

Conformance Test User Meeting 2023

RF/RRM CONFORMANCE TESTING FOR FR1 / FR2

(+TS8991 UPDATES)

Harald Gsoedl
Product Management

ROHDE & SCHWARZ

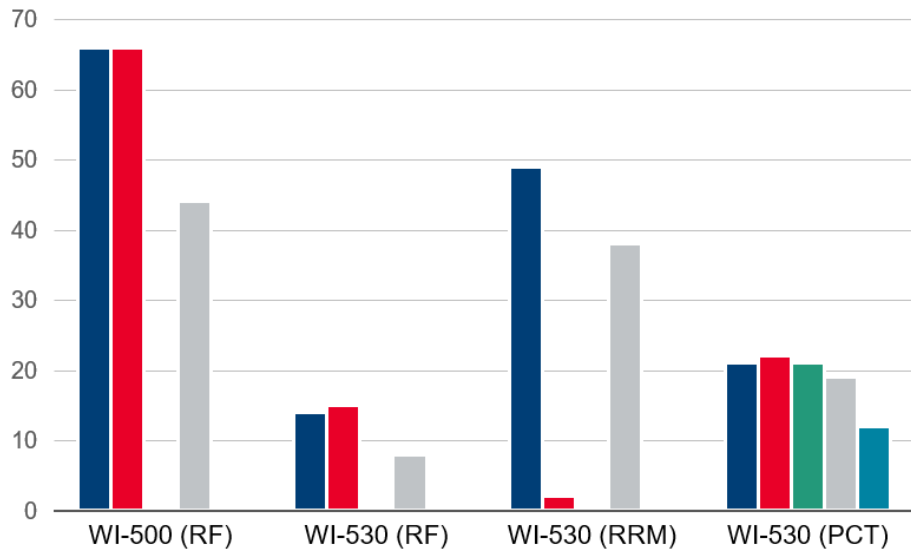
Make ideas real



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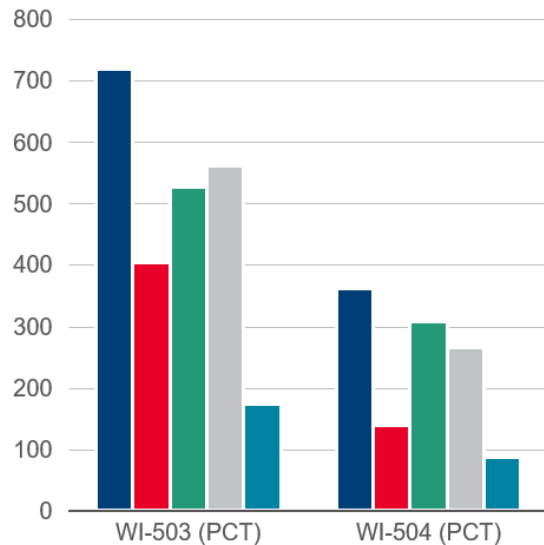
GCF – REDCAP VALIDATION SUBMISSIONS FOR CAG#74 (P1 ONLY)

RF/RRM/PCT WI-500 & 530



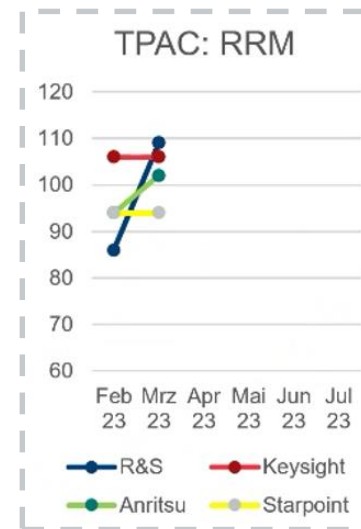
Rohde & Schwarz  Keysight Technologies  Anritsu  StarPoint  Datang

PCT WI-503 & 504



R&S 5G RF/RRM OVERALL HIGHLIGHTS

- **#1 or 2 in test coverage for:**
 - FR1&2 RF&RRM NetOp (AT&T, VzW, TMO)
 - FR2 RF 3gpp
 - FR1&2 RRM 3gpp
 - #1 in terms of reaching the TPAC (Test Platform Acceptance Criteria) in the most RRM-related sub-Wis



TPAC analysis based on
3.88.00 16th March 2023

Rohde & Schwarz paves way for mandatory mobile device RRM certification from GCF for 5G NR FR2 frequencies

The R&S TS-RRM-NR 5G conformance test system from Rohde & Schwarz is the first test platform to achieve test platform approval criteria (TPAC) from the GCF certification organization for 5G radio resource management (RRM) at FR2 frequencies. As a consequence, the first RRM conformance FR2 work items have reached “active” status, making them mandatory for mobile device certification. RRM FR2 test cases with one and two angles of arrival (1xAoA and 2xAoA) have been validated in multiple FR2 EN-DC band combinations.



Rohde & Schwarz first to deliver CTIA authorized 5G mmWave test system with multi-AoA capabilities in FR2

Rohde & Schwarz has cooperated with the US based CTIA organization to authorize the first multiple angles of arrival (multi-AoA) test system for CTIA OTA performance certification. The solution is based on the successful conformance test system R&S TS8980 while also leveraging the R&S CMX500 5G tester together with the R&S ATS1800M mmWave (FR2) chamber from the advanced chamber portfolio from Rohde & Schwarz.



MWC'23 BARCELONA – RF FR2 OUT OF BAND DEMO SPURIOUS EMISSION WITH AUTOMATED FEED SWITCHER



5G FR1: RF / RRM

3GPP CONFORMANCE VALIDATION ROADMAP

5G FR1 RF / RRM



Release 15

- RF: WI500/502/510/512
 - ✓ 80% of 1CC TX/RX (Q2); 90% July; 100% Dec
 - ✓ 88% (30/34) UL MIMO (Q2); 100% July
 - ✓ 80% of PX (Q2); 95% July; 100% Dec
 - ✓ 80% of 2CA UL/DL (Q2); 90% July; 100% Dec
 - ✓ 100% of 3CC DL (Dec)
- RRM: WI501/510/513
 - ✓ **95%** of RRM (now); 98% (Q2); 100% (July)

Release 16

- ✓ RF
 - ✓ **100%** PX 2CC Interband (Q2)
 - ✓ 100% PX HST-DPS (July)
 - ✓ 100% CQI w/ Table 3, RX 3CC (Dec)
 - ✓ 100% Other R16 1H 2024
- RRM
 - ✓ **100%** HST (now)
 - ✓ 100% Power Savings (Dec)
 - ✓ 30% Mobility Enhancements (now); 100% (Dec.)

Release 17 RedCap: WI500/502/530

- ✓ May: **100%** of defined TX & RX ; 75% of defined PX; 10 TC of RRM
- ✓ July: **100%** of defined PX; 20 TC of RRM
- ✓ December: 60 TC of RRM

3GPP CONFORMANCE (FOOTPRINT REDUCTION) 5G FR1 RF / RRM



CMX500 OBT support
H2 / 2023 for 5G systems



TS8980S-3A (TP298)
TS-RRM-NR (TP296)

TS8980FTA-3A (TP298/TP296)
TS8980PRE-3A

TS8980FTA-3A UPGRADE FROM LTE TS8980FTA3 FOR 5G FR1 RF / RRM

GCF / PTCRB TP 96 / 98 for 2G / 3G / 4G

+ TP 296 / 298 for 5G

SMW 6/20 GHz
(must have 500 MHz BW)

✓ **FSW26 GHz**

✓ **SSCU3**

✓ **CMWC**

✓ **Rubidium refer.**

Existing CMWs
(Must have TRX160 / MUA)

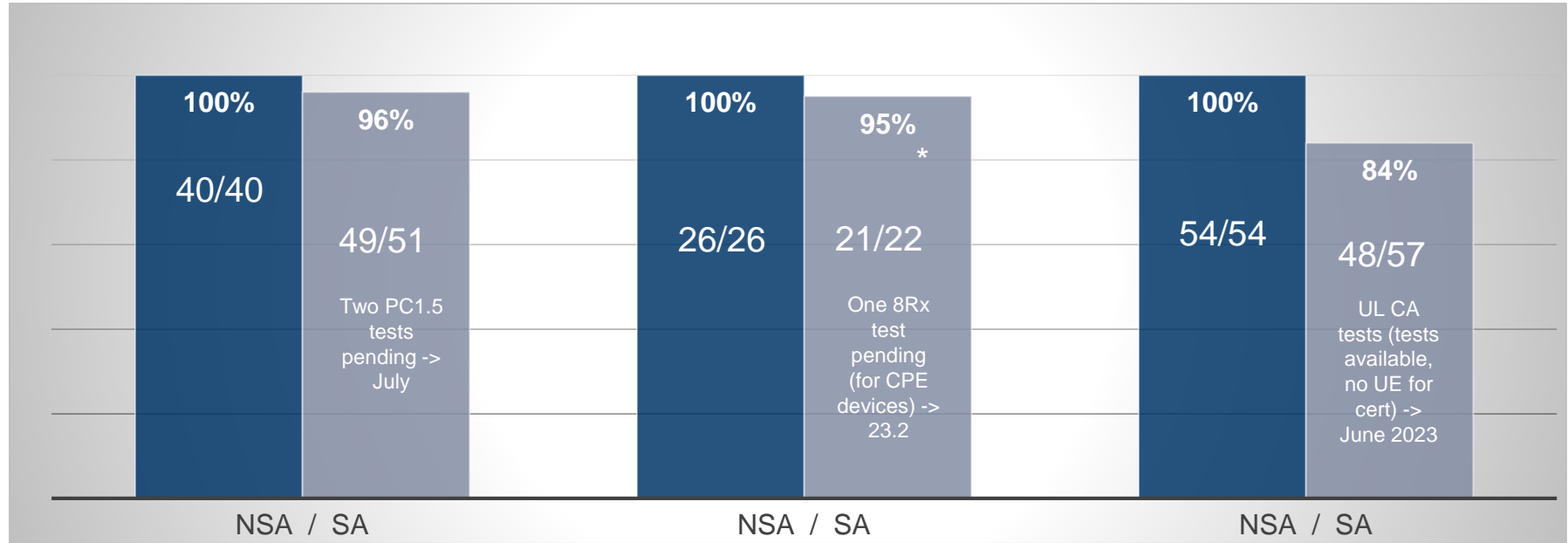
① **New cooling concept**

① **New CMX**

① **New power distribution**



5G FR1 RF NETOP STATUS – TEST CASE COVERAGE



T-Mobile

Q2 23 QC: May



at&t

10776 23.1: May



Feb 2023



CONTEST

- ▶ Same CONTEST and enhancements have continued over the years
- ▶ Synchronization of RF and RRM version release
 - change of device FW not necessary
 - reduces downtime
- ▶ Customized bandwidth selection according to UE capabilities:
 - Channel bandwidth selection
 - SCS selection

Report Filter																	
Verdict (3)		Band (11)		Test Case Name (3)			DUT (8)			Software Version (1)							
< All >		< All >		< All >			< All >			< All >							
Failed with Restrictions (14)		FDD 1 (10)		6.6.3.3_1 FDD - Additional spurious emissions f...			Dut.Fta-2a.2A.Max (36)			BASE-16.00 (16.00.0.149) (166)							
Not Applicable (18)		FDD 12 (12)		6.6.3EA.3 FDD - Additional spurious emissions ...			Dut.Fta-2a.Cat0.Max (3)										
Passed with Restrictions (134)		FDD 13 (5)		9.2.1.3_C.1 FDD - FDD CQI Reporting under A...			Dut.Fta-2C.2A.Max (43)										
		FDD 19 (13)					Dut.Fta-2C.Cat0.Max (21)										
		FDD 20 (12)					Dut.Fta-3.2A.Max (37)										
		FDD 21 (9)					Dut.Fta-3.Cat0.Max (10)										
		FDD 26 (56)					Dut.TS-EXTENDED-2E.2A.Min (8)										
Grouped Test Case Runs																	
Test Case				Verdict	Band			FDD 1	FDD 12	FDD 13	FDD 19	FDD 20					
6.6.3.3_1 FDD - Additional spurious emissions for UL 64QAM					108 103 0 5 0												
6.6.3EA.3 FDD - Additional spurious emissions for UE category M1					34 31 0 3 0												
9.2.1.3_C.1 FDD - FDD CQI Reporting under AWGN conditions - PUCCH 1-0 for eCIC (non-MBSFN ABS)					24 0 0 6 18												
Test Case Runs																	
Drag a column header and drop it here to group by that column																	
Test Case Number	Test Case Name	Test Plan Name	Test Plan Run	Verdict	Band	Test Frequency ID	Bandwidth	Start-Time	End-Time								
LTE 8.2.1.1.1_A.1_A FDD	FDD PDSCH Single /		8.2.1.1.1_A.1_A_2015	Passed	FDD 2/FDD 17	Mid/Mid	10 MHz/10 MHz	2015-09-23 10:	2015-09-23 10:								
LTE 8.2.1.1.1_A.1_A FDD	FDD PDSCH Single /		8.2.1.1.1_A.1_A_2015	Passed	FDD 2/FDD 17	Mid/Mid	10 MHz/10 MHz	2015-09-23 10:	2015-09-23 10:								
LTE 8.2.1.1.1_A.1_A FDD	FDD PDSCH Single /		8.2.1.1.1_A.1_A_2015	Passed	FDD 2/FDD 17	Mid/Mid	10 MHz/10 MHz	2015-09-23 10:	2015-09-23 10:								
LTE 8.2.1.1.1_A.1_A FDD	FDD PDSCH Single /		8.2.1.1.1_A.1_A_2015	Passed	FDD 2/FDD 17	Mid/Mid	10 MHz/10 MHz	2015-09-23 10:	2015-09-23 10:								
Selected Test Cases:				0	Execution Time: Sum.		Ave.	Std.Dev.	Min.	Max.							
All Test Cases:				20	Execution Time: Sum.		1:01:15.1	Ave. 0:03:03.8	Std.Dev. 0:02:25.8	Min. 0:02:23.7	Max. 0:13:38.7						
Test Case Runs				Grouped Measurement Reports													

5G FR2: RF / RRM

TS8980FTA-M1 / PRE-M1

5G FR2 RF + RRM (3GPP CONFORMANCE + NETOP)

T-Mobile



RF in-band
RRM 1AOA



ATS1800C

RF in-band + out-of-band
RRM 1AOA



ATS1800C
(with automatic feed switcher)

RF in-band + out-of-band
RRM 1AOA + 2AOA



ATS1800M
(with automatic feed switcher)

R&S 5G RF/RRM FR2 HIGHLIGHTS

- Best CATR footprint
- Vertical Designed CATR chamber in two flavors:
 - ATS1800C (1AoA) & ATS1800M (M-AoA)
- CTIA FR2 OTA on the same FR2 RF TS8980 system (with SPEAG phantoms)
- 20kg / 45cm Diameter device size for FR2 (3D measurements still possible)
- 2AoA FR2 RRM using Multi-CATR (ATS1800M)
 - All-in-one ATS FR2 chamber: IB, OOB, RRM, BP search
 - All UE antenna configs supported
 - No Vendor antenna config declaration required



ATS1800M



ATS1800C

3GPP CONFORMANCE VALIDATION ROADMAP

5G FR2 RF / RRM



RF

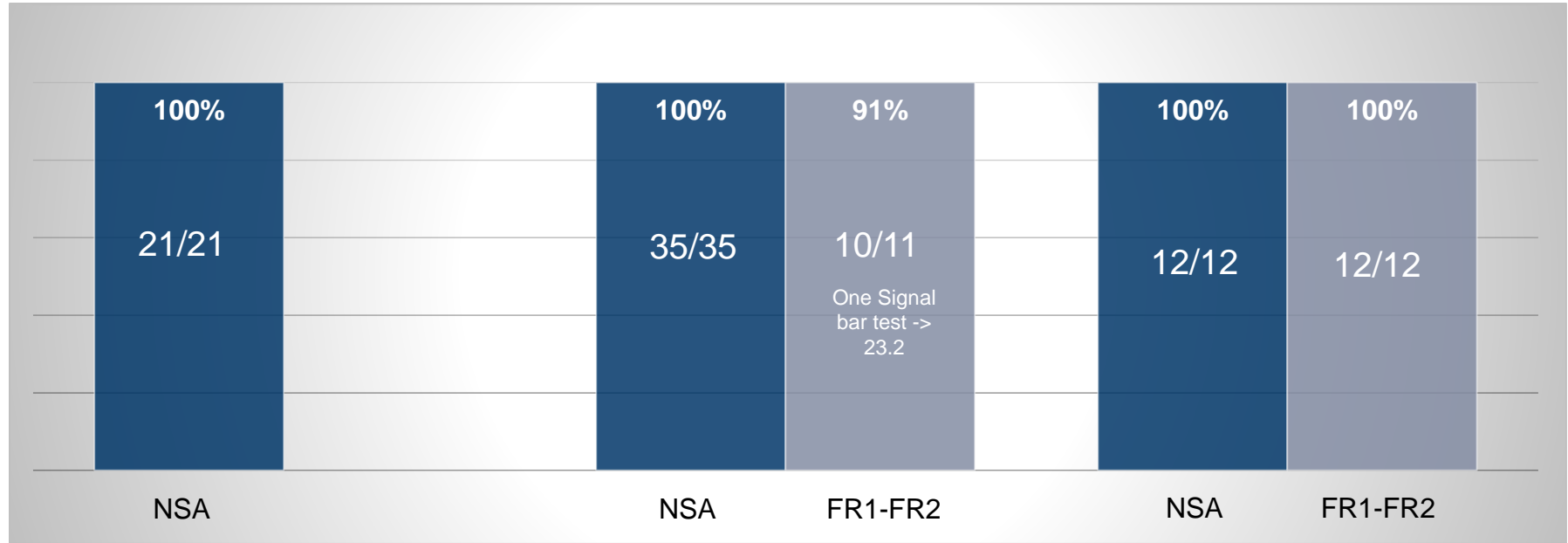
- WI500
 - ✓ **100%** (Q2)
- WI502
 - ✓ **90%** (Q2); 95% (July); 100% Dec
- WI510/512
 - ✓ **90%** (Q2); 95% (July); 100% Dec

RRM


- ✓ WI501/510
 - ✓ **90%** (Q2); 95% (July); 100% Dec



5G FR2 RF NETOP STATUS – TEST CASE COVERAGE

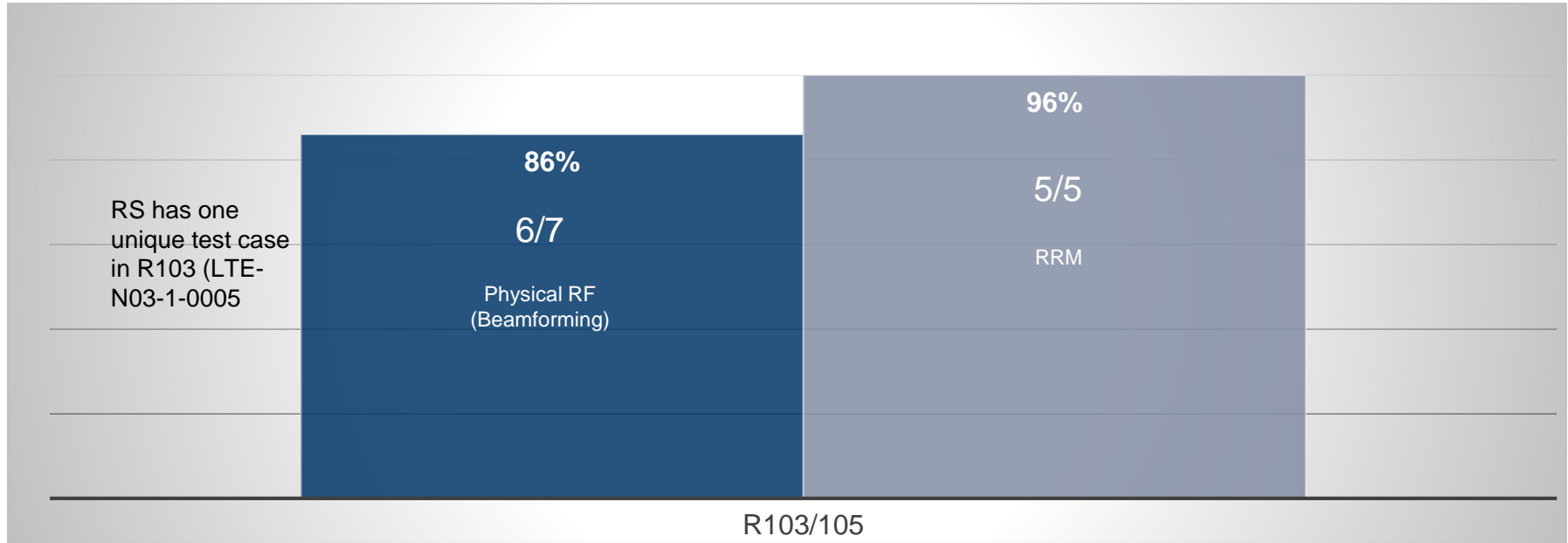


T-Mobile
Q2 23 QC: Q2


at&t
10776 23.1: Q2


verizon
Feb 2023

5G FR2 RRM NETOP STATUS – TEST CASE COVERAGE



R&S developing LTE-N03-1-0007 FR2 beam angle test (potentially others) on ATS1800M for 23.2



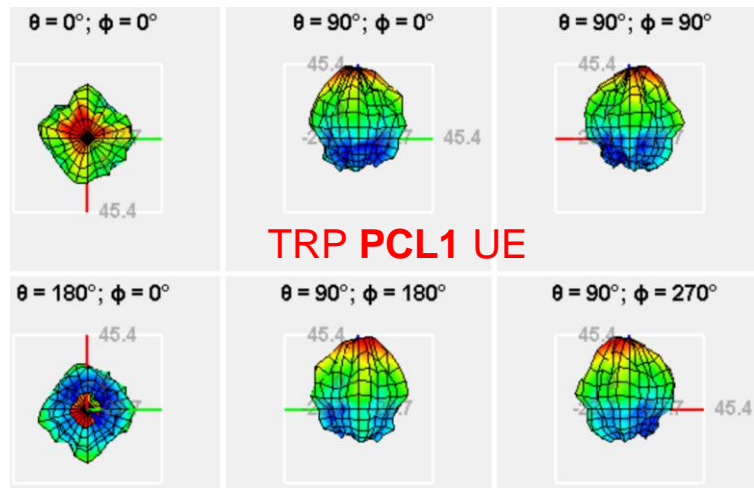
at&t

10776 23.1: Q2

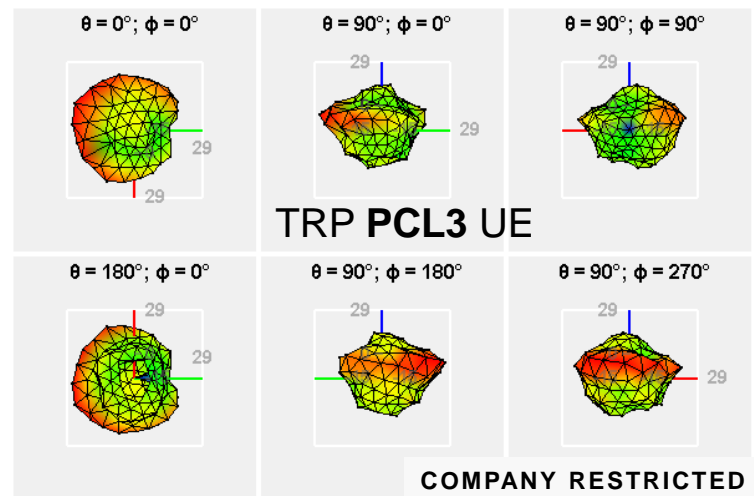


RELEASED FEATURES

- Power Class **1**, 2, 3, 4, 5
- All types of grids
e.g. Step-Step, Charged Particle
- All UE alignments
- Resume functionality
- Early passed / fail for spherical coverage
- RX Beam Search **RSRPB** based (faster!)
- CBW 50MHz, 100MHz, **200MHz**



TRP PCL1 UE



TRP PCL3 UE

TS8980 FOR RF & RRM IN FR2

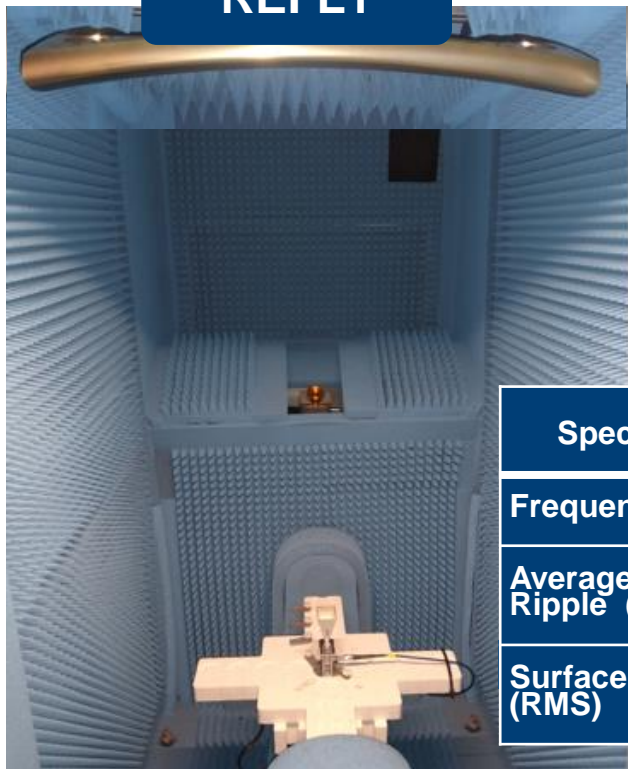
Hot topics



- 1) Larger reflector -> larger QZ
- 2) Full 3D temperature testing
- 3) Automatic feed antenna switcher
- 4) New spurious emissions unit SE90

INCREASED QUIET ZONE SIZE 30CM → 40CM

REFL1



Field upgrade for

- **ATS1800C K03**
(Facelift)
- **ATS1800M**
available

Specification	Value
Frequency Range	6 GHz to 90 GHz +
Average Amplitude Ripple (Inband)	< 0.5 dB
Surface roughness (RMS)	< 1 μm

REFL6



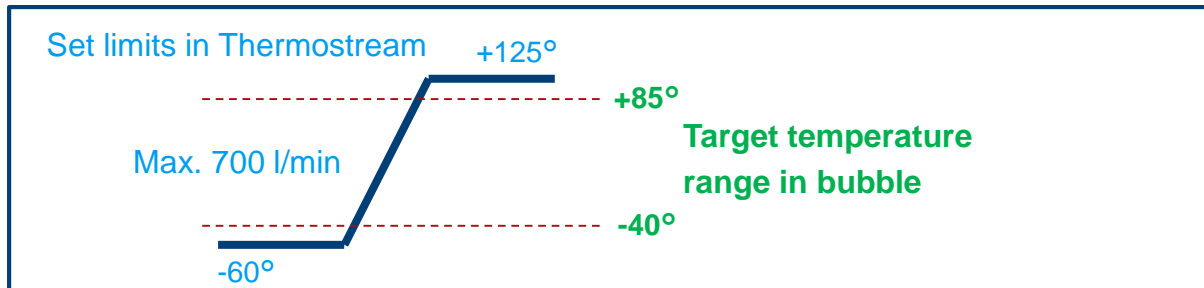
TS8980 FOR RF & RRM IN FR2

Hot topics



- 1) Larger reflector -> larger QZ
- 2) Full 3D temperature testing
- 3) Automatic feed antenna switcher
- 4) New spurious emissions unit SE90

EXTREME TEMPERATURES



Specification	Value	Notes
Frequency Range	18-90 GHz	In-band and OOB measurements
Temperature Range	-40 to +85 °C	Extended range compared to 3GPP
Movement Range	No limitation to positioner movement	Elevation +/-90°

TS8980 FOR RF & RRM IN FR2

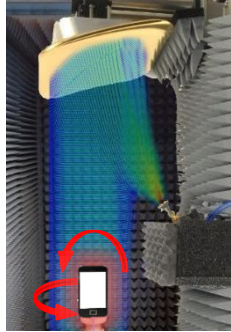
Hot topics



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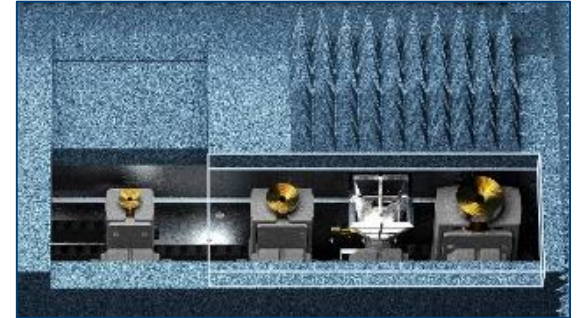
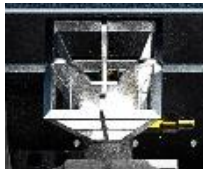
SPURIOUS IN FR2 ? ➔ 6 – 90 GHz !

- ▶ **Why 90 GHz ?**
 - ➔ 2nd harmonic of 45 GHz
- ▶ **Why more than 1 feed antenna?**
 - High gain + optimum directivity
 - ➔ 4 feed antennas needed



Fully automatic feed switcher

- ✓ Fits both ATS1800C and M
- ✓ No manual interaction needed
- ✓ In-field upgrade possible
- ✓ For 24/7 operation



TS8980 FOR RF & RRM IN FR2

Hot topics



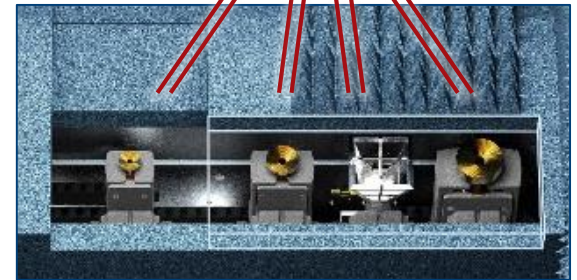
- 1) Larger reflector -> larger QZ
- 2) Full 3D temperature testing
- 3) Automatic feed antenna switch
- 4) New spurious emissions unit SE90

HOW TO COMBINE?



FSW85: only 2 ↑↑ inputs

from DUT: 8 ? outputs



THE SOLUTION FOR SPURIOUS EMISSIONS: NEW SSCU-SE90

SSCU-SE90



FSW85



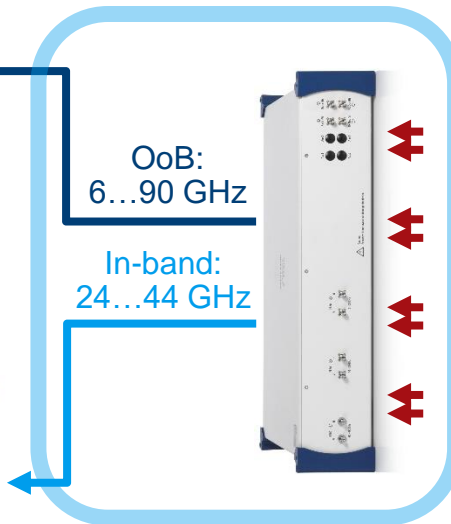
CMX



HEAD

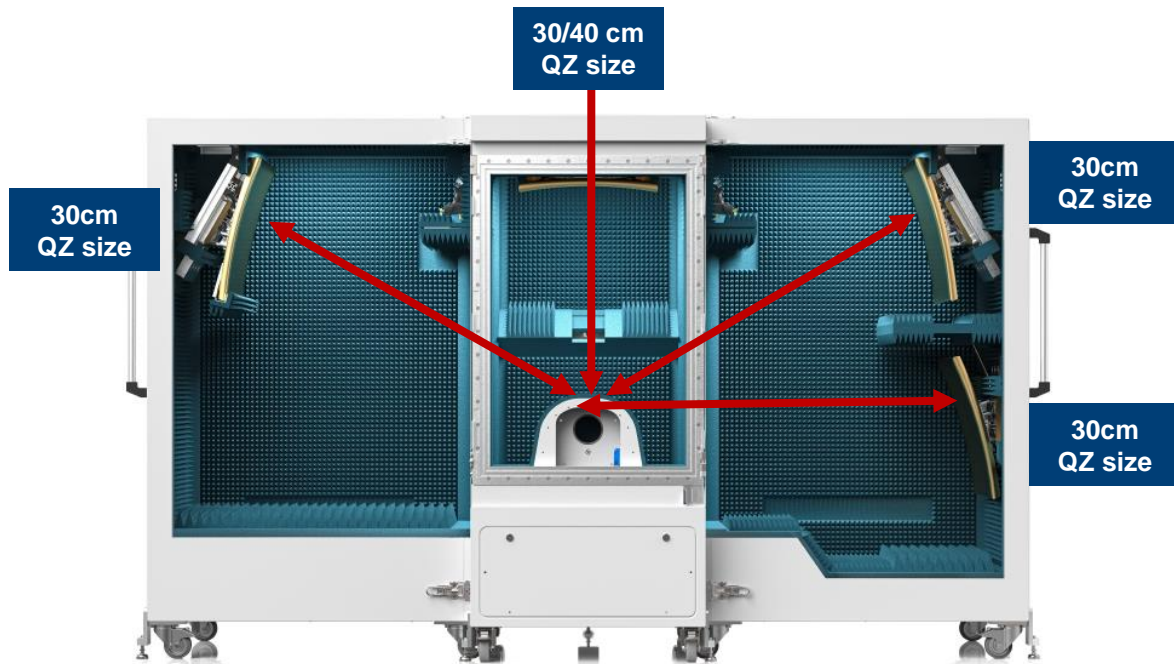


RF42



ATS1800M FOR RRM 2AOA

UE Ant. Config	Antennas	AoA	IFF-IFF (Enh. IFF)
1	Single Panel	1AoA	Yes
		2AoA	Yes
2	Multi Non-coh. Panel	1AoA	Yes
		2AoA	Yes
3	Multi Coherent Panel	1AoA	Yes
		2AoA	Yes



**Only R&S supports all
test methods!**

5G FR1: OTA (CTIA)

TS8991 SUCCESS STORIES

5G upgrades for
installed base

- ▶ ~ 20 setups sold worldwide
- ▶ 3 FVT systems sold
(Full Vehicle Test)



- Full solution supporting 3GPP, CTIA SISO and A-GNSS for legacy and 5G
- Fast and easy to handle single antenna test system
- One-stop-shopping
- Worldwide installed base „Made in Germany“

5G FR1 UPGRADE – NOW WITH OBT LITE

Hardware upgrade

- CMX500 (OBT lite)
- 2x NRQ6
- OSP320
- accessories: cable set, power amplifier, rack

Software upgrade

- 5G NSA / SA supported on Contest
- legacy (2G/3G/4G) remains on AMS32 using CMW500



easy 5G upgrade path

Thank you very much

ROHDE & SCHWARZ

Make ideas real



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Conformance Test User Meeting 2023

5G NR PROTOCOL CONFORMANCE

**Product Management Mobile Conformance and
Operator Testing**

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5GS TTCN-3 ROADMAP + DRAFT ATS DELIVERY SCHEDULE

Date	ATS	Comments
02/12/22	22wk49	Rel-15 : 486 TCs + Rel-15 applicable TCs for Redcap UEs (268 TCs) Rel-16: 165 TCs Rel-17 : 11 TCs, IMS: 97 TCs
24/03/23	23wk12	New Rel-17 Redcap TCs New Rel 17 network enhancement TCs
16/06/23	23wk24	New NB-IoT NTN TCs New SON/MDT enhancements New Network Slicing enhancements
15/09/23	23wk37	

R&S CMX500 (TP 292) VALIDATION STATUS

GCF (CAG#73) and PTCRB (PVG#100)

- Total **537 individual EN-DC and NR PCT** test cases validated
- Currently **469 TC** validated at PTCRB
- **> 9100** band combinations in GCF,
- **>7500** band combinations in PTCRB submitted
- **R&S PCT is leading in GCF individual TC validation**
- **R&S PCT is leading in Rel16 GCF validation**

Internal verification status

- 584 TC now verified,
- Including 94 IMS test cases
- Including 68 Rel-16 test cases (DAPS, NS, MDT, RACS, CAG, SNPN)
- **First 3 Rel17 RedCap TCs verified + 159 TCs for Rel15 RedCap variants**



TP 292



R&S
CMX500

R&S CMX500 (TP 292) VALIDATION STATUS

Work Item	Title	R&S TP292	Vendor 1	Vendor 2	Vendor 3	Vendor 4
WI-503	5G AS Protocol	243	239	226	232	243
WI-504	5G NAS Protocol	74	74	76	75	74
WI-505	5G IMS	93	91	93	93	85
WI-510	5G - SA CA	30	25	30	30	30
WI-512	5G EN-DC CA	5	7	2		7
WI-513	NR-LTE interworking	39	39	39	39	38
WI-516	NR SON & MDT	3	3	3	2	2
WI-517	NR SON & MDT	31	31	28	30	31
WI-518	Rel 16 Private Network	5			1	5
WI-519	Rel 16 CAG	5	5	5	2	5
WI-522	Rel 16 NR mobility enhancements	5	6	6	4	4
WI-523	Rel 16 eNS	4	4	4	4	4
	Grand Total	537	524	512	512	528



TP 292



**R&S
CMX500**

R&S FLEXX2_CMX NR SIGNALING TESTER FOR PCT

EN-DC / NR & LTE FR1 Test Setup

CMWflexx + CMX500 (NR extension box)

Combiner for FR1:

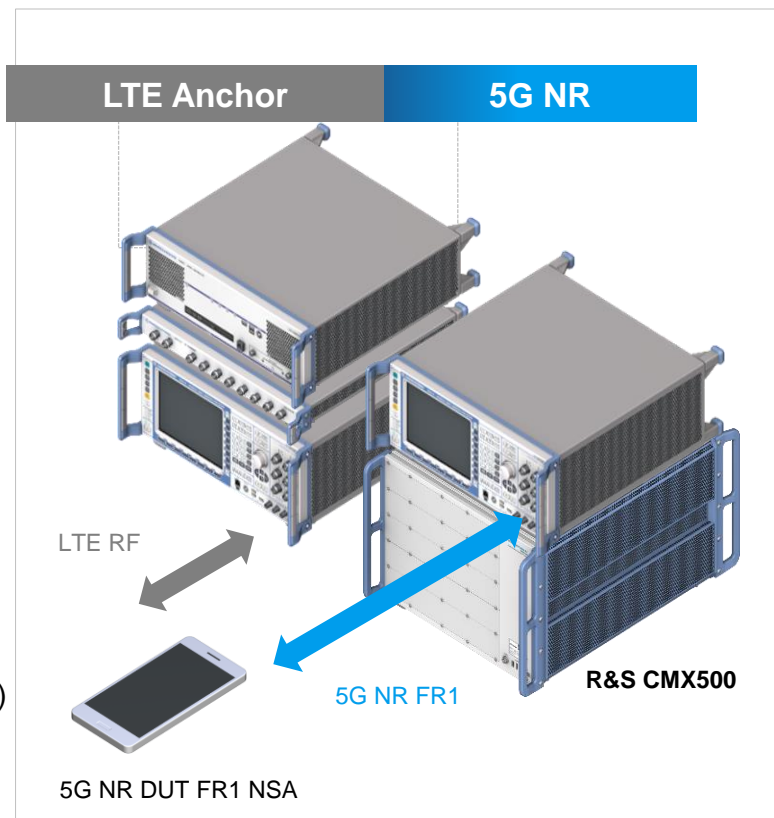
- CMW-Z24 or
- CMW-RF88
- Contest PC

5G EN-DC / NR network simulation

Based on current available test cases

- ~ 85% of the test cases will run on TS-Flexx2_CMX (up to 2 NR cells)
- ~ 10% of the test cases will need a TS-Flexx3_CMX (3 NR cells needed)
- ~ 5% of the test cases will need a TS-Flexx4_CMX (4 NR cells needed)

This is still a valid and supported set-up



R&S CMX NR SIGNALING TESTER FOR PCT WITH OBT

EN-DC / NR & LTE FR1 Test Setup

CMX500

Contest PC is mandatory

5G EN-DC / NR network simulation

Full coverage for NR and EN-DC



R&S CMX500

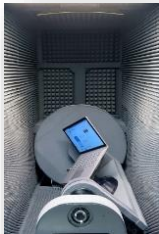


UPGRADE PATH FROM NR FR1 TO FR2

FR1 configuration + **IF boards** + **Remote Radio Head** + **chamber**



CHAMBERS FOR CONFORMANCE & NETOP NR TESTS

Recommended for NetOp and PCT

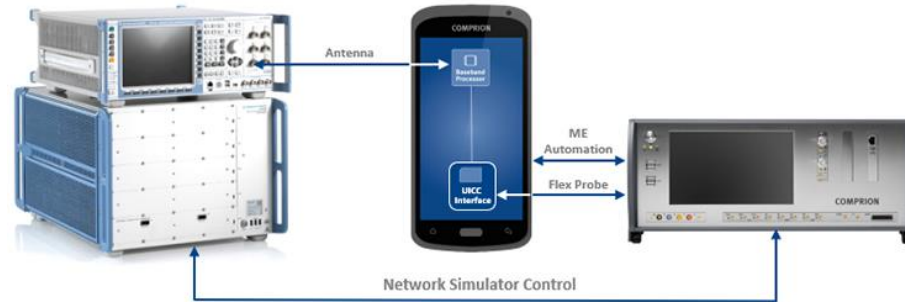
			
	ATS1800C	ATS800R	CMQ500
NPT	compatible	default	compatible
PCT	compatible	default	compatible (for pre-conformance)
PQA	compatible	default	not compatible
LBS	compatible	compatible	default
RRM *	default	not compatible	not compatible
RF	default	not compatible	not compatible

„Default“ refers to most cost efficient solution for the application

* One AoA

5G USIM/USAT

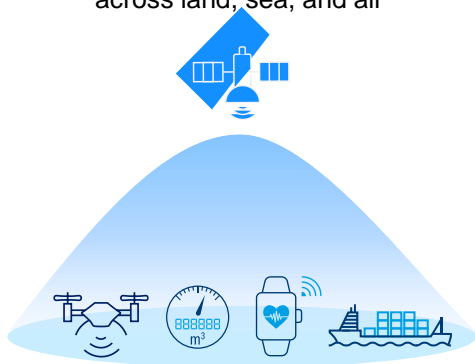
- **5G USIM/USAT, 3GPP TS31.121, GCF WI 508-NR, PTCRB RFT508**
 - **In cooperation with Comprion**
 - Test solution is implemented on CMW500/CMX500 set-up by Comprion
 - Test platform is TP227



HOT TOPIC: 5G NTN HAS ADDRESABLE REVENUE OF \$35B WORLDWIDE BY 2035*

NTN-IoT

Expand to global reach for IoT use cases
across land, sea, and air

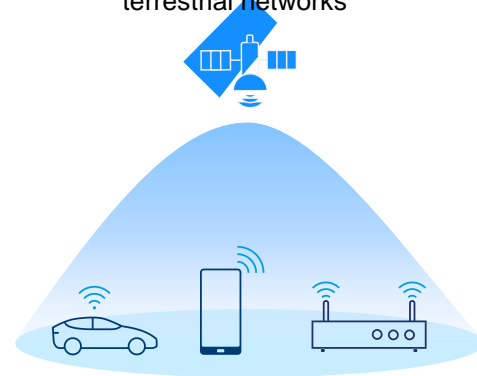


Diverse set of use cases across all verticals e.g.

- Higher resolution of data points in asset tracking and logistics
- Ubiquitous drone connectivity
- Boat position information
- Wearables connectivity
- Operates for both GEO and LEO altitudes, but predominantly GEO
- 8% of IoT market is addressable by NTN-IoT
- Mainly S/L bands

5G NTN-NR

Extended coverage that complements
terrestrial networks



Direct link to smartphones for mission critical
and low data services e.g.

- Disaster recovery
- Emergency services
- Financial services – payments
- Predominantly operates at LEO altitude
- 3G like speeds for smartphones <6GHz
- Fixed broadband services on VSATs >10GHz

Thank you

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