

5G OTA FR1 EN DC

First Test results for 5G OTA antenna TRP & TRS in FR1



Momar GOUMBALLE
senior radio expert
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This document is for to clarify test method for OTA Antenna in EN DC FR1 bands

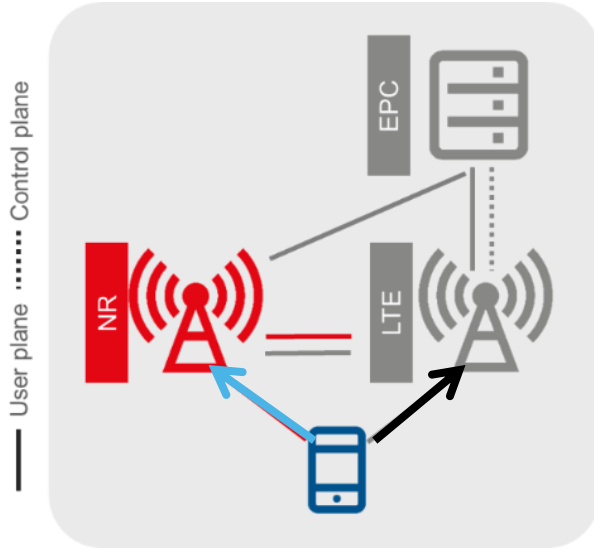
Also some first test results are shown

and possible requirement in TS24 to be considered

Total Radiated Power in EN DC FR1

different type of transmission possible in EN DC FR1

NSA (EN DC FR1)



- **Equally shared power** 50%-50% between LTE and NR
- **Dynamically shared power** (depending on the location and radio condition power on LTE can be higher than NR and vice versa
- **Single uplink** means for certain combination only one Uplink is allowed

Power class :

Power class 3 : 23 dBm (+2 /-3 dB)

Power class 2: 26 dBm (+2 /-3 dB)

Testing configuration

Given that antenna efficiency is first target , TRP can be evaluated with equal power shared mode,

However we should study ways to evaluate the dynamic power sharing maybe with a new KPI , to see how device behaves in live network

Also to consider test scenario which check the max power on NR when LTE power is lowest

when device is a PC3 , then 20 dBm -20 dBm will be considered as conducted power on both RATs LTE and NR respectively

if device is a PC2 , then 23 dBm- 23 dBm will be considered as conducted power on both RATs (LTE & NR)

Theoretical calculation of TRP

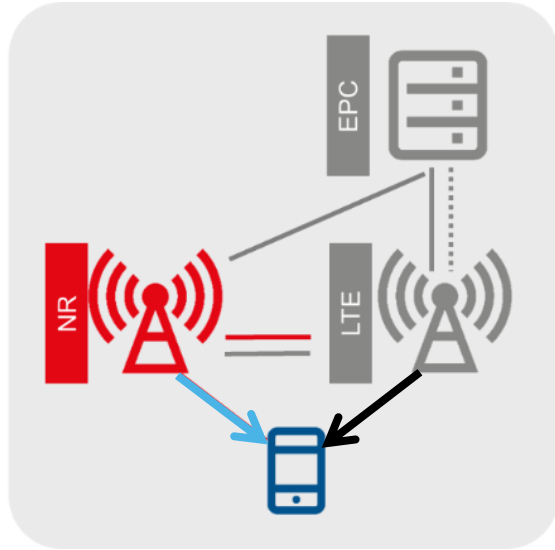
if conducted power is 23 dBm → TRP can be expected to be 19 dBm , means -5 dB losses (that includes efficiency , mismatch etc...)

Total Radiated Sensitivity in EN DC FR1

4 Rx Antenna

NSA (EN DC FR1)

— User plane Control plane



5G device will support 4 Rx antenna receivers on certain bands such as n78 ,n77 etc....

That will lead to better downlink and better MIMO experience

TRS can be measured in similar way to LTE but requirements for certain band can be tighter

Test can be done in different bandwidth configuration however it could be interesting to have similar configuration to LTE testing so that antenna performance can be compared

Theoretical calculation of TRS requirement

if conducted sensitivity on one port antenna is -95 dBm → TRS can be expected to be -90 dBm , means -5 dB losses (that includes efficiency , mismatch etc...) but due to Rx diversity TRS=-93 dBm can be achieved

conducted sensitivity for LTE bands

extract TS 36.521 -1

Channel bandwidth							
E-UTRA Band	1.4 MHz (dBm)	3 MHz (dBm)	5 MHz (dBm)	10 MHz (dBm)	15 MHz (dBm)	20 MHz (dBm)	Duplex Mode
1	-	-	-99.3	-96.3	-94.5	-93.3	FDD
2	-102.0	-99.0	-97.3	-94.3	-92.5	-91.3	FDD
3	-101.0	-98.0	-96.3	-93.3	-91.5	-90.3	FDD
4	-104.0	-101	-99.3	-96.3	-94.5	-93.3	FDD
5	-102.5	-99.5	-97.3	-94.3			FDD
6	-	-	-99.3	-96.3			FDD
7	-	-	-97.3	-94.3	-92.5	-91.3	FDD
8	-101.5	-98.5	-96.3	-93.3			FDD
9	-	-	-98.3	-95.3	-93.5	-92.3	FDD
10	-	-	-99.3	-96.3	-94.5	-93.3	FDD
11	-	-	-99.3	-96.3			FDD
12	-101.0	-98.0	-96.3	-93.3			FDD
13			-96.3	-93.3			FDD
14		-	-96.3	-93.3			FDD

+3 dB every time we multiply by 2

conducted sensitivity 5G NR bands

extract for TS 38.521-1

Operating band / SCS / Channel bandwidth / Duplex-mode														
Operating Band	SCS kHz	5 MHz (dBm)	10 MHz (dBm)	15 MHz (dBm)	20 MHz (dBm)	25 MHz (dBm)	30 MHz (dBm)	40 MHz (dBm)	50 MHz (dBm)	60 MHz (dBm)	80 MHz (dBm)	90 MHz (dBm)	100 MHz (dBm)	Duplex Mode
n1	15	-100.0	-96.8	-95.0	-93.8									FDD
	30		-97.1	-95.1	-94.0									
	60		-97.5	-95.4	-94.2									
	30		-93.6	-91.6	-90.5									
	60		-94.0	-91.9	-90.7									
	30		-97.1	-95.1	-94.0	-92.8								
	60		-97.5	-95.4	-94.2	-93.0								
n77(3.3 to 3.8 GHz) ¹	15		-95.8	-94.0	-92.7			-89.6	-88.6					TDD
	30		-96.1	-94.1	-92.9			-89.7	-88.7	-87.9	-86.6	-86.1	-85.6	
	60		-96.5	-94.4	-93.1			-89.9	-88.8	-88.0	-86.7	-86.2	-85.7	
n77 ¹	15		-95.3	-93.5	-92.2			-89.1	-88.1					TDD
	30		-95.6	-93.6	-92.4			-89.2	-88.2	-87.4	-86.1	-85.6	-85.1	
	60		-96.0	-93.9	-92.6			-89.4	-88.3	-87.5	-86.2	-85.7	-85.2	
n78 ¹	15		-95.8	-94.0	-92.7			-89.6	-88.6					TDD
	30		-96.1	-94.1	-92.9			-89.7	-88.7	-87.9	-86.6	-86.1	-85.6	
	60		-96.5	-94.4	-93.1			-89.9	-88.8	-88.0	-86.7	-86.2	-85.7	
	30							-89.7	-88.7	-87.9	-86.6		-85.6	
	60							-89.9	-88.8	-88.0	-86.7		-85.7	
NOTE 1:	Four Rx antenna ports shall be the baseline for this operating band except for two Rx vehicular UE.													
NOTE 2:	The transmitter shall be set to P _{UMAX} as defined in subclause 6.2.4.													
NOTE 3:	The requirement is modified by -0.5 dB when the assigned NR channel bandwidth is confined within 1475.9-1510.9 MHz													

table is for 2 RX ports and when device is supporting 4 Rx in Band n78 for instance -2.2 dB is to be applied

Possible requirements in TS 24 V4 for EN DC FR1 bands

LTE performance defined in GSMA TS24V3

example of LTE Band 7

→ TRP =18.5 dBm

→ TRS =-94 dBm

5G FR1 EN DC

possible values

Power is shared between NR link and LTE link

Equally shared (50%-50%) → TRP LTE =15.5 dBm

→ TRP NR = 15.5 dBm

sensitivity is 2 times improved since 4Rx are by default in 5G devices except vehicular devices for band n78

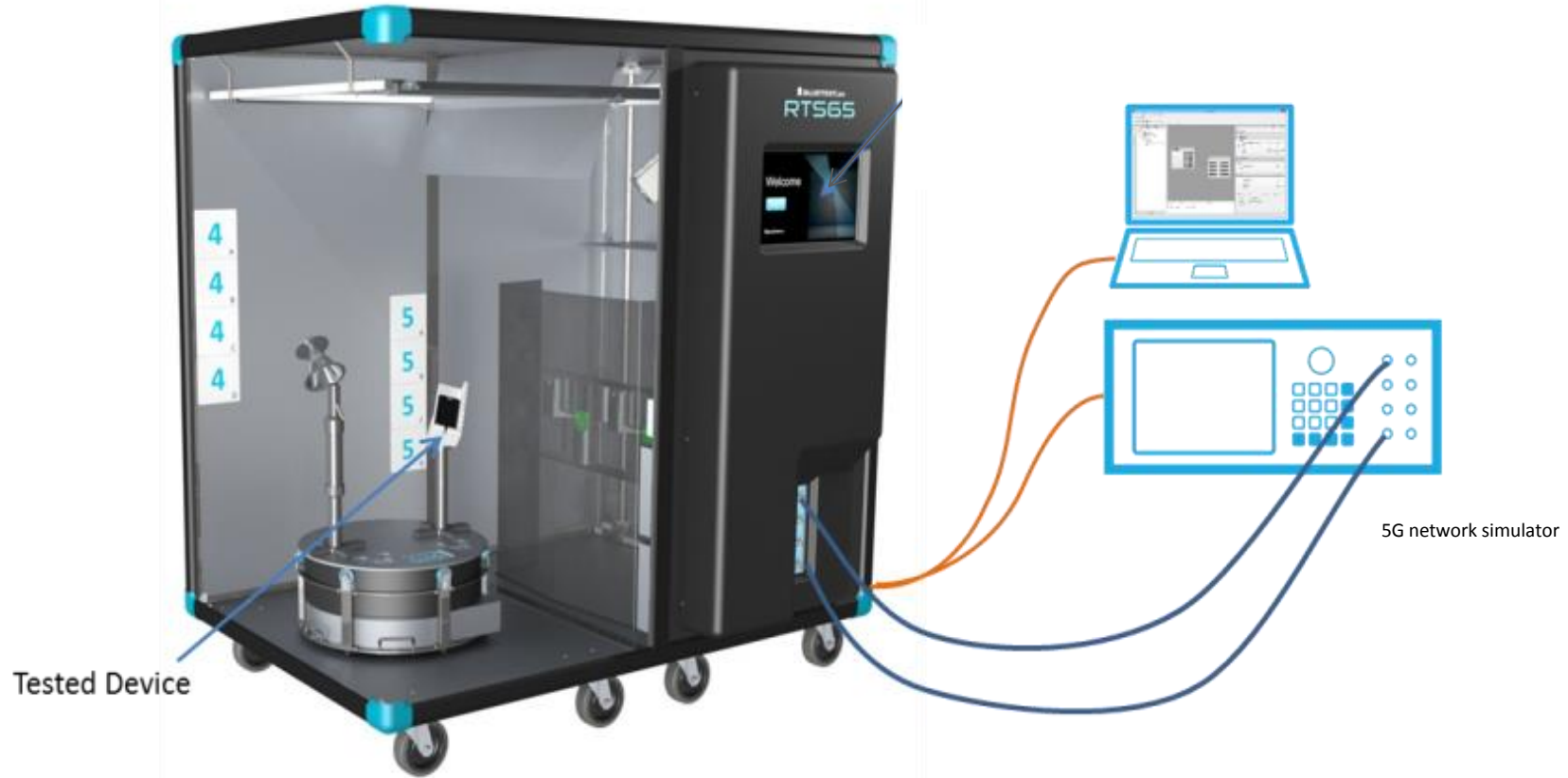
therefore possible TRS

→ TRS on NR = -97 dBm

→ TRS on LTE = TS24V3 value

Note 1 : If the LTE band is also a NR band then 3 dB improvement can be expected on TRS

Lab configuration



Test Results for TRP EN DC 28A-n78A

TRP in EN-DC 28A,n78A

Power measured simultaneously on both RATs

	TRP [dBm] (Total)	LTE PCC	NR PCC
Device 1	17.9	14.5	15.2
Device 2	19.3	17.6	14.5
Device 3	18.3	5.2*	18.06
Device 4	19.8	14.9	18.1
Device 5	18	6.2*	17.7
Device 6	23.4	17.1	22.3
Device 7	17.17	14.86	13.3
Device 8	18.7	16.7	14.3

8 devices from smartphones, CPE and MIFI

* Device 3 and Device 5 have been tested with samples that are locked on NR transmit power

Test results TRS

Test configuration with BW=100 MHz and SCS =30 KHz

Device	TIS NR n78 (dBm)
Device 1	-82,91
Device 2	-86.88
Device 3	-79.9
Device 4	-86,9
Device 5	-84.5
Device 6	-86.6
Device 7	-84,3
Device 8	-82,2

Extrapolation Test results TRS on 10MHz

Device	TIS NR n78 (dBm)
Device 1	-92,91
Device 2	-96.88
Device 3	-89.9
Device 4	-96,9
Device 5	-94.5
Device 6	-96.6
Device 7	-94,3
Device 8	-92,2

Proposal on next version of TS 24 V4

To include 5G FR1 EN DC requirements as follow :

- TRP to be evaluated in equally power sharing (50%-50%)

and define requirement for power class 2 and power class 3

furthermore we need to evaluate the dynamic power sharing test method including to check the max power on NR that can be reached while LTE is at 0 dBm

- TRS to be evaluated in Combined –TIS and requirement to be set per bandwidth

e.g. -86dBm/100 MHz \leftrightarrow -96 dBm/10 MHz

But testing configuration for EN DC to be as close as possible to LTE testing configuration so that results can be comparable

e.g. option 1 : Test with 10 MHz BW and (SCS =15 KHz or 30 KHz) or ,

option 2: Test with 20 MHz BW NR and LTE (in this case LTE test in TS 24V3 can be modify to 20 MHz BW) in order to align LTE and 5G NR EN DC tests

A single point measurement can be added to check the EIS with max bandwidth supported

Thanks !

**should you have question please feel free to contact
momar.goumballe@orange.com**