test 8.2.1A for 4 antennas with one SMW



Fig. 3-42: Test setup for PUSCH test 8.2.1A for 8 antennas with one SMW

Test Procedure

As an example, the settings for two RX antennas, normal prefix, EPA 5 Hz, 10 MHz, FRC A3-5 and two code words are shown. The PUSCH is transmitted continuously in every subframe.

- 1. Set the **routing** to 1x2x2 (see 3.1.1), thus two baseband blocks are routed to two paths (2x2 MIMO).
- 2. For the basic LTE steps see section 3.1.2.
- 3. Click Frame Configuration
- 4. Set **No of PUSCH Config** to 1 (Fig. 3-36). In this case only one subframe has to be configured. The configuration is automatically copied to all other subframes.

EUTRA/LTE A: Frame Configuration									
General	Time Plan	Subframe							
	2	U	E1	۱ſ					
			On						
30	SPP Release	ETE-Ac	lvanced						
No. of PU	CCH Config		1						
No. of PU	SCH Config		1						

Fig. 3-43: Set one configurable PUSCH subframe. The SMW copies the setting to the other subframes automatically.

- 5. Open the User Equipment Configuration (UE1) dialog by double clicking UE1.
- In the tab FRC, activate FRCState. Set the FRC according to the test requirements tables (Table 3-8 to Table 3-25, example: FRC A3-4). With the FRC automatically all FRC parameters (e.g. the allocated RBs) are set.

EUTRA/LTE A: User Equipment Configuration	ı (UE1)						_	×		
OCommon OFRC ORealtime Feedback	PUSCH	PUCCH	DRS	OSRS	Antenna F Mapping	Port				
FRC State						Off		On		
FRC			тѕ	TS 36.141: A3-5						
Allocated Resource Blocks	т	S 36.141	A1 ►	5						
Modulation			т	S 36.521	► A2 ►					
Woddiation			N	.A.	A3 ►	TS 36.141: A3-1	í			
Payload Size					A4 ▶	TS 36.141: A3-2	2	5160		
Physical Bits per Subframe (Unshorte	ened PU	SCH)			A5 ►	TS 36.141: A3-3	3 1	4400		
Offset VRB					A7 ▶	TS 36.141: A3-4	1	0		
					A8 ►	TS 36.141: A3-5	5			
n(2) DMRS								0		

Fig. 3-44: Setting the FRC for UE1.

7. Set in tab **PUSCH** the **Transmission Mode** to **2** (TM2) and the **Number of Antenna Ports** to **2**.

EUTRA/LTE A: L	RA/LTE A: User Equipment Configuration (UE1)									_	×	
OCommon	OFRC	ORealtime Feedback	PUSCH	PUCCH	DR	s	OSRS	Antenna Port Mapping				
Data Source						PN9						•
Transmissio	n Mode					2 (Sp	atial Multi	iplexing Possik	ole)			·
Max. Number Of Antenna Ports For PUSCH 2							•					
	Scrambling											

Fig. 3-45: Transmission mode (TM2) and number of antenna ports

8. Check the Antenna Port Mapping

All many second second

1 11	EUTRA/LTE A: User Equipment Configuration (UE1)										
	OCommon	OFRC	O ^{Realtir} Feedb	ne ack	PUS	сн	PUC	ссн	DRS	OSRS	Antenna Port Mapping
		AP 10 PUSCI SRS	AP 20 H PUSCH	AF PU	21 SCH	AP PUC	100 CCH				
	Baseband A		0								
	Baseband B	3			D						

Fig. 3-46: Antenna port mapping for PUSCH 8.2.1A

9. Set two codewords (CW). All settings can be checked under Config. Enhanced settings.

Сору
All Subfi
r State
Off
) On
On

Fig. 3-47: Two codewords for PUSCH 8.2.1A

HARQ-Feedback

Please note that at the moment HARQ feedback via K69 is not supported for this test.

AWGN and Fading

- 10. Set **Fading** according to Table 3-8 to Table 3-25 (see 3.1.3) (example EPA 5 Hz Low)
- 11. Set **noise power** and **SNR**(see 3.1.4)(example: Noise = -83.5 dBm; SNR = 5.0 dB)

Demo Program

Fig. 3-38 shows the parameters of the test. You can select the test in the section 8.2 **PUSCH.** Select one test under 8.2.1A PUSCH (2 AP). The tests are listed by the different FRC. When selecting a particular test all settings are default according to the specification. The setting of the SNR depends on the channel bandwidth. The fading settings are displayed in the section Fading. There also select the correlation matrix (default: Low). 4 Antennas enables the test for four antennas. 8 Antennas enables the test for eight antennas.



Fig. 3-48: Parameter for PUSCH test 8.2.1

Fig. 3-39 shows the report.

******* Performance Tests *******
8.2.1A PUSCH in Multipath Fading (Two Antenna Ports)
2 Antennas Fading: EPA 5 Hz L SNR: 5 dB Duplex Mode: FDD FRC: A35 Bandwidth: 10 MHz AWGN: -83.5 dBm
Ready !
Fig. 3-49: Report 8.2.1

3.2.3 Performance requirements for UL timing adjustment (Clause 8.2.2)

The test verifies the achieved throughput of a moving UE under multipath fading conditions at a given SNR. Two signals are transmitted, one simulates a moving UE and the second simulates a stationary UE. The throughput is measured by the base station under test. The required throughput is expressed as 70% of maximum throughput for the FRCs. HARQ re-transmission is assumed. The transmission of sounding reference signal (SRS) is optional. Two moving propagation scenarios are specified. Tests with scenario 2 are optional.

Test parameters 8.2.2						
Parameter	Value					
Maximum number of HARQ transmissions	4					
RV sequence	0, 2, 3, 1, 0, 2, 3, 1	0, 2, 3, 1, 0, 2, 3, 1				
Uplink-downlink allocation for TDD	Configuration 1 (2 DL:2 UL)	Configuration 1 (2 DL:2 UL)				
PUSCH transmitted in subframes	FDD	TDD				
#	0,2,4,6,8	2,3,7,8				
SRS transmitted in subframes #	FDD	TDD				
	1	UpPTS				

This test is not applicable for local area and home area BS.

Table 3-30: Parameters for testing PUSCH 8.2.2.

Table 3-31 shows the test requirements. The test is done with two RX antennas and normal cyclic prefix. The FRC and the SNR differs for the other bandwidths. The parameters for the moving propagation scenarios 1 and 2 are described in [1] section B.4.

Performance re	quirements	for PUSCH	(Clause 8.2)
----------------	------------	-----------	--------------

Test requ	Test requirements 8.2.2									
Number of RX antennas	Cyclic prefix	Channel Bandwidth [MHz]	Moving propagation conditions	FRC	SNR [dB]	SNR correction [dB]	Resulting SNR with UE combining + 3.01 dB	LTE Carrier Power level		
							[gB]	[aBm]		
		1 /	Scenario 1	A7-1	13.7	2.01	13.7	-79		
		1.4	Scenario 2	A8-1	-1.6	-3.01	-1.6	-94.3		
			Scenario 1	A7-2	14.0	0.00	13.03	-75.67		
		3	Scenario 2	A8-2	-1.2	-3.98	-2.17	-90.87		
		F	Scenario 1	A7-3	13.8	2.40	13.62	-72.88		
	Normal	5	Scenario 2	A8-3	-1.3	-3.19	- 1.48	-87.98		
2	Normal	40	Scenario 1	A7-4	14.4	2.04	14.4	-69.1		
		10	Scenario 2	A8-4	-1.5	-3,01	-1.5	-85		
		45	Scenario 1	A7-5	14.6	4 77	12.84	-86.86		
		61	Scenario 2	A8-5	-1.5	-4.77	- 3.26	-84.96		
		20	Scenario 1	A7-6	14.5	6.02	11.49	-68.91		
			Scenario 2	A8-6	-1.5	-0.02	- 4.51	-84.91		

Table 3-31: Test requirements for test 8.2.2

SNR Correction Factor

All FRC's in this test case do not allocate all possible RB's. Thus, a special SNR correction factor is applied which depends on the bandwidth (see Table 3-32).

SNR Correction factor 8.2.2						
Bandwidth in MHz	Factor in dB					
1.4	-3.01					
3	-3.98					
5	-3.19					
10	-3.01					
15	- 4.77					
20	- 6.02					

 Table 3-32: SNR Correction Factor for test 8.2.2

Test setup

Fig. 3-50 shows the test setup for scenario 1. Baseband A generates the moving UE, baseband B the stationary UE. A combining network similar to 2x2 MIMO is used. For scenario 1, the fading for the moving UE signal multipath fading is applied by two channel simulators. Additional AWGN is applied for both paths. Only the Moving UE uses the DUTs feedback. The SMW needs an external trigger.



Fig. 3-50: Test setup for test 8.2.2

Test Procedure

An example shows how to perform the settings for a two antenna test setup for a channel bandwidth of 5 MHz, FRC A7-3, Scenario 1 (scenario with Doppler shift taken into account) and fading profile ETU200Hz Moving.

- 1. Set the routing in the SMW to **2 x 1 x 2**, thus two baseband blocks are routed to two paths with a combining network similar to 2x2 MIMO.
- 2. For the basic LTE steps see section 3.1.2.
- 3. Map the I/Q streams to the connectors as shown in Fig. 3-51 (Stream A and C are added to RF A, Stream B and D to RF B).

System Configurat	ion							
Fading/Baseba	and Config	Stream M	apper	Externa	al RF an	d I/Q	Overview	v
	Frequency Offs /Hz	Phase Offs /º	RFA	RF B	I/Q OUT 1	I/Q OUT 2	BBMM 2 1	E
Stream A	0.0	0.00	0				0	
Stream B	0.0	0.00		0				
Stream C	0.0	0.00	0		0			
Stream D	0.0	0.00		0		0		
Combination			Add	Add	Single	Single	Single	

Fig. 3-51: Setting the I/Q Stream Mapper

- 4. Click Frame Configuration
- 5. Set **No of PUSCH Config** to 2 (Fig. 3-36), because according to Table 3-30 the PUSCH has to be transmitted in every second subframe only. With this setting,

 EUTRA/LTE A: Frame Configuration

 General Time Plan Subframe Sf0

 UE1
 VE1

 Image: One of the state of the sta

all other subframes.

Fig. 3-52: Set two configurable PUSCH subframes

As the test requires two UE's, configure two baseband blocks:

Set two different UE ID/n_RNTI (example: path A: 1, path B: 2) (Fig. 3-53 and Fig. 3-54)

two subframes have to be configured. The configuration is automatically copied to

EUTRA/LTE A: User Equipn	nent Configuration (U	IE1)					×
	ORT Feedback	PUSCH	DRS	OSF	۲S		
State				C	Off (On
3GPP Release		Release	9 10				
UE ID/n_RNTI							1
UE Power				0.000	dB		•
Mode		Standar	d				•
Restart Data, A/N, CQ	I and RI Every Su	bframe				(On

Fig. 3-53: Setting UE1 Configuration for the mobile UE (Baseband A)

EUTRA/LTE B: U	Jser Equipn	nent Configuration (U	E1)				_	×
Common	OFRC	ORT Feedback	PUSCH	DRS	Osi	RS		
State						Off (On
3GPP Relea	ase		Release	e 10				•
UE ID/n_RN	ITI							2
UE Power					0.000	dB		•
Mode			Standar	d				•
Restart Data	, A/N, CQ	I and RI Every Su	bframe					🗸 On

Fig. 3-54: Setting UE2 Configuration for the stationary UE (Baseband B)

- In the tab FRC, activate FRCState. Set the FRC according to the test requirements table (Table 3-31, example: FRC A7-3). With the FRC automatically all FRC parameters (e.g. the allocated RBs) are set.
- Both UEs shall occupy consecutive RBs in the lowest possible position. So set the Offset VRBs of path A and path B accordingly (example: Offset VRB path A: 0; Offset VRB path B: 12).

EUTRA/LTE A: User Equipme	ent Configuration (U	IE1)				×
	ORT Feedback	PUSCH	DRS	OSRS		
FRC State				Off		On
FRC			TS 36.141	: A7-3		
Allocated Resource Bl	ocks		1			
Modulation					16	3QAM
Payload Size						5160
Physical Bits per Subfr	rame (Unshortene	d PUSC	:H)			6912
Offset VRB						0
n(2)_DMRS						0

Fig. 3-55: Setting the FRC and Offset VRB (path A)

EUTRA/LTE B: User Equipment Configuration (U	E1)				×
OCommon OFRC ORT Feedback	PUSCH	DRS	OSRS		
FRC State			Off		On
FRC	٦	TS 36.141	: A7-3		
Allocated Resource Blocks					12
Modulation				16	6QAM
Payload Size					5160
Physical Bits per Subframe (Unshortene	d PUSC	H)			6912
Offset VRB					12
n(2)_DMRS					0

Fig. 3-56: Setting the Offset VRB of path B to ensure that the RBs are allocated consecutively.

SRS (optional)

 In the tab SRS, you can enable the transmission by switching SRS state ON. For FDD set the Configuration Index I_SRS to 8, for TDD to 11. Ensure that SRS Bandwidth B_SRS is set to 0.

EUTRA/LTE A: User Equipment Configura	tion (UE1)				×
Common OFRC ORT Feed	Iback PUSCH	DRS	OSRS		
SRS State			Off	0	On
SRS Power Offset		0.0	000 dB		•
SRS Cyclic Shift n_cs					0
	SRS Structure				
Configuration Index I_SRS					8
Periodicity T_SRS				1	0 ms
Subframe Offset T_offset					1
SRS Bandwidth B_SRS					

Fig. 3-57: Setting the SRS parameters in the UE

 In the General UL Settings, set SRS Subframe Configuration to 10 and SRS Bandwidth Configuration C_SRS according to Table 3-33 (example for 5 MHz: 3) (Fig. 3-58)

SRS Bandw	idth Co	nfigura	tion C_	SRS		
Channel-	1.4	3	5	10	15	20
Bandwith						
[MHz]						
SRS Bandwidth Configuration C SRS	7	5	3	2	5	2

Table 3-33: SRS Bandwidth Configuration C_SRS for different bandwidths

UTRA/LTE A	A: General	UL Settings	81				—	×
Physical 5 MHz	Cell	Signals	PRACH	PUSCH	PUCCH			
		_			Com	imon —		
Group Ho	pping					Sequence Hopping		
Delta Sec	luence S	hift for PU	SCH		0	n(1)_DMRS		0
					SI	RS —		
SRS Sub	frame Co	onfiguration	n		10	Configuration Period T_SFC		10
						Transmission Offset Delta_SFC		{ 1}
SRS Ban	dwidth C	onfiguratio	n C_SRS		3	A/N+SRS simultaneous Tx		

Fig. 3-58: Setting SRS basic parameters. Both parameters determine the length of the SRS sequence according to [3].

- 11. In the main dialog, click Frame Configuration.... Select the tab Subframe.
- 12. In the second subframe (example: subframe number 1), switch **State** to **Off** for PUSCH.

	UTRA	'LTE A: Fi	rame C	onfiguration	ı									
100	Gen	eral Ti	me Pl	an Subfr	ame									
	Cell I	ndex		0		Sub	frame		1	Prev	Next	0	Сору	
	Cycli	c Prefix	Norn	nal		- ı	Jplink Sub	frame	1	1	R	eset Al	l Subf	ra
		Content	CW	Modulation / Format	Enhanced Settings	Set 1 No. RB	Set 1 Offset VRB	Set 2 No. RB	Set 2 Offset VRB	Offset PRB Slot (n/n+1)	Physical Bits	Power /dB	State	С
	UE1	PUCCH	-	F1	Config	1	2	-	-	2	-	0.000	Off	
									1					
		PUSCH	1/1	16QAM	Config	12	0	-	-	1,200	1.5402	0.000	Off	

Fig. 3-59: Disable the PUSCH in the second subframe (#1)

AWGN and Fading

- 13. Set Fading according to Table 3-31 (see 3.1.3) (example: Scenario 1)
- 14. Set noise power and SNR. Take in account the SNR correction factor (see 3.1.4) As the SMW automatically decreases the level by -3.01 dB when combing two paths, an additional correction by +3.01 dB has to be applied. This is automatically done by the demo program. (example: Noise = -83.5 dBm; SNR = SNR + Correction + CorrectionSMW = 13.8 dB -3.19 dB + 3.01 dB = 13.62 dB)

Demo program

Fig. 3-60 shows the parameters of the test. You can select the test in the section **8.2 PUSCH.** Select one scenario under **8.2.2 UL Timing**. With the checkbox SRS you can enable the optional transmission of the sounding RS. If enabled the SRS is transmitted according to Table 3-31 for FDD the Configuration Index I_SRS is set to 8, for TDD to 11. All settings are default according to the specification. The setting of the FRC and the SNR depends on the channel bandwidth. Both UE's occupy consecutive RB's in the lowest possible position.

(8.5) N	IB-IoT	Additio	nal Set	tings			
(8.2) P	USCH	(8.3) F	UCCH	(8.4) PRACH		
8.2.1	PUSC	H (1 AP):	Norm	al, EPA 5	Hz, A	-
	4 A	ntenna	S	8 A	ntennas		
	2n	d CC:	BW:	10	-	MHz	
		C	Offset:		0	MHz	
8.2.1A	PUSC	H (2 AP):	FRC	A3-x, EPA	5Hz, A	-
	4.0						
	4 A	Intenna	S	8 A	Intennas	1 C	W
8.2.2	UL Tin	ntenna: ning:	S	Scen	ario 1, FF	1 C RC A7-x	-W
8.2.2	UL Tin	ning:	5	Scen	ario 1, FF S	1 C RC A7-x	•
8.2.2 8.2.3	UL Tin	ning: hing:	s IPX:	Scen Scen SR Norm	ario 1, FF S al, EVA 5	1 C RC A7-x Hz, A	• •
8.2.2 8.2.3 8.2.4	UL Tin HARQ High S	ning: -ACK M Speed:	s IPX:	Scen Scen SR Norm 1 Ant	ario 1, FF S al, EVA 5 enna, HS	1 C RC A7-x Hz, A T 3, 30%	W •
8.2.2 8.2.3 8.2.4	UL Tin HARG High S	ning: A-ACK M	IPX:	Scen Scen SR Norm 1 Ant	ario 1, FF S al, EVA 5 enna, HS CCH	1 C RC A7-x Hz, A T 3, 30%	• •

Fig. 3-60: Parameter for PUSCH test 8.2.2

Fig. 3-61 shows the report.
******* Performance Tests *******

8.2.2 UL Timing Adjustment

Bandwidth: 10 MHz Duplex Mode: FDD Fading: ETU200Hz (Scenario 1) FRC: A74 AWGN: -83.5 dBm SNR: 14.4 dB SNR Correction: -3.01 dB Finished!

Fig. 3-61: Report 8.2.2

3.2.4 Performance requirements for HARQ-ACK multiplexed on PUSCH (Clause 8.2.3)

The test verifies the receivers' performance at detecting HARQ-ACK under multipath fading conditions at a given SNR. The HARQ-ACK is multiplexed on PUSCH.

The probability of detection of ACK on PUSCH is defined as conditional probability of detection of the ACK when the ACK is transmitted within PUSCH allocated RE.

PUSCH	PUSCH	PUSCH	PUSCH	
(data only)	with ACK	(data only)	with ACK	

Fig. 3-62: ACK multiplexing

The test is defined for two fading profiles (for the different base station classes) and normal CP.

For wide area base stations and medium range base stations, ETU 70 Low fading profile is applicable. For home- and local area base stations the fading profile EVA 5 Low is used.

Table 3-35 shows the test requirements. The test is done with two RX antennas. The SNR, SNR correction factor and LTE Carrier Level differ with different bandwidths and FRCs.

Test requirements 8.2.3 for test with 2 Rx antennas. Wide area base stations and medium range base stations									
Cyclic Prefix	Propagation Conditions	Correlation matrix	Channel bandwidt h [MHz]	AWGN power level at BS input [dBm]	FRC	SNR [dB]	add SNR Correct. Factor [dB]	Index HARQ Offset	LTE Carrier Level [dBm]
		Low	1.4	-92.7	A.3-1	7.2	-7.78	8	-93.28
					A.4-3	14.4		5	-78.30
			3	99.7	A.3-1	7.2	-11.76	8	-93.26
				-00.7	A.4-4	13.5		5	-75.20
			5	-86.5	A.3-1	7.1	-13.98	8	-93.38
	ET 11 T 0				A.4-5	13.1		5	-73.40
Normal	EIU 70		40	00.5	A.3-1	7.2	-16.99	8	-93.29
			10	-83.5	A.4-6	12.9		5	-70.60
			45	04.7	A.3-1	7.3	-18.75	8	-93.15
			15	-81.7	A.4-7	12.7		5	-69.00
				00.4	A.3-1	7.1	-20.0	8	-93.30
			20	-80.4	A.4-8	12.6		5	-67.80

Table 3-34: Test requirements for test 8.2.3, wide area and medium range base stations

Test requirements 8.2.3 for test with 2 Rx antennas, Home and Local base stations									
Cyclic Prefix	Propagation Conditions	Correlation matrix	Channel bandwidt h [MHz]	AWGN power level at BS input [dBm]	FRC	SNR [dB]	add SNR Correct. Factor [dB]	Index HARQ Offset	LTE Carrier Level [dBm]
		Low	1.4	-92.7	A.3-1	7.4	-7.78	8	-93.08
					A.4-3	14.2		5	-78.50
			3	007	A.3-1	7.4	-11.76	8	-93.06
				-00.7	A.4-4	13.7		5	-75.00
			5	-86.5	A.3-1	7.5	-13.98	8	-92.98
					A.4-5	13.0		5	-73.50
Normal	EVA 5		40	00.5	A.3-1	7.4	-16.99	8	-93.09
			10	-83.5	A.4-6	13.0		5	-70.50
			45	04.7	A.3-1	7.4	-18.75	8	-93.05
			15	-81.7	A.4-7	12.6		5	-69.10
				00.4	A.3-1	7.4	-20.0	8	-93.00
			20	-80.4	A.4-8	12.5		5	-67.90

Table 3-35: Test requirements for test 8.2.3, home and local base stations

Test setup

Fig. 3-63 shows the test setup.

The wanted signal generated by SMW baseband A is split up in two paths. Multipath fading is simulated in the channel simulators, AWGN is added.



Fig. 3-63: Test setup for PUCCH test 8.2.3

Test Procedure

An example shows how to perform the settings for two RX antennas for a channel bandwidth of 10 MHz, FRC A3-1 and fading profile ETU 70 Hz (for a wide area base station). The ACK is multiplexed on every second subframe.

- 1. Set the routing in the SMW to $1 \times 1 \times 2$ (see 3.1.1).
- 2. For the basic LTE steps see section 3.1.2.
- 3. Click Frame Configuration. Use UE1.
- 4. Set **No of PUSCH Config** to 2 (Fig. 3-64), because the ACK is multiplexed on the PUSCH in every second subframe only. With this setting, two subframes have to be configured. The configuration is automatically copied to all other subframes.

EUTRA/LTE A: Frame Configuration								
General	Time Plan	Subframe						
		U	E1					
			On					
30	PP Release	LTE-Ad	Ivanced -					
No. of PU	CCH Config		2					
No. of PU	SCH Config		2					

Fig. 3-64: Set two configurable PUSCH subframes

 In the tab FRC, activate FRCState. Set the FRC according to the test requirements table (Table 3-35, example: FRC A3-1). With the FRC automatically all FRC parameters (e.g. the allocated RBs) are set.

6. For FRCs using one resource block only (A3-1), the RB in the middle of the channel bandwidth shall be used. In case the number of resource blocks in the channel bandwidth are even the one in the middle with lower number is to be used for testing. To perform this adjustment, shift the used RB by setting Offset VRB (example 24).

EUTRA/LTE A: User Equipment Configuration (UE1		_	×			
OCommon OFRC ORT Feedback	USCH	DRS	os	RS		
FRC State			C	Off		On
FRC	Т	S 36.141	A3-	1		·
Allocated Resource Blocks		TS 36.14	1 🕨	A1	×	1
Modulation		TS 36.52	1 ▶	A2	•	QPSK
	TS 36.141: A3-1 A3					
Payload Size	TS 36.141: A3-2 A4			A4	•	104
Physical Bits per Subframe (Unshortened	TS 3	TS 36.141: A3-3 A			•	288
Offset VRB	TS 3	6.141: A	3-4	A7		24
n(2) DMRS	TS 3	6.141: A	3-5	84		0

Fig. 3-65: Setting the FRC (example A3-1)

- 7. As **Mode** select **UCI+UL-SCH**, which enables multiplexing of the control information (UCI) and data (UL-SCH) on the PUSCH.
- Set the I_HARQ_offset according to Table 3-35 (example: 8). It determines the HARQ-ACK offset index, i.e. the control information MCS offset according to [6], chapter 8.6.3.
- Ensure that I_RI_offset is set to 0 and I_CQI_offset to 2. I_RI_offset determines the RI offset index for control information MCS and I_CQI_offset the CQI offset index for control information MCS, both according to [6], chapter 8.6.3.

EUTRA/LTE A: User Equipme		_	×			
	ORT Feedback	PUSCH	DRS	OSRS		
Data Source			PN9			
State	Scr	ambling		Off		On
	- Channel Codir	ng and Mu	ltiplexing	-	_	
State				Off		On
Mode			UCI+U	JL-SCH		
I_HARQ_offset						8
I_RI_offset						0
I_CQI_offset						2
Channel Interleaver	— Channel Cod	ing Config	guration	Off		On

Fig. 3-66: PUSCH configuration for UE1. Data and control information is multiplexed.

- 10. In the main dialog, click Frame Configuration.... Select the tab Subframe.
- 11. In the second subframe (example: subframe #1), click **Config** in column **Enhanced Settings**.

E	UTRA/	'LTE A: Fr	ame C	onfiguratior	1									
	Gen	eral Tir	me Pl	an <mark>Subfr</mark>	ame									
	Cell I	ndex		0		Sub	frame		1	Prev C	Next		Сору	
9	Cycli	c Prefix	Norm	nal		- เ	Jplink Sub	frame		1	R	eset Al	Subf	ira
		Content	CW	Modulation / Format	Enhanced Settings	Set 1 No. RB	Set 1 Offset VRB	Set 2 No. RB	Set 2 Offset VRB	Offset PRB Slot (n/n+1)	Physical Bits	Power /dB	State	С
	UE1	PUCCH	-	F1	Config	1	-	-	-	-	5 <u>2</u> 5	0.000	Off	

Fig. 3-67: Multiplexing settings in the second subframe (#1)

12. In tab Channel Coding/Multiplexing, set Number of A/N Bits to 1 and the ACK/NACK pattern (example 1). Make sure that no Rank indication and CQI bits are transmitted (set number to 0).

EUTRA/LTE A: Enhanced Sett. (SF 1)		_	×
Common Channel Coding/Multip	lexing		
			— Ì
ACK/NACK Mode	Multip	lexing	•
Number of A/N Bits			1
ACK/NACK Pattern			1
Number of Coded A/N Bits	30		
Rank Indication	(RI) –		
Number of RI Bits			0
RI Pattern			0
Number of Coded RI Bits			o
Channel Quality Indica	tion (C	QI) —	
Number of CQI Bits			0
CQI Pattern			0

Fig. 3-68: PUSCH multiplexing settings: One ACK bit is multiplexed on the PUSCH

AWGN and Fading

- 13. Set Fading according to Table 3-35 (see 3.1.3) (example: Scenario 1)
- 14. Set noise power and SNR. Take in account the SNR correction factor (see 3.1.4) As the SMW automatically decreases the level by -3.01 dB when combing two paths, an additional correction by +3.01 dB has to be applied. This is also automatically done by the demo program. (example: Noise = -83.5 dBm; SNR = SNR + Correction + CorrectionSMW = 14.4 dB -3.01 dB + 3.01 dB = 14.40 dB)

Demo program

Fig. 3-69 shows the parameters of the test. You can select the test in the section **8.2 PUSCH.** Select one test under **8.2.3 HARQ-ACK MPX**. The tests are listed by the fading profile. When selecting a particular test all settings are default according to the specification. The setting of the SNR depends on the fading profile and the channel bandwidth. For FRC's using 1 resource block the RB in the middle of the channel bandwidth is used and the special SNR correction factor is applied. The fading settings are displayed in the section **Fading**. There also select the correlation matrix (default:

Low). The ACK is multiplexed in the PUSCH every second subframe starting on the subframe #1.

(8.5) N	IB-IoT	Additional S	Settings			
(8.2) P	USCH	(8.3) PUCC	CH (8.4)	PRACH		
8.2.1	PUSC	H (1 AP):	EPA5H:	z, FRC A3-x,	30%	
	4 Antennas		8 Ant	ennas		
	2nc	I CC:	BW:	10	-	MHz
			Offset:		0	MHz
8.2.1A	PUSC	H (2 AP):	EPA5H:	z, FRC A3-x		-
	4 A	ntennas	8 Ant	ennas		1 CW
8.2.2	UL Tir	ming:	Scenari	o 1, FRC A7->	(-
			SRS			
8.2.3	HARG	ACK MPX:	EVA5H	z, FRC A3-x		
8.2.4	High S	Speed:	1 Anten	na, HST 3, 30	%	
			PUC0	СН		
8.2.7	PUSC	H for CE:	CE Mod	le A, FRC A3-	2	-

Fig. 3-69: Parameter for PUSCH test 8.2.3

Fig. 3-70 shows the report.

******* Performance Tests *******

8.2.3 HARQ-ACK Multiplexed on PUSCH

Bandwidth: 10 MHz Duplex Mode: FDD Fading: EVA5Hz Low FRC: A31 AWGN: -83.5 dBm SNR: 7.4 dB SNR Correction: -16.99 dB Finished!

Fig. 3-70: Report 8.2.3

3.2.5 Performance requirements for High Speed Train conditions (Clause 8.2.4)

The test shall verify the receiver's ability to achieve throughput under High Speed Train conditions for a given SNR.

The performance requirement is determined by a minimum throughput for a given SNR. The required throughput is expressed as 30% and 70% of maximum throughput for the FRCs listed in Annex A.

The test is optional and applicable for Wide Area base stations and medium range BS only.

Test parameters 8.2.4						
Parameter	Value					
Maximum number of HARQ transmissions	4					
RV sequence	0, 2, 3, 1, 0, 2, 3, 1					
Uplink-downlink allocation for TDD	Configuration 1 (2 DL:2 UL)					
Subframes in which PUSCH is transmitted	For FDD: subframe #0 and #8 in radio frames for which SFN mod 4 = 0 subframe #6 in radio frames for which SFN mod 4 = 1 subframe #4 in radio frames for which SFN mod 4 = 2 subframe #2 in radio frames for which SFN mod 4 = 3 For TDD: Subframe #2 in each radio frames					
Subframes in which PUCCH is transmitted (Note1, Note 2)	For FDD: subframe #5 in radio frames For TDD: Subframe #3 in each radio frame					
Note 1. The configuration of PUCCH (format 2) is optional. Note 2. The SNR values per antenna shall be set to [-4.5 dB and -1.5 dB] for Scenario 1 and 3, respectively.						

Table 3-36: Test parameters for test 8.2.4

Table 3-37 shows the test requirements. The test is done with one or two RX antennas, normal cyclic prefix and propagation condition HST. The FRC and the SNR differs for the other bandwidths.

Test requirements 8.2.4								
Channel Bandwidth [MHz]	FRC (Annex A)	Number of RX antennas	Propagation conditions (Annex B)	Fraction of maximum throughput	SNR [dB]			
		4		30%	-1.2			
		1	HST Scenario 3	70%	2.2			
1.4	A3-2			30%	-3.6			
		2	HST Scenario 1	70%	-0.3			
	A3-3			30%	-1.8			
		1	HST Scenario 3	70%	1.9			
3		2		30%	-4.2			
			HST Scenario 1	70%	-0.7			
		1		30%	-2.3			
			HST Scenario 3	70%	1.6			
5	A3-4	2		30%	-4.8			
			HST Scenario T	70%	-1.1			
				30%	-2.4			
	105	1	HST Scenario 3	70%	1.5			
10	A3-5			30%	-5.1			
		2	HST Scenario 1	70%	-1.2			
				30%	-2.4			
		1	HST Scenario 3	70%	1.5			
15	A3-6			30%	-4.9			
		2	HST Scenario 1	70%	-1.1			
				30%	-2.4			
		1	HST Scenario 3	70%	1.5			
20	A3-7			30%	-5.0			
		2	HST Scenario 1	70%	-1.1			

Table 3-37: Test requirements for test 8.2.4

Test setup

Fig. 3-71 shows the test setup for 2 Rx antennas.

The wanted signal generated by SMW baseband A is split up in two paths. Multipath fading is simulated in the channel simulators, AWGN is added.

The SMW needs an external trigger at USER3. A HARQ-Feedback signal from the base station is required.



Fig. 3-71: Test setup for PUSCH test 8.2.4 for 2 antennas

Test Procedure

As an example the settings for two RX antennas, HST scenario 1, 10 MHz, FRC A3-5 and fraction 30% throughput are shown. The PUSCH is transmitted continuously in every subframe # 0 and #8. A PUCCH is transmitted in subframe #5.

- 1. Set the **routing** to 1x1x2 (see 3.1.1), thus one baseband block is routed to two paths.
- 2. For the basic LTE steps see section 3.1.2.
- 3. Click Frame Configuration
- Set No of PUSCH Config and No of PUCCH Config (example 8 and 10) (Fig. 3-36).



Fig. 3-72: Set configurable PUSCH and PUCCH subframes.

5. Open the User Equipment Configuration (UE1) dialog by double clicking UE1.

6. In the tab **FRC**, activate **FRCState**. Set the FRC according to the test requirements tables (Table 3-37, example: FRC A3-5). With the FRC automatically all FRC parameters (e.g. the allocated RBs) are set.

EUTRA/LTE A: User Equipm			×			
	ORT Feedback	PUSCH	DRS	OSRS		
FRC State				Off		On
FRC		T	S 36.141	: <mark>A3-5</mark>		
Allocated Resource B	locks					50
Modulation					c	PSK
Payload Size						5160
Physical Bits per Subf	rame (Unshortene	d PUSCH	H)		1	4400
Offset VRB						0

Fig. 3-73: Setting the FRC.

7. Switch **Off** the PUSCH in subframes # 1,2,3,4,5,6,7. Switch **On** the PUCCH in subframe #5. (Fig. 3-74)

Subframe	5	Prev 🕝	Next		Copy
• Uplink Sub	frame	5	Res	et All	Subfr
nced Set 1 Set 1 ngs No. RB Offset VRB	Set 2 Set 2 No. RB Offset VRB	Offset PRB Slot (n/n+1)	Physical P Bits	ower /dB	State
fig 1 -		(0/49)	20 0	0.600	On
fig 50 O	-	-	- 0	000.0	Off
	Subframe Uplink Sub Inced Set 1 No. RB Offset VRB Ifig 1 - Ifig 50 0	Subframe 5 Uplink Subframe unced Set 1 No. RB Set 1 Offset VRB No. RB Offset VRB fig 1 50 0	Subframe 5 Prev Uplink Subframe 5 Uplink Subframe 5 Inced Set 1 No. RB Offset VRB No. RB Offset VRB Slat (n/n+1) fig 1 50 0	Subframe 5 Prev Next Uplink Subframe 5 Res Inced Set 1 Set 2 Offset PRB No. RB Offset VRB Slot (n/n+1) Bits ffg 1 (0/49) 20 0 ffg 50 0 0	Subframe 5 Prev Next 1 Uplink Subframe 5 Reset All Inced Set 1 Set 2 Offset PRB Physical Power Inced Set 1 Set 2 Offset VRB Slot (n/n+1) Physical Power fig 1 (0/49) 20 0.600 fig 50 0 0.000

Fig. 3-74: PUCCH is On in subframe #5, PUSCH is Off

HARQ-Feedback

8. Set the needed **Feedback Mode**. Set the **Redundancy Version Sequence** to **0,2,3,1** and the **Max. Number of Transmissions** to **4** (Fig. 3-31).

AWGN and Fading

- 9. Set **Fading** according to Table 3-37 (see 3.1.3) (example: HST scenario 1)
- Set noise power and SNR. For FRC's with one RB only, take in account the SNR correction factor (see 3.1.4)(example: Noise = -83.5 dBm; SNR = -5.1 dB)

Demo Program

Fig. 3-75 shows the parameters of the test. You can select the test in the section **8.2 PUSCH.** Select one test under **8.2.4 High Speed**. The tests are listed by their number of antennas, the fading profile and the throughput percentage. When selecting a particular test all settings are default according to the specification. The setting of the SNR depends on the fading profile and the channel bandwidth. The PUSCH is transmitted in subframes #0 and #8. The checkbox **PUCCH** enables the optional transmission of the PUCCH in subframe #5.

(8.5) N	B-loT	Additional S	Settings	
(8.2) P	USCH	(8.3) PUCO	CH (8.4)) PRACH
8.2.1	PUSC	H (1 AP):	EPA5H	z, FRC A3-x, 30% 🔹
	4 A	ntennas	8 Ant	ennas
	2nc	I CC:	BW:	10 - MHz
			Offset:	0 MHz
8.2.1A	PUSC	H (2 AP):	EPA5H	z, FRC A3-x 👻
	4 A	ntennas	8 Ant	ennas 📃 1 CW
8.2.2	UL Tir	ming:	Scenari	io 1, FRC A7-x 🔹
			SRS	
8.2.3	HARG	ACK MPX:	EVA5H	z, FRC A3-x 👻
8.2.4	High S	Speed:	1 Anten	na, HST 3, 30% 🛛 👻
				СН
8.2.7	PUSC	H for CE:	CE Mod	de A, FRC A3-2 👻

Fig. 3-75: Parameter for PUSCH test 8.2.4

Fig. 3-76 shows the report.

******* Performance Tests *******

8.2.4 High Speed Train Conditions with 1 RX Antenna.

Bandwidth: 10 MHz Duplex Mode: FDD Fading: HST Scenario 3 FRC: A35 AWGN: -83.5 dBm SNR: -2.4 dB Finished!

Fig. 3-76: Report 8.2.4

3.2.6 Performance requirements for PUSCH with TTI bundling and enhanced HARQ pattern (Clause 8.2.5)

Please note that this testcase is not implemented in the SMW firmware yet.

3.2.7 Enhanced performance requirements type A of PUSCH in multipath fading propagation conditions with synchronous interference (Clause 8.2.6)

Please note that this testcase is not implemented yet.

3.2.8 Enhanced performance requirements type A of PUSCH in multipath fading propagation conditions with asynchronous interference (Clause 8.2.6A)

Please note that this testcase is not implemented yet.

3.2.9 Performance requirements of PUSCH in multipath fading propagation conditions transmission on single antenna port for coverage enhancement (Clause 8.2.7)

The test shall verify the receiver's ability to achieve throughput under multipath fading conditions for a given SNR for coverage enhancement CEMode A and CEMode B.

The performance requirement is determined by a minimum throughput for a given SNR. The required throughput is expressed as 70% of maximum throughput for the FRCs listed in Annex A.

The test is applicable only for base stations supporting CEMode A respectively CEMode B.

Test parameters	8.2.7	
Parameter	CEMode A	CEMode B
Maximum number of HARQ transmissions	4	2
RV sequence	0, 2, 3, 1, 0, 2, 3, 1	FDD: 0,0,0,0, 2,2,2,2, 3,3,3,3, 1,1,1,1 TDD: 0,0,0,0,0 2,2,2,2,2, 3,3,3,3,3,3, 1,1,1,1,1
Number of PUSCH repetitions	8	256
Frequency hopping	On	On
Frequency hopping interval	FDD: 4 TDD: 5	FDD: 4 TDD: 5
FRC	A3-2 Modulation: QPSK RB: 6	A3-1 Modulation: QPSK RB: 1

Table 3-38: Test parameters for test 8.2.7

 Table 3-39 and Table 3-40 show the test requirements. The test is done with two RX antennas. The FRC and the SNR differs for the other bandwidths.

Test requir	Test requirements 8.2.7 for CEMode A							
Channel Bandwidth [MHz]	FRC (Annex A)	Number of RX antennas	Propagation conditions (Annex B)	Fraction of maximum throughput	SNR [dB]			
3			EPA 5 Hz Low		-5.6			
5					- 6.0			
10	A3-2	2		70%	- 6.3			
15					- 6.3			
20	<u> </u>				- 6.4			

Table 3-39: Test requirements for test 8.2.7 CEMode A

Test requir	Test requirements 8.2.7 for CEMode B							
Channel Bandwidth [MHz]	FRC (Annex A)	Number of RX antennas	Propagation conditions (Annex B)	Fraction of maximum throughput	SNR [dB]			
3			ETU 1 Hz Low		- 14.4			
5				70%	- 14.6			
10	A3-1	2			- 14.7			
15					- 14.5			
20					- 14.6			

Table 3-40: Test requirements for test 8.2.7 CEMode B

Test setup

Fig. 3-77 shows the test setup.

The wanted signal generated by SMW baseband A is split up in two paths. Multipath fading is simulated in the channel simulators, AWGN is added.

The SMW needs an external trigger at USER3. A HARQ-Feedback signal from the base station is required.



Fig. 3-77: Test setup for PUSCH test 8.2.7 for 2 antennas

Test Procedure

As an example the settings for CEMode A, EPA 5 Hz low, 10 MHz and FRC A3-2 are shown.

- 1. Set the **routing** to 1x1x2 (see 3.1.1), thus one baseband block is routed to two paths.
- 2. For the basic LTE steps see section 3.1.2.
- 3. Click Frame Configuration
- 4. Enable UE1 for eMTC (Fig. 3-36).



Fig. 3-78: Set UE1 to mode eMTC

5. Open the User Equipment Configuration (UE1) dialog by double clicking UE1.

Set the **Repetition, Narrowband Hopping Interval, the Modulation** and the **RB** according Table 3-38 (example: Repetition 8, Hopping 5, Modulation QPSK and 1 RB).

EUT	'RA/	LTE A: Us	er Equipment (onfiguration	(UE1)						-	_	X
0)Ca	ommon	⊖ Realtime Feedback	PUCCH	PUSCH	DRS	eMTC Allocation						
С	EL	evel		0,1			•	Numbe	er of Nar	rowban	ds		8
Na	arro	wband H	lopping Inter	val 4			- Subframes	Numbe	er of Tran	nsmissi	ons		1
		Content	Modulation Format	Enhanced Settings	Start Subframe	Repeti- tions	No. Absolute Subframes	Start Narrowband	No. RB	Offset VRB	Power /dB		
	1	PUSCH	QPSK	Config	0	8	8	2	1	0	0.000		
ſ				_		ARB See	quence Lengt	n ———					
s	ugg	gested	1 Cu	rrent	1 Frame	s -	Adjust L	ength		ARB	Settings		

 The SMW shows the number of needed Frames. Click Adjust Length if necessary.

HARQ-Feedback

7. Set the needed **Feedback Mode** (please note that for eMTC only serial mode are available

AWGN and Fading

- 8. Set Fading according to Table 3-39 (see 3.1.3) (example: EPA 5 Hz low)
- Set noise power and SNR. Take in account the SNR correction factor (see 3.1.4)(example: Noise = -83.5 dBm; SNR = -6.3 dB)

Demo Program

Fig. 3-79 shows the parameters of the test. You can select the test in the tabulator **8.2 PUSCH.** Select one test under **8.2.7 PUSCH for CE**. The tests are listed by the CE mode and the FRC. When selecting a particular test all settings are default according to the specification. The fading settings are displayed in the section **Fading**. There also select the correlation matrix (default: Low).



Fig. 3-79: Parameter for PUSCH test 8.2.7

Fig. 3-80 shows the report.

******* Performance Tests *******

8.2.7 Performance Requirements of PUSCH in Multipath Fading Propagation Conditions Transmission on Single Antenna Port for Coverage Enhancement with CE Mode A and 8 Repetitions.

Bandwidth: 10 MHz Duplex Mode: FDD Fading: EPA5Hz Low FRC: A32 AWGN: -83.5 dBm SNR: -6.3 dB Finished!

Fig. 3-80: Report 8.2.7

3.2.10 Performance requirements of PUSCH with Frame structure type 3 (Clause 8.2.8)

Please note that this testcase is not implemented in the SMW firmware yet (FRC A.20 is needed).

3.3 Performance requirements for PUCCH (Clause 8.3)

The physical uplink control channel (PUCCH) carries control information in the uplink, like ACK/NACK or CQI information.

Special issues for single PUCCH tests are described in the related subchapters.

All tests in this subclause are performed for a given SNR where the AWGN power level is given in Table 3-41.

AWGN power level for PUCCH tests					
Channel bandwidth [MHz]	AWGN power level				
1.4	-89.7dBm / 1.08MHz				
3	-85.7dBm / 2.7MHz				
5	-83.5dBm / 4.5MHz				
10	-80.5dBm / 9MHz				
15	-78.7dBm / 13.5MHz				
20	-77.4dBm / 18MHz				

Table 3-41: AWGN power level for PUCCH tests

As the PUCCH only occupies one (or two RB), a special SNR correction factor is applied which depends on the bandwidth (Table 3-42).

SNR Correction factor for	SNR Correction factor for PUCCH tests						
Bandwidth	1 RB	2 RB					
[MHz]	Correction factor	Correction factor					
	[dB]	[dB]					
1.4	-7.78	-4.77					
3	-11.76	-8.75					
5	-13.98	-10.97					
10	-16.99	-13.98					
15	- 18.75	-15.74					
20	- 20.00	-16.99					

Table 3-42: SNR correction factor for PUCCH tests

3.3.1 ACK missed detection for single user PUCCH format 1a transmission on single antenna port (Clause 8.3.1)

The test verifies the receivers' performance at detecting ACK under multipath fading conditions for a given SNR. The probability of detection of the ACK shall be equal or greater to 0.99. The probability of false detection of the ACK shall be 0.01 or less. The statistics are kept by the base station under test.

This test is applicable for all categories of BS.

For the test one bit of information ACK (\equiv '1') is transmitted in the PUCCH format 1a with following pattern:



Test req	Test requirement PUCCH 8.3.1, 2 RX antennas							
Cyclic	Propagatio	Correlation	Channel B	andwidth /	SNR [dB]		
Prefix	n Conditions	matrix	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz
Normal	EPA 5	Low	-1.9	-3.3	-4.2	-4.8	-4.7	-4.5
	EVA 5	Low	-3.9	-4.5	-4.5	-4.4	-4.5	-4.5
	EVA 70	Low	-4.3	-4.6	-4.6	-4.5	-4.6	-4.5
	ETU 300	Low	-4.4	-4.5	-4.3	-4.4	-4.6	-4.6
Extended	ETU 70	Low	-3.6	-3.7	-3.5	-3.7	-3.6	-3.7

Table 3-43, Table 3-44 and Table 3-45 show the test requirements for two, four and eight RX antennas.

 Table 3-43: Test requirements PUCCH test 8.3.1 for 2 antennas, yellow marked are not applicable for

 Local area and Home BS

Test req	Test requirement PUCCH 8.3.1, 4 antennas							
Cyclic	Propagation	Correlation matrix	Channel Ba	andwidth /	SNR [dB]		
Prefix Conditions	Conditions		1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz
Normal	EPA 5	Low	-7.3	-7.8	-8.1	-8.3	-8.3	-8.4
	EVA 5	Low	-8.2	-8.5	-8.5	-8.2	-8.3	-8.3
	EVA 70	Low	-8.3	-8.4	-8.4	-8.2	-8.4	-8.2
	ETU 300	Low	-8.1	-8.3	-8.1	-8.1	-8.3	-8.2
Extended	ETU 70	Low	-7.3	-7.5	-7.3	-7.5	-7.4	-7.4

 Table 3-44: Test requirements PUCCH test 8.3.1 for 4 antennas, yellow marked are not applicable for

 Local area and Home BS

Test req	Test requirement PUCCH 8.3.1, 8 antennas							
Cyclic	Propagation	Correlation matrix	Channel B	andwidth /	SNR [dB]]		
Prefix Co	Conditions		1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz
Normal	EPA 5	Low	-10.6	-10.9	-11.6	-11.7	-11.7	-11.7
	EVA 5	Low	-11.4	-11.4	-11.5	-11.5	-11.7	-11.6
	EVA 70	Low	-11.4	-11.5	-11.6	-11.5	-11.7	-11.5
	ETU 300	Low	-11.0	-11.0	-11.0	-11.2	-11.0	-11.2
Extended	ETU 70	Low	-9.9	-10.1	-10.0	-10.1	-10.0	-10.0

 Table 3-45: Test requirements PUCCH test 8.3.1 for 8 antennas, yellow marked are not applicable for

 Local area and Home BS

Test setup

Fig. 3-81 to Fig. 3-83 show the test setup.

The wanted signal generated by SMW baseband A is split up in two paths. Multipath fading is simulated in the channel simulators, AWGN is added.

For four RX antennas, the test can be done with just one SMW (suitable options required). For eight RX antennas, the test can be also done with just one SMW.

The SMW needs an external trigger at USER3.



Fig. 3-81: Test setup for PUCCH test 8.3.1 for 2 antennas







Fig. 3-83: Test setup for PUCCH test 8.3.1 for 8 antennas with one SMW

Test Procedure

As an example, the settings for two RX antennas, normal prefix, EPA 5 Hz and 10 MHz are shown. The ACK is transmitted in every second subframe.

- 1. Set the **routing** to 1x1x2 (see 3.1.1), thus one baseband block is routed to two paths.
- 2. For the basic LTE steps see section 3.1.2.
- 3. Click Frame Configuration

EUTRA/LTE A: Frame Configuration							
General	Time Plan	Subframe					
		U	IE1				
			On				
30	SPP Release	LTE-Ac	lvanced	•			
No. of PU	CCH Config			2			
No. of PU	ISCH Config			2			

4. Set No of PUCCH Config to 2 (Fig. 3-84).

- Fig. 3-84: Set two configurable PUCCH subframes
- 5. Click tab Subframe
- 6. Set for the PUCCH the Format to F1a and the state On (Fig. 3-85)

El	JTRA/	'LTE A: Fr	ame C	onfiguratior	1									
General			ne Plan Subframe											
	Cell Index			0		Sub	frame		0	Prev C	Next		Сору	
(Cyclic Prefix		Norm	nal		- 1	Jplink Sub	frame		0	R	eset Al	l Subf	ira
		Content	CW	Modulation / Format	Enhanced Settings	Set 1 No. RB	Set 1 Offset VRB	Set 2 No. RB	Set 2 Offset VRB	Offset PRB Slot (n/n+1)	Physical Bits	Power /dB	State	C
	UE1	PUCCH	-	F1a	Config	1	-	-	-	(5/0)	1	0.000	On	
		PUSCH	1/1	QPSK	Config	6	0	-	-	-	(19 <u>4</u> 00	0.000	Off	

Fig. 3-85: PUCCH with format F1a in subframe 0

- 7. Click in column Enhanced Settings Config
- 8. Set the resource index **n_PUCCH** to 0. (Fig. 3-86)
- 9. Set the ACK/NACK Pattern (one bit) to '1' (Fig. 3-87)

Performance Tests (Chapter 8)

Performance requirements for PUCCH (Clause 8.3)

EUTRA/LTE A: Enhanced Sett. (SF 0)	_	×
Common Channel Coding / Multiples	king	
UE/Content Type	UE1/F	ОССН
PUCCH Format		F1a
n_PUCCH		ο

Fig. 3-86: Set the parameter n_PUCCH to 0

EUTRA/LTE A: Enhanced Sett. (SF 0)	×
Common Channel Coding /	Multiplexing	
HARQ A	ск	
ACK/NACK Pattern		1

Fig. 3-87: Set one bit ACK pattern to '1' (ACK)

10. Make sure that the PUCCH in the second configurable subframe is not transmitted. (example: subframe 1 **State Off**) (Fig. 3-88)

UTRA	/LTE A: Fr	ame C	onfiguration	1									_	×
Gen	eral Ti	me Pl	an Subfr	ame										
Cell	Index		0		Sub	frame		1	Prev C	Next		Сору		Paste
Cycli	c Prefix	Norn	nal		Ţ	Uplink Sub	frame		1	R	eset Al	l Subf	rames	
	Content	CW	Modulation / Format	Enhanced Settings	Set 1 No. RB	Set 1 Offset VRB	Set 2 No. RB	Set 2 Offset VRB	Offset PRB Slot (n/n+1)	Physical Bits	Power /dB	State	Conflict	×
UE1	PUCCH		F1	Config	1	-	-	-	-	-	0.000	Off		
	PUSCH	1/1	QPSK	Config	6	0	7.82	-	-	-	0.000	Off		
1.50	DUCCU	414	ODCK	0	0	0					0.000	04		

Fig. 3-88: In the second configurable subframe (subframe #1) the PUCCH is not transmitted (state Off)

AWGN and Fading

- 11. Set Fading according to Table 3-43, Table 3-44 or Table 3-45 (see 3.1.3) (example EPA 5 Hz Low)
- Set noise power and SNR. Take in account the SNR correction factor (see 3.1.4)(example: Noise = -80.5 dBm; SNR = SNR + Correction = -4.8 dB -16.99 dB = -21.79 dB)

Demo Program

Fig. 3-89 shows the parameters of the test. You can select the test in the section **8.3 PUCCH.** Select one test under **8.3.1 ACK missed (1 TX)**. The tests are listed by their cyclic prefix and fading profile. When selecting a particular test, all settings are default according to the specification. The setting of the SNR depends on the fading profile and the channel bandwidth. The fading settings are displayed in the section **Fading**. There also select the correlation matrix (default: Low). The resource index n_PUCCH is set to 0. This example configures a PUCCH with ACK information in every second subframe. **4 Antennas** enables the test for four antennas. **8 Antennas** enables the test for eight antennas.

(8.5) N (8.2) P	(8.5) NB-IoT Additional Settings (8.2) PUSCH (8.3) PUCCH (8.4) PRACH									
8.3.1	ACK missed (1TX):	Normal, EPA 5Hz 🔹								
	4 Antennas	8 Antennas								
8.3.2	CQI Test:	Normal, EVA 5Hz 👻								
8.3.4 -	8.3.5 – 8.3.6 Test:	Normal, EPA 5Hz 👻								
	4 Antennas	8 Antennas 16 Bit								
8.3.7	ACK missed (2TX):	Normal, EPA 5Hz 👻								
	4 Antennas	8 Antennas								
8.3.9	CQI Test with DTX:	EVA 5Hz 🚽 🗌 2 TX								
8.3.10	ACK missed for CE:	4 v RPTs.								
8.3.11	CQI Test for CE:	4 v RPTs.								
8.3.12	PUCCH Format 4:	Normal, EPA 5Hz 👻								
	4 Antennas	8 Antennas 2 PRB								
8.3.13	PUCCH Format 5:	Normal, EPA 5Hz 👻								
	4 Antennas	8 Antennas								

Fig. 3-89: Parameter for PUCCH test 8.3.1

Fig. 3-90 shows the report.

```
******* Performance Tests *******
8.3.1 ACK missed Detection for Single User PUCCH Format 1A (Single Antenna Port)
with 2RX Antennas.
Bandwidth: 10 MHz
Duplex Mode: FDD
Fading: EPA5Hz Low
AWGN: -80.5 dBm
SNR: -4.8 dB
SNR Correction: -16.99 dB
ACK/NACK Pattern (One Bit): '1'
Finished!
```

Fig. 3-90: Report 8.3.1

3.3.2 CQI performance requirements for PUCCH format 2 transmission on single antenna port (Clause 8.3.2)

The test verifies the receivers' performance at CQI detection under multipath fading conditions for a given SNR. The performance is measured by the required SNR at BLER probability of detection equal to 0.99.

The fraction of falsely detected CQIs shall be less than 1% and the fraction of correctly detected CQIs shall be larger than 99%. The statistics are kept by the base station under test.

This test is applicable for all categories of BS.

For the test, four bits of information CQI (\equiv '1111') are transmitted in the PUCCH format 2 with following pattern:



Test red	quirem	ents 8.3.2									
Number	Cyclic	Propagation	Correlation	Channel Bandwidth / SNR [dB]							
of RX antennas	Prefix	Conditions	matrix	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz		
2	Newsel	EVA 5	Low	-3.1	-3.5	-3.8	-3.4	-3.6	-3.6		
	Normai	ETU 70	Low	-3.3	-3.8	-3.6	-3.8	-3.8	-3.8		

 Table 3-46: Requirements for PUCCH test 8.3.2. The yellow marked tests are applicable for Local area

 and Home BS, the blue for Wide Area BS and Medium Range BS.

Test setup

Fig. 3-91 shows the test setup.

The wanted signal generated by SMW baseband A is split up in two paths. Multipath fading is simulated in the channel simulators, AWGN is added.

The SMW needs an external trigger at USER3.



Fig. 3-91: Test setup for PUCCH test 8.3.2

Test Procedure

As an example, the settings for normal prefix, ETU 70 Hz and 10 MHz are shown. The CQI is set in every second subframe.

- 1. Set the **routing** to 1x1x2 (see 3.1.1), thus one baseband block is routed to two paths.
- 2. For the basic LTE steps, see section 3.1.2.
- 3. Click Frame Configuration
- 4. Set No of PUCCH Config to 2 (Fig. 3-92)

EUTRA/LTE A	UTRA/LTE A: Frame Configuration											
General	Time Plan	Subframe										
		U	E1	٦								
			On									
30	SPP Release	LTE-Ad	lvanced	·								
No. of PU	CCH Config			2								
No. of PU	SCH Config			2								

Fig. 3-92: Set two configurable PUCCH subframes

- 5. Click tab Subframe
- 6. Set for the PUCCH the Format to F2 and the state On (Fig. 3-93)

EUTR	VLTE A: F	rame (Configuration	1								
Ge	neral T	ime P	lan Subfr	ame								
Cell	Index		0		Sub	oframe		0	Prev C	Next	0	Сору
Сус	lic Prefix	Norn	nal		- 1	Uplink Sub	frame	8	0	R	eset A	ll Subfr
	Content	: CW	Modulation / Format	Enhanced Settings	Set 1 No. RB	Set 1 Offset VRB	Set 2 No. RB	Set 2 Offset VRB	Offset PRB Slot (n/n+1)	Physical Bits	Power /dB	State
UE1	PUCCH	-	F2	Config	1		-	7	(0/49)	20	0.000	On
	PUSCH	1/1	QPSK	Config	10	2	4	-		-	0.000	Off
UES	2 PUSCH	1/1	QPSK	Config	10	13	-	_		2	0.000	Off

Fig. 3-93: PUCCH with format F2 in subframe 0

- 7. Click in column Enhanced Settings Config
- 8. Set the resource index **n_PUCCH** to 0. (Fig. 3-94)
- 9. Set the Number of CQI bits to 4 and CQI Pattern (four bits) to '1111' (Fig. 3-95)

E	UTRA/LTE A	: Enhanced Se	tt. (SF 0)		×
	Common	Channel Co	oding / Multiplex	ing	
	UE/Conte	nt Type		UE1/P	иссн
	PUCCH F	ormat			F2
	n_PUCCH	ł			0

Fig. 3-94: Set the parameter n_PUCCH to 0

EUTRA/LTE A	: Enhanced Sett. (SF 0)	_	×
Common	Channel Coding / Multiple	exing	
c	hannel Quality Control Info	ormation	
Number o	of CQI Bits		4
Number o	f Coded CQI Bits		20
CQI Patte	rn	1	111

Fig. 3-95: Set four bits CQI pattern to '1111'

10. Make sure that the PUCCH in the second configurable subframe is not transmitted.(State **Off**) (Fig. 3-96)

EUTRA	/LTE A: Fr	ame C	onfiguration	ì									—	×
Gen	eral Ti	me Pl	an Subfr	ame										
Cell	ndex		0		Sub	frame		1	Prev C	Next	0	Сору		Paste
Cycli	c Prefix	Norn	nal		-	Uplink Sub	oframe		1	R	eset Al	I Subf	rames	
	Content	CW	Modulation / Format	Enhanced Settings	Set 1 No. RB	Set 1 Offset VRB	Set 2 No. RB	Set 2 Offset VRB	Offset PRB Slot (n/n+1)	Physical Bits	Power /dB	State	Conflict	×
UE1	PUCCH		F1	Config	1	-	-	(-	-	-	0.000	Off		
	PUSCH	1/1	QPSK	Config	6	0	280	-	-	-	0.000	Off		
1150	PUSCH	1/1	OPSK	Config	6	0					0.000	Off		

Fig. 3-96: In the second configurable subframe (subframe #1) the PUCCH is not transmitted (state Off)

AWGN and Fading

- 11. Set Fading according to Table 3-46 (see 3.1.3) (example ETU 70 Hz Low)
- Set noise power and SNR. Take in account the SNR correction factor (see 3.1.4)(example: Noise = -80.5 dBm; SNR = SNR + Correction = - 3.8 dB - 16.99 dB = -20.79 dB)

Demo Program

Fig. 3-97 shows the parameters of the test. You can select the test in the section **8.3 PUCCH.** Select one test under **8.3.2 CQI Test**. The tests are listed by their fading profile. When selecting a particular test all settings are default according to the specification. The setting of the SNR depends on the fading profile and the channel bandwidth. The fading settings are displayed in the section **Fading**. There also select the correlation matrix (default: Low). The resource index n_PUCCH is set to 0. This example configures a PUCCH with CQI information in every second subframe.

Performance Tests (Chapter 8)

Performance requirements for PUCCH (Clause 8.3)

(8.5) N (8.2) P	B-IoT USCH	Additional Set (8.3) PUCCH	ttings (8.4) PRACH			
8.3.1	ACK m	nissed (1TX):	Normal, EPA 5	Hz		7
	4 A	ntennas	8 Antennas			
8.3.2	CQI Te	est:	Normal, EVA 5	ίΗz		-
8.3.4 -	- 8.3.5 -	- 8.3.6 Test:	Normal, EPA 5	iHz]
	4 A	ntennas	8 Antennas		16 Bit	t
8.3.7	ACK m	nissed (2TX):	Normal, EPA 5	Hz	-]
	4 A	ntennas	8 Antennas			
8.3.9	CQI Te	est with DTX:	EVA 5Hz	-	2 TX	
8.3.10	ACK m	nissed for CE:	4	-	RPTs.	
8.3.11	CQI Te	est for CE:	4	-	RPTs.	
8.3.12	PUCCI	H Format 4:	Normal, EPA 5	Hz]
	4 A	ntennas	8 Antennas		2 PR	8
8.3.13	PUCC	H Format 5:	Normal, EPA 5	Hz	-]
	4 A	ntennas	8 Antennas			

Fig. 3-97: Parameter for PUCCH test 8.3.2

Fig. 3-98 shows the report.

******* Performance Tests *******

8.3.2 CQI for PUCCH Format 2 (Single Antenna Port)

Bandwidth: 10 MHz Duplex Mode: FDD Fading: EVA5Hz Low AWGN: -80.5 dBm SNR: -3.4 dB SNR Correction: -16.99 dB

CQI Pattern (4 Bits): '1111' Finished!

Fig. 3-98: Report for test 8.3.2

3.3.3 ACK missed detection for multi user PUCCH format 1a (Clause 8.3.3)

The test verifies the receivers' performance at detecting ACK on the wanted signal in the presence of three interfering signals under multipath fading conditions for a given SNR.

The performance is measured on the wanted signal by the required SNR at probability of detection equal to 0.99 or greater. The probability of false detection of the ACK shall be 0.01 or less. The statistics are kept by the base station under test.

The test is applicable for Wide area BS and Medium range BS only.

For the wanted signal one bit of information ACK (\equiv '1') is transmitted in the PUCCH format 1a with following pattern:



All interferers transmit one bit of information ACK (\equiv '1') in the PUCCH format 1a in **all** subframes.

Requirem	Requirements for PUCCH 8.3.3												
Number	Cyclic	Propagation	Correlation	Channel	Bandwid	th / SNR	[dB]						
of RX antennas	Prefix	Conditions	matrix	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz				
2	Normal	ETU 70	Low	-3.5	-3.8	-3.8	-4.0	-4.0	-3.8				

Table 3-47: Requirements for PUCCH test 8.3.3

For this test, the wanted signal and the three interferers transmit PUCCH with one bit ACK information (\equiv '1') on the same resources at the same time, but with different orthogonal covers (n_PUCCH) and different relative power (see Table 3-48).

Additional	test para	meters multi use	r PUCCH 8.3.3		
	Cyclic shift index (δ =0)	Orthogonal cover index	RS orthogonal cover/ ACK/NACK orthogonal cover (n_PUCCH)	Relative power [dB]	Relative timing [ns]
Tested signal	4	0	2	-	-
Interferer 1	2	0	1	0	
Interferer 2	3	1	7	-3	0
Interferer 3	4	2	14	3	

NOTE1: Presented resource index mapping for orthogonal cover and cyclic shift indices are for the first slot of the subframe.

NOTE2: All above listed signals are transmitted on the same PUCCH resources, with different PUCCH channel indices as presented above.

Table 3-48: Additional test parameters multi user PUCCH test 8.3.3

Test setup

The test can be performed with just one SMW (with the suitable options).

Four UE's are simulated with the SMW, a combing network similar to 4x2 MIMO is added with multipath fading by the channel simulators and AWGN is applied.



Test Procedure

The SMW is able to create all four UEs in one instrument. As a combing network similar to 4x2 MIMO is needed, the **System Configuration** functionality of the SMW simplifies the settings. As an example, the settings for 10 MHz are shown. The ACK of UE1 is transmitted in every second subframe. The ACK's of the interferer is transmitted continuously in all subframes.

As in the SMW all four UE's are combined, the sum of the SNRs needs to be set.

Levels for s	SMW, example 1	0 MHz		
UE	SNR - SNR _{corr}	Relative power [dB]	SNR level [dB]	Settings
1	- 4.0 dB – 16.99 dB	0.0	- 20,99	
2	=	0.0	- 20,99	
3	-20.99 dB	- 3.0	- 23,99	Sum = SNR = -14.46 dB
4		+ 3.0	- 17,99	

Table 3-49: SNR calculation example for 8.3.3 in the SMW

SMW SM	NR settings	for PUC	CH 8.3.	3								
Channel Bandwidth / SNR [dB]												
	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz						
SNR	-4.75	-9.03	-11.25	-14.46	-16.22	-17.27						
Table 3-50:	able 3-50: Resulting SNR for 8.3.3 in the SMW											

Set four independent basebands with fading and a MIMO 4x2 setting (see Fig. 3-100)

System Configur	ation						_	×
Fading/Base	band Config	I/Q Stream Mapper	External RF and I/	QOverview				
Set to	Default				Basebands	FAA	••	Streams
Mode		Advanced				Fab		
Signal Output Entities (Users, Cells) 1 ·	ts X	Analog & Digital Basebands (Tx Antennas) 4 -	Streams (Rx Antennas)	BE	<u>в</u>			
BB Source C	onfig	Separate Sources	s •	Be Entity 1		FDA FDB	••	B
Apply		💽 ок						

Fig. 3-100: System configuration for PUCCH 8.3.3. A network combining network similar to 4x2 MIMO is used. Baseband A simulates the wanted signal. Baseband B....D simulate the three interferers.

2. For the basic LTE steps see section 3.1.2

Setting of UE1

- 3. Click Frame Configuration
- 4. Set No of PUCCH Config to 2 (Fig. 3-101)



Fig. 3-101: Set two configurable PUCCH subframes

- 5. Click tab Subframe
- 6. Set for the PUCCH the Format to F1a and the state On (Fig. 3-102)

EU	TRA/	'LTE A: Fr	ame C	onfiguration	1									
(Gen	eral Tir	ne Pl	an Subfra	ame									
C	ell I	ndex		0		Sub	frame		0	Prev C	Next	0	Сору	
С	yclid	c Prefix	Norm	nal		- ı	Jplink Sub	frame	ĺ	0	R	eset Al	l Subl	fra
		Content	CW	Modulation / Format	Enhanced Settings	Set 1 No. RB	Set 1 Offset VRB	Set 2 No. RB	Set 2 Offset VRB	Offset PRB Slot (n/n+1)	Physical Bits	Power /dB	State	C
I	JE1	PUCCH	-	F1a	Config	1	-	-	-	(5/0)	1	0.000	On	
		PUSCH	1/1	QPSK	Config	6	0	-	-	-	(B2-0	0.000	Off	

Fig. 3-102: PUCCH with format F1a in subframe 0

- 7. Click in column Enhanced Settings Config
- 8. Set the resource index n_PUCCH accordingly (UE1: 0). (Fig. 3-103)
- 9. Set the ACK/NACK Pattern (one bit) to '1' (Fig. 3-104)

EUTRA/LTE A: Enhanced Sett. (SF 0)	_	_	×
Common Channel Coding / Multiple>	king		
UE/Content Type	UE	1/ P	UCCH
PUCCH Format			F1a
n_PUCCH			0

Fig. 3-103: Set the parameter n_PUCCH to 0

EUTRA/LTE A	: Enhanced Sett. (SF 0)	_	×
Common	Channel Coding / Multip	plexing	
	HARQ ACK		
	CK Pattern		1

Fig. 3-104: Set one bit ACK pattern to '1' (ACK)

10. Make sure that the PUCCH in the second configurable subframe is not transmitted.(State **Off**) (Fig. 3-105)

UTRA	/LTE A: Fr	ame C	onfiguration	1									_	×
Gen	eral Ti	me Pl	an Subfr	ame										
Cell	Index		0		Sub	oframe		1	Prev	Next	0	Сору		Paste
Cycli	c Prefix	Norn	nal		•	Uplink Sub	oframe		1	R	eset Al	l Subf	rames	
	Content	CW	Modulation / Format	Enhanced Settings	Set 1 No. RB	Set 1 Offset VRB	Set 2 No. RB	Set 2 Offset VRB	Offset PRB Slot (n/n+1)	Physical Bits	Power /dB	State	Conflict	
UE1	PUCCH		F1	Config	1	-	-	-	-	-	0.000	Off		
	PUSCH	1/1	QPSK	Config	6	0	7. 4 2	-	-	-	0.000	Off		
1152	PLISCH	1/1	OPSK	Config	6	0					0.000	Off		

Fig. 3-105: In the second configurable subframe (subframe #1) the PUCCH is not transmitted (state off)

Setting Interferer UE's (UE2...UE4)

- 11. Click Frame Configuration
- 12. Set **No of PUCCH Config** to 1 (Fig. 3-106), because all interferer transmit continuously.

EUTRA/LTE A	: Frame Confi	guration		
General	Time Plan	Subframe		
	2	U	E1	١
			On	
30	PP Release	LTE-Ad	lvanced	
No. of PU	CCH Config			
No. of PU	SCH Config			

Fig. 3-106: Set one configurable PUCCH subframes for the interferers

- 13. Click tab Subframe
- 14. Set for the PUCCH the Format to F1a and the state On (Fig. 3-107)

E	UTRA/	'LTE A: Fr	ame C	onfiguratior	I									
	Gen	eral Tir	ne Pl	an Subfr	ame									
	Cell I	ndex		0		Sub	frame		0	Prev C	Next		Сору	
	Cyclie	c Prefix	Norm	nal		- I	Jplink Sub	oframe		0	R	eset Al	l Subl	fra
		Content	CW	Modulation / Format	Enhanced Settings	Set 1 No. RB	Set 1 Offset VRB	Set 2 No. RB	Set 2 Offset VRB	Offset PRB Slot (n/n+1)	Physical Bits	Power /dB	State	C
	UE1	PUCCH	-	F1a	Config	1	-	-	-	(5/0)	1	0.000	On	
		PUSCH	1/1	QPSK	Config	6	0	-	-	-	154.0	0.000	Off	

Fig. 3-107: PUCCH with format F1a in subframe 0

- 15. Click in column Enhanced Settings Config
- 16. Set the resource index n_PUCCH according to Table 3-48 (UE2...UE4). (Fig. 3-103) and the ACK/NACK Pattern (one bit) to '1' (Fig. 3-104)
- 17. Set individual relative power levels by a click on the line between the baseband and the AWGN block. In the window set the level of (Fig. 3-108 and Fig. 3-109)



Fig. 3-108: Click here to enter baseband offsets

Baseband Offset	Baseband Offsets						
	Frequency Offset /Hz	Phase Off /°	fset	Pati /	n Gain dB		
Baseband A	0.00	C	0.00		0.000		
Baseband B	0.00	C	0.00		0.000		
Baseband C	0.00	C	0.00	-	-3.000		
Baseband D	0.00	C).00		3.000		

Fig. 3-109: Individual level offsets for the UE's are entered as baseband offsets

AWGN und Fading

- 18. Set Fading according to Table 3-47 (see 3.1.3) (example: ETU 70 Hz Low)
- Set noise power and SNR according to Table 3-50 (see 3.1.4). As all UE's are summed up inside the SMW, set the SNR in the way to meet the required levels accordingly (example: Noise = -80.5 dBm; SNR = -14.46 dB)

Demo Program

For this test, no additional parameters have to be set. The setting of the SNR depends on the fading profile and the channel bandwidth. The fading settings are displayed in the section **Fading**. There, also select the correlation matrix (default: Low). The resource indices n_PUCCH are set to the corresponding values. This example configures an ACK information for UE1 in every second subframe.

Fig. 3-110 shows the report.

******* Performance Tests ******* 8.3.3 ACK missed Detection for Mulit User PUCCH Format 1A Bandwidth: 10 MHz Duplex Mode: FDD Fading: ETU70Hz Low AWGN: -80.5 dBm SNR: -4 dB SNR Correction: -16.99 dB ACK/NACK Pattern (One Bit): '1' Finished!

Fig. 3-110: Report for test 8.3.3

3.3.4 ACK missed detection for PUCCH format 1b with Channel Selection (Clause 8.3.4)

The test verifies the receivers' performance at detecting ACK under multipath fading conditions for a given SNR. The probability of detection of the ACK shall be equal or greater to 0.99. The probability of false detection of the ACK shall be 0.01 or less. The statistics are kept by the base station under test.

This test is applicable for all categories of BS. Tests are specified for channel bandwidths of 10 MHz, 15 MHz and 20 MHz, only.

For the test, four bits of information ACK (\equiv '1111') are transmitted in the PUCCH format 1b.

Table 3-51 shows the test requirements for two, four and eight RX antennas.
Test red	Test requirement PUCCH 8.3.4												
Number	Cyclic	Propagation	Correlation	Channel Bandwidth / SNR [dB]									
of RX antennas	of RX Prefix antennas		matrix	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz				
2	Normal	EPA 5	Low	-	-	-	-3.9	-4.0	-4.0				
		EVA 70	Low	-	-	-	-3.7	-3.9	-3.9				
4	Normal	EPA 5	Low	-	-	-	-7.8	-7.9	-8.0				
		EVA 70	Low	-	-	-	-7.7	-7.9	-7.9				
8 Normal	EPA 5	Low	-	-	-	-11.1	-11.2	-11.2					
		EVA 70	Low	-	-	-	-10.9	-11.1	-11.0				

Table 3-51: Requirements for PUCCH 8.3.4

Test setup

Fig. 3-111 to Fig. 3-113 show the test setup.

The wanted signal generated by SMW baseband A is split up in two paths. Multipath fading is simulated in the channel simulators, AWGN is added.

For four RX antennas, the test can be done with just one SMW (suitable options required). For eight RX antennas, the test can be also done with just one SMW.

The SMW needs an external trigger at USER3.



Fig. 3-111: Test setup for PUCCH test 8.3.4 for 2 antennas



Fig. 3-112: Test setup for PUCCH test 8.3.4 for 4 antennas with one SMW



Fig. 3-113: Test setup for PUCCH test 8.3.4 for 8 antennas with one SMW

Test Procedure

As an example, the settings for 2 RX antennas, normal prefix, EVA 70 Hz and 10 MHz are shown. The ACK is sent in every second subframe.

- 1. Set the routing in the SMW to 1 x 1 x 2 (see 3.1.1)
- 2. For the basic LTE steps see section 3.1.2
- 3. Click Frame Configuration
- 4. Set No of PUCCH Config to 2 (Fig. 3-114)

EUTRA/LTE A: Frame Configuration											
General	Time Plan	Subframe									
		U	E1								
			On								
30	SPP Release	LTE-Ac	lvanced	•							
No. of PU	CCH Config			2							
No. of PU	SCH Config			2							

Fig. 3-114: Set two configurable PUCCH subframes

- 5. Click tab **Subframe**
- 6. Set for the PUCCH the Format to F1b and the state On (Fig. 3-115)

EUTRA	VLTE A: F	rame (onfiguration	1									_
Ge	neral T	ime Pl	lan Subfra	ame									
Cell	Index		0		Sul	oframe		0	Prev 🜔	Next		Copy	
Сус	lic Prefix	Norn	nal		•	Uplink Sub	frame		0	R	eset Al	I Subi	fr <mark>am</mark> es
	Conten	t CW	Modulation / Format	Enhanced Settings	Set 1 No. RE	Set 1 Offset VRB	Set 2 No. RB	Set 2 Offset VRB	Offset PRB Slot (n/n+1)	Physical Bits	Power /dB	State	Conflict
UE1	PUCCH	- 1	F1b	Config	1	-	(2)	-	(49/0)	2	0.000	On	
	PUSCH	1/1	QPSK	Config	10	2	17		-		0.000	Off	
UE2	2 PUSCH	1/1	QPSK	Config	10	13	()	-	-	-	0.000	Off	

Fig. 3-115: PUCCH with format F1b in subframe 0

- 7. Click Enhanced Settings Config
- 8. Set the resource index n_PUCCH to 0. (Fig. 3-116)
- 9. Set the ACK/NACK Pattern (two bits) to '11' (Fig. 3-117)

EUTRA/LTE A: Enhanced Se	ett. (SF 0)	_	×
Common Channel C	oding / Multiplex	ting	
UE/Content Type		UE1/P	иссн
PUCCH Format			F1b
n_PUCCH			0



EUTRA/LTE A	: Enhanced Sett. (SF 0)	_	×
Common	Channel Coding / Mul	Itiplexing	
	HARQ ACK	<u></u>	
	K Pattern		11



10. Make sure that the PUCCH in the second configurable subframe is not transmitted.(State **Off**) (Fig. 3-118)

UTRA	/LTE A: Fr	rame (Configuration										_	×
Gen	eral Ti	me Pl	lan Subfr	ame				- 14						
Cell	Index		0		Sub	frame		1	Prev C	Next		Сору		Paste
Cycli	c Prefix	Norn	nal		÷	Jplink Sub	oframe		1	R	eset Al	I Subf	rames	
	Content	CW	Modulation / Format	Enhanced Settings	Set 1 No. RB	Set 1 Offset VRB	Set 2 No. RB	Set 2 Offset VRB	Offset PRB Slot (n/n+1)	Physical Bits	Power /dB	State	Conflict	z
UE1	PUCCH	-	F1	Config	1	-	-	·	-	-	0.000	Off		
-	PUSCH	1/1	QPSK	Config	6	0		-	-	-	0.000	Off		
1150	DUSCU	1/1	OPSK	Config	6	0					0.000	Off		

Fig. 3-118: In the second configurable subframe (subframe #1), the PUCCH is not transmitted (state Off)

AWGN and Fading

- 11. Set Fading according to Table 3-51 (see 3.1.3) (example EVA 70 Hz Low)
- Set noise power and SNR. Take in account the SNR correction factor (see 3.1.4)(example: Noise = -80.5 dBm; SNR = SNR + Correction = -3.7 dB -16.99 dB = -20.69 dB)

Demo program

Fig. 3-119 shows the parameters of the test. You can select the test in the section **8.3 PUCCH.** Select one test under **8.3.4 - 8.3.5 - 8.3.6 Tests**. The tests are listed by their cyclic prefix and fading profile. When selecting a particular test, all settings are default according to the specification. The setting of the SNR depends on the fading profile and the channel bandwidth. The fading settings are displayed in the section **Fading**. There, also select the correlation matrix (default: Low). The resource index n_PUCCH is set to 0. This example configures a PUCCH with ACK information in every second subframe. **4 Antennas** enables the test for four antennas. **8 Antennas** enables the test for eight antennas.



Fig. 3-119: Parameter for PUCCH test 8.3.4

Fig. 3-120 shows the report.

******* Performance Tests ******* 8.3.4 ACK missed Detection for PUCCH Format 1B with Channel Selection with 2RX Antennas. Bandwidth: 10 MHz Duplex Mode: TDD UL/DL Configuration: 0 Special Subframe Configuration: 0 Fading: EVA70Hz Low AWGN: -80.5 dBm SNR: -3.7 dB SNR Correction: -16.99 dB ACK/NACK Pattern (Two Bits): '11' Finished!

Fig. 3-120: Report 8.3.4

3.3.5 ACK missed detection for PUCCH format 3 (Clause 8.3.5)

The test verifies the receivers' performance at detecting ACK under multipath fading conditions for a given SNR. The probability of detection of the ACK shall be equal or greater to 0.99. The probability of false detection of the ACK shall be 0.01 or less. The statistics are kept by the base station under test.

This test is applicable for all categories of BS. Tests are specified for channel bandwidths of 10 MHz, 15 MHz and 20 MHz, only.

For the test, PUCCH format 3 is used. The number of bits are in Table 3-52. One SR bit '0' is always appended. 16 bits are for TDD only.

Ack/Nack Bits in PUCCH 8.3.5								
FDD	TDD							
4 bits '1111'	4 bits '1111' +'0'							
-	16 bits '1111 1111 1111 1111' +'0'							

Table 3-52: AN bits in 8.3.5

Table 3-53 and Table 3-54 show the test requirements for two, four and eight RX antennas.

Test red	Test requirement PUCCH 8.3.5, 4 AN bits												
Number	Cyclic	Propagatio	Correlation	Channel Bandwidth / SNR [dB]									
of RX antennas	tennas Prefix n Conditions		matrix	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz				
2	Normal	EPA 5	Low	-	-	-	-3.1	-3.2	-3.2				
		EVA 70	Low	-	-	-	-2.9	-3.0	-3.1				
4	Normal	EPA 5	Low	-	-	-	-6.7	-6.8	-6.9				
		EVA 70	Low	-	-	-	-6.6	-6.7	-6.7				
8	Normal	EPA 5	Low	-	-	-	-10.5	-10.3	-10.5				
		EVA 70	Low	-	-	-	-10.3	-10.4	-10.4				

Table 3-53: Requirements for PUCCH 8.3.5, 4 AN bits

Test red	Test requirement PUCCH 8.3.5, 16 AN bits, TDD only											
Number	Cyclic	Propagatio	Correlation	Channel E	Bandwidth	/ SNR [d	IB]					
of RX Prefix antennas	Prefix	n Conditions	matrix	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz			
2	Normal	EPA 5	Low	-	-	-	-0.7	-0.6	-0.6			
		EVA 70	Low	-	-	-	-0.2	-0.3	-0.3			
4	Normal	EPA 5	Low	-	-	-	-4.7	-4.7	-4.8			
		EVA 70	Low	-	-	-	-4.4	-4.5	-4.5			
8	Normal	EPA 5	Low	-	-	-	-8.2	-8.2	-8.3			
		EVA 70	Low	-	-	-	-8.1	-8.2	-8.1			

Table 3-54: Requirements for PUCCH 8.3.5, 16 AN bits, TDD only

Test setup

Fig. 3-121 to Fig. 3-123 show the test setup.

The wanted signal generated by SMW baseband A is split up in two paths. Multipath fading is simulated in the channel simulators, AWGN is added.

For four RX antennas, the test can be done with just one SMW (suitable options required). For eight RX antennas, the test can be also done with just one SMW.

The SMW needs an external trigger at USER3.



Fig. 3-121: Test setup for PUCCH test 8.3.5 for 2 antennas



Fig. 3-122: Test setup for PUCCH test 8.3.5 for 4 antennas with one SMW



Fig. 3-123: Test setup for PUCCH test 8.3.5 for 8 antennas with one SMW

Test Procedure

As an example, the settings for 2 RX antennas, 4 AN bits, normal prefix, EVA 70 Hz and 10 MHz are shown. The ACK is set in every second subframe.

- 1. Set the routing in the SMW to **1** x **1** x **2** (see 3.1.1)
- 2. For the basic LTE steps see section 3.1.2.
- 3. Click Frame Configuration
- 4. Set No of PUCCH Config to 2 (Fig. 3-124)

EUTRA/LTE A: Frame Configuration											
General	Time Plan	Subframe									
		U	E1								
			On								
30	SPP Release	LTE-Ac	lvanced	•							
No. of PU	CCH Config			2							
No. of PU	SCH Config			2							

Fig. 3-124: Set two configurable PUCCH subframes

- 5. Click tab Subframe
- 6. Set for the PUCCH the Format to F3 and the state On (Fig. 3-125)

EUTRA	/LTE A: Fr	rame (onfiguratio	n								
Ger	eral Ti	me Pl	an Subf	ame								
Cell	Index		0		Sub	oframe		0	Prev	Next	0	Сору
Cycli	ic Prefix	Norn	nal		•	Uplink Sub	oframe		0	R	eset Al	l Subfra
	Content	CW	Modulation Format	Enhanced Settings	Set 1 No. RB	Set 1 Offset VRB	Set 2 No. RB	Set 2 Offset VRB	Offset PRB Slot (n/n+1)	Physical Bits	Power /dB	State C
UE1	PUCCH	-	F3	Config	1	-	-	-	(0/49)	48	0.000	On
	PUSCH	1/1	QPSK	Config	10	2	-		-7	1.5	0.000	Off
1150	DUSCU	1/1	ODEK	Config	10	10					0.000	0#

Fig. 3-125: PUCCH with format F3 in subframe 0

- 7. Click Enhanced Settings Config
- 8. Set the resource index n_PUCCH to 0. (Fig. 3-126)
- 9. Set the **Number of Bits** to **5** (4 ACK + 1 SR) and the **ACK/NACK Pattern** to '**11110**' (Fig. 3-127)



Fig. 3-126: Set the parameter n_PUCCH to 0

EUTRA/LTE A	: Enhanced Sett. (PCell, SF 0, UE 1)		—	×
Common	Channel Coding / Multiplexing			
	HAF	RQACK —		
Number o	of A/N + SR + CSI Bits			5
A/N + SR	+ CSI Pattern		1 1	1110
Number o	of Coded A/N + SR + CSI Bits			0

Fig. 3-127: Set five bits ACK pattern to '1111' + '0'

10. Make sure that the PUCCH in the second configurable subframe is not transmitted.(State **Off**) (Fig. 3-128)

UTRA	/LTE A: Fr	ame C	onfiguration										_	×
Gen	eral Ti	me Pl	an Subfr	ame				- 10						
Cell	Index		0		Sub	oframe		1	Prev 💽	Next		Сору		Paste
Cycli	c Prefix	Norn	nal		Ţ	Uplink Sub	oframe		1	R	eset Al	I Subf	rames	
	Content	CW	Modulation / Format	Enhanced Settings	Set 1 No. RB	Set 1 Offset VRB	Set 2 No. RB	Set 2 Offset VRB	Offset PRB Slot (n/n+1)	Physical Bits	Power /dB	State	Conflict	×
UE1	PUCCH		F1	Config	1	-	-	-	-	-	0.000	Off		
	PUSCH	1/1	QPSK	Config	6	0	100	-	-	-	0.000	Off		
1150	DUSCU	1/4	ODEK	Config	e	0					0.000	0#		

Fig. 3-128: In the second configurable subframe (subframe 1) the PUCCH is not transmitted (state on)

AWGN and Fading

- 11. Set **Fading** according to Table 3-52 or Table 3-53 (see 3.1.3) (example EVA 70 Hz Low)
- Set noise power and SNR. Take in account the SNR correction factor (see 3.1.4)(example: Noise = -80.5 dBm; SNR = SNR + Correction = -2.9 dB -16.99 dB = -19.99 dB)

Demo program

Fig. 3-129 shows the parameters of the test. You can select the test in the section 8.3 **PUCCH.** Select one test under 8.3.4 - 8.3.5 - 8.3.6 Tests. The tests are listed by their cyclic prefix and fading profile. When selecting a particular test, all settings are default according to the specification. The setting of the SNR depends on the fading profile and the channel bandwidth. The fading settings are displayed in the section Fading. There, also select the correlation matrix (default: Low). The resource index n_PUCCH is set to 0. This example configures a PUCCH with ACK information in every second subframe. If TDD is selected, the test with 16 bit (16 bit) can be performed. 4 Antennas enables the test for four antennas. 8 Antennas enables the test for eight antennas.



Fig. 3-129: Parameter for PUCCH test 8.3.5

Fig. 3-130 shows the report.

```
******* Performance Tests ******
8.3.5 ACK missed Detection for PUCCH Format 3
with 2RX Antennas.
Bandwidth: 10 MHz
Duplex Mode: FDD
Fading: EVA70Hz Low
AWGN: -80.5 dBm
SNR: -2.9 dB
SNR Correction: -16.99 dB
ACK/NACK Pattern (4 Bits + SR): '1111 0'
Finished!
```

Fig. 3-130: Report 8.3.5

3.3.6 NAK to ACK detection for PUCCH format 3 (Clause 8.3.6)

The test verifies the receivers' performance at detecting NAK to ACK under multipath fading conditions for a given SNR. The probability of the NAK to ACK detection shall be equal or less to 0.001. The probability of false detection of the ACK shall be 0.01 or less. The statistics are kept by the base station under test.

This test is applicable for all categories of BS. Tests are specified for channel bandwidths of 10 MHz, 15 MHz and 20 MHz, and TDD mode only.

For the test, PUCCH format 3 is used. 16 AckNack bits are transmitted with NAK always (\equiv '0'). One SR bit '0' is always appended.

Test red	Test requirement PUCCH 8.3.6, 16 AN bits, TDD only												
Number	Cyclic	Propagation	Correlation	Channe	el Bandwi	dth / SNF	R [dB]						
of RX antennas	Prefix	Conditions	matrix	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz				
2	Normal	EPA 5	Low	-	-	-	2.0	2.2	2.1				
		EVA 70	Low	-	-	-	2.7	2.5	2.5				
4	Normal	EPA 5	Low	-	-	-	-2.5	-2.7	-2.9				
		EVA 70	Low	-	-	-	-2.3	-2.5	-2.6				
8	Normal	EPA 5	Low	-	-	-	-6.7	-6.7	-6.7				
		EVA 70	Low	-	-	-	-6.4	-6.5	-6.6				

Table 3-55: Requirements for PUCCH 8.3.6, 16 AN bits, TDD only

Test setup

Fig. 3-131 to Fig. 3-132 show the test setup.

The wanted signal generated by SMW baseband A is split up in two paths. Multipath fading is simulated in the channel simulators, AWGN is added.

For four RX antennas, the test can be done with just one SMW (suitable options required). For eight RX antennas, the test can be also done with just one SMW.

The SMW needs an external trigger at USER3.



Fig. 3-131: Test setup for PUCCH test 8.3.6 for 2 antennas



Fig. 3-132: Test setup for PUCCH test 8.3.6 for 4 antennas with one SMW



Fig. 3-133: Test setup for PUCCH test 8.3.6 for 8 antennas with one SMW

Test Procedure

As an example, the settings for 2 RX antennas, 16 AN bits, normal prefix, EVA 70 Hz and 10 MHz are shown. The ACK is set in every second subframe.

- 1. Set the routing in the SMW to $1 \times 1 \times 2$ (see 3.1.1).
- 2. For the basic LTE steps see section 3.1.2.
- 3. Click Frame Configuration
- 4. Set No of PUCCH Config to 2 (Fig. 3-134)

EUTRA/LTE A: Frame Configuration									
General	Time Plan	Subframe							
		U	E1						
			On						
3G	PP Release	LTE-Ac	lvanced	-					
No. of PU	CCH Config			2					
No. of PU	SCH Config			2					

Fig. 3-134: Set two configurable PUCCH subframes

- 5. Click tab Subframe
- 6. Set for the PUCCH the Format to F3 and the state On (Fig. 3-135)

El	JTRA	LTE A: Fr	ame (onfiguration	1								
	Gen	eral Tir	me Pl	lan Subfr	ame								
	Cell	Index		0		Sub	oframe		0	Prev	Next	0	Сору
(Cycli	c Prefix	Norn	nal		-	Uplink Suk	oframe		0	R	eset Al	l Subfr
		Content	CW	Modulation / Format	Enhanced Settings	Set 1 No. RB	Set 1 Offset VRB	Set 2 No. RB	Set 2 Offset VRB	Offset PRB Slot (n/n+1)	Physical Bits	Power /dB	State (
	UE1	PUCCH	-	F3	Config	1	-	-	-	(0/49)	48	0.000	On
		PUSCH	1/1	QPSK	Config	10	2	-		-		0.000	Off
	1150	DUSCU	1/1	ODEK	Config	10	12					0.000	0#

Fig. 3-135: PUCCH with format F3 in subframe 0

- 7. Click Enhanced Settings Config
- 8. Set the resource index n_PUCCH to 0. (Fig. 3-136)
- 9. Set the Number of Bits to 17 (16 ACK + 1 SR) and the ACK/NACK Pattern to '0000 0000 00000 (Fig. 3-137)

EUTRA/LTE A	UTRA/LTE A: Enhanced Sett. (SF 0)							
Common	Channel Co	oding / Multiplex	ing					
UE/Conte	nt Type		UE	1/ P	UCCH			
PUCCH F	ormat				F3			
n_PUCCH	ł				0			

Fig. 3-136: Set the parameter n_PUCCH to 0

B	UTRA/LTE A	: Enhanced Sett. (PCell, SF 2, UE 1)			×
	Common	Channel Coding / Multiplexing			
		HA	RQACK		
	Number o	f A/N + SR + CSI Bits			17
	A/N + SR	+ CSI Pattern		0 000	0 00
	Number o	of Coded A/N + SR + CSI Bits			0

Fig. 3-137: Set 17 bits ACK pattern to '0000 0000 0000 0000' + '0'

10. Make sure that the PUCCH in the second configurable subframe is not transmitted.(State **Off**) (Fig. 3-138)

UTRA	/LTE A: Fr	rame (Configuration											×
Gen	eral Ti	me Pl	lan Subfr	ame				- 10						
Cell	Index		o		Sub	frame		1	Prev	Next	0	Сору		Paste
Cycli	c Prefix	Norn	nal		÷	Uplink Sub	frame	1	1	R	eset Al	l Subf	rames	
	Content	CW	Modulation / Format	Enhanced Settings	Set 1 No. RB	Set 1 Offset VRB	Set 2 No. RB	Set 2 Offset VRB	Offset PRB Slot (n/n+1)	Physical Bits	Power /dB	State	Conflict	×
UE1	PUCCH		F1	Config	1	-	-	-	-	-	0.000	Off		
	PUSCH	1/1	QPSK	Config	6	0	7.82	-	-	-	0.000	Off		
1150	DUSCU	1/1	ODEK	Config	e	0					0.000	0#		

Fig. 3-138: In the second configurable subframe (subframe #1) the PUCCH is not transmitted (state Off)

AWGN and Fading

- 11. Set Fading according to Table 3-55 (see 3.1.3) (example EVA 70 Hz Low)
- Set noise power and SNR. Take in account the SNR correction factor (see 3.1.4) (example: Noise = -80.5 dBm; SNR = SNR + Correction = 2.7 dB -16.99 dB = -14.29 dB)

Demo program

Fig. 3-139 shows the parameters of the test. When this test is selected, the Duplex mode is switched automatically to TDD. You can select the test in the section **8.3 PUCCH.** Select one test under **8.3.4 - 8.3.5 - 8.3.6 Tests**. The tests are listed by their cyclic prefix and fading profile. When selecting a particular test, all settings are default according to the specification. The setting of the SNR depends on the fading profile and the channel bandwidth. The fading settings are displayed in the section **Fading**. There, also select the correlation matrix (default: Low). The resource index n_PUCCH is set to 0. This example configures a PUCCH with 16 bits of NACK information in every second subframe. **4 Antennas** enables the test for four antennas. **8 Antennas** enables the test for eight antennas.



Fig. 3-139: Parameter for PUCCH test 8.3.6

Fig. 3-140 shows the report.

******* Performance Tests ****** 8.3.6 NAK to ACK Detection for PUCCH Format 3 with 2RX Antennas. Bandwidth: 10 MHz Duplex Mode: TDD UL/DL Configuration: 1 Special Subframe Configuration: 0 Fading: EVA70Hz Low AWGN: -80.5 dBm SNR: 2.7 dB SNR Correction: -16.99 dB ACK/NACK Pattern (16 Bits + SR): '0000 0000 0000 0000 0' Finished!

Fig. 3-140: Report 8.3.6

3.3.7 ACK missed detection for PUCCH format 1a transmission on two antenna ports (Clause 8.3.7)

The test verifies the receivers' performance at detecting ACK under multipath fading conditions for a given SNR. The probability of detection of the ACK shall be equal or greater to 0.99. The probability of false detection of the ACK shall be 0.01 or less. The statistics are kept by the base station under test.

This test is applicable for all categories of BS. It is similar to the test 8.3.1 (see 3.3.1) but uses two antenna ports (UL-MIMO with ports 200 and 201).

For the test one bit of information ACK (\equiv '1') is transmitted in the PUCCH format 1a with following pattern:

ACK ACK • •

Table 3-56, Table 3-57 and Table 3-58 show the test requirements for two, four and eight RX antennas.

Test requirement PUCCH 8.3.7, 2 RX antennas												
Number	Iumber Number Cyclic Propagation Correlation Channel Bandwidth / SNR [dB] (T) (D) (D) (D) (D) (D) (D)											
of TX antennas	of RX antennas	Prefix	Conditions	matrix	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz		
	_	Nerral	EPA 5	Low	-3.8	-4.1	-5.6	-5.7	-5.7	-5.9		
2	2	Normai	EVA 70	Low	-5.0	-5.1	-5.6	-5.1	-5.6	-5.6		

Table 3-56: Test requirements PUCCH test 8.3.7 for 2 RX antennas

Test requirement PUCCH 8.3.7, 4 RX antennas												
Number	Number	Cyclic	Propagation	Correlation	Channel	Bandwid	th / SNR	[dB]				
of TX antennas	of RX antennas	Prefix	Conditions	matrix	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz		
		N	EPA 5	Low	-7.7	-7.7	-8.5	-8.7	-8.7	-8.7		
2	4	Normai	EVA 70	Low	-8.2	-8.4	-8.5	-8.5	-8.6	-8.7		

Table 3-57: Test requirements PUCCH test 8.3.7 for 4 RX antennas

	Test requirement PUCCH 8.3.7, 8 RX antennas													
	Number	Number	Cyclic	Cyclic Propagation Correlation Channel Bandwidth / SNR [dB]										
	of TX antennas	of RX antennas	Prefix	Conditions	matrix	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz			
_				EPA 5	Low	-10.6	-10.7	-11.1	-11.2	-11.1	-11.2			
	2	8	INORMAL	EVA 70	Low	-10.9	-11.0	-11.0	-11.0	-11.0	-11.0			

Table 3-58: Test requirements PUCCH test 8.3.7 for 8 RX antennas

Test setup

Fig. 3-141 to Fig. 3-143 show the test setup.

The wanted signal generated by SMW basebands A and B uses a 2x2 MIMO configuration. Multipath fading is simulated in the channel simulators, AWGN is added.

For four RX antennas, the test can be done with just one SMW (suitable options required) .Here a 2x4 MIMO is applied. For eight RX antennas, the test can be also done with just one SMW. Here a 2x8 MIMO is applied.

The SMW needs an external trigger at USER3.



Fig. 3-141: Test setup for PUCCH test 8.3.7 for 2 antennas



Fig. 3-142: Test setup for PUCCH test 8.3.7 for 4 antennas with one SMW



Fig. 3-143: Test setup for PUCCH test 8.3.7 for 8 antennas with one SMW

Test Procedure

As an example, the settings for two RX antennas, normal prefix, EPA 5 Hz and 10 MHz are shown. The ACK is transmitted in every second subframe.

- 1. Set the **routing** to 1x2x2 (see 3.1.1), thus two baseband blocks are routed to two paths (2x2 MIMO).
- 2. For the basic LTE steps see section 0.
- 3. Click on UE1.



Fig. 3-144: UE1 and No of PUCCH Configuration

4. Enter in tab PUCCH the number of antenna ports, here 2 (Fig. 3-145).

EUTRA/LTE A: User Equipment Configuration (UE1)												
Common	OFRC	ORealtime Feedback	PUSCH	PUCCH	DRS	OSRS	Antenna Port Mapping					
Number Of A	ntenna P	orts For PUCC	CH Forma	t 1/1a/1b		2						
Number Of A	ntenna P	orts For PUCC	CH Forma	t 2/2a/2b		2						
Number Of A	Number Of Antenna Ports For PUCCH Format 3 2											

Fig. 3-145: Number of antenna ports for the different PUCCH formats is 2

5. Check the antenna port mapping (Fig. 3-146)

EUTRA/LTE A: User Equipment Configuration (UE1)												
OCommon	OFRC	ORealtin Feedb	ne ack	PUS	сн	PU	ссн	DR	s	OSRS	Antenna Port Mapping	
	AP 10 PUSCI SRS) AP 20 A H PUSCH PU		P 21 AP 2 JSCH PUC		200 CH	AP 2 PUC	201 CH				
Baseband A												
Baseband B	5						0)				

Fig. 3-146: The antenna port mapping. The PUCCH AP200 is generated by BB A, the AP201 by BB B

- 6. Click Frame Configuration
- 7. Set No of PUCCH Config to 2 (Fig. 3-144)
- 8. Click tab **Subframe**
- 9. Set for the PUCCH the Format to F1a and the state On (Fig. 3-147)

EUTRA	/LTE A: Fr	ame C	onfiguration										_
Gen	eral Tir	ne Pl	an <mark>Subfra</mark>	ame									
Cell I	Index		0		Sub	frame		0	Prev	Next		Сору	
Cycli	c Prefix	Norm	nal		- ı	Jplink Sub	frame		0	Re	eset All	Subf	rames
UE	Content	CW	Modulation / Format	Enhanced Settings	Set 1 No. RB	Set 1 Offset VRB	Set 2 No. RB	Set 2 Offset VRB	Offset PRB Slot (n/n+1)	Physical Bits	Power /dB	State	Conflict
UE1	PUCCH	4	F1a	Config	1	-	9 4 3	-	(49/0)	1	0.000	On	
	PUSCH	1/1	QPSK	Config	10	2	-	-	-	-	0.000	Off	
UE2	PUSCH	1/1	QPSK	Config	10	13	-	-	-		0.000	Off	

Fig. 3-147: PUCCH with format F1a in subframe 0

- 10. Click in column Enhanced Settings Config
- 11. Set the resource index n_PUCCH to 1 and 2. (Fig. 3-148)
- 12. Set the ACK/NACK Pattern (one bit) to '1' (Fig. 3-149)

EUTRA/LTE A: Enhanced Sett. (SF 0)		×
Common Channel Coding / Multiplexing		
UE/Content Type	UE1/P	UCCH
PUCCH Format		F1a
Number Of Used Antenna Ports		2
n_PUCCH Antenna Port 200		1
n_PUCCH Antenna Port 201		2

Fig. 3-148: Set the parameters n_PUCCH to 1 and 2



Fig. 3-149: Set one bit ACK pattern to '1' (ACK)

13. Make sure that the PUCCH in the second configurable subframe is not transmitted. (example: subframe 1 **State Off**) (Fig. 3-150)

EUTRA	'LTE A: Fr	ame C	onfiguration	1									—	×
Gen	eral Ti	me Pl	an Subfr	ame				- 64						
Cell	ndex		0		Sub	frame		1	Prev	Next	0	Сору		Paste
Cycli	c Prefix	Norn	nal		-	Jplink Sub	frame		1	R	eset Al	l Subf	rames	
	Content	CW	Modulation / Format	Enhanced Settings	Set 1 No. RB	Set 1 Offset VRB	Set 2 No. RB	Set 2 Offset VRB	Offset PRB Slot (n/n+1)	Physical Bits	Power /dB	State	Conflict	×
UE1	PUCCH		F1	Config	1	-	-	(-	-	-	0.000	Off		
	PUSCH	1/1	QPSK	Config	6	0	7.80	-	-	-	0.000	Off		
1150	PLISCH	1/1	OPSK	Config	6	0					0.000	Off		

Fig. 3-150: In the second configurable subframe (subframe #1) the PUCCH is not transmitted (state Off)

AWGN and Fading

- 14. Set **Fading** according to Table 3-56, Table 3-57 and Table 3-58(see 3.1.3) (example EPA 5 Hz Low)
- Set noise power and SNR. Take in account the SNR correction factor (see 3.1.4) (example: Noise = -80.5 dBm; SNR = SNR + Correction = -5.7 dB -16.99 dB = -22.69 dB)

Demo Program

Fig. 3-151 shows the parameters of the test. You can select the test in the section **8.3 PUCCH.** Select one test under **8.3.7 ACK missed (2 Tx)**. The tests are listed by their fading profile. When selecting a particular test all settings are default according to the specification. The setting of the SNR depends on the fading profile and the channel bandwidth. The fading settings are displayed in the section **Fading**. There also select the correlation matrix (default: Low). The resource index n_PUCCH for AP200 is set to 1, for AP201 to 2. This example configures a PUCCH with ACK information in every second subframe. **4 Antennas** enables the test for four antennas. **8 Antennas** enables the test for eight antennas.

(8.5) N	B-IoT	Additional Set	ttings								
(8.2) P	USCH	(8.3) PUCCH	(8.4) PRACH	1							
8.3.1	ACK r	nissed (1TX):	Normal, EPA 5	5Hz	Ŧ]					
	4 A	ntennas	8 Antennas								
8.3.2	CQI T	est:	Normal, EVA 5	5Hz	Ţ]					
8.3.4 -	8.3.5	– 8.3.6 Test:	Normal, EVA 7	70H2	Z –]					
	4 A	ntennas	8 Antennas	;	16 Bit						
8.3.7	ACK r	nissed (2TX):	Normal, EPA 5Hz 🗸								
	4 A	ntennas	8 Antennas	;							
8.3.9		est with DTX:	8 Antennas EVA 5Hz	;	2 TX						
8.3.9 8.3.10	CQI TO ACK r	intennas est with DTX: nissed for CE:	8 Antennas EVA 5Hz	• •	2 TX RPTs.						
8.3.9 8.3.10 8.3.11	CQI TO ACK r	intennas est with DTX: nissed for CE: est for CE:	8 Antennas EVA 5Hz 4 4	; ~ ~	2 TX RPTs. RPTs.						
8.3.9 8.3.10 8.3.11 8.3.12	CQI TO ACK TO CQI TO CQI TO PUCC	Intennas est with DTX: nissed for CE: est for CE: H Format 4:	 8 Antennas EVA 5Hz 4 4 Normal, EPA 5 	▼ ▼ ▼ 5Hz	2 TX RPTs. RPTs.						
8.3.9 8.3.10 8.3.11 8.3.12	CQI TO ACK r CQI TO CQI TO PUCC	Intennas est with DTX: nissed for CE: est for CE: H Format 4: Intennas	 8 Antennas EVA 5Hz 4 4 Normal, EPA 5 8 Antennas 	• • • 5Hz	2 TX RPTs. RPTs.	-					
8.3.9 8.3.10 8.3.11 8.3.12 8.3.13	CQI TO ACK TO CQI TO PUCC 4 A PUCC	Intennas est with DTX: nissed for CE: est for CE: H Format 4: ntennas H Format 5:	 8 Antennas EVA 5Hz 4 4 Normal, EPA 5 Normal, EPA 5 	▼ ▼ 5HZ 5HZ	2 TX RPTs. RPTs. 2 PRE	3					

Fig. 3-151: Parameter for PUCCH test 8.3.7

Fig. 3-152 shows the report.

******* Performance Tests *******

8.3.7 ACK missed Detection for PUCCH Format 1A(Two Antenna Ports) with 2RX Antennas.

Bandwidth: 10 MHz Duplex Mode: TDD UL/DL Configuration: 1 Special Subframe Configuration: 0 Fading: EPA5Hz Low AWGN: -80.5 dBm SNR: -5.7 dB SNR Correction: -16.99 dB

ACK/NACK Pattern (One Bit): '1' Finished!

Fig. 3-152: Report 8.3.7

3.3.8 CQI performance requirements for PUCCH format 2 transmission on two antenna ports (Clause 8.3.8)

The test verifies the receivers' performance at CQI detection under multipath fading conditions for a given SNR. The performance is measured by the required SNR at BLER probability of detection equal to 0.99.

The fraction of falsely detected CQIs shall be less than 1% and the fraction of correctly detected CQIs shall be larger than 99%. The statistics are kept by the base station under test.

This test is applicable for all categories of BS. It is similar to the test 8.3.2 (see 3.3.1) but uses two antenna ports (UL-MIMO with ports 200 and 201).

For the test, four bits of information CQI (\equiv '1111') are transmitted in the PUCCH format 2 with following pattern:



Test red	Test requirements 8.3.8												
Number	Number	Cyclic	Propagation	Correlation	Channel Bandwidth / SNR [dB]								
of TX antennas	of RX antennas	Prefix	Conditions	matrix	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz			
2	2	Normal	EVA 5	Low	-4.9	-4.8	-5.1	-5.0	-5.1	-5.1			

Table 3-59: Requirements for PUCCH test 8.3.8.

Test setup

Fig. 3-153 shows the test setup.

The wanted signal generated by SMW basebands A and B uses a 2x2 MIMO configuration. Multipath fading is simulated in the channel simulators, AWGN is added.

The SMW needs an external trigger at USER3.



Fig. 3-153: Test setup for PUCCH test 8.3.8

Test Procedure

As an example the settings for normal prefix, EVA 5 Hz and 10 MHz are shown. The CQI is set in every second subframe.

- 1. Set the **routing** to 1x2x2 (see 3.1.1), thus two baseband blocks are routed to two paths (2x2 MIMO).
- 2. For the basic LTE steps see section 0.
- 3. Click on UE1.

EUTRA/LTE A: Frame Configuration											
General Time Plan	Subframe Sf 0										
	UE1										
	🗸 On										
3GPP Release	LTE-Advanced										
No. of PUCCH Config	. 2										
No. of PUSCH Config	. 2										

Fig. 3-154: UE1 and No of PUCCH Configuration

4. Enter in tab PUCCH the number of antenna ports, here 2 (Fig. 3-155).

EUTRA/LTE A: User Equipment Configuration (UE1)												
Common	OFRC	OSRS	Antenna Port Mapping									
Number Of Antenna Ports For PUCCH Format 1/1a/1b 2												
Number Of A	ntenna P	2										
Number Of A	Antenna P	orts For PUC	CH Forma	ıt 3		2						

Fig. 3-155: Number of antenna ports for the different PUCCH formats is 2

5. Check the antenna port mapping (Fig. 3-156)

E	UTRA/LTE A: U	JTRA/LTE A: User Equipment Configuration (UE1)												
	OCommon	OFRC	ORealtin Feedb	ne ack	PUS	сн	PU	ссн	DR	s	OSRS	Antenna Port Mapping		
		AP 10 PUSCI SRS	AP 20 H PUSCH	AF PU	21 SCH	AP 2 PUC	200 CH	AP 2 PUC	201 CH					
	Baseband A		0			0)							
	Baseband B	3			D			0						

Fig. 3-156: The antenna port mapping. The PUCCH AP200 is generated by BB A, the AP201 by BB B

- 6. Click Frame Configuration
- 7. Set No of PUCCH Config to 2 (Fig. 3-154)
- 8. Click tab Subframe
- 9. Set for the PUCCH the Format to F2 and the state On (Fig. 3-157)

EU'	tra/	LTE A: F	rame C	onfiguration										_
(Gene	eral Ti	ime Pl	an Subfra	ame									
C	ell li	ndex		0		Sub	frame		0	Prev	Next	0	Сору	
С	Cyclic Prefix Normal					- Uplink Subframe 0 Reset All Subfra						rames		
	UE	Content	t CW	Modulation / Format	Enhanced Settings	Set 1 No. RB	Set 1 Offset VRB	Set 2 No. RB	Set 2 Offset VRB	Offset PRB Slot (n/n+1)	Physical Bits	Power /dB	State	Conflict
U	E1	PUCCH	-	F2	Config	1	-	-	- 4	(0/0)	20	0.000	On	
		PUSCH	1/1	QPSK	Config	6	2	-	-		-	0.000	Off	

Fig. 3-157: PUCCH with format F2 in subframe 0

- 10. Click in column Enhanced Settings Config
- 11. Set the resource index n_PUCCH to 1 and 2. (Fig. 3-158)
- 12. Set the Number of CQI bits to '4' and the CQI pattern to '1111' (Fig. 3-159)

E	UTRA/LTE A: Enhanced Sett. (SF 0)	_	×
	Common Channel Coding / Multiplexing		
	UE/Content Type	UE1/P	UCCH
	PUCCH Format		F2
	Number Of Used Antenna Ports		2
	n_PUCCH Antenna Port 200		1
	n_PUCCH Antenna Port 201		2

Fig. 3-158: Set the parameters n_PUCCH to 1 and 2

UTRA/LTE A	: Enhanced Sett. (SF 0)	_	×						
Common	Channel Coding / Mult	iplexing							
c	hannel Quality Control	Information							
Number o	Number of CQI Bits								
Number o	of Coded CQI Bits		20						
CQI Patte	ern	1	111						

Fig. 3-159: Set four bits CQI pattern to '1111'

13. Make sure that the PUCCH in the second configurable subframe is not transmitted. (example: subframe 1 **State Off**) (Fig. 3-160)

EUTRA	/LTE A: Fr	rame (onfiguration	1									_	×
Gen	eral Ti	me Pl	an Subfra	ame										
Cell	Index		0		Sub	oframe		1	Prev 🜔	Next	0	Сору		Paste
Cycli	c Prefix	Norn	nal		-	Uplink Sub	frame		1	R	eset Al	l Subf	rames	
	Content	CW	Modulation / Format	Enhanced Settings	Set 1 No. RB	Set 1 Offset VRB	Set 2 No. RB	Set 2 Offset VRB	Offset PRB Slot (n/n+1)	Physical Bits	Power /dB	State	Conflict	Å
UE1	PUCCH	-	F1	Config	1	-	-	-	-	-	0.000	Off		
	PUSCH	1/1	QPSK	Config	6	0	7. 4 2	-	-	-	0.000	Off		
1152	PUSCH	1/1	OPSK	Config	6	0					0.000	Off		

Fig. 3-160: In the second configurable subframe (subframe #1) the PUCCH is not transmitted (state Off)

AWGN and Fading

- 14. Set Fading according to Table 3-46 (see 3.1.3) (example EVA 5 Hz Low)
- Set noise power and SNR. Take in account the SNR correction factor (see 3.1.4)(example: Noise = -80.5 dBm; SNR = SNR + Correction = - 5.0 dB - 16.99 dB = -21.99 dB)

Demo Program

For this test, no additional parameters have to be set. The setting of the SNR depends on the fading profile and the channel bandwidth. The fading settings are displayed in the section **Fading**. There, also select the correlation matrix (default: Low). The resource index n_PUCCH for AP200 is set to 1, for AP201 to 2. This example configures a PUCCH with CQI information in every second subframe.

Fig. 3-161 shows the report.



Fig. 3-161: Report 8.3.7

3.3.9 CQI performance requirements for PUCCH format 2 with DTX detection (Clause 8.3.9)

This test verifies the receiver's ability to detect CQI under multipath fading propagation conditions for a given SNR. The performance is measured by the required SNR at CQI BLER of 1% and CQI false alarm rate of 10%.[1]

The CQI false alarm probability shall not exceed 10% and the CQI block error probability shall not exceed 1% at the given SNR. The CQI false alarm probability is defined as the conditional probability of false detecting the CQI information transmitted from UE when no CQI information is sent.

The performance requirement of PUCCH format 2 for CQI is determined by the block error probability (BLER) of CQI. The CQI BLER is defined as the sum of the:

- Conditional probability of incorrectly decoding the CQI information when the CQI information is sent and
- Conditional probability of detecting UE transmission as DTX, when the CQI information is sent.

For the test, four bits of information CQI (\equiv '1111') are transmitted in the PUCCH format 2 with following pattern. The statistics number of incorrectly decoded CQI and the number of incorrectly detected DTX are kept.

CQI	CQI	CQI
-----	-----	-----

Test requirements 8.3.9											
Number	Number	Cyclic	Propagation	Correlation	Channel E	Bandwidth	/ SNR [de	3]			
of TX antennas	of RX antennas	Prefix	Conditions	matrix	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz	
	_		EVA 5*	Low	-3.1	-3.4	-3.8	-3.4	-3.6	-3.6	
1	2 No	2 Normal	ETU 70**	Low	-3.1	-3.4	-3.1	-3.5	-3.3	-3.5	
2	2		EVA 5	Low	-4.5	-4.4	-4.7	-4.6	-4.5	-4.7	

Note*: Only applicable for Local Area base station and Home base station

Note**: Only applicable for Wide Area base station and Medium Range base station

Table 3-60: Requirements for PUCCH test 8.3.9.

Test setup

Fig. 3-162 shows the test setup for one Tx antenna. The wanted signal generated by SMW baseband A is split up in two paths.

Fig. 3-163 shows the test setup for two Tx antennas. The wanted signal generated by SMW basebands A and B uses a 2x2 MIMO configuration.

For both setups, multipath fading is simulated in the channel simulators, AWGN is added. The SMW needs an external trigger at USER3.



Fig. 3-162: Test setup for PUCCH test 8.3.9 for one Tx antenna



Fig. 3-163: Test setup for PUCCH test 8.3.9 for two Tx antennas

Test Procedure:

As an example, the settings for 2 TX antennas, normal prefix, EVA 5 Hz and 10 MHz are shown. The CQI is set in every second subframe.

- 1. Set the **routing** to 1x2x2 (see 3.1.1), thus two baseband blocks are routed to two paths (2x2 MIMO).
- 2. For the basic LTE steps, see section 0.
- 3. Click on UE1.
- 4. Enter in tab PUCCH the Number of Antenna Ports, here 2 (Fig. 3-164).
- 5. Check the antenna port mapping (Fig. 3-165).

EUTRA/LTE A: User Equipment Configuration (UE1)										
Common	non OFRC ORealtime PUSCH PUCCH DRS OSRS Antenna Por Mapping									
Number Of Antenna Ports For PUCCH Format 1/1a/1b							2			
Number Of Antenna Ports For PUCCH Format 2/2a/2b							2			
Number Of A	Antenna P	orts For PUC	CH Forma	it 3		2				

Fig. 3-164: Number of antenna ports for the different PUCCH formats is 2

EUTRA/LTE A: U	lser Equipn	nent Configu	iratio	on (UE	1)						
Common			ne ack	PUS	сн	PU	ссн	DR	s	OSRS	Antenna Port Mapping
	AP 10 PUSC SRS) AP 20 H PUSCH	AF PU	21 SCH	AP PUC	200 CCH	AP 2 PUC	201 CH			
Baseband A		0									
Baseband B	3			D							

Fig. 3-165: The antenna port mapping. The PUCCH AP200 is generated by BB A, the AP201 by BB B

- 6. Click Frame Configuration.
- 7. Set No of PUCCH Config to 2 (Fig. 3-166).



Fig. 3-166: UE1 and No of PUCCH Configuration

- 8. Click tab Subframe.
- 9. Set for the PUCCH the Format to F2 and the state On (Fig. 3-167).

EUTRA/	LTE A: Fr	ame C	onfiguration	lê.									_
Gene	eral Tir	ne Pla	an Subfra	ame									
Cell I	ndex		0		Sub	frame		0	Prev C	Next	0	Сору	
Cyclic	: Prefix	Norm	nal		- ı	Jplink Sub	frame		0	Re	eset Al	Subf	rames
UE	Content	cw	Modulation / Format	Enhanced Settings	Set 1 No. RB	Set 1 Offset VRB	Set 2 No. RB	Set 2 Offset VRB	Offset PRB Slot (n/n+1)	Physical Bits	Power /dB	State	Conflict
UE1	PUCCH	-	F2	Config	1	-	-	- 2	(0/0)	20	0.000	On	
	-					1.1			and the second	Section 1		~ ~	

Fig. 3-167: PUCCH with format F2 in subframe 0

10. Click in column Enhanced Settings Config

11. Set the resource index **n_PUCCH** to 1 and 2 (Fig. 3-168).

EUTRA/LTE A: Enhanced Sett. (SF 0)	_	×
Common Channel Coding / Multiplexing		
UE/Content Type	UE1/P	UCCH
PUCCH Format		F2
Number Of Used Antenna Ports		2
n_PUCCH Antenna Port 200		1
n_PUCCH Antenna Port 201		2

Fig. 3-168: Set the parameters n_PUCCH to 1 and 2

12. Set the Number of CQI bits to 4 and the CQI pattern to 1111 (Fig. 3-169).

EUTRA/LTE A	_	×				
Common	Channel Coding / Multiple	xing				
c	hannel Quality Control Info	rmation				
Number o	Number of CQI Bits					
Number o	Number of Coded CQI Bits					
CQI Patte	ern		1111			


- EUTRA/LTE A: Frame Configuration × Subframe General Time Plan Cell Index 0 Subframe Prev Next Copy Paste Cyclic Prefix Normal **Uplink Subframe** Reset All Subframes 1
 Modulation /
 Enhanced
 Set 1
 Set 1
 Set 2
 Set 2
 Offset PRB

 Format
 Settings
 No. RB
 Offset VRB
 No. RB
 Offset VRB
 Slot (n/n+1)
 Physical Power Bits /dB Content CW State Conflict UE1 PUCCH F1 Config 0.000 Off 1 QPSK PUSCH 1/1 Config 6 0 0 000 Off Confic OPEL
- 13. Make sure that the PUCCH in the second configurable subframe is not transmitted (example: subframe 1 **State Off**) (Fig. 3-170).

Fig. 3-170: In the second configurable subframe (subframe #1) the PUCCH is not transmitted (state Off)

AWGN and Fading

- 14. Set Fading according to Table 3-60 (see 3.1.3)
- 15. Set noise power and SNR. Take in account the SNR correction factor (see 3.1.4)(example: Noise = -80.5 dBm; SNR = SNR + Correction = -4.6 dB -16.99 dB = -21.59 dB)

Demo Program

Fig. 3-171 shows the parameters of the test. You can select the test in the section 8.3 PUCCH. Select one test under 8.3.9 CQI F2 DTX. The tests are listed by their fading profile. When selecting a particular test all settings are default according to the specification. The setting of the SNR depends on the fading profile and the channel bandwidth. The fading settings are displayed in the section Fading. There also select the correlation matrix (default: Low). The resource index n_PUCCH for AP200 is set to 1, for AP201 to 2. This example configures a PUCCH with ACK information in every second subframe. 4 Antennas enables the test for four antennas. 8 Antennas enables the test for eight antennas. To use one single SMW, mark the basic Use 1 SMW for 4/8 antenna tests and 8.3.3. The test is performed with 1Tx antenna by default. Enable 2 Tx Antennas to use two Tx Antennas.

(8.5) N	B-loT	Additional Se	ttings				
(8.2) P	USCH	(8.3) PUCCH	(8.4) PRACH	ł			
8.3.1	ACK n	nissed (1TX):	Normal, EPA	5Hz			y)
	4 A	ntennas	8 Antennas	;			
8.3.2		est:	Normal, EVA	5Hz			-
8.3.4 -	8.3.5	– 8.3.6 Test:	Normal, EVA	70H	Z		Ŧ
	4 A	ntennas	8 Antennas	;		16 E	Bit
8.3.7	ACK r	nissed (2TX):	Normal, EPA	5Hz			-
	_ 4 A	ntennas	8 Antennas	;			
8.3.9	CQI T	est with DTX:	8 Antennas	; •		2 T)	x
8.3.9 8.3.10	4 A CQI T ACK r	ntennas est with DTX: nissed for CE:	8 Antennas EVA 5Hz 4	; •	E :	2 T) Ts.	x
<mark>8.3.9</mark> 8.3.10 8.3.11	ACK r	intennas est with DTX: nissed for CE: est for CE:	8 Antennas EVA 5Hz 4 4	• • •	RP ²	2 T) Ts. Ts.	x
8.3.9 8.3.10 8.3.11 8.3.12	ACK r CQI T CQI T CQI T PUCC	est with DTX: nissed for CE: est for CE: H Format 4:	8 Antennas EVA 5Hz 4 4 Normal, EPA 8	▼ ▼ ▼ 5Hz	RP RP	2 T) Ts. Ts.	×
8.3.9 8.3.10 8.3.11 8.3.12	ACK r CQI T CQI T CQI T PUCC	est with DTX: nissed for CE: est for CE: H Format 4: ntennas	8 Antennas EVA 5Hz 4 4 Normal, EPA 8 8 Antennas	▼ ▼ 5Hz	RP RP	2 T) Ts. Ts. 2 Pf	x RB
8.3.9 8.3.10 8.3.11 8.3.12 8.3.13	ACK r CQI T CQI T PUCC 4 A	est with DTX: nissed for CE: est for CE: H Format 4: ntennas	8 Antennas EVA 5Hz 4 4 Normal, EPA 8 Normal, EPA 8	▼ ▼ 5Hz 5Hz	RP RP	2 T) Ts. Ts. 2 Pf	x RB

Fig. 3-171: Parameter for PUCCH test 8.3.9

Fig. 3-172 shows the report.

******* Performance Tests *******

8.3.9 CQI for PUCCH Format 2 with DTX Detection with 1TX Antenna.

Bandwidth: 10 MHz Duplex Mode: FDD Fading: EVA5Hz Low AWGN: -80.5 dBm SNR: -3.4 dB SNR Correction: -16.99 dB

CQI Pattern (4 Bits): '1111' Finished!

Fig. 3-172: Report 8.3.9

3.3.10 ACK missed detection for PUCCH format 1a transmission on single antenna port for coverage enhancement (Clause 8.3.10)

The test verifies the receivers' performance at detecting ACK under multipath fading conditions for a given SNR. The probability of detection of the ACK shall be equal or greater to 0.99. The probability of false detection of the ACK shall be 0.01 or less. The statistics are kept by the base station under test.

This test is applicable for BS supporting coverage enhancement.

For the test one bit of information ACK (\equiv '1') is transmitted in the PUCCH format 1a with following pattern:



Table 3-61 shows the test requirements.

Test req	Test requirement PUCCH 8.3.10, 2 RX antennas								
	Propagatio			Channel Bandwidth / SNR [dB]					
Cyclic Prefix	n Conditions	Correlation matrix	Repetitions	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz	
			4	-4.6	-4.9	-4.9	-5.0	-4.9	
Normal	EPA 5	Low	8	-8.6	-10.4	-10.3	-10.5	-10.7	
			32	-13.1	-14.2	-14.5	-14.5	-14.5	

Table 3-61: Test requirements PUCCH test 8.3.10 for 2 RX antennas

The hopping interval is 4 for FDD and 10 for TDD.

To generate a test pattern with 50% transmission and 50% gap, the SMW uses following numbers of frames to ensure a continuous pattern in the ARB of the SMW:

Transmission and frames for FDD							
Repetition	Subframes for transmission and gap	Number of transmissions	Number of frames				
4	8	5	4				
8	16	5	8				
32	64	5	32				

Table 3-62: Transmission and frames FDD

As for TDD there is no Uplink/Downlink configuration mentioned, configuration 2 is used.

Transmission and frames for TDD, DL/UL configuration 2						
Repetition	Number of transmissions	Number of frames				
4	1	4				
8	1	8				
32	1	32				

Table 3-63: Transmission and frames TDD, DL/UL configuration 2

Test setup

Fig. 3-173 shows the test setup.

The wanted signal generated by SMW baseband A is split up in two paths. Multipath fading is simulated in the channel simulators, AWGN is added.

The SMW needs an external trigger at USER3.



Fig. 3-173: Test setup for PUCCH test 8.3.10

Test Procedure

As an example, the settings for two RX antennas, normal prefix, EPA 5 Hz, 10 MHz and 32 repetitions are shown.

- 1. Set the **routing** to 1x1x2 (see 3.1.1), thus one baseband block is routed to two paths.
- 2. For the basic LTE steps see section 3.1.2.
- 3. Click Frame Configuration
- 4. Set UE1o to eMTC (Fig. 3-84).

EUTRA/LTE A: UL Frame Configuration							
General Time	Plan Subfr	rame					
		UE1	١				
		V On					
3GPP Re	elease	eMTC	•				
No. of PUCCH C	Config.						
No. of PUSCH C	Config.						

Fig. 3-174: UE1 transmits eMTC

- 5. Click UE1.
- 6. Set **Content** to **PUCCH Format F1a** and the **Repetition** (example 32) (Fig. 3-85). Please note that the available repetitions depend on the CE Level.
- To generate the test pattern, create 5 Transmissions. Set the Start Subfr increasing by Subframes transmission and gap of Table 3-95 (Example: 32 (0, 64, 128, 192, 256)).

UTRA	/LTE A: Use	er Equipment (Configuration	(UE1)						_	-	×
Oc	ommon (⊖ <mark>Realtime</mark> Feedbacl	PUCCH	PUSCH	DRS	eMTC Allocation						
CE L	evel		2,3				Numbe	er of Nar	rowband	ls		8
Narro	wband H	opping Inter	val 4			- Subframes	Numbe	er of Tra	nsmissio	ons		5
	Content	Modulation Format	Enhanced Settings	Start Subframe	Repeti- tions	No. Absolute Subframes	Start Narrowband	No. RB	Offset VRB	Power /dB		
2	PUCCH	F1a	Config	64	32	32		1	-	0.000		
3	PUCCH	F1a	Config	128	32	32	-	1	-	0.000		
4	PUCCH	F1a	Config	192	32	32	-	1	-	0.000		
5	PUCCH	F1a	Config	256	32	32	-	1	-	0.000		
					ARB Se	quence Lengti	n					
Sug	gested	29 Cu	irrent	32 Frame	s -	Adjust I	ength		ARB	Settings.		

Fig. 3-175: Five transmissions of NPUSCH format 2 to generate the wanted pattern

8. Click in every transmission on **Enhanced Settings Config...** to set the **ACK/NACK Pattern** to '1'.

EUTRA/LTE A: Enhanced Sett. (PCell, Transmission 3, UE 1)				
Common Channel Coding / Multiplexin	la l			
Number of A/N Bits		1		
ACK/NACK Pattern		1		
Number of Coded A/N Bits		16		

Click ARB Settings to set the Sequence Length to Number of frames in Table 3-95 (Example: '32')

EUTRA/LTE	: Filter/Clipping/	/ARB/TD\	N/Power Setting	S	_	×
Filter		ARB	O Time Do Window	omain ing	Power	
Sequen	ce Length		32	Fram	es	

Fig. 3-176: 32 frames to generate the pattern continuously

10. Switch On EUTRA/LTE A.

AWGN and Fading

- 11. Set Fading according to EPA 5 Hz Low (see 3.1.3)
- Set noise power and SNR. Take in account the SNR correction factor (see 3.1.4)(example: Noise = -80.5 dBm; SNR = SNR + Correction = -14.5 dB -16.99 dB = -31.49 dB)

Demo Program

Fig. 3-177 shows the parameters of the test. You can select the test in the tabulator **8.3 PUCCH.** Select one test under **8.3.10 ACK missed for CE**. The tests are listed by their repetition. When selecting a particular test, all settings are default according to the specification. The fading settings are displayed in the section **Fading**. There also select the correlation matrix (default: Low). This example configures a PUCCH with a ration of PUCCH transmission with ACK information to no PUCCH transmission of 50:50.

((8.5) N	B-loT	Additional Set	tings	
((8.2) P	USCH	(8.3) PUCCH	(8.4) PRACH	
	8.3.1	ACK n	nissed (1TX):	Normal, EPA 5Hz	· · ·
l		4 A	ntennas	8 Antennas	
	8.3.2	CQI T	est:	Normal, EVA 5Hz	· · ·
	8.3.4 –	8.3.5	– 8.3.6 Test:	Normal, EPA 5Hz	· · ·
l		4 A	ntennas	8 Antennas	16 Bit
	8.3.7	ACK n	nissed (2TX):	Normal, EPA 5Hz	· · · ·
l		4 A	ntennas	8 Antennas	
	8.3.9	CQI T	est with DTX:	EVA 5Hz 🔹	2 TX
ł	8.3.10	ACK n	nissed for CE:	4 🔹	RPTs.
	8.3.11	CQI T	est for CE:	4 8	RPTs.
4	8.3.12	PUCC	H Format 4:	32	· · · ·
l		4 A	ntennas	8 Antennas	2 PRB
	8.3.13	PLICC	H Format 5:	Normal EDA 5Hz	
	0.0.10	1000	arri ornat o.	Normal, LFA JHZ	· · · · · · .

Fig. 3-177: Parameter for PUCCH test 8.3.10

Fig. 3-178 shows the report.

******* Performance Tests *******

8.3.10 ACK missed Detection for PUCCH Format 1A Transmission on Single Antenna Port for Coverage Enhancement with 4 Repetitions.

Bandwidth: 10 MHz Duplex Mode: FDD Fading: EPA5Hz Low AWGN: -83.5 dBm SNR: -4.9 dB SNR Correction: -16.99 dB

ACK/NACK Pattern (One Bit): '1' Finished!

Fig. 3-178: Report 8.3.10

3.3.11 CQI performance requirements for PUCCH format 2 transmission on single antenna port for coverage enhancement (Clause 8.3.11)

The test verifies the receivers' performance at detecting CQI under multipath fading conditions for a given SNR. The performance measured by the BLER shall be less 1%. The statistics are kept by the base station under test.

This test is applicable for BS supporting coverage enhancement.

For the test four bits of information CQI (\equiv '1111') are transmitted in the PUCCH format 2 with following pattern:



Table 3-61 shows the test requirements.

Test req	Test requirement PUCCH 8.3.11, 2 RX antennas							
Cyclic	Cyclic Propagatio	Correlation	Repetitions	Channel Bandwidth / SNR [dB]				
Prefix	n Conditions	matrix		3 MHz	5 MHz	10 MHz	15 MHz	20 MHz
Normal	EVA 5		4	-3.5	-4.4	-4.5	-4.3	-4.1
	Low	Low	8	-9.2	-9.7	-9.4	-9.5	-9.4
		32	-13.1	-13.5	-13.2	-13.4	-13.3	

Table 3-64: Test requirements PUCCH test 8.3.10 for 2 RX antennas

The hopping interval is 4 for FDD and 10 for TDD.

To generate a test pattern with 50% transmission and 50% gap, the SMW uses following numbers of frames to ensure a continuous pattern in the ARB of the SMW:

Transmission and frames									
Repetition	Subframes for transmission and gap	Number of transmissions	Number of frames						
4	8	5	4						
8	16	5	8						
32	64	5	32						

Table 3-65: Transmission and frames

As for TDD there is no Uplink/Downlink configuration mentioned, configuration 2 is used.

Transmission and frames for TDD, DL/UL configuration 2						
Repetition	Number of transmissions	Number of frames				
4	1	4				
8	1	8				
32	1	32				

Table 3-66: Transmission and frames TDD, DL/UL configuration

Test setup

Fig. 3-173 shows the test setup.

The wanted signal generated by SMW baseband A is split up in two paths. Multipath fading is simulated in the channel simulators, AWGN is added.

The SMW needs an external trigger at USER3.



Fig. 3-179: Test setup for PUCCH test 8.3.11

Test Procedure

As an example, the settings for two RX antennas, normal prefix, EVA 5 Hz, 10 MHz and 4 repetitions are shown.

- 1. Set the **routing** to 1x1x2 (see 3.1.1), thus one baseband block is routed to two paths.
- 2. For the basic LTE steps see section 3.1.2.
- 3. Click Frame Configuration
- 4. Set UE1o to eMTC (Fig. 3-84).

EUTRA/LTE A: UL Frame Configuration											
$\frac{\text{General}}{\text{General}} \text{Time Plan} \left[\begin{array}{c} S \\ S \end{array} \right]$	Subframe										
	UE1										
	🗸 On										
3GPP Release	eMTC ·										
No. of PUCCH Config.											
No. of PUSCH Config.											

Fig. 3-180: UE1 transmits eMTC

- 5. Click UE1 and set the **CE Level** to **2,3**.
- 6. Set **Content** to **PUCCH** and **Modulation Format** to **F2** and the repetition (example 32) (Fig. 3-85).
- To generate the test pattern, create 5 Transmissions. Set the Start Subfr increasing by Subframes transmission and gap of Table 3-95 (Example: 4 (0, 8, 16, 24, 32)).

EUTR	UTRA/LTE A: User Equipment Configuration (UE1)												
					DRS	eMTC Allocation							
CE Level 2,3							•	• Number of Narrowbands 8					
Narrowband Hopping Interval 4 - Subframes Number of Transmissio									ons	5			
		Content	Modulation Format	Enhanced Settings	Start Subframe	Repeti- tions	No. Absolute Subframes	Start Narrowband	No. RB	Offset VRB	Power /dB		
2	2	РИССН	F2	Config	8	4	4	. .	1	-	0.000		
3	5	РИССН	F2	Config	16	4	4	-	1		0.000		
4	ļ.	риссн	F2	Config	24	4	4	-	1		0.000		
5	5	риссн	F2	Config	32	4	4	-	1	-	0.000		
					•	ARB Se	quence Lengt	n ———					
Suggested 4 Current 4 Frames Adjust Length ARB Settings													

Fig. 3-181: Five transmissions of NPUSCH format 2 to generate the wanted pattern

8. Click in every transmission on **Enhanced Settings Config...** to set the **CQI Pattern** to '1111'.

E	UTRA/LTE A: Enhanced Sett. (PCell, Transmi		×						
	Common Channel Coding / Multiplexi	ing							
1	Channel Qu	ality Control Information							
	Number of CQI Bits	4							
	CQI Pattern	1111							
	Number of Coded CQI Bits			20					

- Click ARB Settings to set the Sequence Length to Number of frames in Table 3-95 (Example: '4')
- 10. Switch On EUTRA/LTE A.

AWGN and Fading

- 11. Set Fading according to EVA 5 Hz Low (see 3.1.3)
- Set noise power and SNR. Take in account the SNR correction factor (see 3.1.4)(example: Noise = -80.5 dBm; SNR = SNR + Correction = -13.2 dB -16.99 dB = -30.19 dB)

Demo Program

Fig. 3-182 shows the parameters of the test. You can select the test in the tabulator 8.3 PUCCH. Select one test under 8.3.11 CQI Test for CE. The tests are listed by their repetition. When selecting a particular test, all settings are default according to the specification. The fading settings are displayed in the section Fading. There also select the correlation matrix (default: Low). This example configures a PUCCH with a ration of PUCCH transmission with CQI information to no PUCCH transmission of 50:50.

(8.5) N (8.2) P	B-IoT USCH	Additional Set (8.3) PUCCH	(8.4) PRACH								
8.3.1	ACK r	nissed (1TX):	Normal, EPA 5Hz	-							
	4 A	ntennas	8 Antennas								
8.3.2	CQI T	est:	Normal, EVA 5Hz 👻								
8.3.4 -	8.3.5	– 8.3.6 Test:	Normal, EPA 5Hz	-							
	_ 4 A	ntennas	8 Antennas 16 Bit								
8.3.7	ACK r	nissed (2TX):	Normal, EPA 5Hz	-							
	4 A	ntennas	8 Antennas								
8.3.9	CQI T	est with DTX:	EVA 5Hz 👻	2 TX							
8.3.10	ACK r	nissed for CE:	4 - R	PTs.							
8.3.11	CQI T	est for CE:	4 • R	PTs							
8.3.12	PUCC	H Format 4:	4 8	-							
	4 A	ntennas	32	2 FRB							
8.3.13	PUCC	H Format 5:	Normal, EPA 5Hz	-							
	4 A	ntennas	8 Antennas								

Fig. 3-183 shows the report.

******* Performance Tests *******

8.3.11 CQI Performance Requirements for PUCCH Format 2 Transmission on Single Antenna Port for Coverage Enhancement with 4 Repetitions.

Bandwidth: 10 MHz Duplex Mode: FDD Fading: EVA5Hz Low AWGN: -83.5 dBm SNR: -4.5 dB SNR: Correction: -16.99 dB

CQI Pattern (4 Bits): '1111' Finished!

Fig. 3-183: Report 8.3.11

3.3.12 ACK missed detection for PUCCH format 4 (Clause 8.3.12)

The test verifies the receivers' performance at detecting ACK in PUSCH format 4 under multipath fading conditions for a given SNR. The probability of detection of the ACK shall be equal or greater to 0.99. The probability of false detection of the ACK shall be 0.01 or less. The statistics are kept by the base station under test.

This test is applicable to all BS.

For the test 24 bits (with 1 PRB) or 64 bits (for 2 PRB) of information ACK (\equiv 'All 1') are transmitted in the PUCCH format 4.

Table 3-67 and Table 3-68 show the test requirements for two, four and eight RX antennas.

Fig. 3-182: Parameter for PUCCH test 8.3.11

Test rec	quiremer	nt PUCCH 8.	.3.12 with ⁻	1 PRB									
Number	Cyclic	Propagation Conditions	Correlation matrix	Channel Bandwidth / SNR [dB]									
of RX antennas	Prefix			1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz				
2	Normal	EPA 5	Low	-	-	-	1.8	1.7	1.6				
		EVA 70	Low	-	-	-	2.0	1.8	1.8				
4	Normal EF	EPA 5	Low	-	-	-	-2.4	-2.2	-2.3				
		EVA 70	Low	-	-	-	2.0	-2.4	-2.4				
8	Normal	EPA 5	Low	-	-	-	-5.5	-5.5	-5.5				
		EVA 70	Low	-	-	-	-5.4	-5.4	-5.5				

Table 3-67: Test requirements PUCCH test 8.3.12 with 1 PRB

Number	Cyclic	Propagation Conditions	Correlation	Channel Bandwidth / SNR [dB]							
of RX antennas	Prefix		matrix	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz		
2	Normal	EPA 5	Low	-	-	-	2.3	2.1	2.1		
		EVA 70	Low	-	-	-	2.7	2.6	2.5		
4	Normal	EPA 5	Low	-	-	-	-2.4	-2.3	-2.3		
		EVA 70	Low	-	-	-	-1.9	-2.1	-2.1		
8	Normal	EPA 5	Low	-	-	-	-5.7	-5.6	-5.8		
		EVA 70	Low	-	-	-	-5.4	-5.6	-5.6		

Table 3-68: Test requirements PUCCH test 8.3.12 with 2 PRB

Test setup

Fig. 3-173 shows the test setup.

The wanted signal generated by SMW baseband A is split up in two, four or eight paths. Multipath fading is simulated in the channel simulators, AWGN is added.

The SMW needs an external trigger at USER3.







Fig. 3-185: Test setup for PUCCH test 8.3.12 for 4 antennas with one SMW



Fig. 3-186: Test setup for PUCCH test 8.3.12 for 8 antennas with one SMW

Test Procedure

As an example, the settings for two RX antennas, normal prefix, EPA 5 Hz, 10 MHz and 2 PRB are shown.

- 1. Set the **routing** to 1x1x2 (see 3.1.1), thus one baseband block is routed to two paths.
- 2. For the basic LTE steps see section 3.1.2.
- 3. Click Frame Configuration

4. Set UE10 to LTE-Advanced and No. of PUCCH Config to 2 (Fig. 3-84).

EUTRA/LTE A: UL Frame Co	nfiguration						
General Time Plan	Subframe						
	UE1						
	🗸 On						
3GPP Release	LTE-Advanced						
No. of PUCCH Config.	2						
No. of PUSCH Config.	1						

Fig. 3-187: UE1

- 5. Click on tab **Subframe**.
- 6. Set Modulation/Format in the row PUCCH F4 and the State ON (Fig. 3-85).

EUTRA/	LTE A: UL	_ Fram	e Configura	tion									—
Gene	eral Tim	ne Pla	n <mark>Subfran</mark> Sf 0	ne									
Cell	Cell PCell - Sub							0	Prev	Next		Сору	
Cyclic	Cyclic Prefix Normal						Subfra	me	0	Reset	All Su	bfram	ies
UE	Content	CW	Modulation / Format	Enhanced Settings	Set 1 No. RB	Set 1 Offset VRB	Set 2 No. RB	Set 2 Offset VRB	Offset PRB Slot (n/n+1)	Physical Bits	Power /dB	State	Conflict
UE1	PUCCH	-	F4	Config	1	-	-	-	(0/49)	288	0.000	On	
	PUSCH	1/1	QPSK	Config	10	2	-	-	-	-	0.000	Off	

Fig. 3-188: PUCCH format 4

- 7. Click Enhanced Settings Config in the row PUCCH.
- 8. Set **M_RB** (example: **2**) and in the tab Channel Coding Multiplexing the Number of Bit (example 64) and all bits to '1111.....'.

EUTRA/LTE A: Enhanced Sett. (PCell, SF 0,	UE 1)		_	×
Common Channel Coding / Multiple	exing DRS			
UE/Content Type		PCell/SF 0	/UE1/P	иссн
PUCCH Format	F4			•
Number Of Used Antenna Ports				1
n_PUCCH Antenna Port 100				0
M_RB	2			



EUTRA/LTE A: Enhanced Sett. (PCell, SF 0, UE 1)			_	×
Common Channel Coding / Multiplexing	DRS			
HA	-			
Number of A/N + SR + CSI Bits				64
A/N + SR + CSI Pattern		1111 1111 1111 1111 1111 1111	1111 1: 1111 1:	111 111
Number of Coded A/N + SR + CSI Bits	1111 1111 1111 1111 1111	111		

Fig. 3-190: 64 ACK bits

9. To generate the test pattern, disable the PUCCH transmission in subframe 1.

	EUTRA/LTE A: UL Frame Configuration													_
General Time Plan Subframe														
	Cell PCell - Subf					frame		1	Prev 💽	Next		Сору		
	Cyclic Prefix Normal				Uplink Subframe 1 Reset All Subframes							es		
	UE	Content	CW	Modulation / Format	Enhanced Settings	Set 1 No. RB	Set 1 Offset VRB	Set 2 No. RB	Set 2 Offset VRB	Offset PRB Slot (n/n+1)	Physical Bits	Power /dB	State	Conflict
	UE1	PUCCH	-	F4	Config	1	-	-	-		===	0.000	Off	
		PUSCH	1/1	QPSK	Config	10	2	-	-	8	-	0.000	Off	

Fig. 3-191: In the second configurable subframe (subframe #1) the PUCCH is not transmitted (state Off)

- 10. Switch On EUTRA/LTE A.
- 11. The SMW shows the correct settings in the time plan.



Fig. 3-192: Timeplan 8.3.12

AWGN and Fading

- 12. Set Fading according to EPA 5 Hz Low (see 3.1.3)
- Set noise power and SNR. Take in account the SNR correction factor (see 3.1.4)(example: Noise = -80.5 dBm; SNR = SNR + Correction = 1.8 dB -13.98 dB = -12.18 dB)

Demo Program

Fig. 3-193 shows the parameters of the test. You can select the test in the tabulator 8.3 PUCCH. Select one test under 8.3.12 PUCCH Format 4. The tests are listed by their cyclic prefix and fading profile. When selecting a particular test, all settings are default according to the specification. The setting of the SNR depends on the fading profile and the channel bandwidth. The fading settings are displayed in the section Fading. There, also select the correlation matrix (default: Low). This example configures a PUCCH with a ration of PUCCH transmission with ACK information to no PUCCH transmission of 50:50. 4 Antennas enables the test for four antennas. 8 Antennas enables the test for eight antennas. Check 2 PRB to transmit 64 bits.

(8.5) N (8.2) P	B-IoT USCH	Additional Set (8.3) PUCCH	ttings (8.4) PRA	СН	
8.3.1	ACK m	issed (1TX):	Normal, EP	A 5Hz	
	4 A	ntennas	8 Antenn	as	
8.3.2	CQI Te	est:	Normal, EV	A 5Hz	. –
8.3.4 -	- 8.3.5 -	- 8.3.6 Test:	Normal, EP	A 5Hz	
	4 A	ntennas	8 Antenn	as	16 Bit
8.3.7	ACK m	issed (2TX):	Normal, EP	A 5Hz	. v
	4 A	ntennas	8 Antenn	as	
8.3.9	CQI Te	st with DTX:	EVA 5Hz	-	2 TX
8.3.10	ACK m	issed for CE:	4	-	RPTs.
8.3.11	CQI Te	st for CE:	4	-	RPTs.
8.3.12	PUCC	H Format 4:	Normal, EP	A 5Hz	. •]
	🗖 4 A	ntennas	🔲 8 Antenn	as	🗌 2 PRB
8.3.13	PUCC	H Format 5:	Normal, EP	A 5Hz	
	1 4	atonnas	8 Antenn	as	

Fig. 3-193: Parameter for PUCCH test 8.3.12

Fig. 3-194 shows the report.

****** Performance Tests ****** 8.3.12 ACK missed Detection for PUCCH Format 4 with 1 PRB and 2RX Antennas. Bandwidth: 10 MHz Duplex Mode: FDD Fading: EPA5Hz Low AWGN: -83.5 dBm SNR: 1.8 dB SNR Correction: -16.99 dB A/N + SR + CSI Pattern (24 Bits): '1111 1111 1111 1111 1111 1111 Finished!

Fig. 3-194: Report 8.3.12

3.3.13 ACK missed detection for PUCCH format 5 (Clause 8.3.13)

The test verifies the receivers' performance at detecting ACK in PUCCH format 5 under multipath fading conditions for a given SNR. The probability of detection of the ACK shall be equal or greater to 0.99. The probability of false detection of the ACK shall be 0.01 or less. The statistics are kept by the base station under test.

This test is applicable to all BS.

For the test 24 bits of information ACK (\equiv 'All 1') are transmitted in the PUCCH format 5.

Test red	Test requirement PUCCH 8.3.13											
Number	Cyclic	Propagation	Correlation	Channel Bandwidth / SNR [dB]								
of RX antennas	Prefix	Conditions	matrix	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz			
2	Normal EPA 5		Low	-	-	-	2.2	1.9	1.9			
		EVA 70	Low	-	-	-	2.2	2.1	2.1			
4	Normal	EPA 5	Low	-	-	-	-2.3	-2.2	-2.2			
		EVA 70	Low	-	-	-	-1.9	-2.2	-2.1			
8	Normal	EPA 5	Low	-	-	-	-5.4	-5.3	-5.4			
		EVA 70	Low	-	-	-	-5.2	-5.3	-5.4			

Table 3-61 shows the test requirements for two, four and eight RX antennas.

Table 3-69: Test requirements PUCCH test 8.3.13

Test setup

Fig. 3-173 shows the test setup.

The wanted signal generated by SMW baseband A is split up in two, four or eight paths. Multipath fading is simulated in the channel simulators, AWGN is added.

The SMW needs an external trigger at USER3.



Fig. 3-195: Test setup for PUCCH test 8.3.13



Fig. 3-196: Test setup for PUCCH test 8.3.13 for 4 antennas with one SMW



Fig. 3-197: Test setup for PUCCH test 8.3.13 for 8 antennas with one SMW

Test Procedure

As an example, the settings for two RX antennas, normal prefix, EPA 5 Hz, 10 MHz are shown.

- 1. Set the **routing** to 1x1x2 (see 3.1.1), thus one baseband block is routed to two paths.
- 2. For the basic LTE steps see section 3.1.2.
- 3. Click Frame Configuration

- EUTRA/LTE A: UL Frame Configuration General Time Plan Subframe Sf 0 UE1 On 3GPP Release LTE-Advanced No. of PUCCH Config. 2 No. of PUSCH Config. 1
- 4. Set UE10 to LTE-Advanced and No. of PUCCH Config to 2 (Fig. 3-84).

Fig. 3-198: UE1

- 5. Click on tab **Subframe**.
- 6. Set Modulation/Format in the row PUCCH F5 and the State ON (Fig. 3-85).

EUT	ra/	LTE A: UL	. Fram	e Configura	tion									_
General Time Plan Subframe														
Cell PCell - Subframe 0 Prev Next O Copy														
Cyclic Prefix Normal - Uplink Subframe 0 Reset All Subframes											es			
	UE	Content	CW	Modulation / Format	Enhanced Settings	Set 1 No. RB	Set 1 Offset VRB	Set 2 No. RB	Set 2 Offset VRB	Offset PRB Slot (n/n+1)	Physical Bits	Power /dB	State	Conflict
U	E1	PUCCH	-	F5	Config	1	4	-	-	(0/14)	144	0.000	On	
		PUSCH	1/1	QPSK	Config	10	2	-	-		-	0.000	Off	

Fig. 3-199: PUCCH format 5

- 7. Click Enhanced Settings Config in the row PUCCH.
- 8. Set in the tab **Channel Coding Multiplexing** the **Number of Bit** to 24 and all bits to '1111.....'.

E	UTRA/LTE A: E	nhanced Sett. (PCell, SF 0, UE 1)				×
	Common	hannel Coding / Multiplexing	DRS			
		HA	RQACK			
	Number of A	A/N + SR + CSI Bits				24
	A/N + SR +	CSI Pattern		1 111 1111 1111 1111	1111 11	111
	Number of (Coded A/N + SR + CSI Bits				

Fig. 3-200: 24 ACK bits

9. To generate the test pattern, disable the PUCCH transmission in subframe 1.

EUTRA/LTE A: UL Frame Configuration												_		
Ge	General Time Plan Subframe													
Ce	ell F	Cell		•		Sub	frame		1	Prev 💽	Next		Сору	
Cyclic Prefix Normal · Uplink Subframe 1 Reset All Subframes												es		
U	JE	Content	CW	Modulation / Format	Enhanced Settings	Set 1 No. RB	Set 1 Offset VRB	Set 2 No. RB	Set 2 Offset VRB	Offset PRB Slot (n/n+1)	Physical Bits	Power /dB	State	Conflict
UE	1	PUCCH	-	F5	Config	1	-	-	-		i den de la composición de la	0.000	Off	
		PUSCH	1/1	QPSK	Config	10	2	-	-		4	0.000	Off	

Fig. 3-201: In the second configurable subframe (subframe #1) the PUCCH is not transmitted (state Off)

- 10. Switch On EUTRA/LTE A.
- 11. The SMW shows the correct settings in the time plan.



AWGN and Fading

- 12. Set Fading according to EPA 5 Hz Low (see 3.1.3)
- Set noise power and SNR. Take in account the SNR correction factor (see 3.1.4)(example: Noise = -80.5 dBm; SNR = SNR + Correction = 2.2 dB -16.99 dB = -14.79 dB)

Demo Program

Fig. 3-202 shows the parameters of the test. You can select the test in the tabulator **8.3 PUCCH.** Select one test under **8.3.13 PUCCH Format 5**. The tests are listed by their cyclic prefix and fading profile. When selecting a particular test, all settings are default according to the specification. The setting of the SNR depends on the fading profile and the channel bandwidth. The fading settings are displayed in the section **Fading**. There, also select the correlation matrix (default: Low). This example configures a PUCCH with a ration of PUCCH transmission with ACK information to no PUCCH transmission of 50:50. **4 Antennas** enables the test for four antennas. **8 Antennas** enables the test for eight antennas.

(8.5) N (8.2) P	B-loT Additional Service (8.3) PUCCI	ettings (8.4) PRACH					
8.3.1	ACK missed (1TX):	Normal, EPA 5Hz	Ŧ				
	4 Antennas	8 Antennas					
8.3.2	CQI Test:	Normal, EVA 5Hz	~				
8.3.4 -	- 8.3.5 – 8.3.6 Test:	Normal, EPA 5Hz					
	4 Antennas	8 Antennas	16 Bit				
8.3.7	ACK missed (2TX):	Normal, EPA 5Hz					
	4 Antennas	8 Antennas					
8.3.9	CQI Test with DTX:	EVA 5Hz 👻	2 TX				
8.3.10	ACK missed for CE	. 4 🔹	RPTs.				
8.3.11	CQI Test for CE:	4 -	RPTs.				
8.3.12	PUCCH Format 4:	Normal, EPA 5Hz					
	4 Antennas	8 Antennas	2 PRB				
8.3.13	PUCCH Format 5:	Normal, EPA 5Hz	•				
	4 Antennas	8 Antennas					

Fig. 3-202: Parameter for PUCCH test 8.3.13

Fig. 3-203 shows the report.

******* Performance Tests *******

8.3.13 ACK missed Detection for PUCCH Format 5 with 2RX Antennas.

Bandwidth: 10 MHz Duplex Mode: FDD Fading: EPA5Hz Low AWGN: -83.5 dBm SNR: 2.2 dB SNR Correction: -16.99 dB

A/N + SR + CSI Pattern (24 Bits): '1111 1111 1111 1111 1111 1111 'Finished!

Fig. 3-203: Report 8.3.13

3.4 Performance requirements for PRACH (Clause 8.4)

This section covers the performance of the physical random access channel (PRACH). All tests in this subclause are performed with the AWGN power level given in Table 3-70.

AWGN Power level for PRACH Tests									
Channel Bandwidth [MHz]	AWGN Power Level								
1.4	-89.7dBm / 1.08MHz								
3	-85.7dBm / 2.7MHz								
5	-83.5dBm / 4.5MHz								
10	-80.5dBm / 9MHz								
15	-78.7dBm / 13.5MHz								
20	-77.4dBm / 18MHz								

Table 3-70: AWGN Power Levels for PRACH Tests

As the PRACH (Burst Format 0...3: 839×1250 Hz, Burst Format 4: 139×7500 Hz) does not occupy the full AWGN bandwidth, a special SNR correction factor is applied, which depends on the bandwidth and the burst format (Table 3-71).

SNR Correction Factor for PRACH Tests											
Bandwidth in MHz	Facto	r in dB									
	Burst Format 03	Burst format 4									
1.4	-0.13	-0.15									
3	-4.11	-4.13									
5	-6.33	-6.35									
10	-9.34	-9.36									
15	- 11.10	-11.13									
20	- 12.34	-12.37									

Table 3-71: SNR Correction Factor for PRACH Tests

3.4.1 PRACH false alarm probability and missed detection (Clause 8.4.1)

The performance is measured by the base station and is determined by the total probability of false detection of the preamble (Pfa) and the probability of detection of preamble (Pd). Pd shall be 99% or greater, Pfa 0.1% or less. The statistics are kept by the base station under test.

The test for Pfa is done when the input signal is only noise, thus PRACH is not transmitted. The test for Pd shall verify the receiver's ability to detect PRACH preamble under multipath fading propagation conditions for a given SNR.

While normal mode test is applicable to all BS, the high speed mode test is applicable to high speed BS.

Fig. 3-204 shows the pattern of the transmitted preamble. The timing offset base is set to 50% of Ncs. A cyclic timing offsets is applied to the preamble (Fig. 3-205). Thus, ten preambles have to be transmitted.



Fig. 3-205: Timing Offset

Table 3-72 to Table 3-76 list the parameters like propagation conditions and SNR according to different burst formats. For some test cases, an additional frequency offset is required.

Requi	Requirements PRACH 8.4.1 for 2RX Antennas											
Mode	Propagation	Frequency	SNR [dB]									
	Conditions	Offset	Burst Format 0	Burst Format 1	Burst Format 2	Burst Format 3	Burst Format 4					
Nemeral	AWGN	0	-13.9	-13.9	-16.1	-16.2	-6.9					
Normai	ETU 70	270 Hz	- 7.4	- 7.2	- 9.4	- 9.5	0.5					
	AWGN	0	-13.8	-13.9	-16.0	-16.3	-					
High	ETU 70	270 Hz	- 6.8	- 6.7	- 8.7	- 8.9	-					
Type A	AWGN	625 Hz	-12.1	-12.0	-14.1	-14.1	-					
	AWGN	1340 Hz	-13.1	-13.2	-15.2	-15.4	-					
	AWGN	0	-14.2	-13.8	-16.4	-16.5	-					
High	ETU 70	270 Hz	-6.7	-6.3	-8.5	-8.6	-					
Type B	AWGN	625 Hz	-11.7	-11.4	-13.6	-13.6	-					
	AWGN	1875 Hz	-11.5	-11.1	-13.5	-13.7	-					

Table 3-72: Requirements PRACH Test 8.4.1 for 2RX Antennas

Requir	Requirements PRACH 8.4.1 for 4RX Antennas										
Mode	Propagation	Frequency	SNR [dB]								
	Conditions	Offset	Burst	Burst	Burst	Burst	Burst				
			Format 0	Format 1	Format 2	Format 3	Format 4				
Normal	AWGN	0	-16.6	-16.4	-18.7	-18.5	-9.5				
Normai	ETU 70	270 Hz	-11.5	-11.1	-13.5	-13.3	-4.5				
	AWGN	0	-16.6	-16.3	-18.6	-18.5	-				
High	ETU 70	270 Hz	-11.2	-10.8	-13.1	-13.1	-				
Speed Type A	AWGN	625 Hz	-14.6	-14.3	-16.5	-16.5	-				
	AWGN	1340 Hz	-15.6	-15.2	-17.5	-17.5	-				
	AWGN	0	-16.8	-16.3	-18.8	-18.8	-				
High Speed Type B	ETU 70	270 Hz	-11.2	-10.7	-12.9	-12.8	-				
	AWGN	625 Hz	-14.1	-13.8	-15.8	-15.9	-				
	AWGN	1875 Hz	-13.9	-13.5	-15.6	-16.0	-				

Table 3-73: Requirements PRACH Test 8.4.1 for 4RX Antennas

Requir	Requirements PRACH 8.4.1 for 8RX Antennas										
Mode	Propagation	Frequency	SNR [dB]								
	Conditions	Offset	Burst	Burst	Burst	Burst	Burst				
			Format 0	Format 1	Format 2	Format 3	Format 4				
Normal	AWGN	0	-19.5	-19.1	-21.2	-21.0	-11.5				
nomai	ETU 70	270 Hz	-15.7	-15.3	-17.2	-16.9	- 8.0				
	AWGN	0	-19.0	-18.8	-20.6	-20.7	-				
High	ETU 70	270 Hz	-15.0	-14.5	-16.4	-16.4	-				
Speed Type A	AWGN	625 Hz	-17.4	-17.1	-19.0	-19.1	-				
	AWGN	1340 Hz	-18.4	-18.1	-20.2	-20.2	-				
	AWGN	0	-19.3	-18.8	-20.9	-20.9	-				
High Speed Type B	ETU 70 Low	270 Hz	-14.7	-14.5	-16.5	-16.9	-				
	AWGN	625 Hz	-16.1	-16.0	-17.8	-17.9	-				
	AWGN	1875 Hz	-16.0	-15.7	-17.7	-18.1	-				

Table 3-74: Requirements PRACH Test 8.4.1 for 8RX Antennas

Requirements PRACH 8.4.1 for Coverage Enhancement (2RX Antennas, PRACH Frequency Hopping OFF) SNR [dB] Number of Propagation Frequency Conditions Offset Repetitions Burst Burst Burst Burst Format 0 Format 1 Format 2 Format 3 4 -21.0 -20.8 -8 -21.4 -21.0 _ AWGN 0 16 -24.7 _ -24.8 32 -25.3 -25.0 _ 4 -11.5 -11.1 -8 -12.4 -11.7 EPA 1 270 Hz 16 -16.6 -16.6 32 -18.4 -18.0

Table 3-75: Requirements PRACH Test 8.4.1 for Coverage Enhancement, Frequency Hopping OFF

Requirements PRACH 8.4.1 for Coverage Enhancement (2RX Antennas, PRACH Frequency Hopping ON)										
Propagation Frequency Number of SNR [dB]										
Conditions	Offset	Repetitions	Burst Format 0	Burst Format 1	Burst Format 2	Burst Format 3				
		4	-	-	-14.9	-14.7				
		8	-15.6	-15.2	-	-				
EPA 1	270 Hz	16	-	-	-19.5	-19.6				
		32	-20.7	-20.5	-	-				

Requirements in this table apply for channel bandwidth of 5MHz, 10MHz or 20MHz. For channel bandwidth of 3MHz, the requirements in Table 3-75 apply.

Table 3-76: Requirements PRACH Test 8.4.1 for Coverage Enhancement, Frequency Hopping ON

Test Setup

Fig. 3-206 to Fig. 3-208 show the test setup.

The wanted signal generated by the SMW's baseband A is split up in two paths. Multipath fading is simulated in the channel simulators and AWGN is added.

For four and eight RX antennas, the test can be done with just one SMW. Please note: Suitable options are required!

The SMW needs an external trigger at USER3.



Fig. 3-206: Test Setup for PUCCH Test 8.4.1 for 2 Antennas



Fig. 3-207: Test Setup for PUCCH Test 8.4.1 for 4 Antennas with one SMW



Fig. 3-208: Test Setup for PUCCH Test 8.4.1 for 8 Antennas with one SMW

Demo Program

Fig. 3-209 shows the parameters of the test. The test can be select in section **PRACH**. The tests are listed by their cyclic prefix, the fading profile and the frequency offset. When selecting a particular test, all settings are default according to the specification. The setting of the SNR depends on the channel bandwidth and the fading profile. The fading settings are displayed in the section **Fading**. There, also select the correlation matrix (Default: Low).

For normal or high speed mode **4** Antennas respectively **8** Antennas enables the test with four or eight antennas. Alternatively mark **Coverage Enhancement / eMTC** for PRACH for eMTC or **False Detection** to generate noise only.

(8.2) PUSCH (8.3)		(8.3) PU	ССН	(8.4) PRA	СН				
8.4.1	PRACH Missed Detection:								
	Conditi	ons:	Norr	Normal, AWGN 0Hz -					
			Burs	Burst Format:			0 -		
			4	Antenr	ennas				
Coverage Enhancement / eMTC									
	Conditi	ions:	EPA1Hz, 270Hz Offset						
			CE Le	vel:		0	-		
			Burst	Format:		0	-		
			Repet	itions:		8	-		
			Frequ	ency Hoppi	ng:				
	For this	s Detecti Test on	on Te ly Nois	st se is transm	itted!				

Fig. 3-209: Parameter for PRACH Test 8.4.1

Fig. 3-210 shows the report.

******* Performance Tests *******

8.4.1 PRACH False Alarm Probability and missed Detection Test Procedure for Detection Pd with 2RX Antennas.

Bandwidth: 10 MHz Duplex Mode: FDD PRACH Mode: Nomal Conditions: AWGNonly Frequency Offset: 0 Hz Burst Format: 0 AWGN: -80.5 dBm SNR: -13.9 dB SNR Correction: -9.34 dB Finished!

Fig. 3-210: Report 8.4.1

3.4.1.1 Test procedure for detection Pd

Test procedure for Normal and High Speed Mode

As in [7, Table 5.7.1-1...4] many different configurations are possible, but only certain ones are used here.

Table 3-77 shows the used FDD configurations.

DD PRACH Configuration				
Burst Format / Preamble Format	PRACH Configuration Index			
0	6			
1	22			
2	38			
3	54			

Table 3-77: Used FDD PRACH Configurations.

With these used configurations in FDD mode, a PRACH is transmitted in subframe 1 and 6, so five frames are necessary to transmit ten PRACH's.

Table 3-78 shows the used TDD configurations.

TDD PRACH Configuration							
Burst Format / Preamble Format	PRACH Configuration Index	Possible UL/DL Configuration					
0	3	all					
1	23	0,1,3,4,6					
2	33	0,1,3,4,6					
3	43	0,3,6					
4	51	all					

Table 3-78: Used TDD PRACH Configurations.

Burst Format 4 is only possible in TDD mode for Special Subframe Configurations 5...8 and without High Speed Mode. The possible UL/DL Configuration depends on the Burst Format. With these used configurations, only one PRACH is transmitted each frame, so ten frames are necessary to transmit ten PRACHs.

An example shows how to perform the settings for a two-antenna test setup with a channel bandwidth of 10 MHz, FDD, Normal Mode, ETU 70 and an offset of 270 Hz as well as burst format 0.

- 1. Set the routing in the SMW to 1 x 1 x 2 (see 3.1.1)
- 2. For the basic LTE steps see section 3.1.2.
- 3. Click Filter/Clipping/ARB/TDW/Power.

EUTRA/LTE A			_	×		
General Stop Trigger In Arm Auto Marker Clock	Info					
Off On Set To Default	Recall	Save	Ger Way	nerate veform		
Test Case Wizard	on					
Mode LTE	Duplexing	ng FDD ·				
	Link Directio	ection Uplink (SC-FDMA)				
General Settings	F	Frame Configuration				
Filter/Clipping/ARB/TDW/Power		LTE / Clip Off / 5 Frames				

Fig. 3-211: Additional Settings: Here Frames.

4. Set the Sequence Length in tab **ARB** (Example: FDD \rightarrow 5 Frames).



Fig. 3-212: Setting the Number of Frames (FDD: 5, TDD 10).

- 5. Click General UL Settings.
- 6. Set PRACH Configuration according to Table 3-77 or Table 3-78 (see Fig. 3-213).

Example: Burst Format $0 \rightarrow PRACH$ Configuration 6

EUTRA/LTE A: General UL Settings								_	×		
	OCA	Physical 10 MHz	Cell	Signals	PRACH	PUSCH	PUCCH				
	PRACH Frequency Offset							0	LTE		
	PRACH Configuration							6			
	Restricted Set (High Speed Mode)										

Fig. 3-213: PRACH Configuration

Test Preambles

The transmitted test preambles depend on the burst format, the Ncs, a logical sequence index and v. The value for Ncs cannot be directly set in the SMW, but the Ncs configuration. Table 3-79 shows the relationship between Ncs value and Ncs configuration, according to TS 136.211 Table 5.7.2-2.
Ncs Configura	tion			
	N_{CS}	Value		N _{CS} Configuration
	Burst Format 03		Burst Format 4	
Unrestricted Set	Restricted Set Type A	Restricted Set Type B		
0	15	15	2	0
13	18	18	4	1
15	22	22	6	2
18	26	26	8	3
22	32	32	10	4
26	38	38	12	5
32	46	46	15	6
38	55	55	-	7
46	68	68	-	8
59	82	82	-	9
76	100	100	-	10
93	128	118	-	11
119	158	137	-	12
167	202	-	-	13
279	237	-	-	14
419	-	-	_	15

Table 3-79: Preamble Ncs Configuration [6]

Timing offset base value shall be 50% Ncs. The duration of Ncs can be calculated via:

 $t_{\rm Ncs}$ = Ncs * (1 / ($\Delta\!f_{\rm RA}$ * $N_{\rm ZC}$)), where $\Delta\!f_{\rm RA}$ and $N_{\rm ZC}$ are:

Sequence I	Length ar	nd Baseband Parameters
Burst Format	N _{ZC}	$\Delta f_{\rm RA}$
03	839	1250 Hz
4	139	7500 Hz

Table 3-80: Parameters for Calculation of t_{Ncs}

This leads to test preamble parameters in Table 3-81 and Table 3-82, which have to be set in the SMW.

Test Preambles for Normal Mode					
Burst Format	Ncs	Ncs Configuration (SMW)	Logical Sequence Index	v	Base Offset Value (us)
0	13	1	22	32	6.2
1	167	13	22	2	79.62
2	167	13	22	0	79.62
3	0	0	22	0	0

Table 3-81: Test Preambles for Normal Mode

Test Preambles for High Speed Mode Type A						
Burst Format	Ncs	Ncs Configuration (SMW)	Logical Sequence Index	v	Base Offset Value (us)	
0	15	0	384	0	7.15	
1	202	13	384	0	96.31	
2	202	13	384	0	96.31	

Table 3-82: Test Preambles for High Speed Mode Type A

Test Preambles for High Speed Mode Type B						
Burst Format	Ncs	Ncs Configuration (SMW)	Logical Sequence Index	V	Base Offset Value (us)	
0	15	0	30	30	7.15	
1	100	10	168	20	47.68	
2	118	11	204	10	56.26	
3	137	12	264	0	65.32	

Table 3-83: Test Preambles for High Speed Mode Type B

- 7. Click Frame Configuration and on UE1.
- 8. Set Mode to PRACH.

EUTRA/LTE A: User Equipment Configuration (UE1)		 ×
State	Off	On
3GPP Release	LTE-A	•
UE ID/n_RNTI		0
UE Power	0.000 dB	•
Mode	PRACH	·
Restart Data, A/N, CQI and RI every Subframe and Codeword		On

Fig. 3-214: UE in PRACH Mode.

 In the tab PRACH, enter the settings according to Table 3-81 or Table 3-82 (see Fig. 3-215). For this example set Ncs Conf. to 1, Log. Root Seq. Index to 22, Seq. Index (v) to 32 and Delta t to 6.2 us.

UTRA	/LTE A: U	ser Equip	ment Configuration ((UE1)					_	
o c	ommon	PRACH	4							
Prea	mble Fo	ormat (Bi	urst Format)		0					
SF	RB Offset	Ncs Config.	Logical Root Sequence Index	Sequence Index (v)	∆t /µs	Power /dB	State			_
0	0	0	0	0	0.00	0.000	Off			
1	0	1	22	32	6.20	0.000	On			
2	0	0	0	0	0.00	0.000	Off			
3	0	0	0	0	0.00	0.000	Off			
4	0	0	0	0	0.00	0.000	Off			
5	0	0	0	0	0.00	0.000	Off			
6	0	1	22	32	6.30	0.000	On			
-		-	_		0.00	0.000	011			

Fig. 3-215: Details of the Test Preambles.

10. Make sure to configure all 10 preambles and to increase the Delta t by 0.1 us.

AWGN and Fading

11. Set Fading according to Table 3-72, Table 3-73 or Table 3-74 (see 3.1.3)

Example: EVA 70 Hz Low

12. Set **Noise Power** and **SNR**. Take in account the **SNR Correction Factor** (see 3.1.4). For this example Noise Power has to be set to -80.5 dBm. SNR results from SNR (-7.4 dB) and the corresponding Correction Factor (-9.34 dB) and has to be set to -14.04 dB.

Test procedure for Coverage Enhancement

As in [7, Table 5.7.1-1...4] many different configurations are possible, but only certain ones are used here. The requirements in Table 3-75 and Table 3-76 are defined based on simulation results with the following configuration indexes.

PRACH Configuration	
Burst Format	PRACH Configuration Index
0	3
1	19
2	35
3	51

Table 3-84: Used PRACH Configurations for Coverage Enhancement

An example shows how to perform the settings for a coverage enhancement test setup with a channel bandwidth of 10 MHz, EPA 1 Low and an offset of 270 Hz, burst format 0 and without frequency hopping.

- 1. Set the routing in the SMW to $1 \times 1 \times 2$ (see 3.1.1).
- 2. For the basic LTE steps see section 3.1.2.
- 3. Click General UL Settings and open the PRACH tab.
- 4. For **eMTC** set the PRACH Configuration and the Number of Repetitions for the corresponding CE Level according to Table 3-84, Table 3-75 and Table 3-76.

E	UTRA/LTE A:	General UL Settin	gs						_	×
	OCA	Physical IO MHz Cell	Signals	PRACH	PUSCH P	ИССН				
ſ	Hopping (Offset	0	Restr	icted Set (Hi	gh Speed M	ode)		LTE	
	CE Level	PRACH Config	Freq Offset	Hopping	Number of Repetitions	Starting SF Periodicity			eMTC	
	0	3	0		8	None			NB-lo	г
	1	0	0		1	None				
	2	0	0		1	None				
	3	0	0		1	None				
									ļ	

Example: Burst Format $0 \rightarrow$ Configuration 3 and Repetitions 8.

Fig. 3-216: PRACH Configuration and Number of Repetitions

Test Preambles

The transmitted test preambles depend on the Burst Format, the NCS, a Logical Root Sequence Index and the Sequence Index (v). Based to Table 3-79, this leads to the following test preamble parameters, which have to be set in the SMW.

Test Preambles for Coverage Enhancement					
Burst Format	NCS Config. (SMW)	Logical Root Sequence Index	Sequence Index (v)	Base Offset Value (us)	
0	1	22	32	6.2	
1	13	22	2	79.62	
2	13	22	0	0.0	
3	0	22	0	4.8	

Table 3-85: Test Preambles for Coverage Enhancement

5. Click Frame Configuration and enable UE1 for eMTC.

EUTRA/LTE A: UL Frame Con	figuration								×
General Time Plan St	ubframe						. M		
	UE1	UE2	UE3	UE4	UE5	UE6	UE7	ורי	JE8
	🗸 On	On	On	On	On	On	On]On
3GPP Release	eMTC •	Rel. 8/9 -	Rel. 8/9	Rel	. 8/9 -				
No. of PUCCH Config.		1	1	1	1	1			1
No. of PUSCH Config.		1	1	1	1	1	1		1

Fig. 3-217: Set UE1 to eMTC Mode.

- 6. Open the UE Configuration by clicking UE1 and set Mode to PRACH (Fig. 3-214).
- 7. In the tab **PRACH**, enter the CE Level and the settings according to Table 3-85.

umber o	f Preamble	Attempts			10				
CE Level	Starting Subframe	Repetitions	RB Offset	Ncs Config.	Logical Root Sequence Index	Sequence Index (v)	∆t /µs	Power /dB	
0	1	8	0	1	22	32	6.20	0.000	
0	81	8	0	1	22	32	6.30	0.000	
0	161	8	0	1	22	32	6.40	0.000	
0	241	8	0	1	22	32	6.50	0.000	
0	321	8	0	1	22	32	6.60	0.000	
^	404	0	0	4	22	22	6 70	0.000	

Fig. 3-218: Details of the Test Preambles.

- 8. Make sure to configure all 10 preambles and to increase the Delta t by 0.1 us.
- 9. This example requires a frequency offset of 270 Hz, which can be set directly in the baseband. To apply this, select **Baseband A** and **Baseband Offsets**.

Stop<	Baseband A	
SOT .	🗸 On	_[∆f]
OM	EUTRALTE	

Fig. 3-219: Frequency Offset

Baseband Offset	_	×	
	Frequency Offset /Hz	Phase Offset	Gain /dB
Baseband A	270.00	0.00	0.000
BB Input A	0.00	0.00	0.000

AWGN and Fading

- 10. Set Fading according to Table 3-75 and Table 3-76 (see 3.1.3).
- Set Noise Power and SNR. Take in account the SNR Correction Factor (see 3.1.4). For this example Noise Power has to be set to -80.5 dBm. SNR results from SNR (-12.4 dB) and the corresponding Correction Factor (-9.34 dB) and has to be set to -21.74 dB.

3.4.1.2 Test procedure for false detection Pfa

For this test, only noise is transmitted.

- 1. In the block diagram, select AWGN.
- 2. Set the Mode to Noise Only (Fig. 3-220).
- 3. Set System Bandwidth and Ratio.

Example: 10 MHz BW_{channel} → 9 MHz System Bandwidth

A	WGN Settings					_	×
(Coupled Mode						On
	General No	oise Power / Output Res	ults			O _{Noise}	Only
	State			Off	On	OB Naise	Only
	Mode		Noise Only		•		
	System Bandv	vidth		9.000 0	MHz ·		
	Min Noise/Sys	tem Bandwidth Ratio			1.5		

Fig. 3-220: For the Pfa test, the SMW generates noise only.

4. In the tab **Noise Power / Output Results** set the **Noise Power** according to Table 3-70.

Example: 10 MHz \rightarrow -80.5 dBm

AWGN Settings		_ ×
Coupled Mode		On
General Noise Power / Output Res	sults	OA Naise Only
Show Powers For Output	RF A -	O B Naise Only
Noise Power (System Bandwidth)	-80.50 dBm •	
Noise Power (Total Bandwidth)	-77.32 dBm •	
Noise Bandwidth	13.500 0 MHz ·	





5. Repeat the steps with the second path (see Fig. 3-220 and Fig. 3-221).

Fig. 3-222: Overview SMW for the noise only settings.

3.5 Performance requirements for Narrowband IoT (Clause 8.5)

This section covers the performance tests for NB-IoT.

All tests in this subclause are performed with the AWGN power level given in Table 3-86.

AWGN power level for NB-IoT tests					
Channel bandwidth [MHz] AWGN power level					
0.2	- 100.5 dBm / 0.18 MHz				

Table 3-86: AWGN power level for NB-IoT tests

SNR Correction Factor

For FRC's not using all subcarriers (NPUSCH format 1), NPUSCH format 2 and NPRACH, a special SNR correction factor has to be applied by the user.

 $SNR\Delta = 10 \log (used subcarriers / possible subcarriers)$

Example: For FRC A16-1 (for 3.75 kHz spacing) only one subcarrier is used. 3.75 kHz spacing allows 48 subcarriers. Thus $SNR\Delta = 10 \log (1 / 48) = -16.81 dB$. This factor depends on the bandwidth, see Table 3-87.

SNR Correction factor for NB-IoT						
Subcarrier spacing in kHz	Max subcarriers	Channel	FRC	Number of subcarriers	SNR∆	
3.75		NPUSCH F1	16-1	1		
	48	NPUSCH F2		1	- 16.81	
		NPRACH		1		
	12	NPUSCH F1	16-2	1	- 10.79	
			16-3	3	- 6.02	
15			16-4	6	- 3.01	
			16-5	12	0.00	
		NPUSCH F2		1	- 10.79	

Table 3-87: SNR correction factor for PUSCH tests with 1RB allocated.

Testsetup

The wanted signal generated by SMW baseband A is split up in two paths. Multipath fading is simulated in the channel simulators, AWGN is added.

The SMW needs an external trigger at USER3. A HARQ-Feedback signal from the base station is required for 8.5.1 tests.



Fig. 3-223: Test Setup for NB-IoT tests 8.5 (the feedback is necessary for 8.5.1 only)

3.5.1 Performance requirements for NPUSCH format 1 (Clause 8.5.1)

The test verifies the receiver's ability to achieve the data throughput in the NPUSCH (format 1) under multipath fading propagation.

The throughput is measured by the base station under test. The required throughput is expressed as a fraction of maximum throughput for the FRC's. HARQ re-transmission is assumed.

Performance Tests (Chapter 8)

Performance requirements for Narrowband IoT (Clause 8.5)

Test parameters 8.5.1	
Parameter	Value
Maximum number of HARQ transmissions	4
Redundancy version (RV) sequence	RV0, RV2

Following test pattern applies:



Test Requirements

Table 3-88 to Table 3-90 list the different requirements, which depend on the subcarrier spacing and the repetitions.

Parameter for NPUSCH format 1, 3.75 kHz subcarrier spacing							
Tx Antennas	RX Antennas	Allocated Subcarriers	Propagation Conditions	FRC	Repetition number	Throughput	SNR in dB
					1		- 1.3
1	2	1	ETU 1 Hz Low	A16-1	16	70 %	- 8.6
					64		- 11.6

Table 3-88: NPUSCH format 1, 3.75 kHz subcarrier spacing

Parameter for NPUSCH format 1, 15 kHz subcarrier spacing, single subcarrier								
Tx Antennas	RX Antennas	Allocated Subcarriers	Propagation Conditions	FRC	Repetition number	Throughput	SNR in dB	
1 2	2	1	ETU 1 Hz Low	A16-2	1	70 %	- 1.5	
					16		- 8.2	
					64		- 12.0	

Table 3-89: NPUSCH format 1, 15 kHz subcarrier spacing, single subcarrier

Performance Tests (Chapter 8)

Performance requirements for Narrowband IoT (Clause 8.5)

Parameter for NPUSCH format 1, 15 kHz subcarrier spacing, multiple subcarriers							
Tx Antennas	RX Antennas	Allocated Subcarriers	Propagation Conditions	FRC	Repetition number	Throughput	SNR in dB
					2		- 2.4
		3		A16-3	16		- 7.5
				64		- 10.8	
		6 ETU	ETU 1 Hz Low	Low A16-4	2	70 %	0.0
1	2				16		- 6.2
					64		- 9.9
					2		- 0.1
		12		A16-5	16		- 5.8
					64		- 9.5

Table 3-90: NPUSCH format 1, 15 kHz subcarrier spacing, multiple subcarrier

To generate a test pattern with 50% transmission and 50% gap, the SMW uses following numbers of frames to ensure a continuous pattern in the ARB of the SMW:

Transmission and frames for PUSCH F1 3.75 kHz spacing							
Repetition	Subframes for transmission and gap	Number of transmissions	Number of frames				
1	128	5	64				
16	2048	5	1024				
64	8192	5	4096				

Table 3-91: Transmission and frames 3.75 kHz spacing

Transmission and frames for PUSCH F1 15 kHz spacing									
Subcarriers	Repetition	Subframes for transmission and gap	Number of transmissions	Number of frames					
	1	32	5	16					
1	16	512	5	256					
	64	2048	5	1024					
	2	16	5	8					
3	16	128	5	64					
	64	512	5	256					
	2	8	5	4					
6	16	64	5	32					
	64	256	5	128					
12	2	4	5	2					
	16	32	5	16					
	64	128	5	64					

Table 3-92: Transmission and frames 15 kHz spacing

Test Procedure

As an example, the settings for two RX antennas, 15 kHz spacing with one subcarrier (FRC A16-2) and 1 repetition are shown. The PUSCH is transmitted 50 percent of the time, for 50 percent there are no transmissions.

- 1. Set the **routing** to 1x1x2 (see 3.1.1), thus one baseband block is routed to two paths.
- 2. For the basic NB-IoT steps see section 3.1.2.
- 3. Click Frame Configuration.

EUTRA/LTE A: UL Frame Configuration								
General	Time Plan							
	2		UE1					
		6	🗸 On	8				
30	SPP Releas	se N	IB-IoT	•				

- 4. Click on UE1.
- 5. Click on the tab NB-IoT Allocation
- 6. To generate the test pattern, create **5 Transmissions**.
- 7. Switch on the FRC in the tab FRC (example FRC A16-2).

E	UTRA/LTE A: User Equipn	ment Co	onfiguration	(UE1)						—	×
	Common CReal	ltime dback	● FRC	NPUSCH	NDRS	NB-IoT Allocation					
ſ	FRC State								Off		On
	FRC						TS 36.1	141: A16-4			·
	Subcarrier Spacing									1	5 kHz
	Number of Allocated	Subca	arriers								6
	Modulation									c	PSK
	Number of NPUSCH	Repet	titions								1

Fig. 3-224: NPUSCH F1: FRC

 Set the Start Subfr increasing by Subframes transmission and gap of Table 3-92 (Example: 1 (0, 32, 64, 96, 128)).

EUTRA	'LTE A: Us	er Equipme	ent Configu	iration	(UE1))								_	×
OC	ommon	⊖ <mark>Realtir</mark> Feedb	me back	RC	NPU	ISCH	NDRS	NB-IoT Allocation							
Subc	<mark>arrier S</mark> p	acing	15 kHz												
Reso	urce Blo	ck Index				0	Δf	to DC/MHz				0.000	0 MHz	:	
Mode)		Standalo	one			Nur	mber of Transmissi	ions						5
	NPUSCH Format	Modulation	Enhanced Settings	Start Subfr.	Start Slot	Repeti- tions	Res. Units	Subcarr. Indication or ACK/NACK Res. Field	No. of Subc.	Slots	Starting Subcar.	Power /dB			
3	F1	π/2-BPSK	Config	64	128	1	2	0	1	16	0	0.000			
4	F1	π/2-BPSK	Config	96	192	1	2	0	1	16	0	0.000			
5	F1	π/2-BPSK	Config	128	256	1	2	0	1	16	0	0.000			
				_		— AI	RB Se	equence Length —			_				
Sug	gested	15	Current		16 F	rames		Adjust Len	gth			ARB	Settin	gs	

Fig. 3-225: Transmission settings

- 9. Enable the wanted Realtime feedback.
- Click ARB Settings to set the Sequence Length to Number of frames in Table 3-95 (Example: '16')



Fig. 3-226: 16 frames to generate the pattern continuously

11. Switch On EUTRA/LTE A.

AWGN and Fading

- 12. Set Fading according to ETU 1 Hz Low (see 3.1.3)
- Set noise power and SNR. Take in account the SNR correction factor (see 3.1.4)(example: Noise = -100.5 dBm; SNR = SNR + Correction = -9.9 dB -3.01 dB = -12.91 dB)

Demo program

Fig. 3-227 shows the parameters of the test. You can select the test in the section **8.5 NB-IoT.** Select one test under **8.5.1 NPUSCH Format 1**. The tests are listed by the subcarrier spacing, the number of subcarriers and the repetition. When selecting a

particular test all settings are default according to the specification. The setting of the SNR depends on the spacing. For FRCs using not all subcarriers a special SNR correction factor is applied. The fading settings are displayed in the section **Fading**. There also select the correlation matrix (default: Low). Set also parameters in the section **Real-Time Feedback**.

(8.2) F (8.5) N	USCH (8.3) PUCCH	t (8.4) PRACH
8.5.1	NPUSCH Format 1:	3.75 kHz Spacing 🔹
		1 Subcarrier
		■ RPTs.
8.5.2	ACK missed Test:	3.75 kHz Spacing 👻
		T RPTs.
8.5.3	NPRACH Test:	AWGN, 0Hz, 8 RPTs.
		Preamble Format: 0 -

Fig. 3-227: Parameter for PUSCH test 8.5.1

Fig. 3-228 shows the report.



Fig. 3-228: Report 8.5.1

3.5.2 ACK missed detection for NPUSCH format 2 (Clause 8.5.2)

The test verifies the receiver's ability to detect the ACK inside the NPUSCH (format 2) under multipath fading propagation. The probability of false detection of the ACK is defined as a conditional probability of erroneous detection of the ACK when input is only noise.

The probability of detection of the ACK shall be equal or greater to 0.99. The probability of false detection of the ACK shall be 0.01 or less.

The statistics are kept by the base station under test.

Following test pattern applies:



Test Requirement

Parameter for NPUSCH format 2, 3.75 kHz subcarrier spacing									
Ty Antonnas	BY Antonnas	Allocated	Propagation	Repetition	SNR	Resulting			
TX Antennas	KA Antennas	Subcarriers	Conditions	number	in dB	Level			
				1	7.6	- 109.71			
1	2	1	EPA 5 Low	16	- 4.7	- 122.01			
				64	- 10.3	- 127.61			

Table 3-93: NPUSCH format 2, 3.75 kHz

Parameter for NPUSCH format 2, 15 kHz subcarrier spacing									
Tx Antennas	RX Antennas	Allocated Subcarriers	Propagation Conditions	Repetition number	SNR in dB	Resulting			
				1	6.9	- 104.39			
1	2	1	EPA 5 Low	16	- 3.3	- 114.59			
				64	- 8.9	- 120.19			

Table 3-94: NPUSCH format 2, 15 kHz

To generate a test pattern with 50% transmission and 50% gap, the SMW uses following numbers of frames to ensure a continuous pattern in the ARB of the SMW:

Transmi	Transmission and frames								
Repetition	Subcarrier Spacing	Subframes for transmission and gap	Number of transmissions	Number of frames					
4	3.75	16		8					
1	15	4		2					
10	3.75	256	_	128					
16	15	64	5	32					
	3.75	3.75 1024		512					
64	15	256		128					

Table 3-95: Transmission and frames

Test Procedure

As an example, the settings for two RX antennas, 15 kHz spacing and 16 repetitions are shown. The PUSCH is transmitted for 32 subframes, then the next 32 subframes are no transmissions.

- 1. Set the **routing** to 1x1x2 (see 3.1.1), thus one baseband block is routed to two paths.
- 2. For the basic NB-IoT steps see section 3.1.2.
- 3. Click Frame Configuration.



- 4. Click on UE1.
- To generate the test pattern, create 5 Transmissions. Set all to NPUSCH Format F2 and the Repetition to '16'. Set the Start Subfr increasing by Subframes transmission and gap of Table 3-95 (Example: 64 (0, 64, 128, 192, 256)).

EUT	'RA/I	LTE A: Us	er Equipme	ent Configu	iration	(UE1))								_	×
0)Co	mmon	⊖ Realtir Feedb	ne back	RC	NPU	ISCH	NDRS	NB-IoT Allocation							
Su	Subcarrier Spacing 15 kHz															
Re	esol	urce Blo	ck Index				0	Δf	to DC/MHz				0.000 0	MHz		
Mo	ode			Standalo	one			Nur	nber of Transmissi	ons						5
		NPUSCH Format	Modulation	Enhanced Settings	Start Subfr.	Start Slot	Repeti- tions	Res. Units	Subcarr. Indication or ACK/NACK Res. Field	No. of Subc.	Slots	Starting Subcar.	Power /dB			
	3	F2	π/2-BPSK	Config	128	256	16	1	0	1	4	0	0.000			\sim
	4	F2	π/2-BPSK	Config	192	384	16	1	0	1	4	0	0.000			
	5	F2	π/2-BPSK	Config	256	512	16	1	0	1	4	0	0.000			\sim
		_			_	_	— A	RB Se	equence Length —							
S	ugg	ested	29	Current		1 F	rames	•	Adjust Len	gth			ARB	Settin	gs	

Fig. 3-229: Five transmissions of NPUSCH format 2 to generate the wanted pattern

6. Click in every transmission on **Enhanced Settings Config...** to set the **ACK/NACK Pattern** to '1'.

EUTRA/LTE A: Enhanced Sett. (PC	Cell, Transmission 3, UE 1)	_ ×
Common Channel Coding	/ Multiplexing	
Number of A/N Bits		1
ACK/NACK Pattern		1
Number of Coded A/N Bits		16

 Click ARB Settings to set the Sequence Length to Number of frames in Table 3-95 (Example: '32')

EUTRA/LT	E: Filter/Clipping/	/ARB/TD\	N/Power Setting	S	_	×
Filter	Clipping	ARB	O Time Do Window	omain ing	Power	
Sequen	ce Length		32	Fram	es	·

Fig. 3-230: 32 frames to generate the pattern continuously

8. Switch On EUTRA/LTE A.

AWGN and Fading

- 9. Set Fading according to EPA 5 Hz Low (see 3.1.3)
- Set noise power and SNR. Take in account the SNR correction factor (see 3.1.4)(example: Noise = -100.5 dBm; SNR = SNR + Correction = -3.3 dB -10.79 dB = -14.09 dB)

Demo program

Fig. 3-231 shows the parameters of the test. You can select the test in the section **8.5 NB-IoT.** Select one test under **8.5.2 ACK missed test**. The tests are listed by the subcarrier spacing and the repetition. When selecting a particular test all settings are default according to the specification. The setting of the SNR depends on the spacing. As only one subcarriers is used a special SNR correction factor is applied. The fading settings are displayed in the section **Fading**. There also select the correlation matrix (default: Low).

(8.2) F (8.5) N	PUSCH IB-IoT	(8.3) PUCCH Additional Set	(8.4) PRACH tings	
8.5.1	NPUS	CH Format 1:	3.75 kHz Spac	ing 👻
			1 -	Subcarrier
			1 -	RPTs.
				,
8.5.2	ACK r	nissed Test:	3.75 kHz Spac	ing 🚽
8.5.2	ACK r	nissed Test:	3.75 kHz Spac	ing ▼ RPTs.
8.5.2 8.5.3	ACK r	nissed Test: CH Test:	3.75 kHz Spac 1	ing ▼ RPTs. RPTs. ▼

Fig. 3-231: Parameter for PUSCH test 8.5.2

Fig. 3-232 shows the report.

******* Performance Tests *******

8.5.2 ACK missed Detection for NPUSCH Format 2

Subcarrier Spacing: 3.75 kHz Repetition: 1

Bandwidth: 0.2 MHz Duplex Mode: FDD Fading: EPA5 Hz Low AWGN: -100.5 dBm SNR: 7.6 dB SNR Correction: -16.81 dB Finished!

Fig. 3-232: Report 8.5.2

3.5.3 Performance requirements for NPRACH (Clause 8.5.3)

The performance is measured by the base station and is determined by the total probability of false detection of the preamble (Pfa) and the probability of detection of preamble (Pd). Pd shall be 99% or greater, Pfa shall be 0.1% or less. The statistics are kept by the base station under test.

The test for Pfa is done when the input signal is only noise, thus NPRACH is not transmitted.

The test for Pd shall verify the receiver's ability to detect NPRACH preamble under multipath fading propagation conditions for a given SNR.

Fig. 3-233 shows the pattern of the transmitted preamble. The preambles are sent with a fixed timing offset of 0.5 T_{CP} during the test.

Timing offset 0.5 T _{CP}						
Preamble Format	Offset					
0	67 µs					
1	267 µs					

Table 3-96: NPRACH timing offsets

Preamble

Preamble

•••

Fig. 3-233: NPRACH test pattern

The test requires two different NPRACH configurations as in Table 3-97.

NPRACH Test Parameters						
Parameter	Configuration 0	Configuration 1				
Narrowband physical layer cell identity	0	0				
nprach-Periodicity (ms)	80	320				
nprach-SubcarrierOffset	0	0				
nprach-NumSubcarriers	12	12				
numRepetitionsPerPreambleAttempt	8	32				

Table 3-97: NPRACH Test parameter configurations

Requirements NPRACH 8.5.3							
Tx Rx Antennas Antennas		_		_	SNR [dB]		
		Repetition	Propagation	Frequency	Preamble	Preamble	
Antennas 7	Antennas	number	conditions	onset	Format 0	Format 1	
		8	AWGN	0	- 1.8	- 1.8	
			EPA 1 Low	200 Hz	6.7	6.7	
1 2	22	AWGN	0	- 6.5	- 6.5		
	32	EPA 1 Low	200 Hz	1.1	1.1		

Table 3-98: NPRACH tests

Test Procedure

As an example, the settings for two RX antennas, 8 repetitions and EPA 1 low are shown.

- 1. Set the **routing** to 1x1x2 (see 3.1.1), thus one baseband block is routed to two paths.
- 2. For the basic NB-IoT steps see section 3.1.2.

The test requires two different NPRACH configurations and both Preamble Formats.

3. In General Settings, you can find the relevant settings in the tab **PRACH** and **NB-IoT**. Set two configurations according Table 3-97.

UTRA/LTE A: Gen	eral UL Settir	igs					—	×
CA Phys	ical /z Cell	Signals	PRACH PL		ссн			
Preamble For	mat		0				LTE	
NPRACH Configuration	Periodicity /ms	Starting Time /ms	Number of Repetitions	Number o Subcarrier	f Subcarrier s Offset		eMTC	>
0	80	8	8	12	0	-	NB-Io	т
1	320	8	32	12	0	-		_
2	40	8	1	12	0			

Fig. 3-234: General NPRACH settings

4. In Frame Configuration, set in the UE block the Mode to PRACH

EUTRA/LTE A: User Equipment Configuration (UE1)	×
State	Off On
3GPP Release	NB-IoT -
UE ID/n_RNTI	0
UE Power	0.000 dB -
Mode	PRACH

Fig. 3-235: NPRACH mode

 In the NPRACH tab, set the wanted configuration. The SMW calculates automatically the necessary number of frames. Click Adjust Length to set them. (example: Preamble Format 0 with Configuration 0 (8 repetitions) This leads to 6 frames).

EUTRA/LTE A: Us	er Equipment	t Configuration	(UE1)					_	×
Common	NPRACH									
Mode		Star	ndalo	ne	•					
Resource Blo	ck Index				0	∆ f to DC/MHz		0.000 0 MHz	:	•
Number of Pre	eamble Atte	empts			1					
NPRACH Configuration	Starting Subframe	Number of Repetitions	n init	n start	Power /dB					
0	8	8	0	0	0.000					
Suggested	6 C	Current	1 F	rames	ST C	Adjust Leng	gth	ARB Set	tings	

Fig. 3-236: NPRACH configuration

6. The example requires a frequency offset of 200 Hz. Set this directly in the baseband.

Run	Baseban	d A				
8		Ē	Σ			
Baseband Offsets						
Baseband Offset	5		_ ×			
Baseband Offsets	Frequency Offset	Phase Offs	et Gain /dB			
Baseband Offset: Baseband A	Frequency Offset /Hz 200.00	Phase Offs /°	K et Gain /dB 00 0.000			
Baseband Offset: Baseband A BB Input A	Frequency Offset /Hz 200.00 0.00	Phase Offs <i>f</i> ° 0.1	K et Gain /dB 00 0.000 00 0.000			
Baseband Offsets Baseband A BB Input A BB Input B	Frequency Offset /Hz 200.00 0.00	Phase Offs ^{/°} 0.1	K et Gain /dB 00 0.000 00 0.000 00 0.000			

Fig. 3-237: Frequency offset

7. Set the timing offset for the NPRACH (see Table 3-96) in the tab **Trigger In**. Please note that this delay is not possible with the AUTO trigger mode.

EUTRA/LTE A	_ ×	
General General ArmAuto	Clock Internal Info	
Mode	Armed Auto -	
	Stopped	200
Source	External Global Trigger 1	
Sync. Output To Ext. Trigger	[On	l
External Delay Unit	Time	
Specified External Delay	67.000 <mark>0</mark> µs	
Actual External Delay	67.000 0 µs	

Fig. 3-238: NPRACH timing offset via trigger delay

AWGN and Fading

- 8. Set Fading according to EPA 1 Hz Low (see 3.1.3)
- Set noise power and SNR. Take in account the SNR correction factor (see 3.1.4)(example: Noise = -100.5 dBm; SNR = SNR + Correction = 6.7 dB -16.81 dB = -10.11 dB)

Demo program

Fig. 3-239 shows the parameters of the test. You can select the test in the section **8.5 NB-IoT.** Select one test under **8.5.3 NPRACH Test**. The tests are listed by the fading, offset and the repetition. When selecting a particular test all settings are default according to the specification. The setting of the SNR depends on the spacing. As only one subcarriers is used a special SNR correction factor is applied. The fading settings are displayed in the section **Fading**. There also select the correlation matrix (default: Low). In addition, select the **Preamble Format**.

(8.2) F (8.5) N	USCH	(8.3) PUCCH Additional Set	(8.4 tings) PRACH	
8.5.1	NPUS	CH Format 1:	3.75	kHz Spaci	ing 👻
			1	-	Subcarrier
		(1	-	RPTs.
8.5.2	ACK n	nissed Test:	3.75	kHz Spaci	ing 👻
			1	-	RPTs.
8.5.3	NPRA	CH Test:	AWG	N, OHz, 8	RPTs. 👻
			Prear	nble Form	at: 0 🔹

Fig. 3-239: Parameter for PUSCH test 8.5.3

Fig. 3-240 shows the report.

******* Performance Tests *******

8.5.3 Performance Requirements for NPRACH

Scenario: AWGN, 0 Hz Frequency Offset and 8 Repetitions Preamble Format: 0

Bandwidth: 0.2 MHz Duplex Mode: FDD AWGN: -100.5 dBm SNR: -1.8 dB SNR Correction: -16.81 dB Finished!

Fig. 3-240: Report 8.5.3

4 Appendix

4.1 R&S TSrun Program

The TSrun software application makes it possible to combine tests (modules) provided by Rohde & Schwarz into test plans to allow rapid and easy remote control of test instruments. This program is available free of charge from our website.

Requirements

Operating system:

- Microsoft Windows XP / Vista / Windows 7 / Windows 8
- .NET framework V4.0 or higher

General PC requirements:

- Pentium 1 GHz or faster
- I Gbyte RAM
- 100 Mbyte space harddisk
- XGA monitor (1024x768)

Remote control interface:

- National Instruments VISA
- GPIB card
- Or
- LAN connectionAfter TSrun is launched, the following splash screen appears:

🙊 R&S TSrun	
File View Resources Options Testplan Favorites Help	
🛱 File Browsers 🛛 🎦 New 🚰 Open 💷 Save All 💷 Abort All	
Test Plans Tests Reports No Testplan Loaded	
💁 Add 🔚 Remove 🖼 Favorite	
Installed Image: Application Notes	
Session: schulz License Server: None	

Fig. 4-1: Overview TSrun

Tests and test plans

Tests are separate, closed modules for TSrun. A test plan can consist of one or more tests.

LTE_BS_Tx_Te	sts 🛛						
🕨 Run 💷 A	bort 🕅	Step	Idl	e	🧧 🤪 Param	eters 📲 Resource	s * 🛒
TC 🖻 🖗 🛛	a 4	$\mathbb{P} \cong X$	6	७, 만			
Steps				escription			
	Tx Tests BS_Tx_T	ests	,	-			
Testplan Details	Yield	Measurement	Report S	SCPI Report	Progress Log		

Fig. 4-2: Overview of a test plan in TSrun. The test plan in the example contains only one test (LTE_BS_Tx_Tests). After the test is completed, the bar along the bottom can be used to display the measurement and SCPI reports.

The LTE BS tests can be found under Tests/ApplicationNotes.

Click RUN to start the current test plan.

SCPI connections

Under Resources|SCPI Connections, you can add all required instruments for remote control.

🏇 R&S TSrun	Control Second and	Constituent pro- can all
File View	Resources Options Testplan	Favorites Help
🔍 File Browsers	Bar Code Reader	pen 🕼 Save All 🗇 Abort All
Test Plans Tes	CMW Instrument	oaded
🔁 Add 🖻 Re	Measurement Report	
🖭 🔝 🔝	CMW-ZASB Instrument	
🗄 🕛 My Test	SCPI Connections	
🕀 🕀 🔢 🕀 🕀	SCPI Report	
	Serial Port	
	Test Setup	

Fig. 4-3: Setting the SCPI connections.

Use **Configure...** to open a wizard for entering the VISA parameters (Fig. 4-5). Enter "localhost" for the external PC SW. Use the **Test Connection** button to test the connection to the instrument. When the **Demo Mode** button is enabled, no instrument needs to be connected because TSrun will run in demo mode and output a fictitious test report.

SCPI Connections		×
Globals		
D Alias	Resource Name	Timeout ^
SMx	TCPIP::RSSMU200A103455::I	10000
Sx FSx	TCPIP::FSW13-101157::INSTR	10000
		-
Reporting	Break test after 10	successive timeouts
Demo Mode		
Add Delete	Configure	Test Connection
		OK Cancel

Fig. 4-4: SCPI connections.

Resource Name Composer		
Alias	Remote Interface Assistant	
FSx	VISA: National Instruments; V5.2.0f0	
Resource Name	Interface Type: VXI11 (Network) -	
TCPIP::FSW13-101157::INSTR	Board No.	
< Assistant	TCPIP	
Timeout (ms)	IP Address 🔘 Host Name 💿	
10000	Host Name FSW13-101157	
OK Cancel		

Fig. 4-5: Wizard for entering VISA parameters. Both the IP address and a host name can be entered directly.

Reports: Measurement and SCPI

After the test is completed, TSrun automatically generates both a measurement and a SCPI report.

The measurement report shows the actual results and the selected settings.

The SCPI report returns a LOG file of all transmitted SCPI commands. These can then be copied and easily used in separate applications.

Ξ

Protocol

Test Case 1: Measurement

0:00:00.048.359: Initializing testcase! 0:00:00.048.710: TCPIP::FSW13-101157::INSTR already open. Opening new channel! 0:00:00.049.308: Opening new remote channel: FSx 0:00:00.050.740: Connection to FSx(TCPIP::FSW13-101157::INSTR) established! 0:00:00.051.207: Session handle: 1 0:00:00.051.898: Resource Name: TCPIP0::FSW13-101157::INSTR 0:00:00.052.318: VISA Manufacturer: National Instruments 0:00:00.052.728: [-->TCPIP::FSW13-101157::INSTR] *IDN? 0:00:00.053.519: [<--TCPIP::FSW13-101157::INSTR] Rohde&Schwarz,FSW-13,1312.8000 K13/101157,1.81 11 Beta 0:00:00.062.515: [-->TCPIP::FSW13-101157::INSTR] *RST;*CLS;*OPC; 0:00:00.063.483: [-->TCPIP::FSW13-101157::INSTR] INST:SEL LTE;*OPC? 0:00:00.389.506: [<--TCPIP::FSW13-101157::INSTR] 1 0:00:00.391.530: Opening new remote channel: SMx 0:00:00.416.394: Connection to SMx(TCPIP::RSSMU200A103455::INSTR) established! 0:00:00.428.844: Session handle: 2 0:00:00.431.486: Resource Name: TCPIP0::RSSMU200A103455::INSTR 0:00:00.433.090: VISA Manufacturer: National Instruments 0:00:00.434.619: [-->TCPIP::RSSMU200A103455::INSTR] *IDN? 0:00:00.437.948: [<--TCPIP::RSSMU200A103455::INSTR] Rohde&Schwarz,SMU200A,114 1.2005k02/103455,2.7.15.1-02.20.360.142 0:00:00.440.240: [-->TCPIP::RSSMU200A103455::INSTR] SYST:ERR:ALL? 0:00:00.442.742: [<--TCPIP::RSSMU200A103455::INSTR] 0,"No error" 0:00:00.444.658: [-->TCPIP::RSSMU200A103455::INSTR] *RST;*CLS;*OPC? 0:00:01.340.916: [<--TCPIP::RSSMU200A103455::INSTR] 1 0.00.01 342 753. [--- TOTD-RCCMI 12004103455-TNISTRI COLIR1-DOW/OFEC 0 Testplan Details Yield Measurement Report SCPI Report Progress Log

Fig. 4-6: SCPI report.

4.2 References

[1] Technical Specification Group Radio Access Network; E-UTRA Base Station Conformance Testing, Release 14; 3GPP TS 36.141, V 14.9.0, March 2019

[2] Rohde & Schwarz: **UMTS Long Term Evolution (LTE) Technology Introduction**, Application Note 1MA111, October 2012

[3] Rohde & Schwarz: LTE-A Base Station Receiver Tests according to TS 36.141 Rel. 14, Application Note 1MA195, May 2019

[4] Rohde & Schwarz: LTE-A Base Station Transmitter Tests according to TS 36.141 Rel. 14, Application Note 1MA154, May 2019

[5] Technical Specification Group Radio Access Network; E-UTRA, UTRA and GSM/EDGE; Multi-Standard Radio (MSR) Base Station (BS) Conformance Testing, Release 10; 3GPP TS 37.141, V 10.10.0, July 2013

[6] Technical Specification Group Radio Access Network; E-UTRA Physical Layer Procedures, Release 10; 3GPP TS 36.213, V10.10.0, June 2013

[7] Technical Specification Group Radio Access Network; E-UTRA Physical Channels and Modulation, Release 10; 3GPP TS 36.211, V10.7.0, February 2013

[8] Rohde & Schwarz: Measuring Multistandard Radio Base Stations according to TS 37.141, Application Note 1MA198, July 2012

[9] Rohde & Schwarz: LTE-Advanced (3GPP Rel.11) Technology Introduction, White Paper 1MA232, July 2013

[10] Rohde & Schwarz: LTE-Advanced (3GPP Rel.12) Technology Introduction, White Paper 1MA252, June 2014

4.3 Additional Information

Please send your comments and suggestions regarding this white paper to

TM-Applications@rohde-schwarz.com

4.4 Ordering Information

Ordering Information for Signal Generators			
Vector Signal Generator			
Product Description	Туре	Ordering No.	
Vector Signal Generator	SMW200A	1412.0000.02	
Baseband Generator	SMW-B10	1413.1200.02	
Baseband Generator	SMW-B11	1159.8411.02	
Baseband Main Module	SMW-B13	1141.8003.04	
Fading Simulator	SMW-B14	1413.1500.02	
1₅t RF path	SMW-B10x		
2nd RF path	SMW-B20x		
AWGN	SMW-K62	1413.3484.02	
Digital Standard LTE/EUTRA	SMW-K55	1413.4180.02	
LTE Release 10 / LTE-Advanced	SMW-K85	1413.5487.02	
LTE Release 13/14	SMW-K119	1414.3542.02	
Cellular IoT	SMW-K115	1414.2723.02	
Dynamic Fading	SMW-K71	1413.3532.02	
MIMO Fading/Routing	SMW-K74	1413.3632.02	
Differential Analog I/Q Outputs	SMW-K16	1413.3384.02	
Digital Baseband Output	SMW-K18	1413.3432.02	
Signal Generator			
Product Description	Туре	Ordering No.	
SGMA RF Source	SGS100A	1416.0505.02	
SGMA RF Source	SGT100A	1419.4501.02	

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Environmental commitment

- Energy-efficient products
- Continuous improvement in environmental sustainability
- ISO 14001-certified environmental management system



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