

Report Reference ID:	400107-11TRFWL
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Test specification:	Title 47 – Telecommunication Chapter I – Federal Communications Commission Subchapter A – General Part 24 – Personal Communication Services Subpart E – Broadband PCS
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Applicant:	TEKO Telecom Srl. Via Meucci, 24/a I-40024 Castel S. Pietro Terme (BO) (Italy)
Apparatus:	Very Very High Power Module Amplifier
Model:	MWHPA2001PCS-D2
FCC ID:	XM2-WHPA19HN

Testing laboratory:	Nemko Italy Spa Via del Carroccio, 4 20853 Biassono (MB) – Italy Telephone: +39 039 2201201 Facsimile: +39 039 2201221
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	Name and title	Date
Tested by: (name, function and signature)	 P. Barbieri (project handler)	2020-07-17
Reviewed by: (name, function and signature)	 R. Giampaglia (verifier)	2020-07-17

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Table of contents

Section 1: Report summary	3
1.1 Test specification	3
1.2 Statement of compliance	3
1.3 Exclusions	3
1.4 Registration number	3
1.5 Test report revision history	3
1.6 Limits of responsibility	3
Section 2: Summary of test results	4
2.1 FCC Part 24, test results	4
Section 3: Equipment under test (EUT) and application details	5
3.1 Applicant details	5
3.2 Modular equipment	5
3.3 Product details	5
3.4 Application purpose	5
3.5 Composite/related equipment	6
3.6 Sample information	6
3.7 EUT technical specifications	6
3.8 Accessories and support equipment	7
3.9 Operation of the EUT during testing	8
3.10 EUT setup diagram	8
Section 4: Engineering considerations	9
4.1 Modifications incorporated in the EUT	9
4.2 Deviations from laboratory tests procedures	9
4.3 Technical judgment	9
Section 5: Test conditions	10
5.1 Deviations from laboratory tests procedures	10
5.2 Test conditions, power source and ambient temperatures	10
5.3 Measurement uncertainty	10
5.4 Test equipment	12
Appendix A: Test results	13
Clause 935210 D05v01 (3.2) AGC threshold	13
Clause 935210 D05 (3.3) Out of band rejection	14
Clause 24.238(b) Occupied bandwidth	15
Clause 24.232(a) Peak output power at RF antenna connector	17
Clause 24.238(a) Spurious emissions at RF antenna connector	22
Clause 24.238(a) Radiated Spurious emissions	29
Appendix B: Block diagrams of test set-ups	36
Appendix C: EUT Photos	37

Section 1: Report summary

1.1 Test specification

Specifications	Part 24 Subpart E, Broadband PCS
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1.2 Statement of compliance

Compliance	In the configuration tested the EUT was found compliant Yes ☒ No ☐ Test method: ANSI C63.26-2015, 662911 D01 Multiple Transmitter Output v02r01, 662911 D02 MIMO with Cross-Polarized Antennas v01
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1.3 Exclusions

Exclusions	None
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1.4 Registration number

Test site FCC ID number	682159
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1.5 Test report revision history

Revision #	Details of changes made to test report
TRF	Original report issued

1.6 Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

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Section 2: Summary of test results

2.1 FCC Part 24, test results

Part	Methods	Test description	Verdict
	§ 935210 D05v01r04 (3.2)	AGC threshold	Pass
	§ 935210 D05v01r04 (3.3)	Out of band rejection	Pass
§24.238(b)	§ 935210 D05v01r04 (3.4)	Occupied bandwidth	Pass
§24.232(a)	§ 935210 D05v01r04 (3.5)	Peak output power at RF antenna connector	Pass
§24.238(a)	§ 935210 D05v01r04 (3.6)	Spurious emissions at RF antenna connector	Pass
§24.238(a)	§ 935210 D05v01r04 (3.8)	Radiated spurious emissions	Pass
§24.235	§ 935210 D05v01r04 (3.7)	Frequency stability	N/A a)

Notes:

- a) NOT APPLICABLE: Modulation/frequency conversion circuitry not in use. No frequency change in EUT (input and output have same frequency)

Section 3: Equipment under test (EUT) and application details

3.1 Applicant details

Applicant complete business name	Name:	Teko Telecom Srl
	Federal Registration Number (FRN):	0018963462
	Grantee code	XM2
Mailing address	Address:	Via Meucci, 24/a
	City:	Castel S. Pietro Terme
	Province/State:	Bologna
	Post code:	40024
	Country:	Italy

3.2 Modular equipment

a) Single modular approval	Single modular approval Yes ☐ No ☒
b) Limited single modular approval	Limited single modular approval Yes ☐ No ☒

3.3 Product details

FCC ID	Grantee code:	XM2
	Product code:	-WHPA19HN
Equipment class	B2I	
Description of product as it is marketed	Booster	
	Model name/number:	MWHPA2001PCS-D2
	Serial number:	1017521002

3.4 Application purpose

Type of application	☒ Original certification
	☐ Change in identification of presently authorized equipment
	Original FCC ID: Grant date:
	☐ Class II permissive change or modification of presently authorized equipment

Section 3: Equipment under test

3.5 Composite/related equipment

a) Composite equipment	The EUT is a composite device subject to an additional equipment authorization Yes ☐ No ☒
b) Related equipment	The EUT is part of a system that operates with, or is marketed with, another device that requires an equipment authorization Yes ☐ No ☒
c) Related FCC ID	If either of the above is "yes": ☐ has been granted under the FCC ID(s) listed below: ☐ is in the process of being filled under the FCC ID(s) listed below: ☐ is pending with the FCC ID(s) listed below: ☐ has a mix of pending and granted statuses under the FCC ID(s) listed below: i FCC ID: ii FCC ID:

3.6 Sample information

Receipt date:	2020-05-18
Nemko sample ID number:	400107

3.7 EUT technical specifications

Operating band:	Down Link 1930-1995 MHz; Up Link 1850-1915 MHz
Operating frequency:	Wideband
Modulation type:	GSM, EDGE, CDMA, WCDMA, LTE (QAM and QPSK)
Occupied bandwidth:	GSM and EDGE: 200 kHz; CDMA: 1,25 MHz, WCDMA: 5 MHz LTE: 1.4 MHz, 3 MHz, 5 MHz, 10 MHz, 15 MHz, 20 MHz
Channel spacing:	standard
Emission designator:	GSM and EDGE: GXW; CDMA, WCDMA: F9W, LTE: D7W
RF Output	Down Link: 46dBm (40W) Up Link: N.A. (The EUT does not transmit over the air in the up-link direction)
Gain	Down Link: 51dB Up Link: N.A. (The EUT does not transmit over the air in the up-link direction)
Antenna type:	External Antenna is not provided, equipment that has an external 50 Ω RF connector
Power source:	28-30 Vdc

Section 3: Equipment under test

3.8 Accessories and support equipment

The following information identifies accessories used to exercise the EUT during testing:

Item # 1

Type of equipment:	Power Supply
Brand name:	EA-PS
Model name or number:	8080-60
Serial number:	1421120002
Nemko sample number:	-----
Connection port:	To supply amplifier
Cable length and type:	-----

Item # 2

Type of equipment:	Power supply
Brand name:	GWINSTEK
Model name or number:	GPS4303
Serial number:	GER846883
Nemko sample number:	-----
Connection port:	To supply cooling fan of heatsink
Cable length and type:	-----

Item # 3

Type of equipment:	Management Module
Brand name:	Teko Telecom
Model name or number:	MSPVRUV0001
Serial number:	100739447
Nemko sample number:	-----
Connection port:	LAN Port, To manage amplifier module
Cable length and type:	-----

Item # 4

Type of equipment:	
Brand name:	
Model name or number:	
Serial number:	
Nemko sample number:	
Connection port:	
Cable length and type:	

3.9 Operation of the EUT during testing

Details:	In down-link direction, normal working at max gain with max RF power output.
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3.10 EUT setup diagram

In this system, Very Very High Power Amplifier is the EUT and it is intended for mounting in Remote Unit and Digital Service Front-End (optical system with Master Unit that includes only management module and optical module, to convert RF signal in optical signal in down link direction and viceversa optical signal in RF signal in up link direction). As described in "Operational description", master unit is connected directly to base station, so the system doesn't use another equipment (under another FCC ID) to exercise the EUT. Signal generator is linked directly to the RF input connector.

Test setup for output power, occupied bandwidth, spurious emissions:



Procedure

Connect the signal modulated generator to the input of the EUT, so that the EUT works at the max gain. Raise the input level to the EUT until reach the maximum output power. Connect the spectrum analyzer to the RF output connector of the EUT.

Section 4: Engineering considerations

4.1 Modifications incorporated in the EUT

Modifications

Modifications performed to the EUT during this assessment
None ☒ Yes ☐, performed by Client ☐ or Nemko ☐
Details:

4.2 Deviations from laboratory tests procedures

Deviations

Deviations from laboratory test procedures
None ☒ Yes ☐ - details are listed below:

4.3 Technical judgment

Judgment

None

Section 5: Test conditions

5.1 Deviations from laboratory tests procedures

No deviations were made from laboratory test procedures.

5.2 Test conditions, power source and ambient temperatures

Normal temperature, humidity and air pressure test conditions	Temperature: 15–30 °C Relative humidity: 20–75 % Air pressure: 86–106 kPa When it is impracticable to carry out tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests shall be recorded and stated.
Power supply range:	The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages $\pm 5\%$, for which the equipment was designed.

5.3 Measurement uncertainty

The measurement uncertainty was calculated for each test and quantity listed in this test report, according to CISPR 16-4-2 and other specific test standard and is documented in Nemko Spa working manual WML1002.

The assessment of conformity for each test performed on the equipment is performed not taking into account the measurement uncertainty. The two following possible verdicts are stated in the report:

P (Pass) - The measured values of the equipment respect the specification limit at the points tested. The specific risk of false accept is up to 50% when the measured result is close to the limit.

F (Fail) - One or more measured values of the equipment do not respect the specification limit at the points tested. The specific risk of false reject is up to 50% when the measured result is close to the limit.

Hereafter Nemko's measurement uncertainties are reported:

Section 5: Test conditions, continued

EUT	Type	Test	Range	Measurement Uncertainty	Notes
Transmitter	Conducted	Frequency error	0.001 MHz ÷ 40 GHz	0.08 ppm	(1)
		Carrier power RF Output Power	0.009 MHz ÷ 30 MHz	1.1 dB	(1)
			30 MHz ÷ 18 GHz	1.5 dB	(1)
			18 MHz ÷ 40 GHz	3.0 dB	(1)
			40 MHz ÷ 140 GHz	5.0 dB	(1)
		Adjacent channel power	1 MHz ÷ 18 GHz	1.4 dB	(1)
		Conducted spurious emissions	0.009 MHz ÷ 18 GHz	3.0 dB	(1)
			18 GHz ÷ 40 GHz	4.2 dB	(1)
			40 GHz ÷ 220 GHz	6.0 dB	(1)
		Intermodulation attenuation	1 MHz ÷ 18 GHz	2.2 dB	(1)
		Attack time – frequency behaviour	1 MHz ÷ 18 GHz	2.0 ms	(1)
		Attack time – power behaviour	1 MHz ÷ 18 GHz	2.5 ms	(1)
		Release time – frequency behaviour	1 MHz ÷ 18 GHz	2.0 ms	(1)
		Release time – power behaviour	1 MHz ÷ 18 GHz	2.5 ms	(1)
		Transient behaviour of the transmitter– Transient frequency behaviour	1 MHz ÷ 18 GHz	0.2 kHz	(1)
		Transient behaviour of the transmitter – Power level slope	1 MHz ÷ 18 GHz	9%	(1)
		Frequency deviation - Maximum permissible frequency deviation	0.001 MHz ÷ 18 GHz	1.3%	(1)
		Frequency deviation - Response of the transmitter to modulation frequencies above 3 kHz	0.001 MHz ÷ 18 GHz	0.5 dB	(1)
		Dwell time	-	3%	(1)
		Hopping Frequency Separation	0.01 MHz ÷ 18 GHz	1%	(1)
		Occupied Channel Bandwidth	0.01 MHz ÷ 18 GHz	2%	(1)
		Modulation Bandwidth	0.01 MHz ÷ 18 GHz	2%	(1)
	Radiated	Radiated spurious emissions	0.009 MHz ÷ 26.5 GHz	6.0 dB	(1)
			26.5 GHz ÷ 66 GHz	8.0 dB	(1)
			66 GHz ÷ 220 GHz	10 dB	(1)
		Effective radiated power transmitter	10 kHz ÷ 26.5 GHz	6.0 dB	(1)
			26.5 GHz ÷ 66 GHz	8.0 dB	(1)
Receiver	Radiated	Radiated spurious emissions	66 GHz ÷ 220 GHz	10 dB	(1)
			0.009 MHz ÷ 26.5 GHz	6.0 dB	(1)
			26.5 GHz ÷ 66 GHz	8.0 dB	(1)
	Conducted	Conducted spurious emissions	66 GHz ÷ 220 GHz	10 dB	(1)
			1 MHz ÷ 18 GHz	6.0 dB	(1)
			0.009 MHz ÷ 18 GHz	3.0 dB	(1)
			18 GHz ÷ 40 GHz	4.2 dB	(1)
			40 GHz ÷ 220 GHz	6.0 dB	(1)

NOTES:

(1) The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor $k = 2$, which for a normal distribution corresponds to a coverage probability of approximately 95 %

Section 5: Test conditions, continued

5.4 Test equipment

Equipment	Manufacturer	Model No.	Asset/Serial No.	Next cal.
Vector Signal Generator	Keysight	N5172B EXG	MY53051238	2021-05
Vector Signal Generator	Keysight	N5172B EXG	MY56200267	2022-12
Spectrum Analyzer	Agilent	N9030A PXA	MY53120882	2020-12
Trilog Antenna (25 ÷ 8000 MHz)	Schwarzbeck Mess-Elektronik	VULB9162	9162-025	2021-07
Antenna (1 ÷ 18 GHz)	Schwarzbeck Mess-Elektronik	STLP9148	STLP 9148-152	2021-09
Double ridge horn antenna (4 ÷ 40 GHz)	RFSpin	DRH40	061106A40	2023-04
Broadband Amplifier (18 ÷ 40 GHz)	Sage	STB-1834034030-KFKF-L1	18490-01	2021-03
Broadband preamplifier (1 ÷ 18 GHz)	Schwarzbeck	BBV 9718	9718-137	2021-07
EMI receiver (2 Hz ÷ 44 GHz)	R&S	ESW44	101620	2020-08
Controller	Maturo	FCU3.0	10041	NCR
Tilt antenna mast	Maturo	TAM4.0-E	10042	NCR
Turntable	Maturo	TT4.0-5T	2.527	NCR
Semi-anechoic chamber	Nemko	10m semi-anechoic chamber	530	2021-09
Shielded room	Siemens	10m control room	1947	NCR

Note: N/A = Not Applicable, NCR = No Cal Required, COU = CAL On Use

Appendix A: Test results

Clause 935210 D05v01 (3.2) AGC threshold

Measure of EUT AGC Threshold

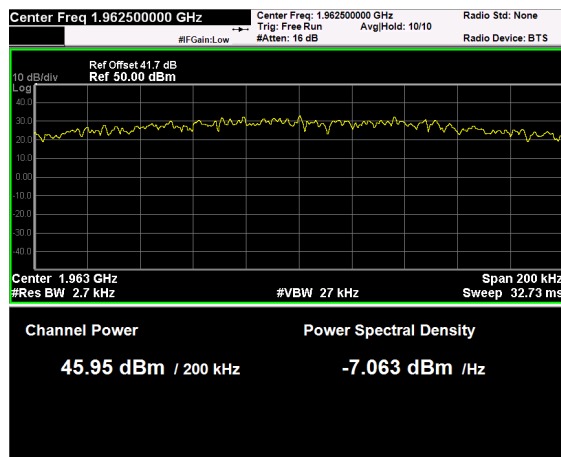
Test date: 2020-05-18 to 2020-06-05

Test results: Pass

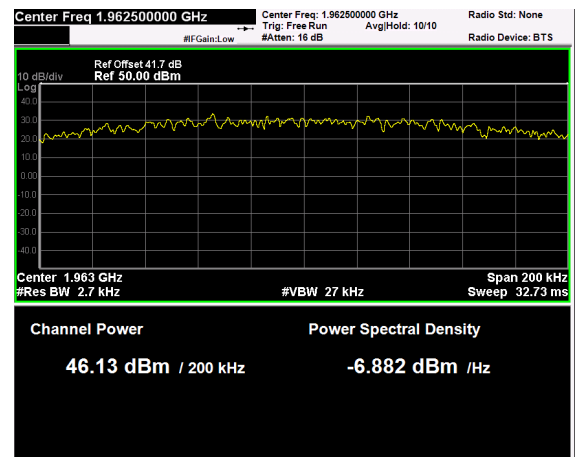
Special notes

- Narrowband amplifiers: MSK test signal used (GSM-TDMA signal)
- Broadband amplifiers: AWGN test signal used (5 MHz LTE channel)

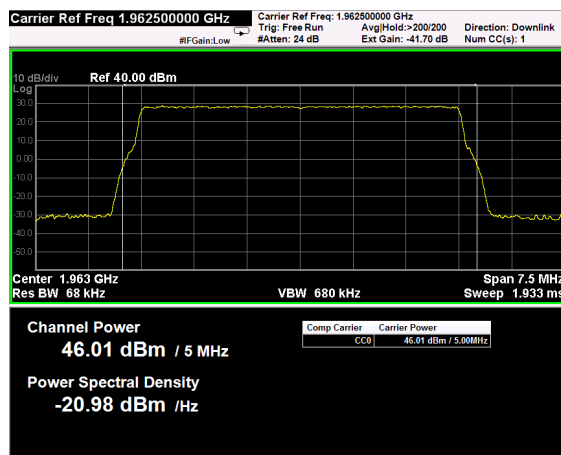
Test data



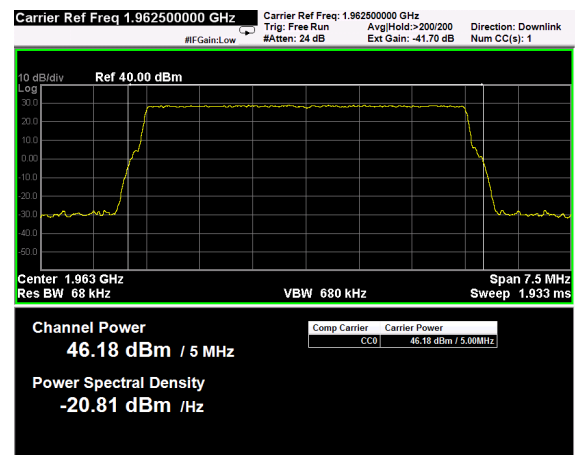
MSK Signal, Nominal Input Signal



MSK Signal, Nominal Input Signal +1dB



AWGN Signal, Nominal Input Signal



AWGN Signal Nominal Input Signal +1dB

Clause 935210 D05 (3.3) Out of band rejection

Out of Band Rejection – Test for rejection of out of band signals.

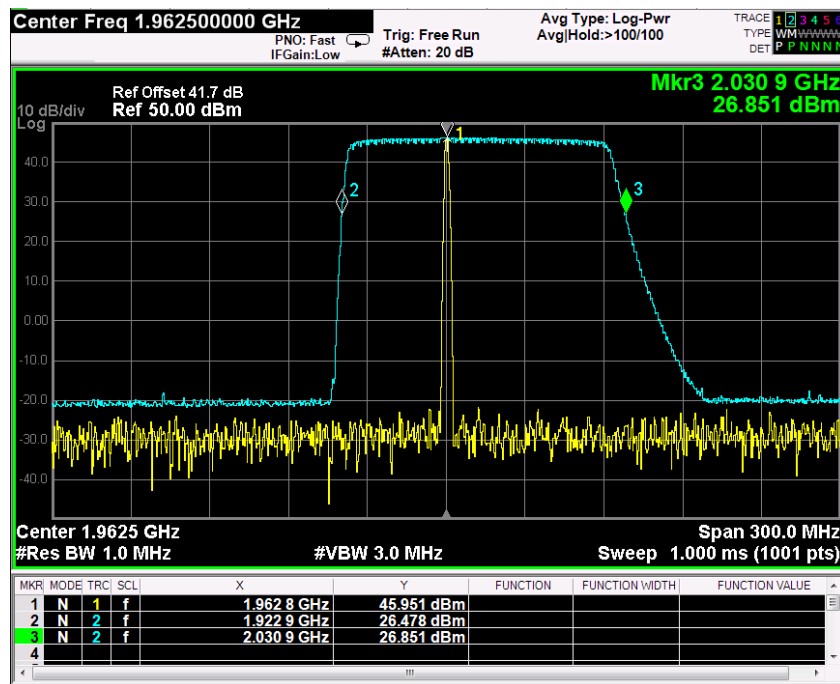
Test date: 2020-05-18 to 2020-06-05

Test results: Pass

Special notes

–

Test data



Clause 24.238(b) Occupied bandwidth

The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

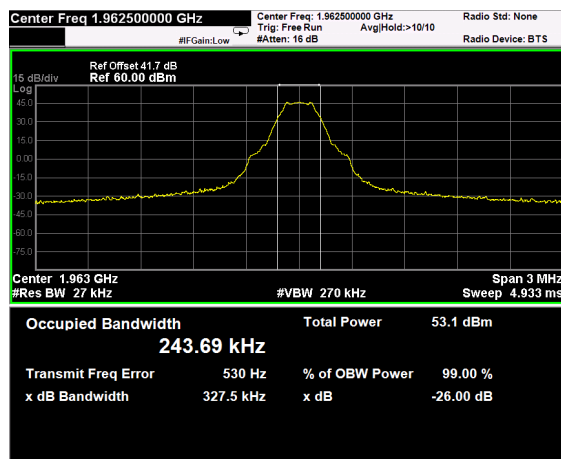
Test date: 2020-05-18 to 2020-06-05

Test results: Pass

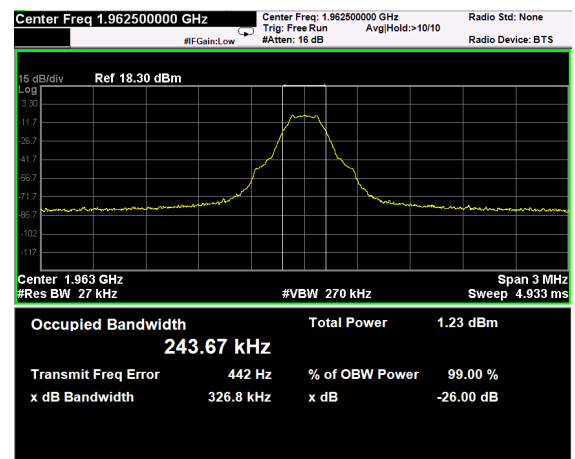
Special notes

- Narrowband amplifiers: MSK test signal used (GSM-TDMA signal)
- Broadband amplifiers: AWGN test signal used (5 MHz LTE channel)

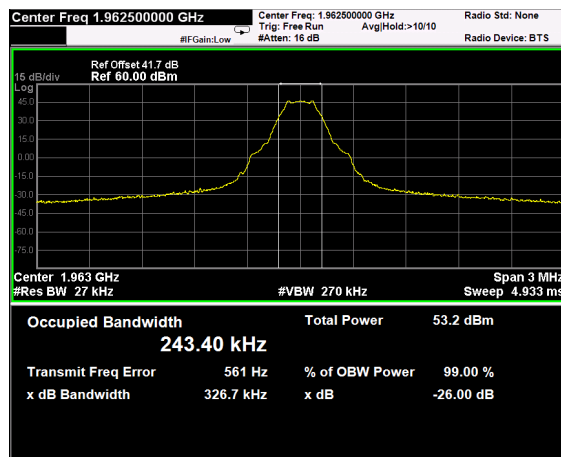
Test data



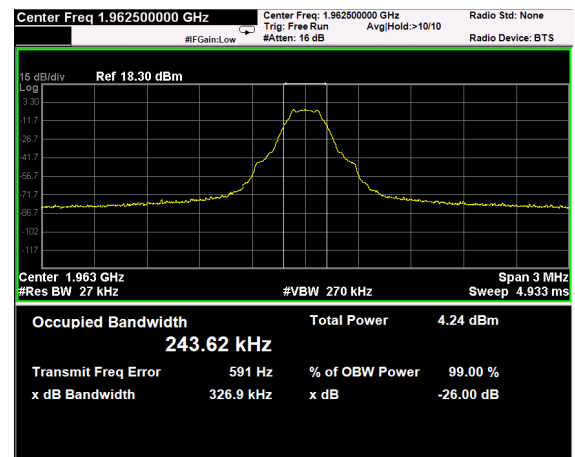
MSK Signal, Nominal Input Signal, Output



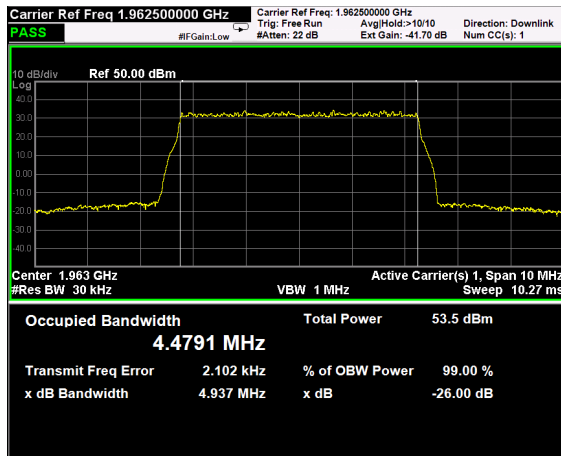
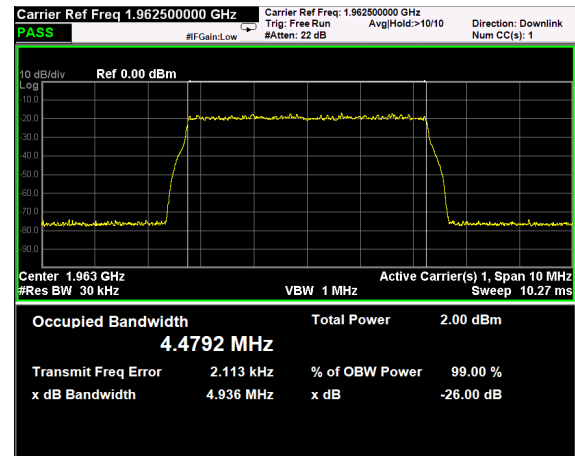
MSK Signal, Nominal Input Signal, Input



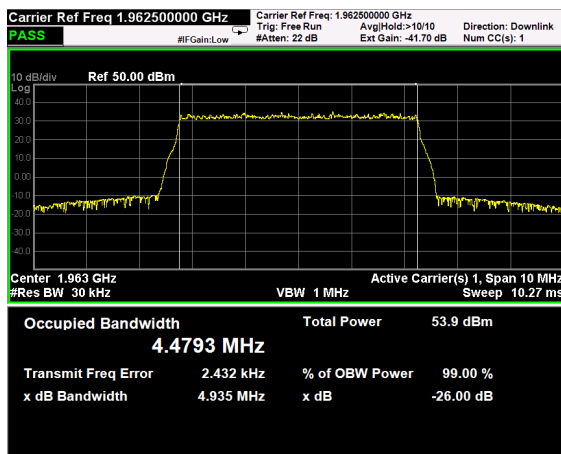
MSK Signal, Nominal Input Signal +3dB, Output



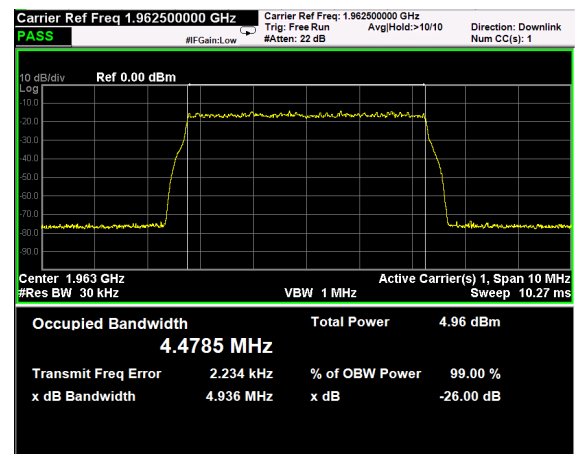
MSK Signal, Nominal Input Signal +3dB, Input

AWGN Signal, Nominal Input Signal,
Output

AWGN Signal, Nominal Input Signal,
Input



AWGN Signal, Nominal Input Signal +3dB,
Output



AWGN Signal, Nominal Input Signal +3dB,
Input

Clause 24.232(a) Peak output power at RF antenna connector

(a) (1) Base stations with an emission bandwidth of 1 MHz or less are limited to 1640 watts equivalent isotropically radiated power (EIRP) with an antenna height up to 300 meters HAAT, except as described in paragraph (b) below.

(a) (2) Base stations with an emission bandwidth greater than 1 MHz are limited to 1640 watts/MHz equivalent isotropically radiated power (EIRP) with an antenna height up to 300 meters HAAT, except as described in paragraph (b) below.

(d) Power measurements for transmissions by stations authorized under this section may be made either in accordance with a Commission-approved average power technique or in compliance with paragraph (e) of this section. In both instances, equipment employed must be authorized in accordance with the provisions of §24.51. In measuring transmissions in this band using an average power technique, the peak-to-average ratio (PAR) of the transmission may not exceed 13 dB.

Test date: 2020-05-18 to 2020-06-05

Test results: Pass

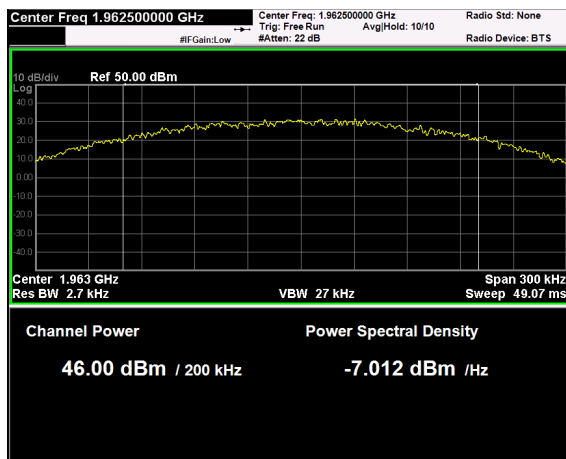
Special notes

- Narrowband amplifiers: MSK test signal used (GSM-TDMA signal)
- Broadband amplifiers: AWGN test signal used (5 MHz LTE channel)

Test data

MSK signal, nominal input signal

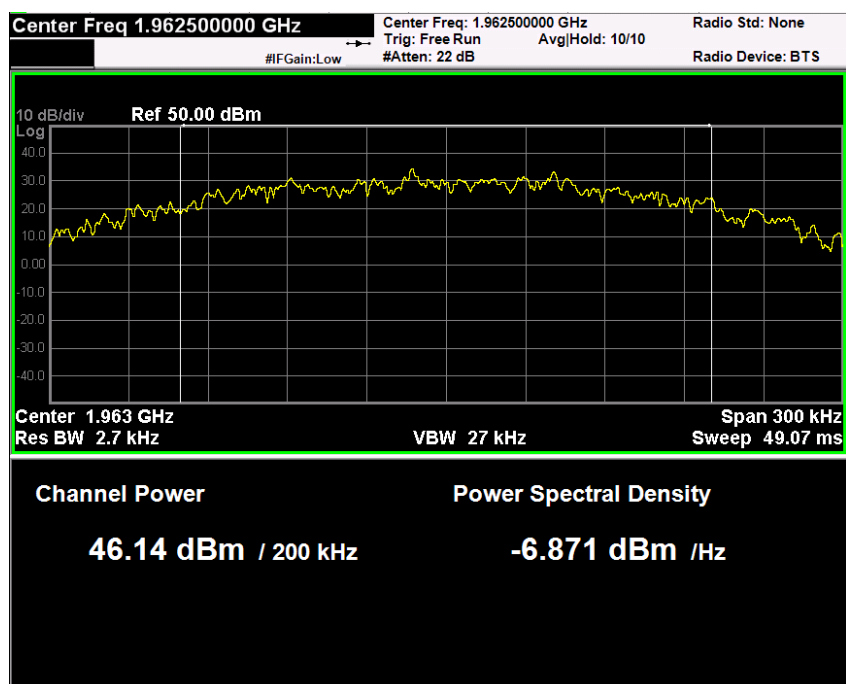
Test data					
Direction	Modulation	Frequency (MHz)	RF output Power (dBm)	RF output channel Power (W)	PAR (dB)
Down-link	MSK (GSM, 200kHz)	1962.5	46.0	40.0	0.1



PAR measure is performed by the “CCDF” function installed on Spectrum analyzer that provides average power (the same measured with “Channel power” function), peak power and PAR.

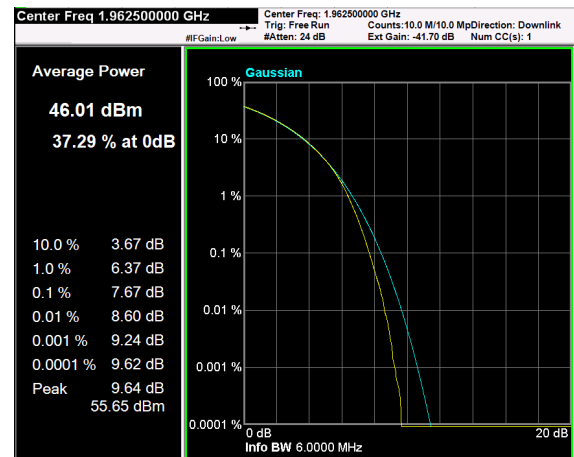
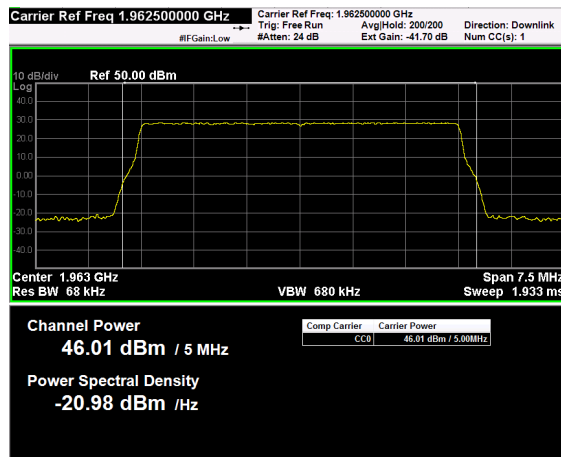
MSK signal, nominal input signal + 3dB

Test data				
Direction	Modulation	Frequency (MHz)	RF output Power (dBm)	RF output channel Power (W)
Down-link	MSK (GSM, 200kHz)	1962.5	46.1	41.1



AWGN signal, nominal input signal

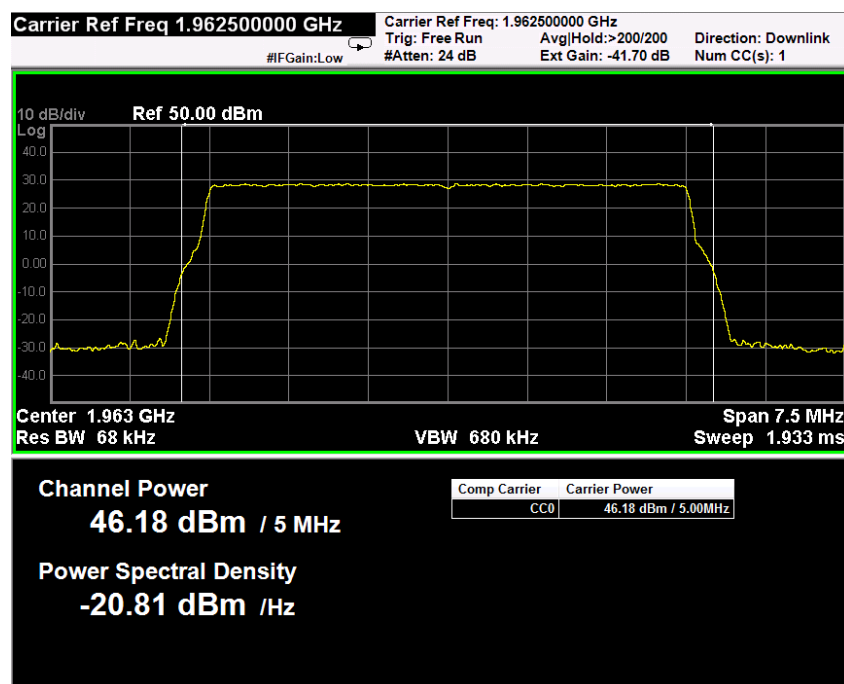
Test data						
Direction	Modulation	Frequency (MHz)	RF output Power (dBm)	RF output channel Power (W)	RF output Power (W/MHz)	PAR (dB)
Down-link	AWGN (LTE, 5MHz)	1962.5	46.0	40.0	8.0	9.6



PAR measure is performed by the “CCDF” function installed on Spectrum analyzer that provides average power (the same measured with “Channel power” function), peak power and PAR.

AWGN signal, nominal input signal + 3dB

Test data					
Direction	Modulation	Frequency (MHz)	RF output Power (dBm)	RF output channel Power (W)	RF output Power (W/MHz)
Down-link	AWGN (LTE, 5MHz)	1962.5	46.2	41.5	8.3



Clause 24.238(a) Spurious emissions at RF antenna connector

a) Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least $43 + 10 \log(P)$ dB.

Test date: 2020-05-18 to 2020-06-05

Test results: Pass

Special notes

- Narrowband amplifiers: MSK test signal used (GSM-TDMA signal)
- Broadband amplifiers: AWGN test signal used (5 MHz LTE channel)

Test data

See Plots below

Spurious emissions measurement results:

Frequency (MHz)	Spurious emission (dBm)	Limit (dBm)	Margin (dB)
First channel	Negligible	-13	
Mid channel	Negligible	-13	
Last channel	Negligible	-13	

MIMO consideration

In the final Remote Unit, the EUT could be used in MIMO configuration according to KDB 662911-D01 v02r01 and 662911-D02 v01 with signals completely uncorrelated. So, the maximum emission is calculated as follows:

- MIMO Maximum Emission = Emission at each path + $10\log(N_{\text{ant}})$ dB =
= Emission at each path + $10\log(2)$ = Emission at each path + 3dB
- Spurious emission limit is -16dBm.

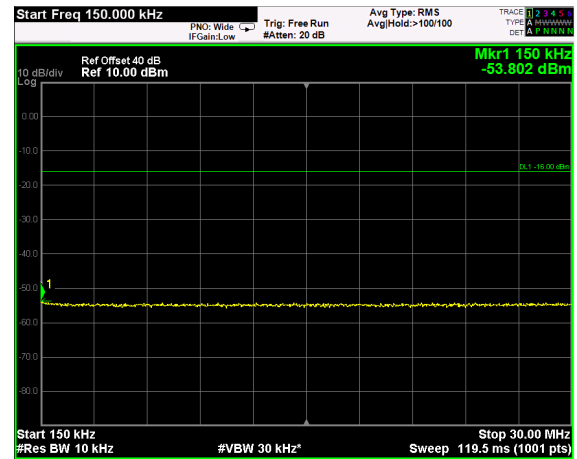
Test data: spurious emissions at antenna terminal

MSK signal

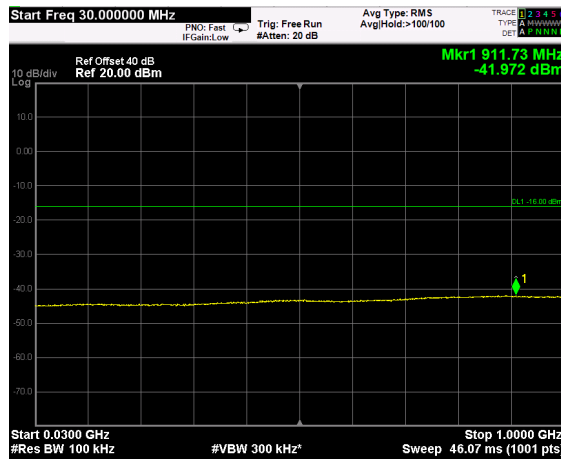
(Plots are referred to modulated carrier at the Middle Channel)



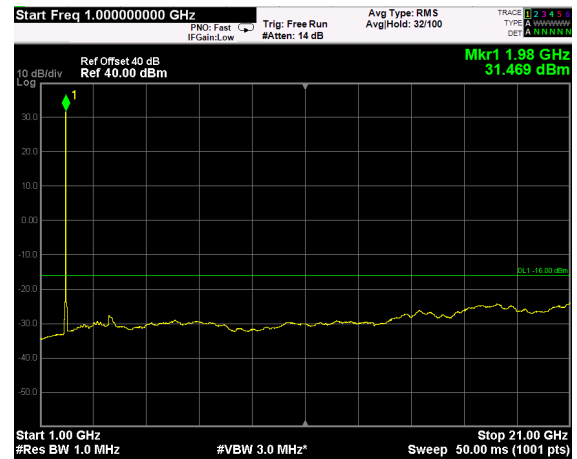
MSK SIGNAL, 9kHz-150kHz



MSK SIGNAL, 150kHz-30MHz



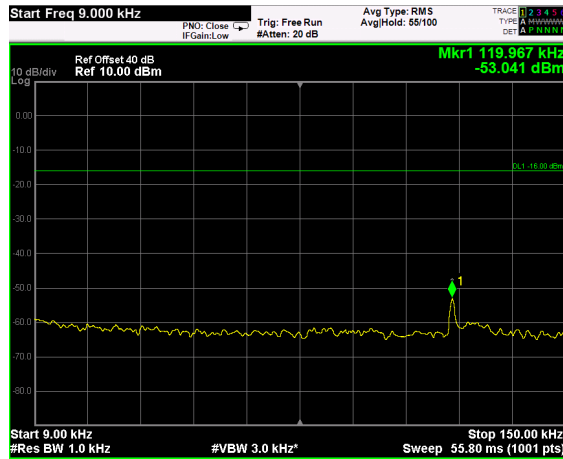
MSK SIGNAL, 30MHz-1GHz



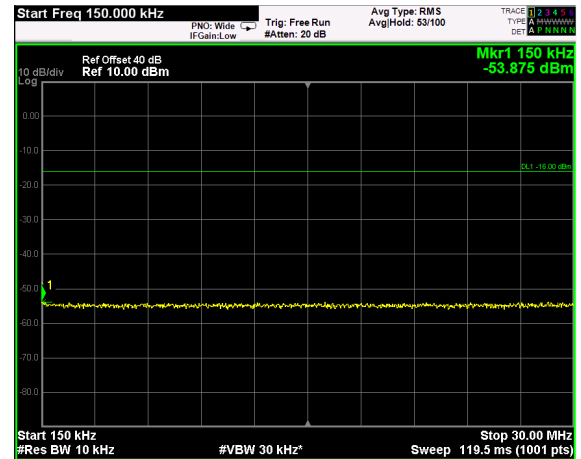
MSK SIGNAL, 1GHz-21GHz

AWGN signal

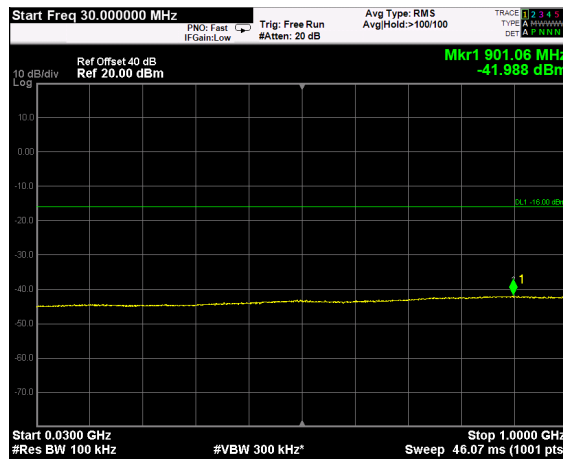
(Plots are referred to modulated carrier at the Middle Channel)



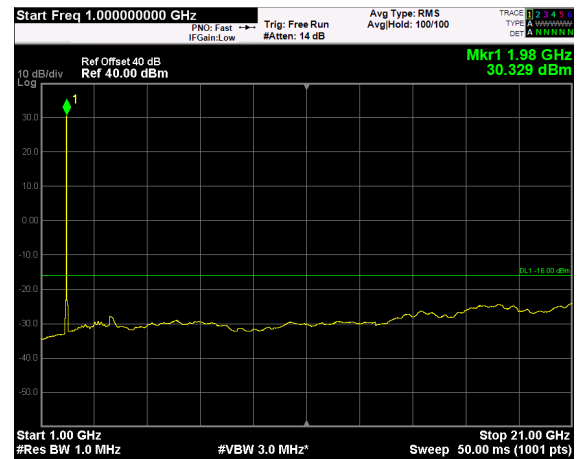
AWGN SIGNAL, 9kHz-150kHz



AWGN SIGNAL, 150kHz-30MHz



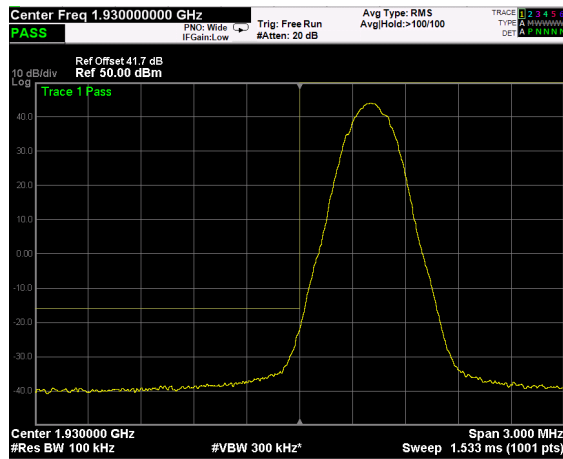
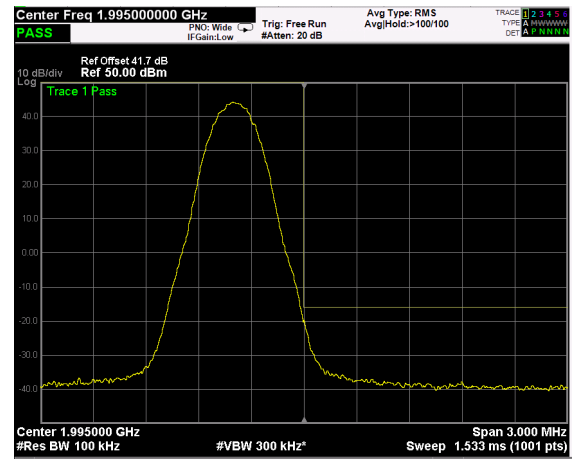
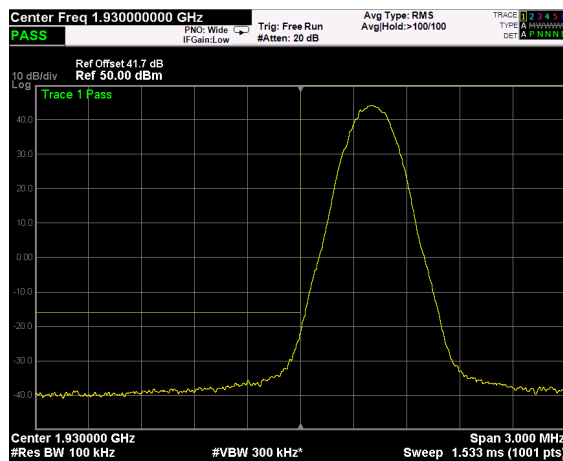
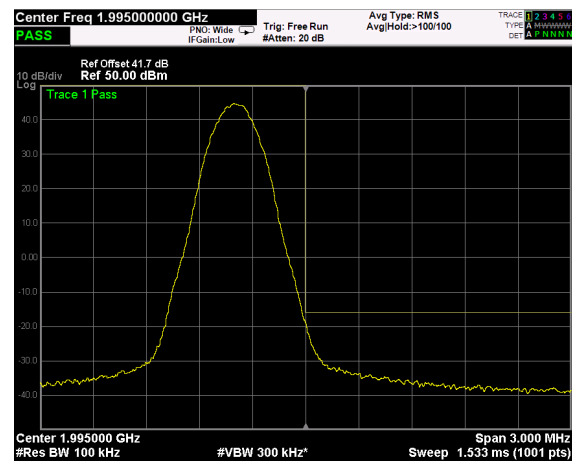
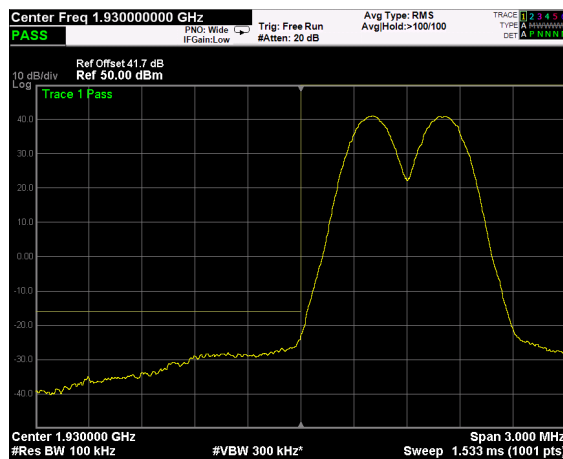
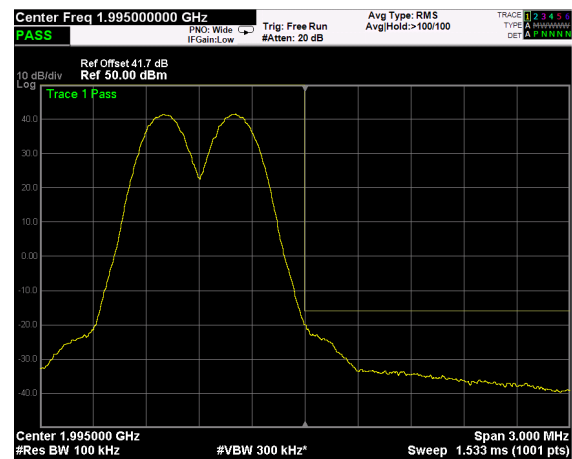
AWGN SIGNAL, 30MHz-1GHz

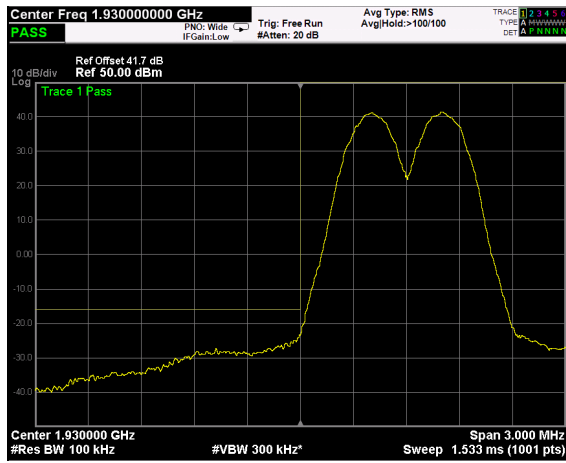


AWGN SIGNAL, 1GHz-21GHz

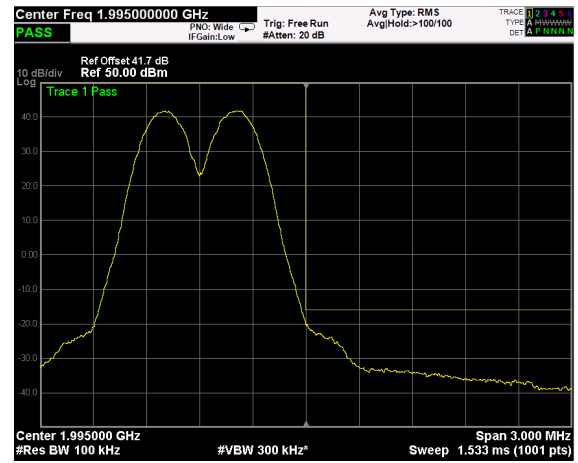
Test data, continued: band edges Inter modulation

MSK signal


MSK Signal, Nominal Input Signal,
Low Band Edge, 1 Carrier

MSK Signal, Nominal Input Signal,
High Band Edge, 1 Carrier

MSK Signal, Nominal Input Signal +3dB,
Low Band Edge, 1 Carrier

MSK Signal, Nominal Input Signal +3dB,
High Band Edge, 1 Carrier

MSK Signal, Nominal Input Signal,
Low Band Edge, 2 Carrier

MSK Signal, Nominal Input Signal,
High Band Edge, 2 Carrier

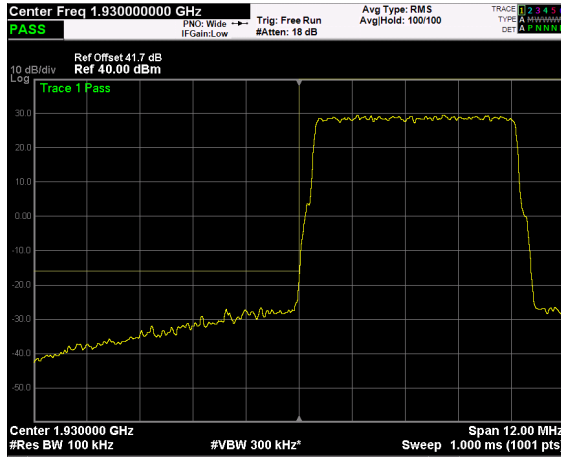


MSK Signal, Nominal Input Signal +3dB,
 Low Band Edge, 2 Carrier

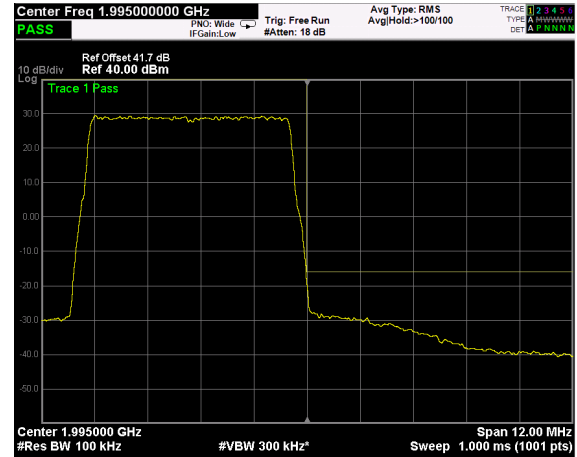


MSK Signal, Nominal Input Signal +3dB,
 High Band Edge, 2 Carrier

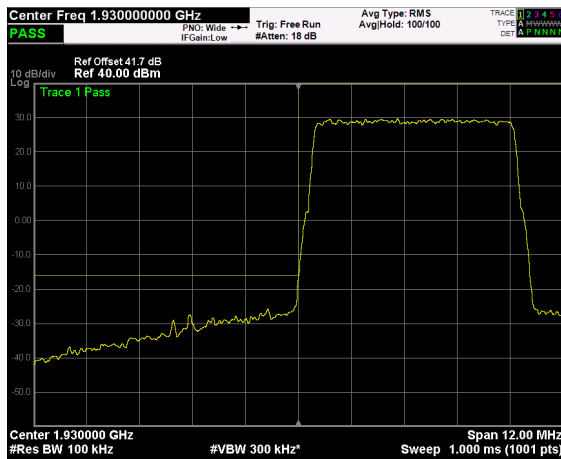
AWGN signal



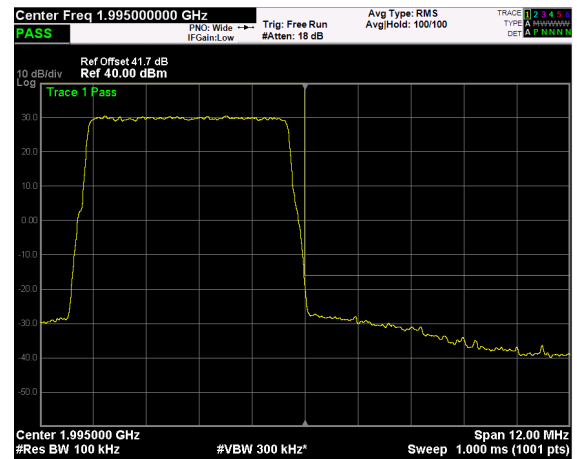
AWGN Signal, Nominal Input Signal,
Low Band Edge, 1 Carrier



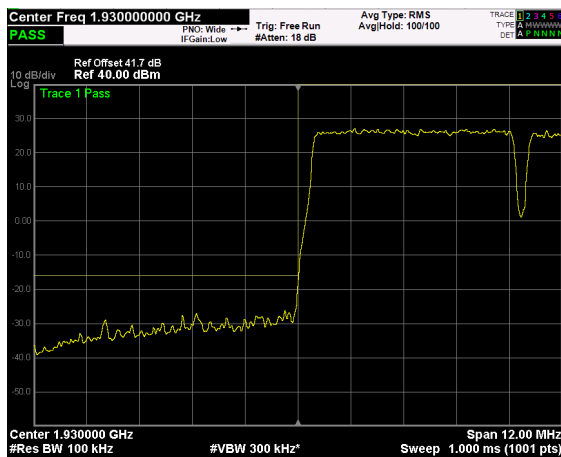
AWGN Signal, Nominal Input Signal,
High Band Edge, 1 Carrier



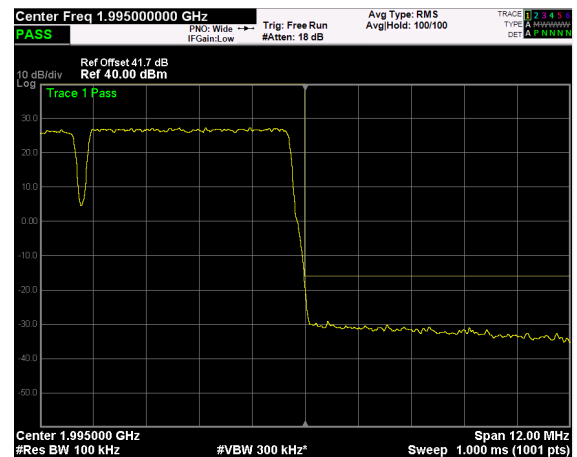
AWGN Signal, Nominal Input Signal +3dB,
Low Band Edge, 1 Carrier



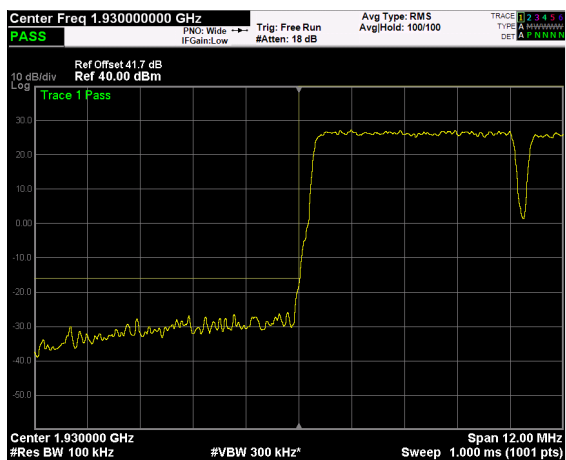
AWGN Signal, Nominal Input Signal +3dB,
High Band Edge, 1 Carrier



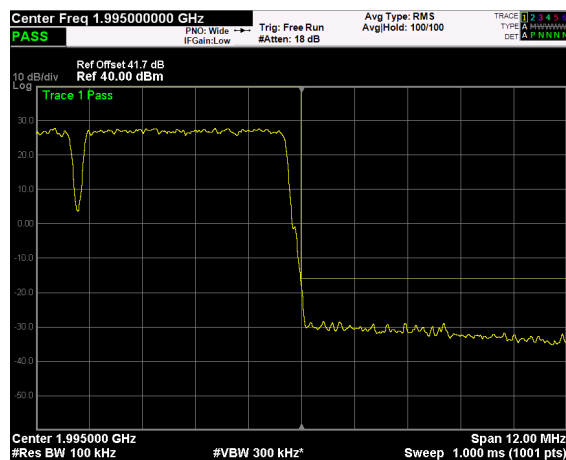
AWGN Signal, Nominal Input Signal,
Low Band Edge, 2 Carrier



AWGN Signal, Nominal Input Signal,
High Band Edge, 2 Carrier



AWGN Signal, Nominal Input Signal +3dB,
Low Band Edge, 2 Carrier



AWGN Signal, Nominal Input Signal +3dB,
High Band Edge, 2 Carrier

Clause 24.238(a) Radiated Spurious emissions

a) Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least $43 + 10 \log(P)$ dB.

Test date: 2020-07-17

Test results: Pass

Special notes

-

Test data

The D.U.T. was positioned according to the radiated emissions set-up

The D.U.T. antenna connector was terminated by a 50 Ω shielded dummy load.

The spectrum was searched from 30 MHz to 1 GHz (RBW 100 kHz) & 1 GHz (RBW 1 MHz) to the tenth harmonic of the carrier.

There were no emissions detected above the noise floor which was at least 20 dB below the specification limit.

Spurious emissions measurement results:

Frequency (MHz)	Polarization. V/H	Field strength (dBm)	Limit (dBm)	Margin (dB)
First Channel	V/H	Negligible	-13	
Mid channel	V/H	Negligible	-13	
Last Channel	V/H	Negligible	-13	

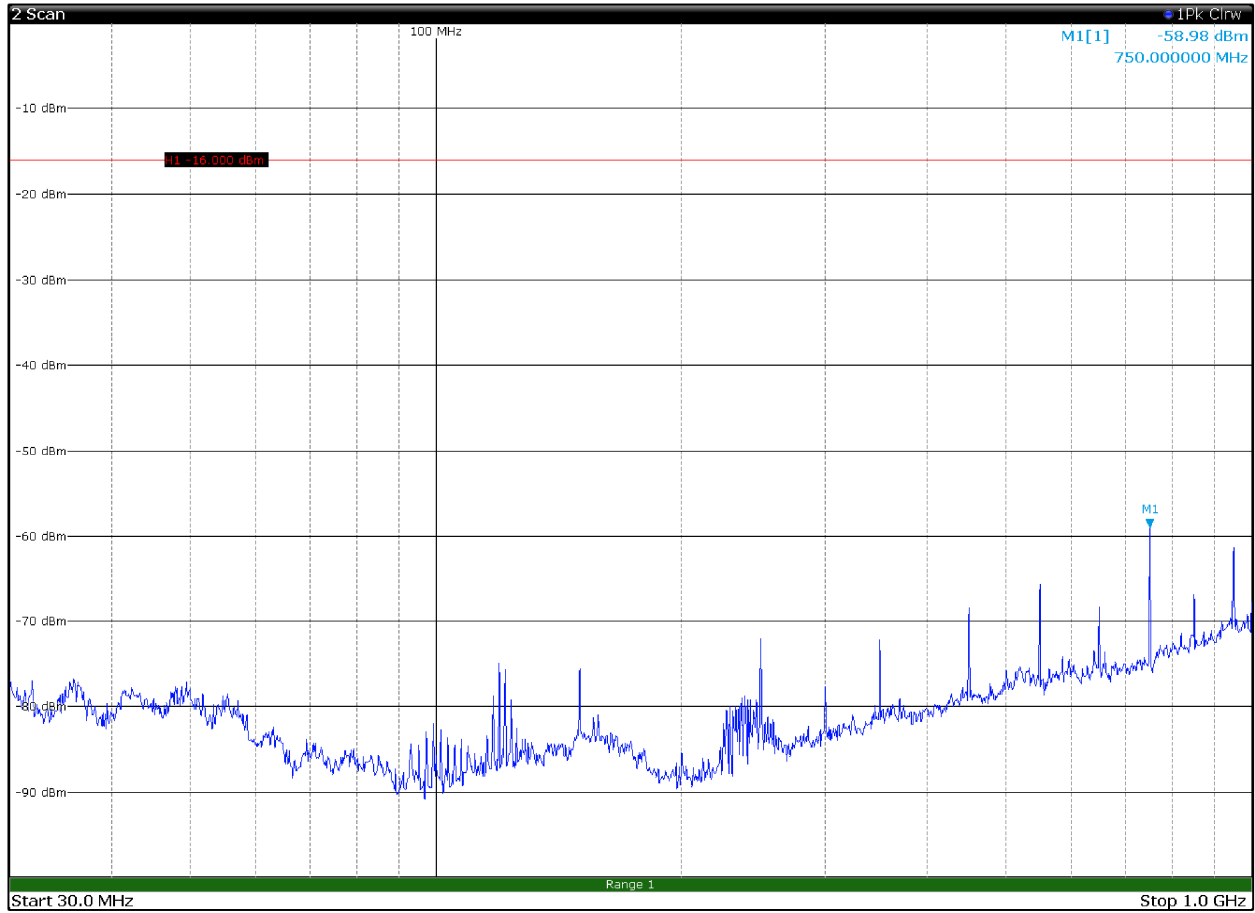
Note: Field strength includes correction factor of antenna, cable loss, amplifier, and attenuators where applicable.

MIMO consideration

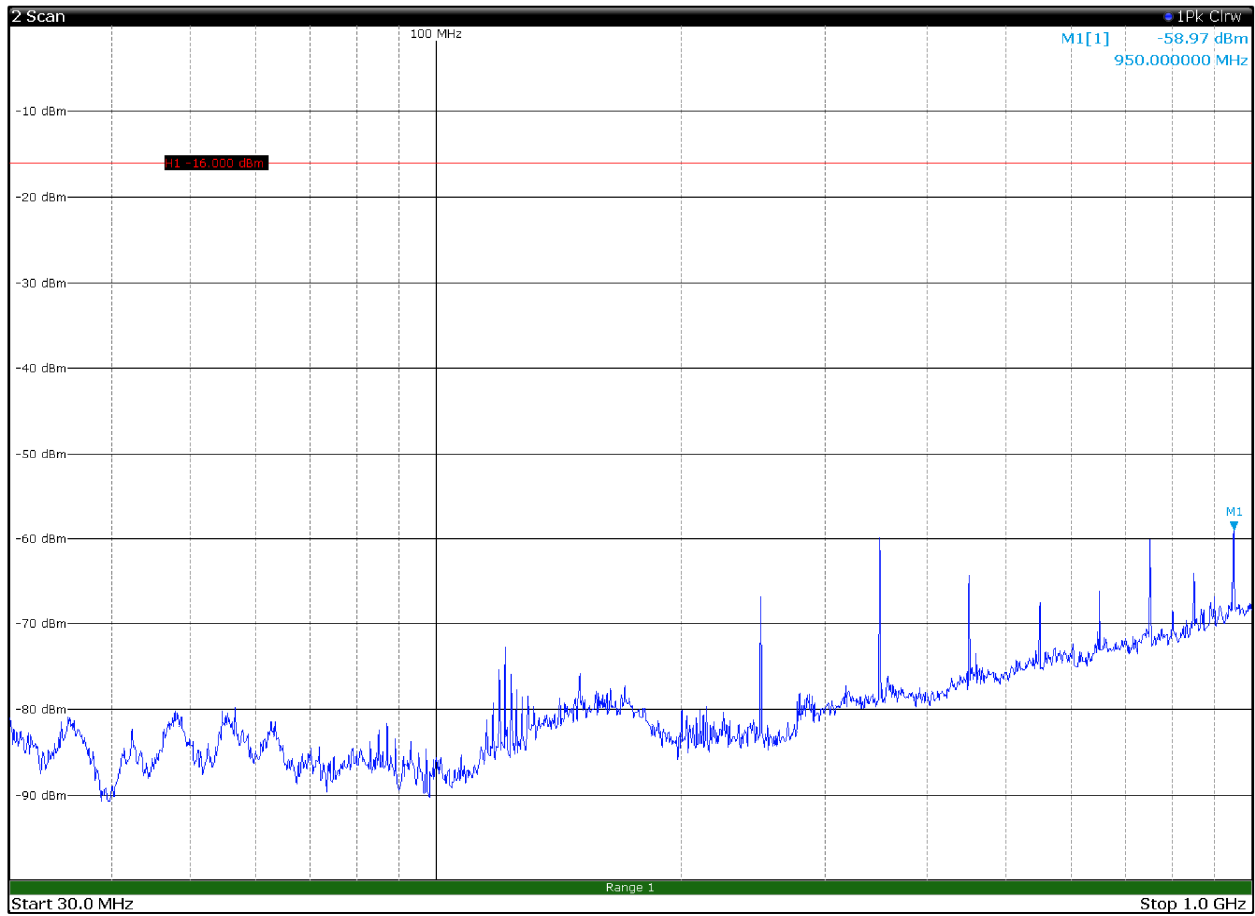
In the final Remote Unit, the EUT could be used in MIMO configuration according to KDB 662911-D01 v02r01 and 662911-D02 v01 with signals completely uncorrelated. So, the maximum emission is calculated as follows:

- MIMO Maximum Emission = Emission at each path + $10 \log(N_{ant})$ dB =
= Emission at each path + $10 \log(2)$ = Emission at each path + 3dB
- Spurious emission limit is -16dBm.

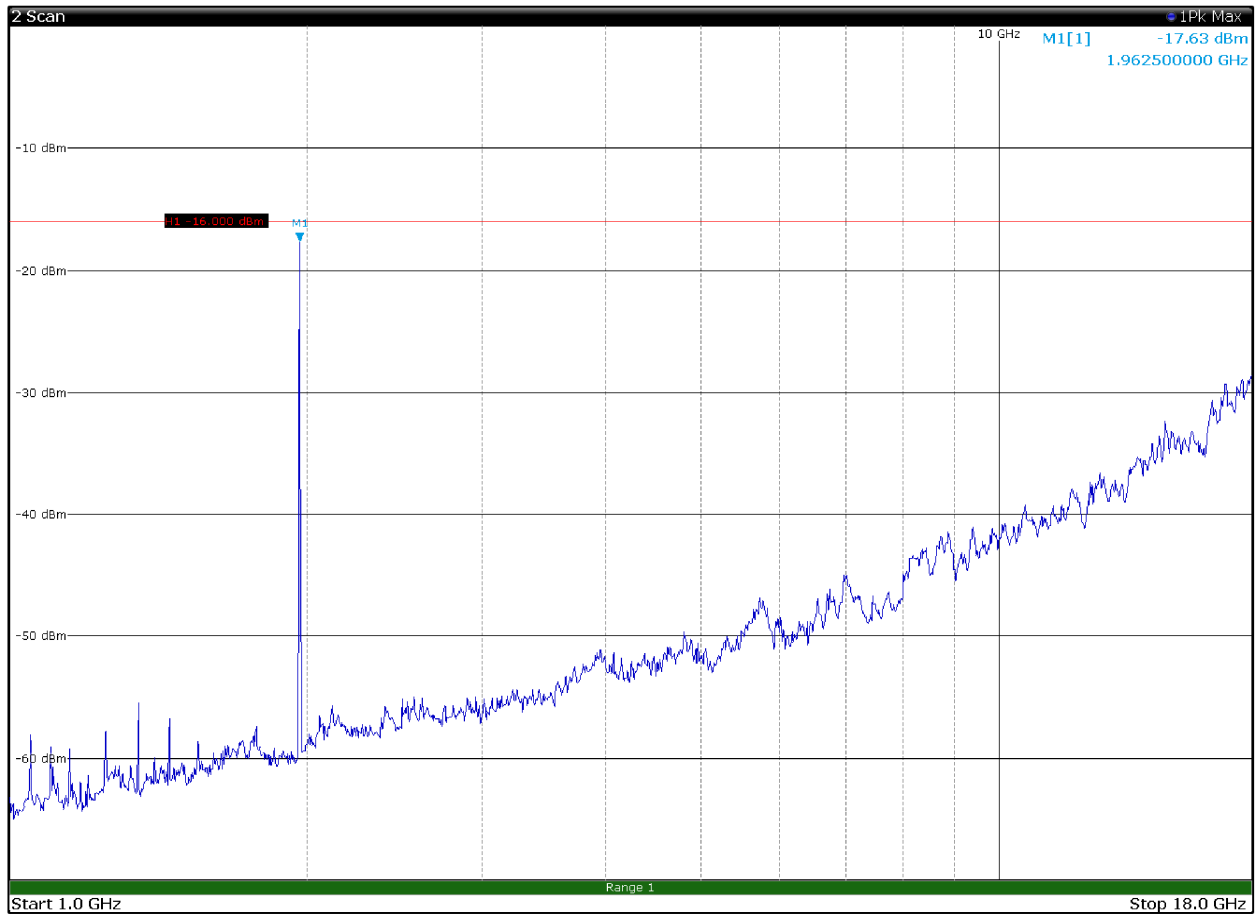
Test data



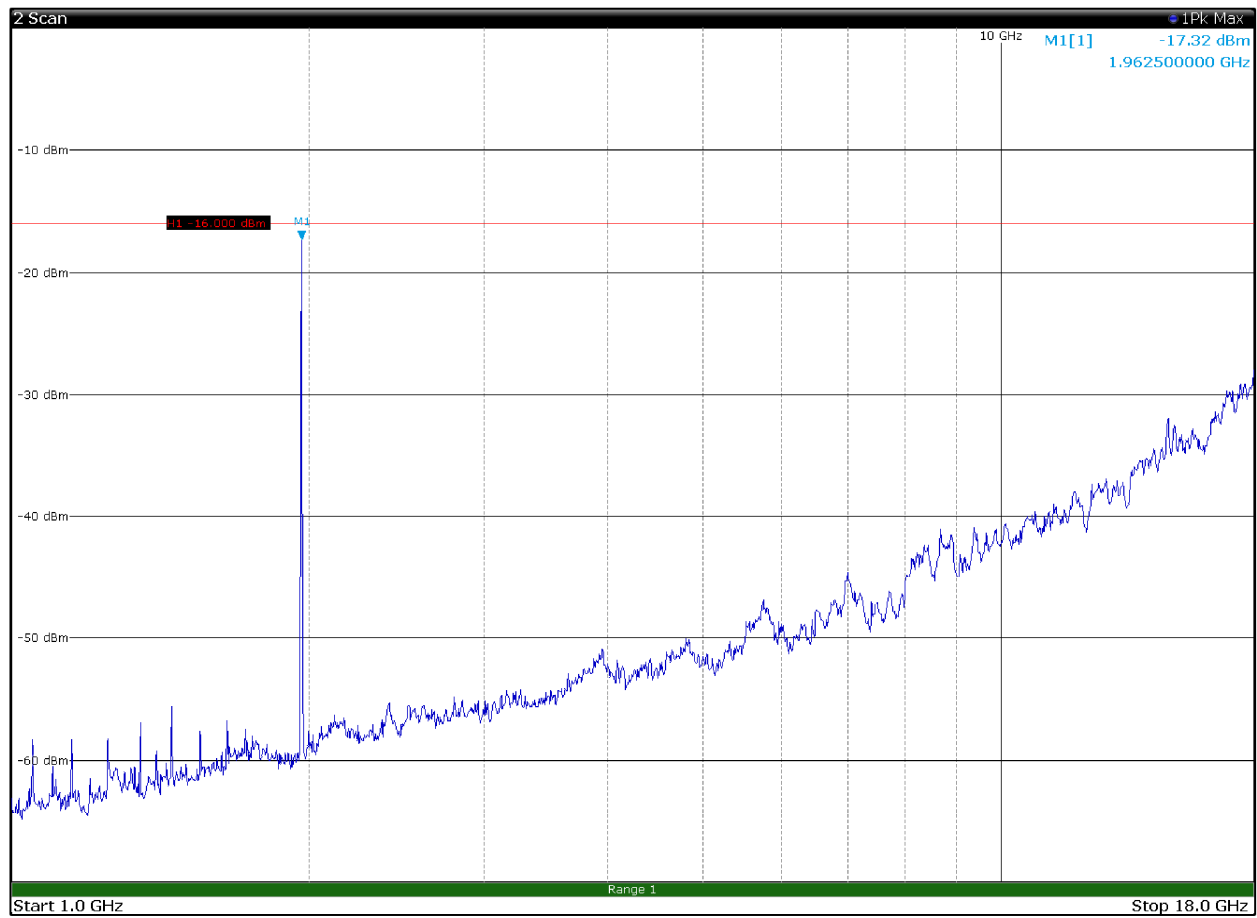
30 MHz – 1 GHz – H Pol



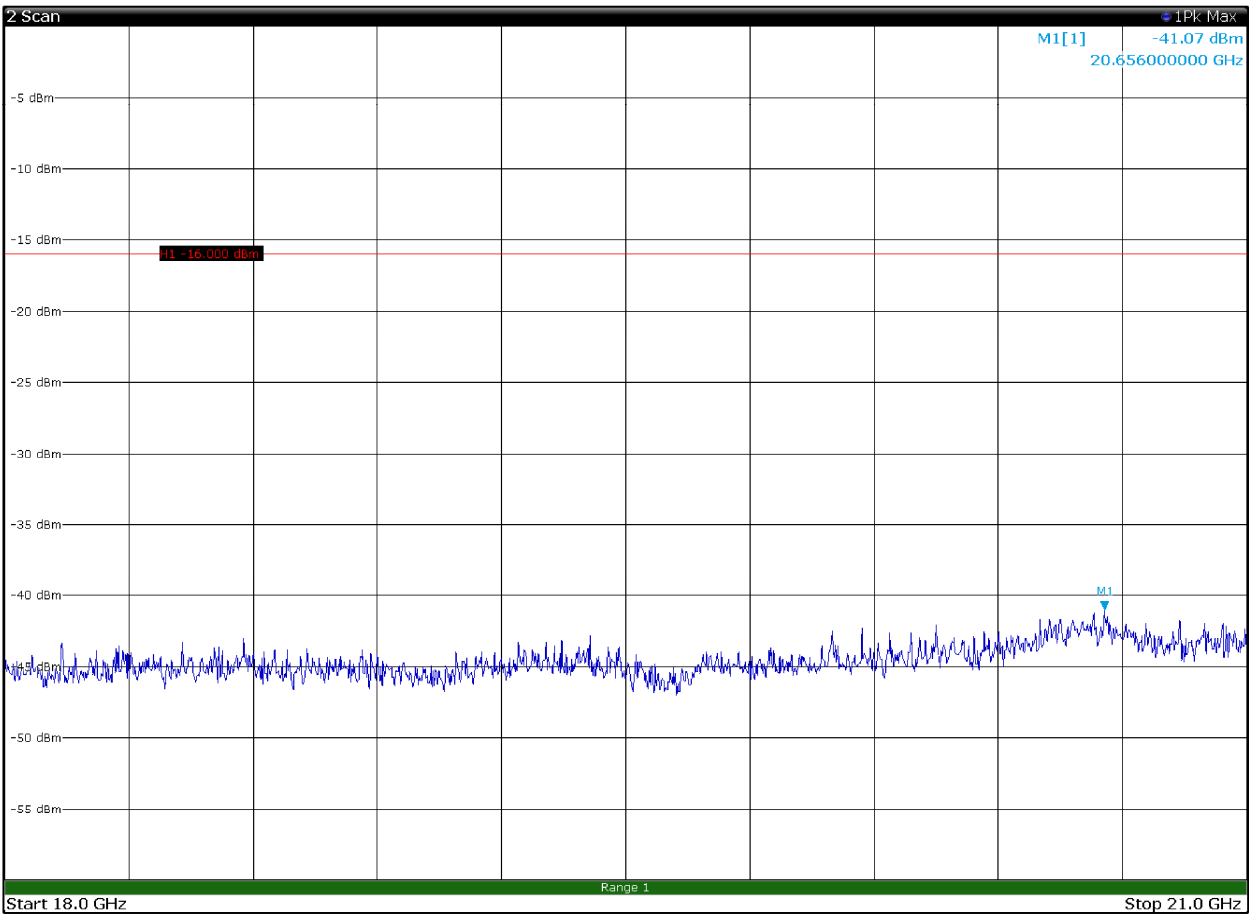
30 MHz – 1 GHz – V Pol



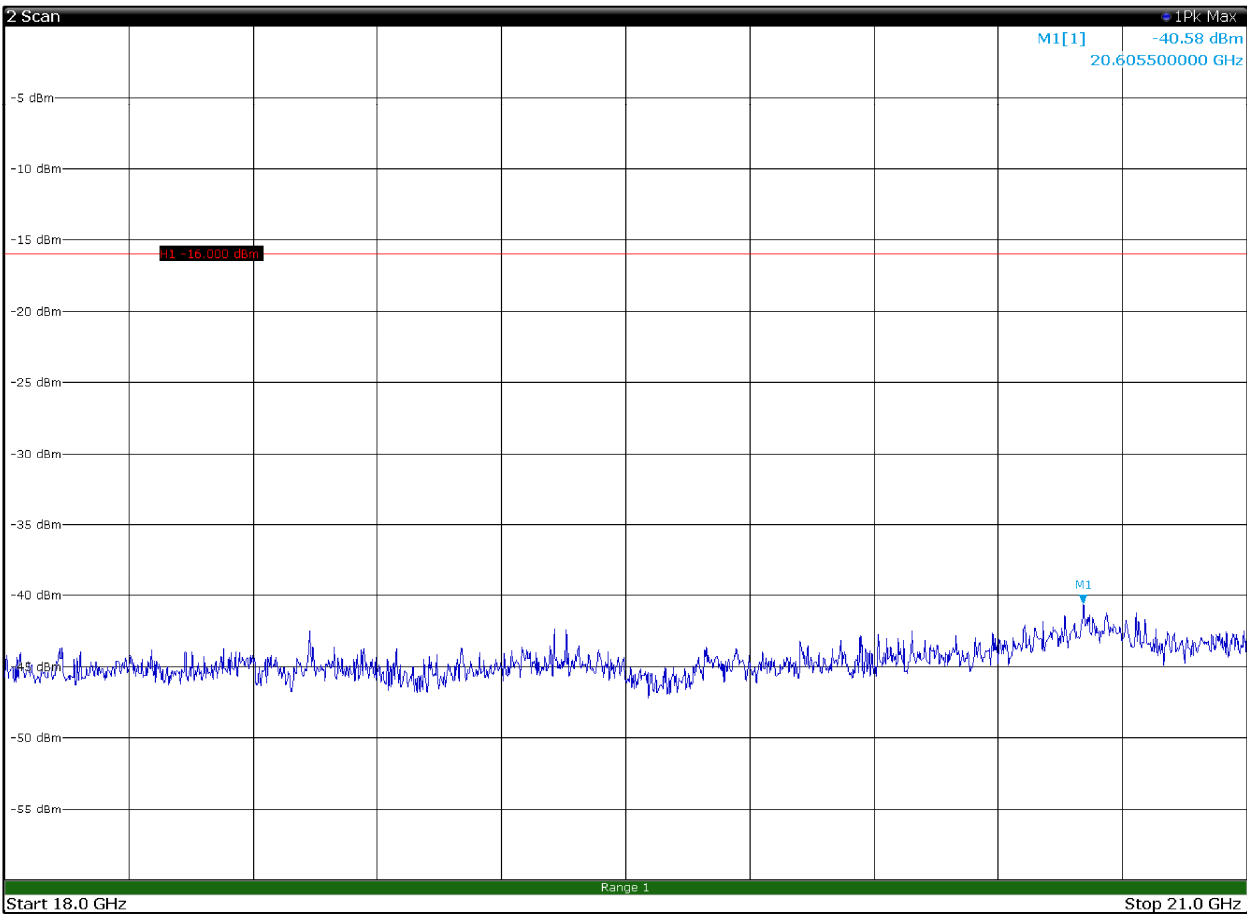
1 GHz – 18 GHz – H Pol



1 GHz – 18 GHz – V Pol



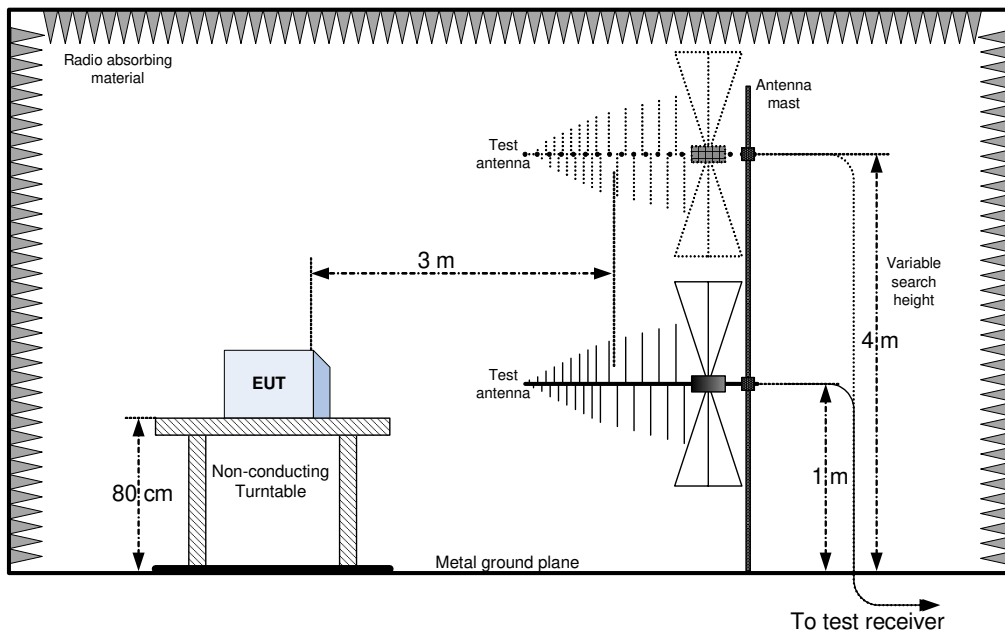
18 GHz – 21 GHz – H Pol



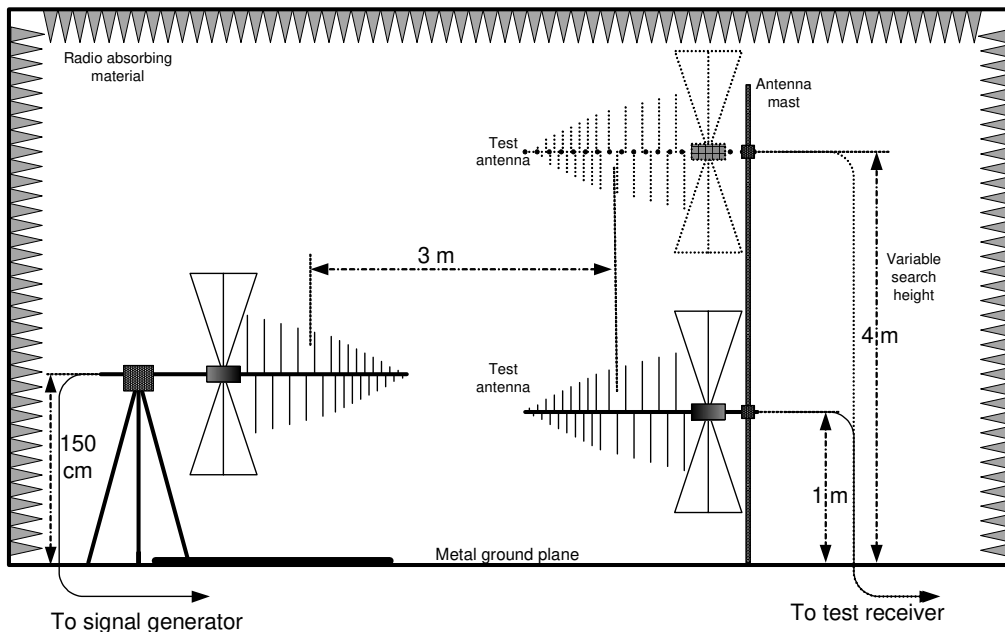
18 GHz – 21 GHz – V Pol

Appendix B: Block diagrams of test set-ups

Radiated emissions set-up



Substitution method set-up



Appendix C: EUT Photos

Photo Set up



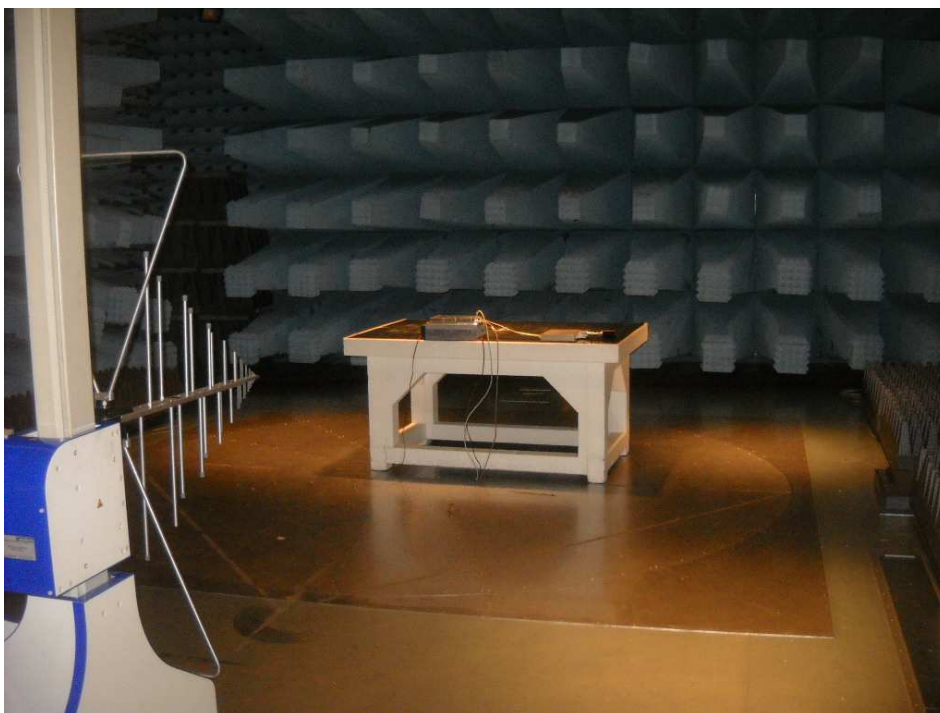


Photo EUT



END OF REPORT