Report on the Radio Testing

For

PBE Europe Ltd

on

Multi Band Fibre optic fed repeater

Report no. TRA-050281-47-00A

14th July 2022

Report Number: TRA-050281-47-00A
Issue: A

REPORT ON THE RADIO TESTING OF A
PBE Europe Ltd
Multi Band Fibre optic fed repeater
WITH RESPECT TO SPECIFICATION
FCC 47CFR 90

TEST DATE: 1st of February to 16th of March 2022

Written by:	Digitally signed by Steven Hodgkinson DN: cn=Steven Hodgkinson, o=Element Materials Technology Ltd, ou, email=steven.hodgkinson@element.com, c=GB Date: 2022.07.14 14:14:30 +01'00'	S Hodgkinson Radio Test Engineer
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Date:	14th July 2022	

1 Revision Record

Issue Number	*Issue Date*	*Revision History*
A	14th July 2022	Original

2 Summary

TEST REPORT NUMBER:	TRA-050281-47-00A
WORKS ORDER NUMBER:	TRA-050281-02
PURPOSE OF TEST:	USA: Testing of radio frequency equipment per the relevant authorization procedure of chapter 47 of CFR (code of federal regulations) Part 2, subpart J.
TEST SPECIFICATION:	47CFR90
EQUIPMENT UNDER TEST (EUT):	Multi Band Fibre optic fed repeater
FCC IDENTIFIER:	NEOA218DSERIES
EUT SERIAL NUMBER:	MBF4171:QJVV
MANUFACTURER/AGENT:	PBE Europe Ltd
ADDRESS:	Unit 5, Cordwallis Business Park Clivemont Road Maidenhead Berkshire Sl6 7BU GB
CLIENT CONTACT:	Brian Barton ☎ +44 (0) 203 943 5185 ✉ brian.barton@axellwireless.com
ORDER NUMBER:	12007509
TEST DATE:	1st of February to 16th of March 2022
TESTED BY:	S Hodgkinson Element

2.1 Test Summary

Test Method and Description	*Requirement Clause* *47CFR90*	*Applicable to this equipment*	**Result / Note**
Output power	90.219(e)(1)	☒	Pass
Noise figure	90.219(e)(2)	☒	Pass
Retransmitted masks	90.219(e)(4)(ii); 90.219(e)(4)(iii)	☒	Pass
Spurious emissions at antenna terminals	90.219(e)(3)	☒	Pass
Intermodulation products	90.219(d)(6)(i)	☒	Pass
Field strength of spurious radiation	90.219(e)(3)	☒	Pass
Frequency stability	90.213	☒	Pass
AGC Threshold Level	KDB 935210 D05 (3.2) (4.2)	☒	Pass
Out of Band Rejection	KDB 935210 D05 (3.3) (4.3)	☒	Pass
Input-versus-Output signal Comparison	KDB 935210 D05 (3.4) (4.4)	☒	Pass
Mean Output power and Amplifier Gain	KDB 935210 D05 (3.5) (4.5)	☒	Pass
Out-of-band/Out-of-block emissions, and spurious emissions (Including intermodulation)	KDB 935210 D05 (3.6) (4.7.2) (4.7.3)	☒	Pass
Frequency Stability	KDB 935210 D05 (3.7) (4.8)	☒	Pass
Radiated spurious emissions	KDB 935210 D05 (3.8) (4.9)	☒	Pass

Notes:

The results contained in this report relate only to the items tested, in the condition at time of test, and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

The apparatus was set-up and exercised using the configurations, modes of operation and arrangements defined in this report only. Any modifications made are identified in Section 8 of this report.

Particular operating modes, apparatus monitoring methods and performance criteria required by the standards tested to have been performed except where identified in Section 5.2 of this test report (Deviations from Test Standards).

Note:

1) In order that the noise figure complies with the limit, the total system loss must be taken into account.
2) In order that the intermodulation figure complies with the limit, the total system loss must be taken into account.

3) The Cable Loss (dB) + Splitter Loss (dB) - antenna gain (dBi) - 2.15 dB (EIRP to ERP conversion) must be greater than or equal to 26 dB.

4) The Uplink direction is connected via cable, and not over the air, and therefore the Uplink was not tested.

3 Contents

4 Introduction

This report TRA-050281-47-00A presents the results of the Radio testing on a PBE Europe Ltd, Multi Band Fibre optic fed repeater to specification '47CFR90.219 Use of signal boosters'

The testing was carried out for PBE Europe Ltd by Element, at the address detailed below.

☐ Element Hull
Unit E
South Orbital Trading Park
Hedon Road
Hull
HU9 1NJ
UK

☒ Element Skelmersdale
Unit 1
Pendle Place
Skelmersdale
West Lancashire
WN8 9PN
UK

This report details the configuration of the equipment, the test methods used and any relevant modifications where appropriate.

FCC Site Listing:
The test laboratory is accredited for the above sites under the following US-UK MRA, Designation numbers.

Element Hull	UK2007
Element Skelmersdale	UK2020

The test site requirements of ANSI C63.4-2014 are met up to 1GHz.
The test site SVSWR requirements of CISPR 16-1-4:2010 are met over the frequency range 1 GHz to 18 GHz.

5 Test Specifications

5.1 Normative References

- FCC 47 CFR Ch. I – Part 90 – Private Land Mobile Radio Services
- FCC KDB Publication 935210 D05 v01r04 April 3, 2020 – Measurements guidance for industrial and non-consumer signal booster, repeater and amplifier devices.
- TIA-603-E-2016 – Land Mobile FM or PM Communications Equipment Measurement and Performance Standards
- ANSI C63.26-2015 – American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services

5.2 Deviations from Test Standards

There were no deviations from the test standard.

6 Glossary of Terms

§	Denotes a section reference from the standard, not this document
AC	Alternating Current
AM	Amplitude Modulated
AWGN	Additive White Gaussian Noise
BW	Bandwidth
C	Celcius
CW	Continuous Wave
Class A	Class A signal booster is designed to retransmit signals on one or more specific channels where none of its passbands exceed 75kHz.
Class B	Class B signal booster is designed to retransmit any signals within a wide frequency band greater than 75kHz.
dB	Decibels
dBm	dB relative to 1 milliwatt
CDMA	Code Division Multiple Access – a modulation technique used in cellular networks
DC	Direct Current
EIRP	Equivalent Isotropically Radiated Power
emf	electromotive force
erp	Effective Radiated Power
EUT	Equipment Under Test
f	Frequency
FCC	Federal Communications Commission
GSM	Group Special Mobile – a cellular network standard
Hz	Hertz
IC	Industry Canada (now ISED)
IF	Intermediate Frequency
ISED	Innovation, Science and Economic Development Canada
ITU	International Telecommunication Union
KDB	Knowledge Data Base (of the FCC Office of Engineering and Technology).
LO	Local Oscillator
m	metre
max	Maximum
min	Minimum
N/A	Not Applicable
No.	Number
PCB	Printed Circuit Board
PDF	Portable Document Format
PLMR	Private Land Mobile Radio
RE	Radio Equipment
RF	Radio Frequency
RH	Relative Humidity
RMS	Root Mean Square
Rx	Receiver
s	Second
Tx	Transmitter
UKAS	United Kingdom Accreditation Service
V	Volt
W	Watt
Ω	Ohm

7 Equipment Under Test

7.1 EUT Identification

- Name: Multi Band Fibre optic fed repeater
- Serial Number: MBF4171:QJVV
- Model Number: MBF4170 (AC), MBF4171 (DC)
- Software Revision: SW00346 Rev 2.0.11, SW01015 Rev 2.4.x, SW01077 Rev 2.6.1
- Build Level / Revision Number: MBF4171: Rec C

7.2 System Equipment

Equipment listed below forms part of the overall test setup and is required for equipment functionality and/or monitoring during testing. The compliance levels achieved in this report relate only to the EUT and not items given in the following list.

HP ProBook 4540s

7.3 EUT Mode of Operation

7.3.1 Transmissions downlink

The mode of operation for Tx tests was as follows:-

The repeater test software was via a Web GUI, each of the operating bands were enabled.

7.4 EUT Radio Frequency Parameters

7.4.1 General

Frequency of operation:	DL 758 MHz - 775 MHz DL 851 MHz - 869 MHz UL 788 MHz - 805 MHz UL 806 MHz - 824 MHz
Passband gain:	33 dB
Supported channel bandwidth(s) & class:	Class B > 75 kHz
Modulations used:	16K0F3E, 11K3F3E, 8K10F1E,8K10F1W, 4M00G7D
Rated mean output power (P_{rated}):	37dBm.
Nominal Supply Voltage:	115 Vac and -48 Vdc depending on model

Note: Full testing was performed on the AC variant,
The Output power and gain, and radiated spurious emissions were performed on the DC variant only.

7.5 EUT Description

The EUT is a dual band repeater covering the UL frequency bands 788 MHz-805 MHz and 806 MHz-824 MHz and DL frequency bands 758 MHz-775 MHz and 851 MHz 869 MHz

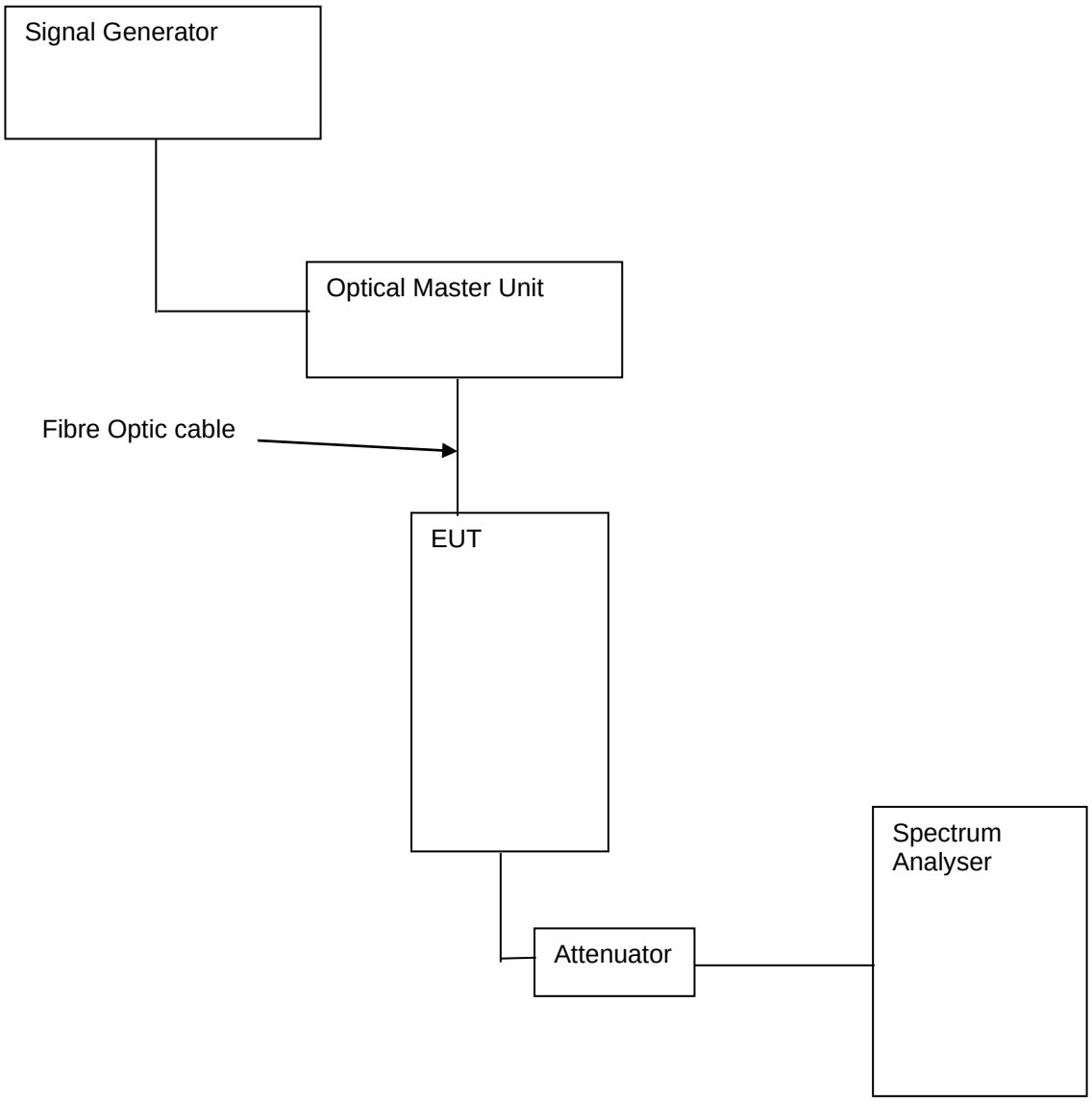
8 Modifications

No modifications were performed during this assessment.

9 EUT Test Setup

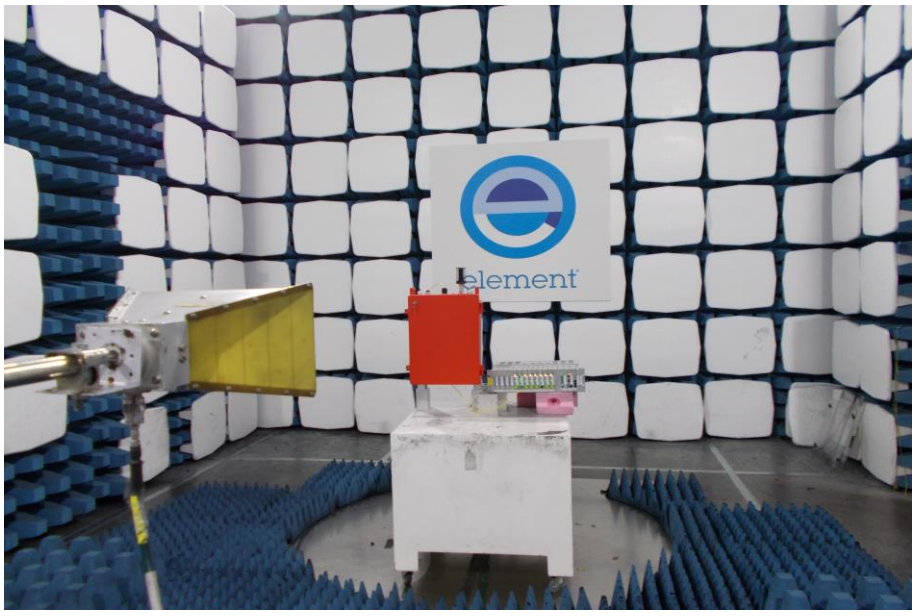
9.1 Block Diagram

The following diagram shows basic EUT interconnections:



9.2 General Set-up Photograph

The following photograph shows basic EUT set-up:



9.3 Measurement software

Where applicable, the following software was used to perform measurements contained within this report.

Element Emissions R5 (See Note)
Element Transmitter Bench Test (See Note)
ETS Lindgren EMPower V1.0.4.2

Note:

The version of the Element software used is recorded in the results sheets contained within this report.

10 General Technical Parameters

10.1 Normal Conditions

The E U T was tested under the normal environmental conditions of the test laboratory, except where otherwise stated. The normal power source applied was approx. -48 Vdc / 115 Vac from the mains. depending on the model under test.

10.2 Varying Test Conditions

Variation of temperature is required to ensure stability of the declared fundamental frequency. During frequency error testing the following variations were made:

	Category	***Variation***
☒	Standard	-20 to +50 C in 10 degree steps
☐	Extended	

Variation of supply voltage is required to ensure stability of the declared output power and frequency. During carrier power and frequency error testing the following variations were made:

	Category	***Nominal***	***Variation***
☒	Mains		85% and 115%
☐	Battery	New battery	N/A

11 Out-of-band rejection

11.1 Definition

The passband is the range of frequencies over which the booster is intended to apply gain. Each booster may include one or more passbands. The bandwidth of each passband is defined by two points either side of the band where the gain has fallen by 20dB from maximum.

11.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Laboratory
Test Standard and Clause:	KDB 935210 D05 v01 , Clause 3.3 and 4.3
Frequencies Measured:	758 MHz -775 MHz 851 MHz-869 MHz (+/-250% declared pass band)
Source Modulation:	CW
Source Level:	0 dBm (3dB below the AGC threshold)
Deviations from Standard:	None
Bandwidth:	RBW 200 kHz (1-5% pass band); VBW 1 MHz (3xRBW).
Measurement Detector:	Peak; Max-Hold.

Environmental Conditions (Normal Environment)

Temperature: 20°C	+15 ºC to +35 ºC (as declared)
Humidity: 43 %RH	20%RH to 75%RH (as declared)
Supply: 115 V ac	

11.3 Test Limits

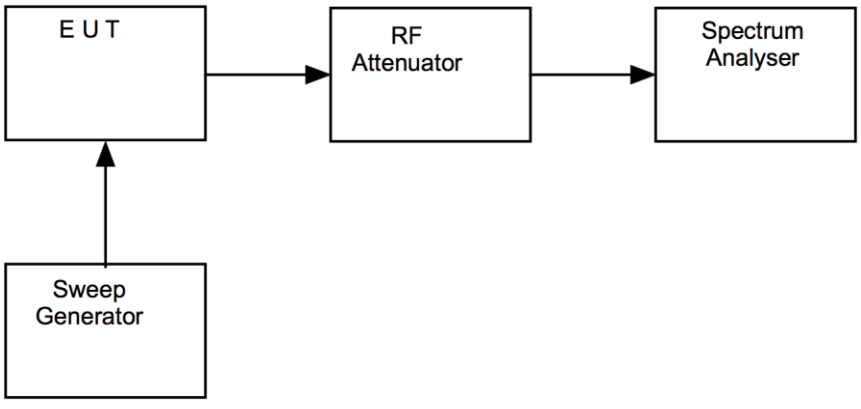
11.3.1 FCC 47CFR90.

Not specified.

11.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure v, the 20dB bandwidth of the EUT was measured on a spectrum analyser.
The measurements were performed with EUT set at its nominal / maximum gain.

Figure v Test Setup

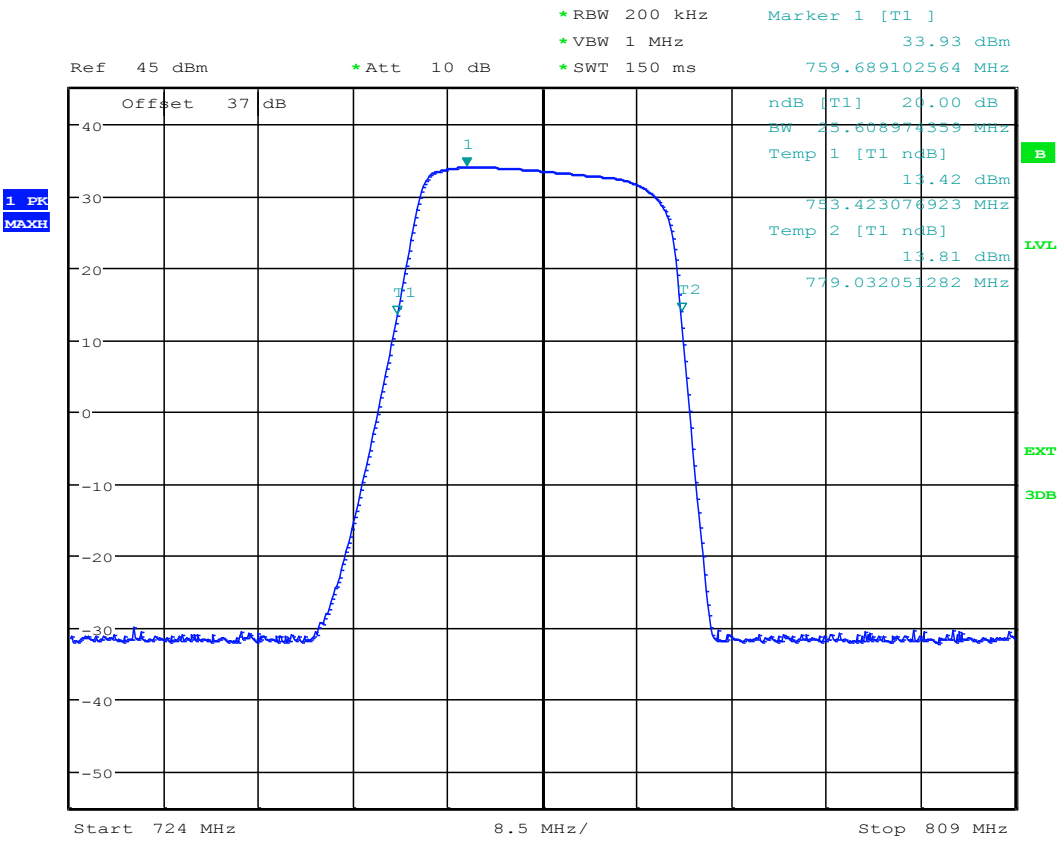


11.5 Test Equipment

Equipment Description	*Manufacturer*	*Equipment Type*	*Element No*	*Last Cal Calibration*	*Calibration Period*	*Due For Calibration*
Signal Generator	R&S	SMBV100A	REF916	2021-05-24	12	2022-05-24
Spectrum Analyser	R&S	FSU46	U405	2021-03-31	12	2022-03-31
Multimeter	Agilent	34405a	REF976	2021-12-21	12	2022-12-21
Power Supply	Kikusui	PCR4000L	UH580	USE REF976		
Attenuator	Bird	6 dB	U073	USE REF916 AND U405		
Attenuator	Radiall	R417030110 30 dB	U730	USE REF916 AND U405		

11.6 Test Results

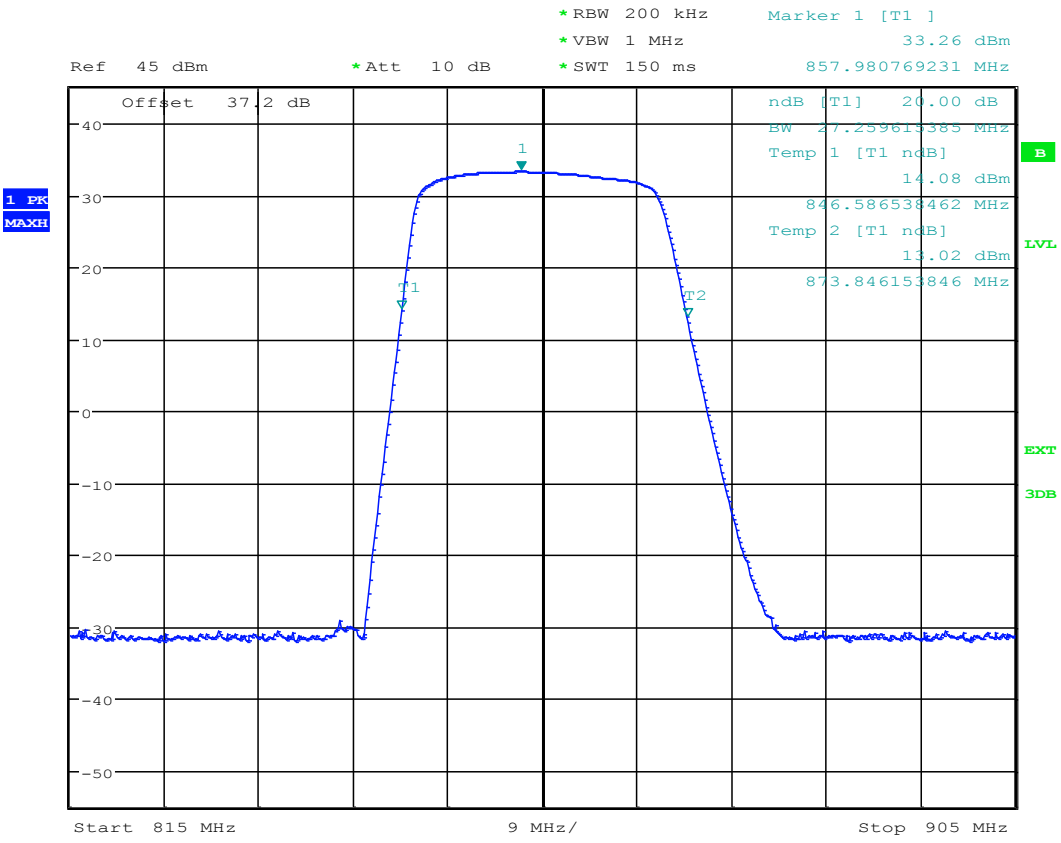
758 MHz - 775 MHz



Date: 1.FEB.2022 13:17:45

Pass Band Nominal Centre (MHz)	Lower Mkr Frequency (MHz)	Upper Mkr Frequency (MHz)	20dB Bandwidth (MHz)	F0 (MHz)
776.5000	753.423076	779.032051	25.60	759.689102

851 MHz- 869 MHz



Date: 1.FEB.2022 13:41:59

Pass Band Nominal Centre (MHz)	*Lower Mkr Frequency (MHz)*	*Upper Mkr Frequency (MHz)*	*20dB Bandwidth (MHz)*	*F0 (MHz)*
860.0000	846.586538	873.846153	27.25	857.980769

12 Mean Output power and amplifier/booster gain

12.1 Definition

The average power supplied to the antenna transmission line by a transmitter during an interval of time sufficiently long compared with the lowest frequency encountered in the modulation taken under normal operating conditions.

12.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Laboratory
Test Standard and Clause:	Part 90.219(e)(1) KDB 935210 D05 v01, clause 3.5 4.5
EUT Operating Frequencies Tested:	759.989102 MHz, 857.982371 MHz
Source Modulations:	CW, AWGN
Source Level:	4.54 dBm (maximum input rating)
Deviations from Standard:	None
Bandwidth:	RBW 100 kHz; VBW 3xRBW
Span:	1 MHz
Measurement Detector:	Peak; Max-Hold.

Environmental Conditions (Normal Environment)

Temperature: 20°C	+15 ºC to +35 ºC (as declared)
Humidity: 32 %RH	20%RH to 75%RH (as declared)
Supply: 115 V ac	

12.3 Test Limits

12.3.1 FCC 47CFR90

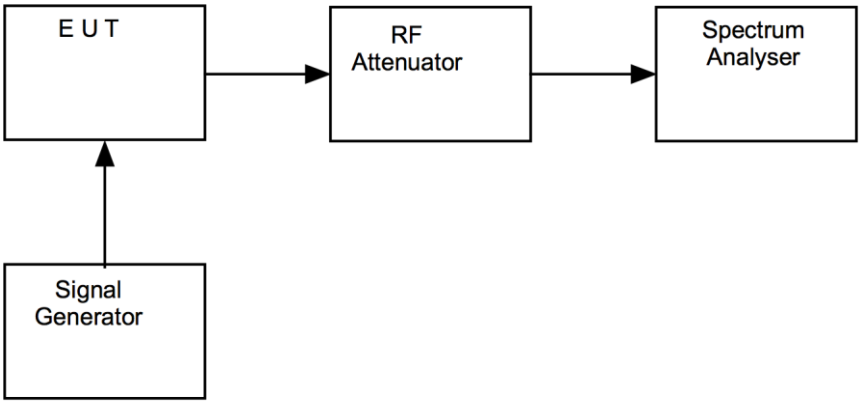
The output power capability of a signal booster must be designed for deployments providing a radiated power not exceeding 5 Watts ERP for each retransmitted channel.[1]

12.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure i, the power of the EUT was calculated by taking into account any cable and attenuator calibration factors. It was confirmed that at the maximum input level there was no compression.
Gain was calculated by removing the EUT from the setup and measuring the signal generator to EUT level.

[1] Note, as of December 27, 2018 Railroad licensees may operate Class A signal boosters transmitting on a single channel with up to 30 Watts ERP on frequencies 452/457.9000 to 452/457.96875 MHz in areas where communication between the front and rear of trains is unsatisfactory due to distance or intervening terrain barriers.

Figure i Test Setup



12.5 Test Equipment

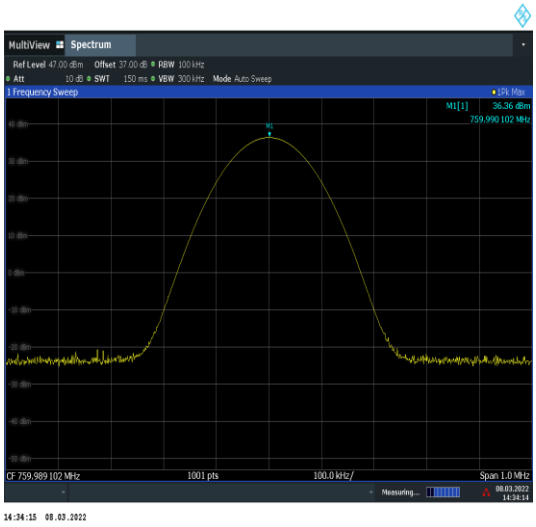
Equipment Description	*Manufacturer*	*Equipment Type*	*Element No*	*Last Cal Calibration*	*Calibration Period*	*Due For Calibration*
Signal Generator	R&S	SMBV100A	REF916	2021-05-24	12	2022-05-24
Spectrum Analyser	R&S	FSU46	U405	2021-03-31	12	2022-03-31
Multimeter	Agilent	34405a	REF976	2021-12-21	12	2022-12-21
Power Supply	Kikusui	PCR4000L	UH580	USE REF976		
Attenuator	Bird	6 dB	U073	USE REF916 AND U405		
Attenuator	Radiall	R417030110 30 dB	U730	USE REF916 AND U405		

12.6 Test Results

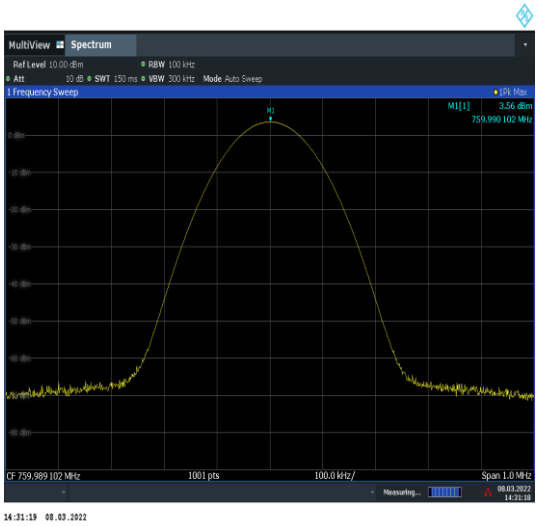
700 MHz Narrow band AC power supply

AGC Threshold f0 759.989102 MHz AC power supply						
Channel Fo Frequency (MHz)	***Modulation***	***Signal Generator Input Level (dBm)***	***Conducted Output Power (dBm)***	***Rated Output Power (dBm)***	***Gain (dB)***	***Result***
759.989102	CW	3.56	36.36	37.00	32.80	PASS

EUT

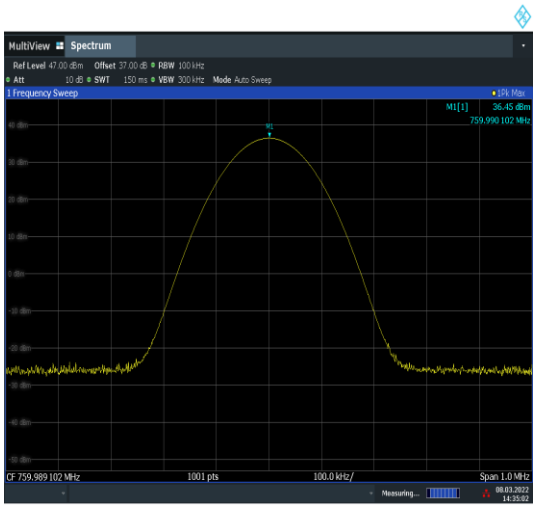


Signal Generator

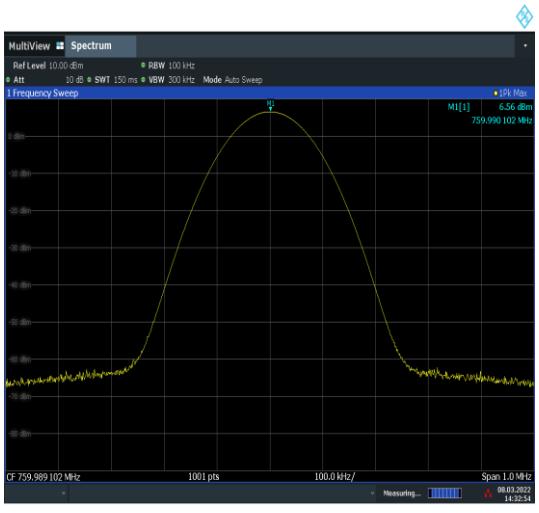


AGC +3 dB f0 759.989102 MHz AC power supply						
Channel Fo Frequency (MHz)	***Modulation***	***Signal Generator Input Level (dBm)***	***Conducted Output Power(dBm)***	***Rated Output Power (dBm)***	***Gain (dB)***	***Result***
759.989102	CW	6.56	36.45	37.00	29.89	PASS

EUT



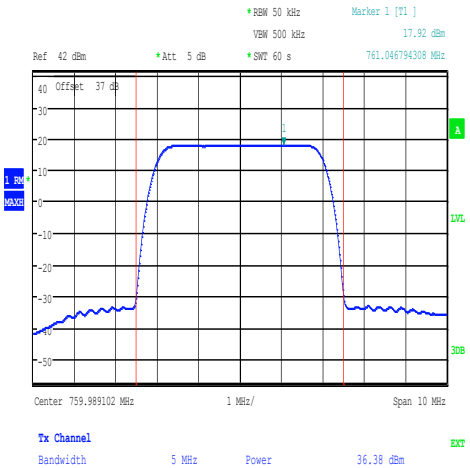
Signal Generator



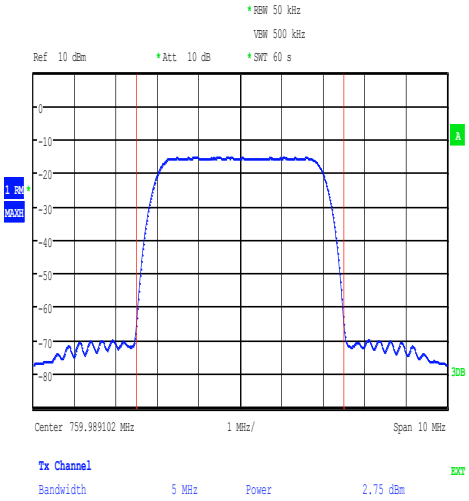
700 MHz Wide Band AC power supply

AGC Threshold f0 759.989102 MHz AC power supply						
Channel Fo Frequency (MHz)	***Modulation***	***Signal Generator Input Level (dBm)***	***Conducted Output Power (dBm)***	***Rated Output Power (dBm)***	***Gain (dB)***	***Result***
759.989102	AWGN	2.75	36.38	37.00	33.63	PASS

EUT

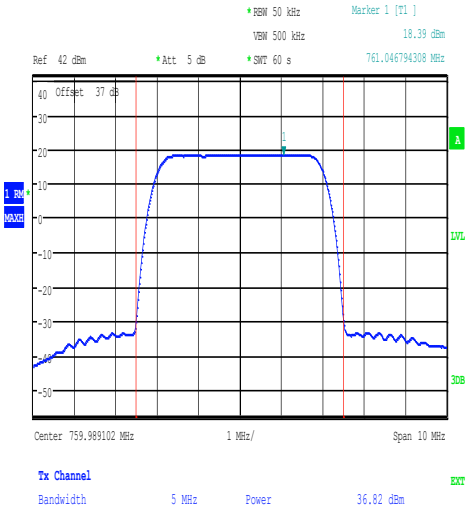


Signal Generator

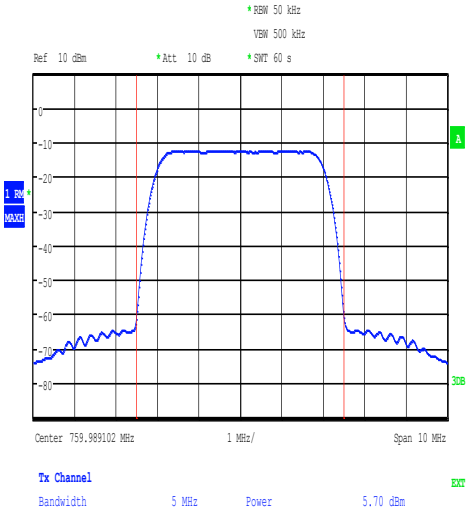


AGC +3 dB f0 759.989102 MHz AC power supply						
Channel Fo Frequency (MHz)	***Modulation***	***Signal Generator Input Level (dBm)***	***Conducted Output Power(dBm)***	***Rated Output Power (dBm)***	***Gain (dB)***	***Result***
759.989102	AWGN	5.70	36.82	37.00	31.12	PASS

EUT



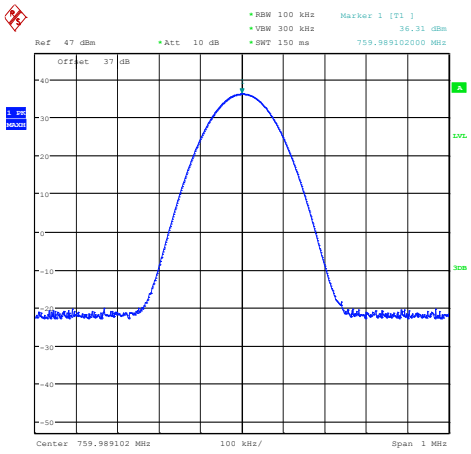
Signal Generator



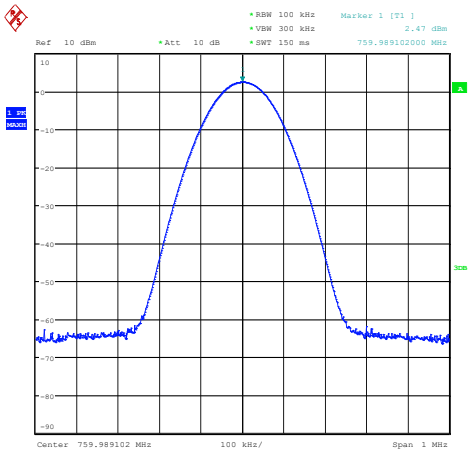
700 MHz Narrow band DC power supply

AGC Threshold f0 759.989102 MHz DC power supply						
Channel Fo Frequency (MHz)	***Modulation***	***Signal Generator Input Level (dBm)***	***Conducted Output Power (dBm)***	***Rated Output Power (dBm)***	***Gain (dB)***	***Result***
759.989102	CW	2.47	36.31	37.00	33.84	PASS

EUT

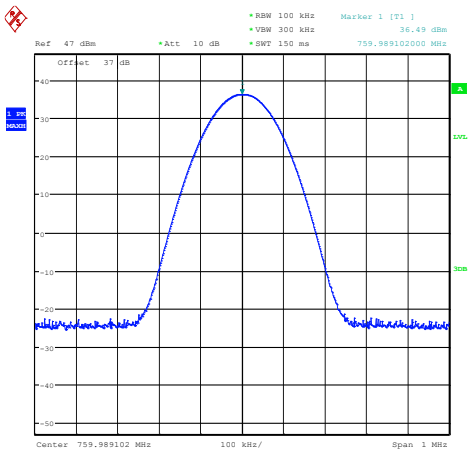


Signal Generator

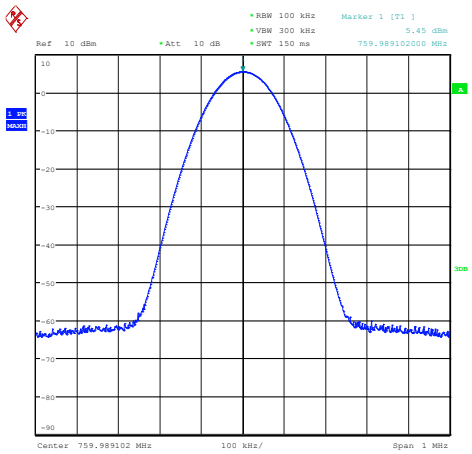


AGC +3 dB f0 759.989102 MHz DC power supply						
Channel Fo Frequency (MHz)	***Modulation***	***Signal Generator Input Level (dBm)***	***Conducted Output Power(dBm)***	***Rated Output Power (dBm)***	***Gain (dB)***	***Result***
759.989102	CW	5.45	36.49	37.00	31.04	PASS

EUT



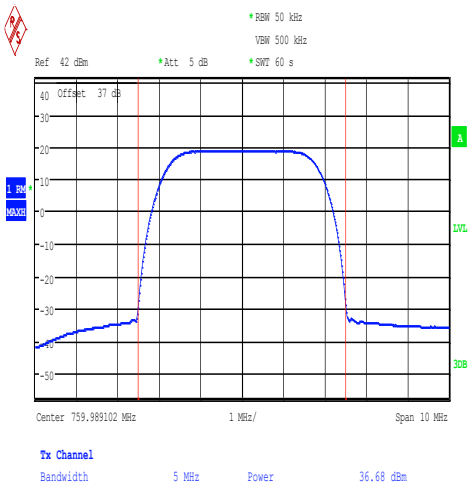
Signal Generator



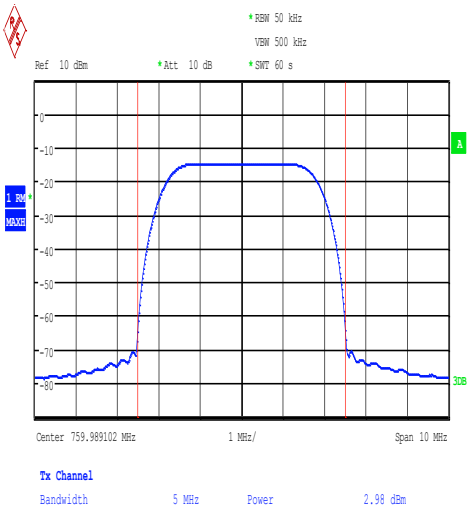
700 MHz Wide band DC power supply

AGC Threshold f0 759.989102 MHz DC power supply						
Channel Fo Frequency (MHz)	**Modulation**	**Signal Generator Input Level (dBm)**	**Conducted Output Power (dBm)**	**Rated Output Power (dBm)**	**Gain (dB)**	**Result**
759.989102	AWGN	2.98	36.68	37.00	33.70	PASS

EUT

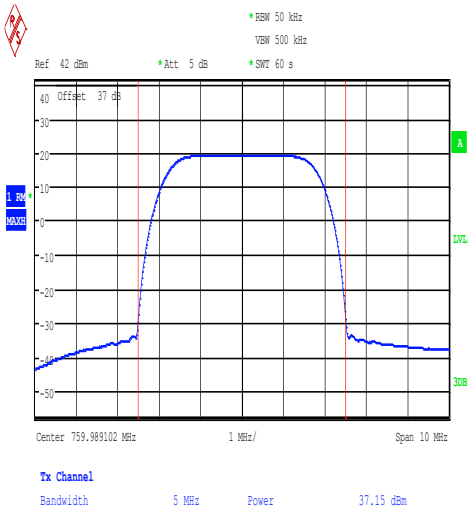


Signal Generator

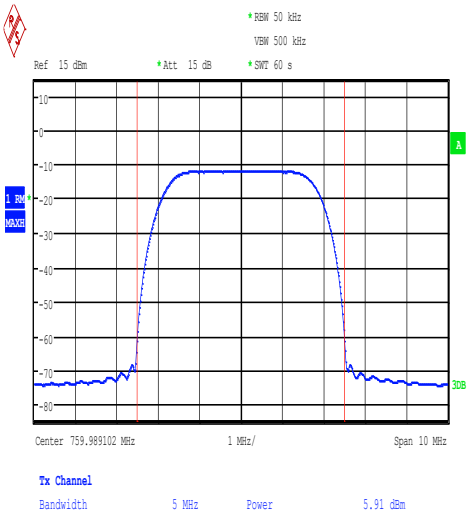


AGC +3 dB f0 759.989102 MHz DC power supply						
Channel Fo Frequency (MHz)	**Modulation**	**Signal Generator Input Level (dBm)**	**Conducted Output Power(dBm)**	**Rated Output Power (dBm)**	**Gain (dB)**	**Result**
759.989102	AWGN	5.91	37.15	37.00	31.24	PASS

EUT



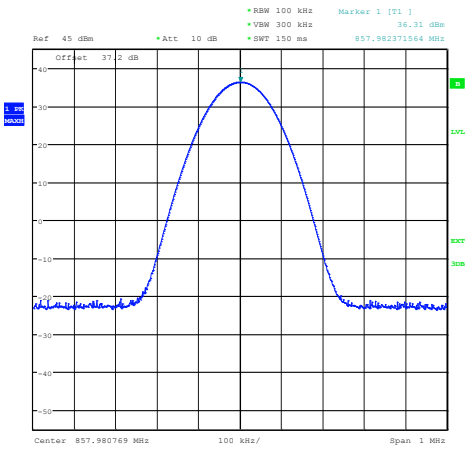
Signal Generator



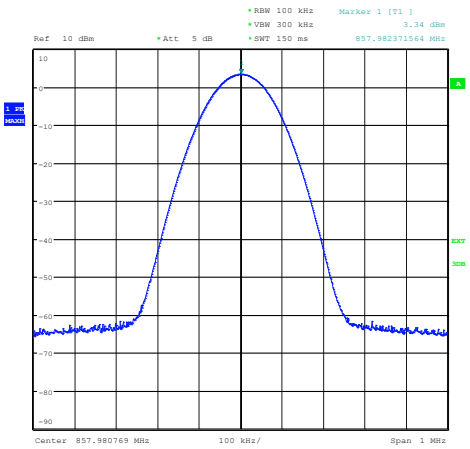
800 MHz AC Power Supply

AGC Threshold f0 857.982371 MHz AC power supply						
Channel Fo Frequency (MHz)	***Modulation***	***Signal Generator Input Level (dBm)***	***Conducted Output Power (dBm)***	***Rated Output Power (dBm)***	***Gain (dB)***	***Result***
857.982371	CW	3.34	36.31	37.00	32.97	PASS

EUT

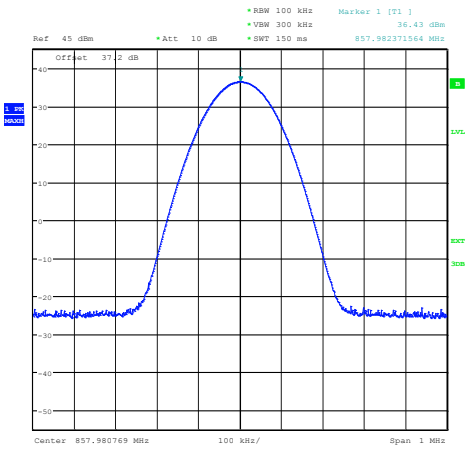


Signal Generator

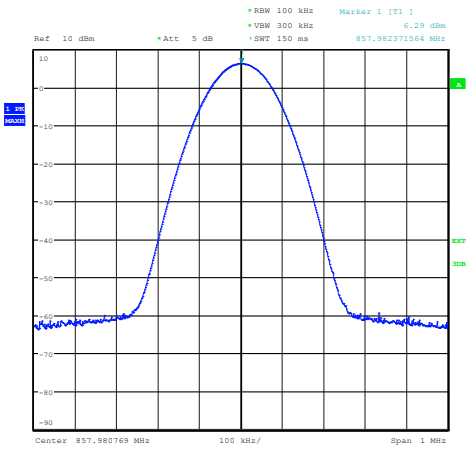


AGC +3 dB f0 857.982371 MHz AC power supply						
Channel Fo Frequency (MHz)	***Modulation***	***Signal Generator Input Level (dBm)***	***Conducted Output Power(dBm)***	***Rated Output Power (dBm)***	***Gain (dB)***	***Result***
857.982371	CW	6.29	36.43	37.00	30.14	PASS

EUT



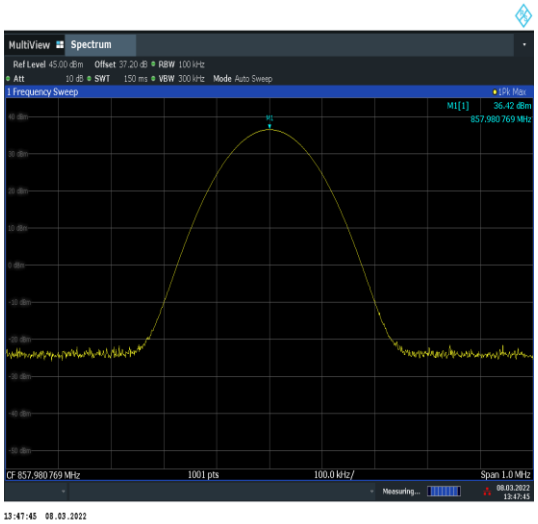
Signal Generator



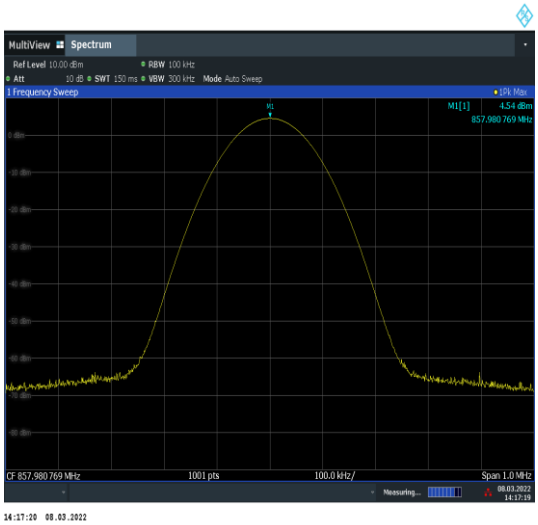
800 MHz AC Power Supply

AGC Threshold f0 857.982371 MHz DC power supply						
Channel Fo Frequency (MHz)	***Modulation***	***Signal Generator Input Level (dBm)***	***Conducted Output Power (dBm)***	***Rated Output Power (dBm)***	***Gain (dB)***	***Result***
857.982371	CW	4.54	36.42	37.00	31.88	PASS

EUT

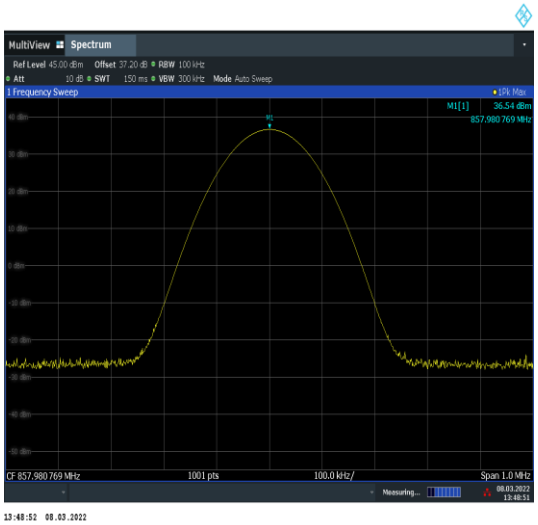


Signal Generator

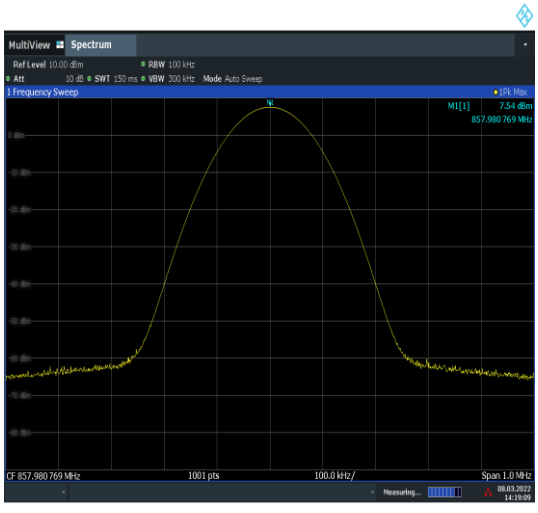


AGC +3 dB f0 857.982371 MHz AC power supply						
Channel Fo Frequency (MHz)	***Modulation***	***Signal Generator Input Level (dBm)***	***Conducted Output Power(dBm)***	***Rated Output Power (dBm)***	***Gain (dB)***	***Result***
857.982371	CW	7.54	36.54	37.00	29.00	PASS

EUT



Signal Generator



13 Frequency stability

13.1 Definition

Frequency stability is a measure of the frequency drift due to temperature and supply voltage variations, with reference to the frequency measured at +20C and rated supply voltage.

13.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Laboratory
Test Standard and Clause:	TIA-603-E-2010 Clause 2.2.2, 2.1055, Part 90.213(a), KDB 935210 D05 (3.7) (4.8) ANSI C63.26.(5.6.3)
Deviations from Standard:	None
Temperature Extreme Environment Test Range:	-30 to +50 C
Voltage Extreme Environment Test Range:	Mains Power = ±15% of Nominal; Battery: nominal and end point;

Environmental Conditions (Normal Environment)

Temperature: 17 °C	Standard Requirement: +20 ºC
Humidity: 60 %RH	20%RH to 75%RH (as declared)

13.3 Test Limits

The signals are retransmitted on the same channels as received. Minor departures from the exact provider or reference frequencies of the input signals are allowed, *provided that* the retransmitted signals meet the requirements of § 90.213 for the equipment with which the zone enhancer is to be used.

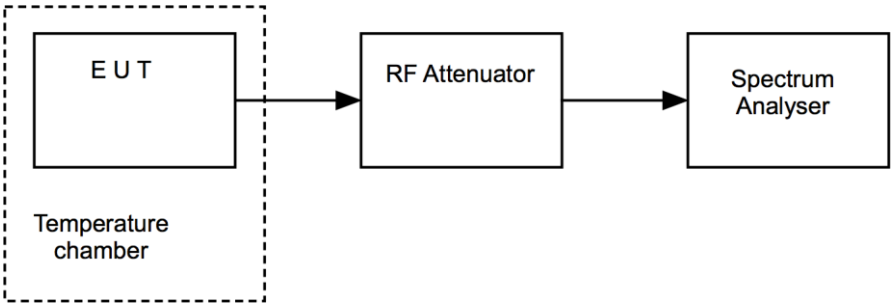
§ 90.532 758–769 MHz (b) The frequency stability of base transmitters operating in the narrowband segment must be 100 parts per billion or better.

(d) The frequency stability of base transmitters operating in the wideband segment must be 1 part per million or better.

13.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure viii, the EUT local oscillator frequency was measured under varying conditions of temperature and supply voltage. Measurements were made once temperature stability was achieved at each temperature.

Figure viii Test Setup



13.5 Test Equipment

Equipment Description	*Manufacturer*	*Equipment Type*	*Element No*	*Last Cal Calibration*	*Calibration Period*	*Due For Calibration*
Signal Generator	R&S	SMBV100A	REF916	2021-05-24	12	2022-05-24
Spectrum Analyser	R&S	FSU46	U405	2021-03-31	12	2022-03-31
Temperature Indicator	52 Series II	Fluke	L426	2021-07-01	12	2022-07-01
Multimeter	Agilent	34405a	REF976	2021-12-21	12	2022-12-21
Power Supply	Kikusui	PCR4000L	UH580	USE REF976		
Temperature Chamber	ETS	ETS-S1000CHS	U522	USE L426		
Attenuator	Bird	6 dB	U073	USE REF916 AND U405		
Attenuator	Radiall	R417030110 30 dB	U730	USE REF916 AND U405		

13.6 Test Results

Narrow Band 769 MHz-775 MHz :769.0125 MHz						
Vnom Vac	Temperature °C	Frequency MHz	Drift kHz	Drift ppm	Limit ppm	Result
115	-30 °C	769.01249994	-0.00006400	-0.00008322	0.1	Pass
115	-20 °C	769.01249994	-0.00006400	-0.00008322	0.1	Pass
115	-10 °C	769.01249994	-0.00006400	-0.00008322	0.1	Pass
115	0 °C	769.01249994	-0.00006400	-0.00008322	0.1	Pass
115	10 °C	769.01249994	-0.00006400	-0.00008322	0.1	Pass
115	20 °C	769.01249994	-0.00006400	-0.00008322	0.1	Pass
115	30 °C	769.01249994	-0.00006400	-0.00008322	0.1	Pass
115	40 °C	769.01249994	-0.00006400	-0.00008322	0.1	Pass
115	50 °C	769.01249994	-0.00006400	-0.00008322	0.1	Pass
Voltage Variation						
Vnom 85%-115%	Temperature °C	Frequency MHz	Drift kHz	Drift ppm	Limit ppm	Result
97.75	+20 °C	769.01249994	-0.00006400	-0.00008322	0.1	Pass
132.25	+20 °C	769.01249994	-0.00006400	-0.00008322	0.1	Pass

Narrow Band 769 MHz-775 MHz: 774.9875 MHz						
Vnom Vac	Temperature °C	Frequency MHz	Drift kHz	Drift ppm	Limit ppm	Result
115	-30 °C	774.98750000	0.00000000	0.00000000	0.1	Pass
115	-20 °C	774.98750000	0.00000000	0.00000000	0.1	Pass
115	-10 °C	774.98750000	0.00000000	0.00000000	0.1	Pass
115	0 °C	774.98750000	0.00000000	0.00000000	0.1	Pass
115	10 °C	774.98750000	0.00000000	0.00000000	0.1	Pass
115	20 °C	774.98750000	0.00000000	0.00000000	0.1	Pass
115	30 °C	774.98750000	0.00000000	0.00000000	0.1	Pass
115	40 °C	774.98750000	0.00000000	0.00000000	0.1	Pass
115	50 °C	774.98750000	0.00000000	0.00000000	0.1	Pass
Voltage Variation						
Vnom 85%-115%	Temperature °C	Frequency MHz	Drift kHz	Drift ppm	Limit ppm	Result
97.75	+20 °C	774.98750000	0.00000000	0.00000000	0.1	Pass
132.25	+20 °C	774.98750000	0.00000000	0.00000000	0.1	Pass

Wide Band LTE 758 MHz -768 MHz Bottom Frequency 760.500 MHz						
Vnom Vac	Temperature °C	Frequency MHz	Drift kHz	Drift ppm	Limit ppm	Result
115	-30 °C	760.50000000	0.00000000	0.00000000	1.0	Pass
115	-20 °C	760.50000000	0.00000000	0.00000000	1.0	Pass
115	-10 °C	760.50000000	0.00000000	0.00000000	1.0	Pass
115	0 °C	760.50000000	0.00000000	0.00000000	1.0	Pass
115	10 °C	760.50000000	0.00000000	0.00000000	1.0	Pass
115	20 °C	760.50000000	0.00000000	0.00000000	1.0	Pass
115	30 °C	760.50000000	0.00000000	0.00000000	1.0	Pass
115	40 °C	760.50000000	0.00000000	0.00000000	1.0	Pass
115	50 °C	760.50000000	0.00000000	0.00000000	1.0	Pass
Voltage Variation						
Vnom 85%-115%	Temperature °C	Frequency MHz	Drift kHz	Drift ppm	Limit ppm	Result
97.75	+20 °C	760.50000000	0.00000000	0.00000000	1.0	Pass
132.25	+20 °C	760.50000000	0.00000000	0.00000000	1.0	Pass

Wide Band LTE 700 MHz Top Frequency 765.500 MHz						
Vnom Vac	Temperature °C	Frequency MHz	Drift kHz	Drift ppm	Limit ppm	Result
115	-30 °C	765.50000000	0.00000000	0.00000000	1.0	Pass
115	-20 °C	765.50000000	0.00000000	0.00000000	1.0	Pass
115	-10 °C	765.50000000	0.00000000	0.00000000	1.0	Pass
115	0 °C	765.50000000	0.00000000	0.00000000	1.0	Pass
115	10 °C	765.50000000	0.00000000	0.00000000	1.0	Pass
115	20 °C	765.50000000	0.00000000	0.00000000	1.0	Pass
115	30 °C	765.50000000	0.00000000	0.00000000	1.0	Pass
115	40 °C	765.50000000	0.00000000	0.00000000	1.0	Pass
115	50 °C	765.50000000	0.00000000	0.00000000	1.0	Pass
Voltage Variation						
Vnom 85%-115%	Temperature °C	Frequency MHz	Drift kHz	Drift ppm	Limit ppm	Result
97.75	+20 °C	765.50000000	0.00000000	0.00000000	1.0	Pass
132.25	+20 °C	765.50000000	0.00000000	0.00000000	1.0	Pass

851.0125 MHz						
Vnom Vac	Temperature °C	Frequency MHz	Drift kHz	Drift ppm	Limit ppm	Result
115	-30 °C	851.01249994	-0.00006400	-0.00007520	1.0	Pass
115	-20 °C	851.01249994	-0.00006400	-0.00007520	1.0	Pass
115	-10 °C	851.01249994	-0.00006400	-0.00007520	1.0	Pass
115	0 °C	851.01249994	-0.00006400	-0.00007520	1.0	Pass
115	10 °C	851.01249994	-0.00006400	-0.00007520	1.0	Pass
115	20 °C	851.01249994	-0.00006400	-0.00007520	1.0	Pass
115	30 °C	851.01249994	-0.00006400	-0.00007520	1.0	Pass
115	40 °C	851.01249995	-0.00004800	-0.00005640	1.0	Pass
115	50 °C	851.01249997	-0.00003200	-0.00003760	1.0	Pass
Voltage Variation						
Vnom 85%-115%	Temperature °C	Frequency MHz	Drift kHz	Drift ppm	Limit ppm	Result
97.75	+20 °C	851.01249994	-0.00006400	-0.00007520	1.0	Pass
132.25	+20 °C	851.01249994	-0.00006400	-0.00007520	1.0	Pass

868..9875 MHz						
Vnom Vac		Frequency MHz	Drift kHz	Drift ppm	Limit ppm	Result
115	-30 °C	868.98750003	0.00003200	0.00003682	1.5	Pass
115	-20 °C	868.98750006	0.00006400	0.00007365	1.5	Pass
115	-10 °C	868.98750006	0.00006400	0.00007365	1.5	Pass
115	0 °C	868.98750006	0.00006400	0.00007365	1.5	Pass
115	10 °C	868.98750006	0.00006400	0.00007365	1.5	Pass
115	20 °C	868.98750000	0.00000000	0.00000000	1.5	Pass
115	30 °C	868.98750006	0.00006400	0.00007365	1.5	Pass
115	40 °C	868.98750006	0.00006400	0.00007365	1.5	Pass
115	50 °C	868.98750005	0.00004800	0.00005524	1.5	Pass
Voltage Variation						
Vnom 85%-115%	Temperature °C	Frequency MHz	Drift kHz	Drift ppm	Limit ppm	Result
97.75	+20 °C	868.98750000	0.00000000	0.00000000	1.5	Pass
132.25	+20 °C	868.98750000	0.00000000	0.00000000	1.5	Pass

14 Out-of-band/Out-of-block emissions and spurious emissions (including intermodulation)

14.1 Definition

Spurious intermodulation products result from intermodulation between: – the oscillations at the carrier, characteristic, or harmonic frequencies of an emission, or the oscillations resulting from the generation of the carrier or characteristic frequency; and – oscillations of the same nature, of one or several other emissions, originating from the same transmitting system or from other transmitters or transmitting systems.

14.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Laboratory
Test Standard and Clause:	Part 90.219(d)(6)(i), KDB 935210 D05 v01, (3.6) (4.7.2) (4.7.3)
EUT Operating Frequencies Tested, f_0:	Narrow band 857.980769 MHz
EUT Centre Frequency Tested:	Wide band 763.0 MHz
Source Tones:	Narrow band f_0 +/- 12.5 kHz/ +/-6.25 kHz Wide band ±2.5 MHz
Source Level:	3.0 dBm (AGC threshold); 6 dBm (3dB above)
Deviations from Standard:	None
Bandwidth:	RBW 300 Hz; VBW 3xRBW
Span:	100 kHz
Measurement Detector:	Average, rms.

Environmental Conditions (Normal Environment)

Temperature: 23°C	+15 ºC to +35 ºC (as declared)
Humidity: 30 %RH	20%RH to 75%RH (as declared)
Supply: 115 Vac	

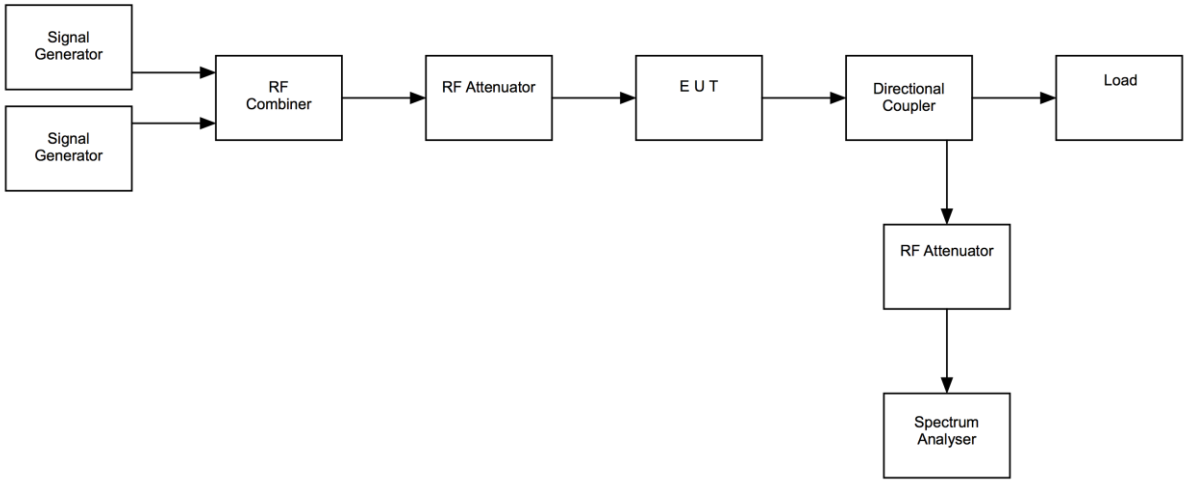
14.3 Test Limits

47CFR90 Part 90.219 (d)(6)(i)
In general, the ERP of intermodulation products should not exceed -30 dBm in 10 kHz measurement bandwidth

14.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure vi, two tones were input to the EUT. The combined level at the EUT input was set by the attenuator to just below the EUT AGC threshold level and the intermodulation products were measured on the spectrum analyser. The measurement was repeated with the input attenuator decreased by 3dB.

Figure vi Test Setup



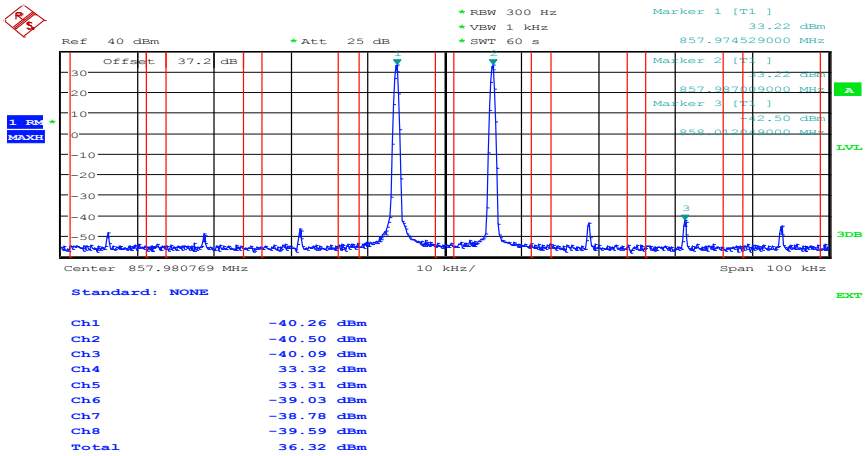
14.5 Test Equipment

Equipment Description	*Manufacturer*	*Equipment Type*	*Element No*	*Last Cal Calibration*	*Calibration Period*	*Due For Calibration*
Spectrum Analyser	R&S	FSW 43	U728	2021-04-20	12	2022-04-20
Signal Generator	Marconi	2042	L176	2021-06-10	12	2022-06-10
Signal Generator	Marconi	2023	UH105	2021-08-19	12	2022-08-19
Signal Combiner	PBE	05-003503	-	Cal USE U405 AND L176		
Attenuator	Bird	6 dB	U073	Cal USE U405 AND L176		
Attenuator	Radiall	R417030110 30 dB	U730	Cal USE U405 AND L176		

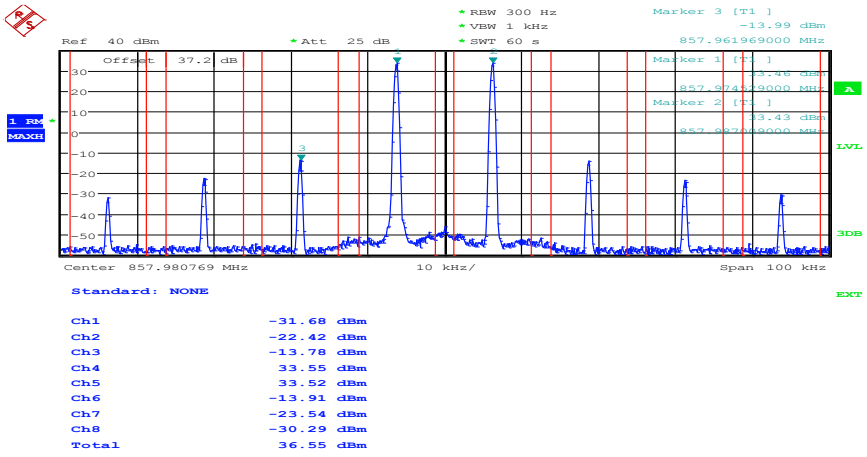
14.6 Test Results

800 MHz Passband

Downlink Intermodulation @ AGC threshold 12.5 kHz						
fo Frequency (MHz)	***Tone 2 (MHz)***	***Tone 2 (MHz)***	***Frequency of Intermodulation Product (MHz)***	***Highest Intermodulation Product Level (dBm)***	***Limit (dBm)***	***Result***
857.980769	857.974519	857.987019	858.012049	-38.78	-30 dBm	Pass



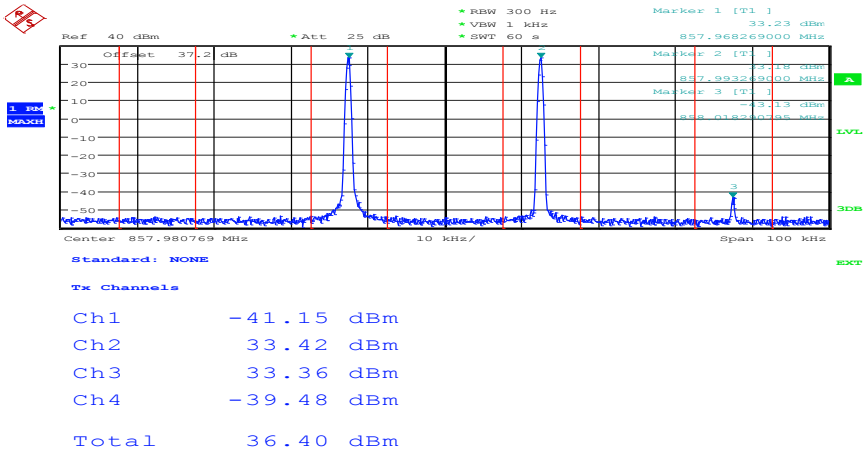
Downlink Intermodulation @ AGC +3 dB 12.5 kHz						
fo Frequency (MHz)	***Tone 2 (MHz)***	***Tone 2 (MHz)***	***Frequency of Intermodulation Product (MHz)***	***Highest Intermodulation Product Level (dBm)***	***Limit (dBm)***	***Result***
857.980769	857.974519	857.987019	857.987009	-13.78	-30 dBm	*



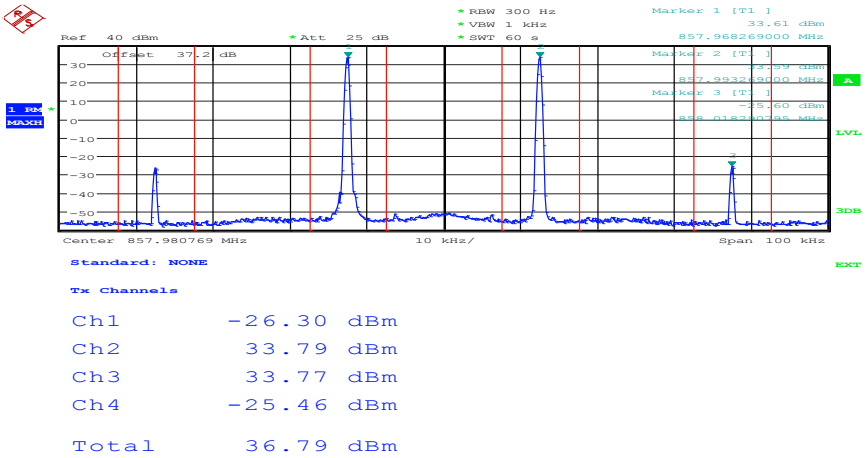
Note*: The Cable Loss (dB) + Splitter Loss (dB) - antenna gain (dBi) - 2.15 dB (EIRP to ERP conversion) must be greater than or equal to 26 dB.

Link Direction	Test Result (dBm)	System Loss (dB)	ERP (dBm)	Limit = -30 (dBm)
Downlink	-13.78	≥ 26.0 dB	-39.78	Pass

Downlink Intermodulation @ AGC threshold 25 kHz						
fo Frequency (MHz)	***Tone 2 (MHz)***	***Tone 2 (MHz)***	***Frequency of Intermodulation Product (MHz)***	***Highest Intermodulation Product Level (dBm)***	***Limit (dBm)***	***Result***
857.980769	857.968269	857.993269	858.018290	-39.48	-30 dBm	Pass



Downlink Intermodulation @ AGC +3 dB 25 kHz						
fo Frequency (MHz)	***Tone 2 (MHz)***	***Tone 2 (MHz)***	***Frequency of Intermodulation Product (MHz)***	***Highest Intermodulation Product Level (dBm)***	***Limit (dBm)***	***Result***
857.980769	857.968269	857.993269	858.018290	-25.46	-30 dBm	*



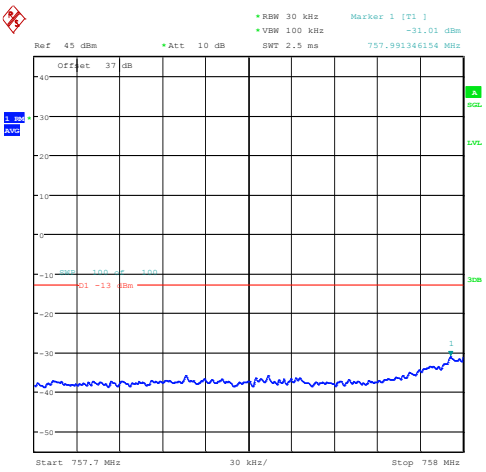
Note*: The Cable Loss (dB) + Splitter Loss (dB) - antenna gain (dBi) - 2.15 dB (EIRP to ERP conversion) must be greater than or equal to 26.0 dB.

Link Direction	Test Result (dBm)	System Loss (dB)	ERP (dBm)	Limit = -30 (dBm)
Downlink	-25.46	≥ 26.0 dB	-51.46	Pass

758 MHz-768 MHz

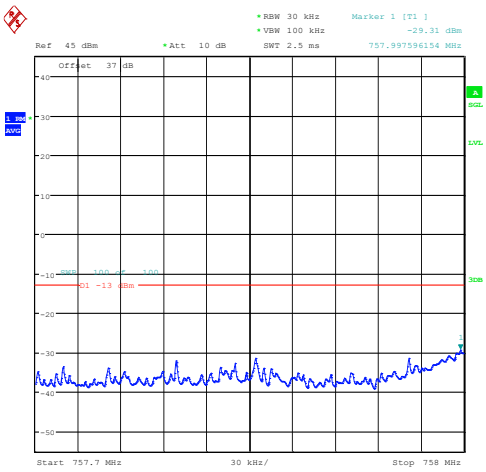
Clause 3.6.2 Out-of-band/out-of-block emissions conducted

2 x AWGN Signals Lower band-edge AGC



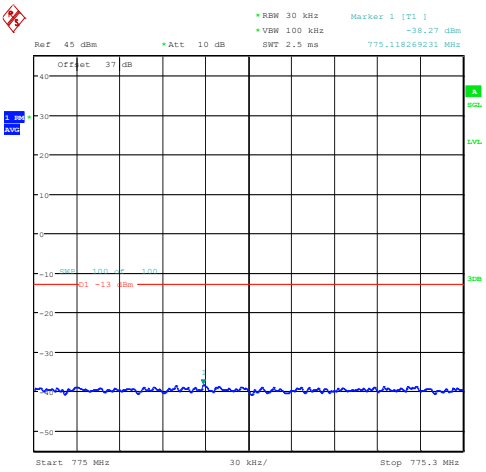
Date: 16.MAR.2022 15:57:59

2 x AWGN Signals Lower band-edge AGC 3



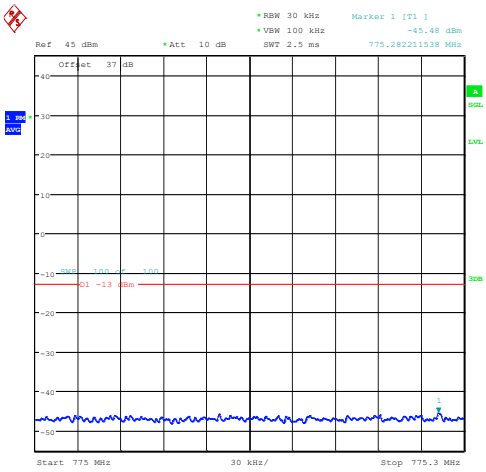
Date: 16.MAR.2022 15:58:42

2 x AWGN Signals Upper band-edge AGC



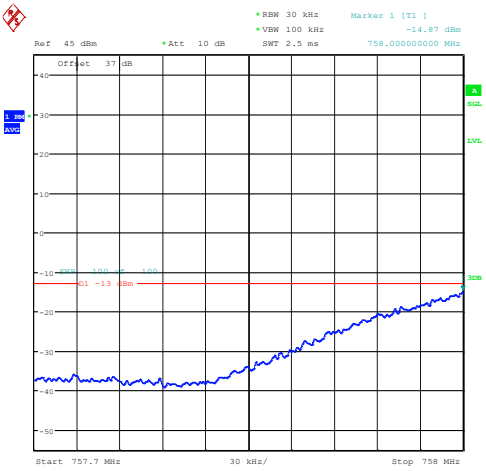
Date: 16.MAR.2022 16:01:57

2 x AWGN Signals Upper band-edge AGC 3



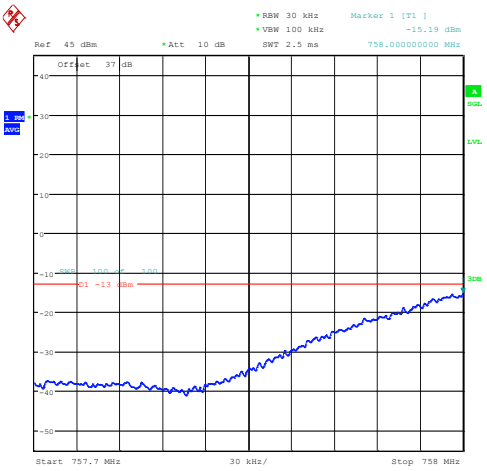
Date: 16.MAR.2022 16:02:30

1 x AWGN Signal Lower band-edge AGC



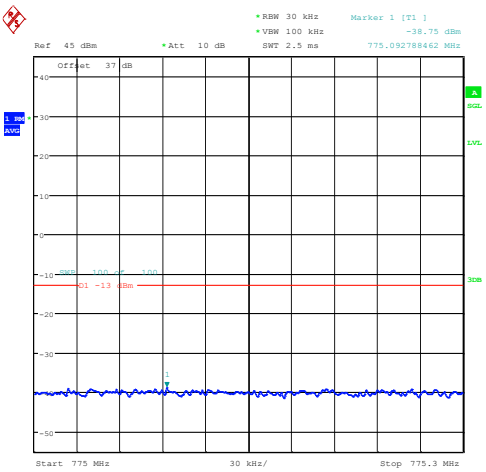
Date: 15.MAR.2022 11:40:50

1 x AWGN Signal Lower band-edge AGC 3



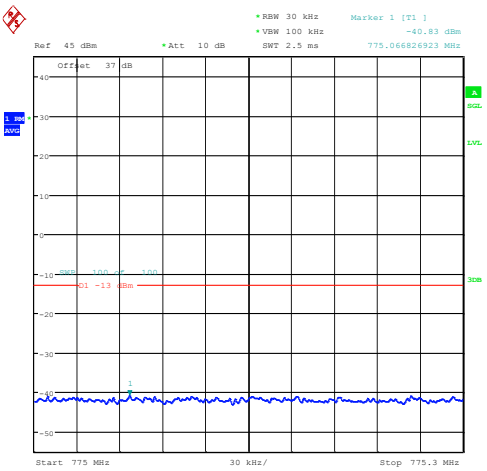
Date: 15.MAR.2022 11:41:21

1 x AWGN Signal Upper band-edge AGC



Date: 15.MAR.2022 11:39:19

1 x AWGN Signal Upper band-edge AGC 3



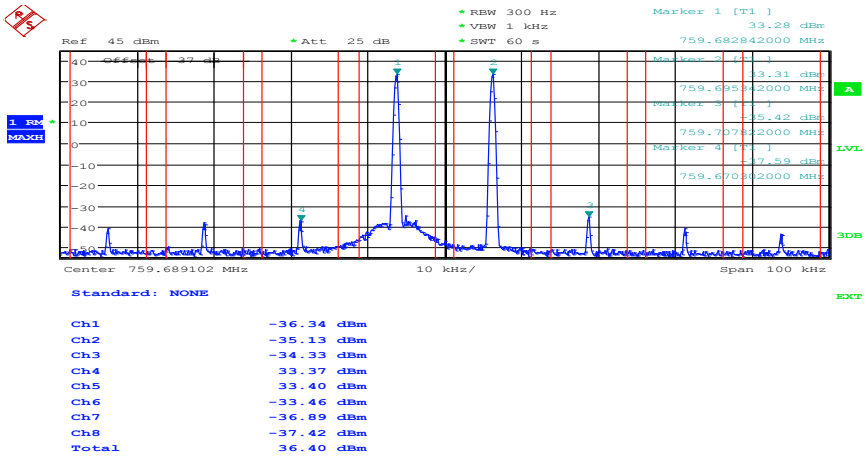
Date: 15.MAR.2022 11:39:47

Note: Frequency Band 758 MHz-775 MHz.

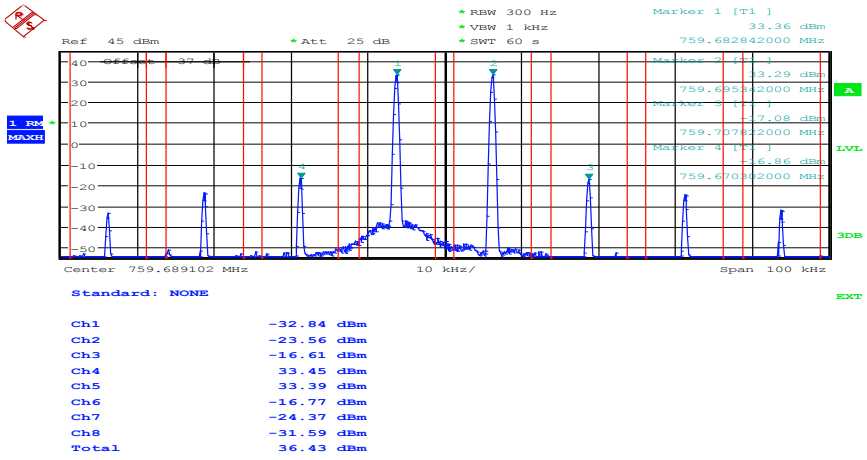
.

The frequency band is sub divided into the following
758 MHz-768 MHz (Broad band)(LTE)
769 MHz 775 MHz (Narrow band).

Downlink Intermodulation @ AGC threshold 12.5 kHz						
fo Frequency (MHz)	***Tone 2 (MHz)***	***Tone 2 (MHz)***	***Frequency of Intermodulation Product (MHz)***	***Highest Intermodulation Product Level (dBm)***	***Limit (dBm)***	***Result***
759.689102	759.682852	759.695352	759.707822	-33.46	-30 dBm	Pass



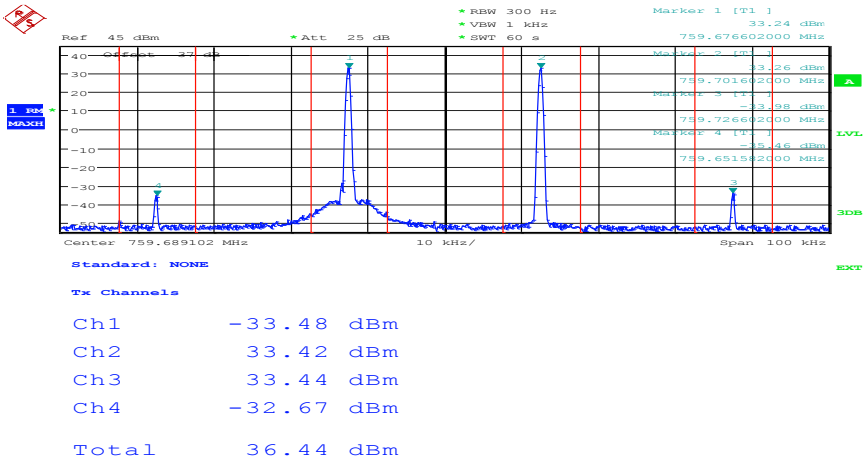
Downlink Intermodulation @ AGC +3 dB 12.5 kHz						
fo Frequency (MHz)	***Tone 2 (MHz)***	***Tone 2 (MHz)***	***Frequency of Intermodulation Product (MHz)***	***Highest Intermodulation Product Level (dBm)***	***Limit (dBm)***	***Result***
759.689102	759.682852	759.695352	759.670302	-16.61	-30 dBm	*



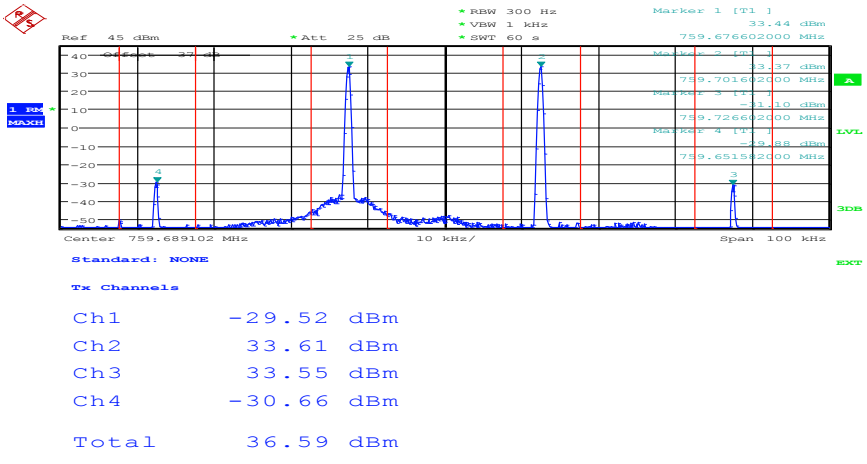
Note*: The Cable Loss (dB) + Splitter Loss (dB) - antenna gain (dBi) - 2.15 dB (EIRP to ERP conversion) must be greater than or equal to 26.0 dB..

Link Direction	Test Result (dBm)	System Loss (dB)	ERP (dBm)	Limit = -30 (dBm)
Downlink	-16.61	≥ 26.0 dB	-42.61	Pass

Downlink Intermodulation @ AGC threshold 25.0 kHz						
fo Frequency (MHz)	***Tone 2 (MHz)***	***Tone 2 (MHz)***	***Frequency of Intermodulation Product (MHz)***	***Highest Intermodulation Product Level (dBm)***	***Limit (dBm)***	***Result***
759.689102	759.676602	759.701602	759.726602	-32.67	-30 dBm	Pass



Downlink Intermodulation @ AGC +3 dB 25.0kHz						
fo Frequency (MHz)	***Tone 2 (MHz)***	***Tone 2 (MHz)***	***Frequency of Intermodulation Product (MHz)***	***Highest Intermodulation Product Level (dBm)***	***Limit (dBm)***	***Result***
759.689102	759.676602	759.701602	759.726602	-29.52	-30 dBm	*



Note*: The Cable Loss (dB) + Splitter Loss (dB) - antenna gain (dBi) - 2.15 dB (EIRP to ERP conversion) must be greater than or equal to 26.0dB.

Link Direction	Test Result (dBm)	System Loss (dB)	ERP (dBm)	Limit = -30 (dBm)
Downlink	-29.52	≥ 26.0 dB	-55.52	Pass

15 Input-versus-output signal comparison

15.1 Definition

The emission mask is the required attenuation relative to the channel power up to 250% of the channel bandwidth. For frequencies greater than 250% of the authorized bandwidth, refer to spurious emission measurement.

15.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Laboratory
Test Standard and Clause:	Part 90.219(e)(4)(ii)(iii), KDB 935210 D05 v01, clause (3.4) (4.4)
EUT Operating Frequencies Tested:	852.5 MHz,861.5 MHz,772.0 MHz,763.0 MHz
Source Modulations:	16K0F3E, 11K3F3E, 8K10F1E,8K10F1W,
Source Levels:	3.0dBm, 6.0 dBm (AGC threshold and 3dB above)
Deviations from Standard:	None
Bandwidth, RBW:	Various, see plots. VBW =3xRBW
Span:	62.5 kHz/100 kHz (2-5 times OBW)
Measurement Detector:	Peak; Max-Hold.

Environmental Conditions (Normal Environment)

Temperature: 23°C	+15 ºC to +35 ºC (as declared)
Humidity: 30%RH	20%RH to 75%RH (as declared)
Supply: 115 Vac	

15.3 Test Limits

15.3.1 FCC 47CFR90

(i) There is no change in the occupied bandwidth of the retransmitted signals.
(ii) The retransmitted signals continue to meet the unwanted emissions limits of §90.210 applicable to the corresponding received signals (assuming that these received signals meet the applicable unwanted emissions limits by a reasonable margin).

TABLE 1 TO § 90.210—APPLICABLE EMISSION MASKS

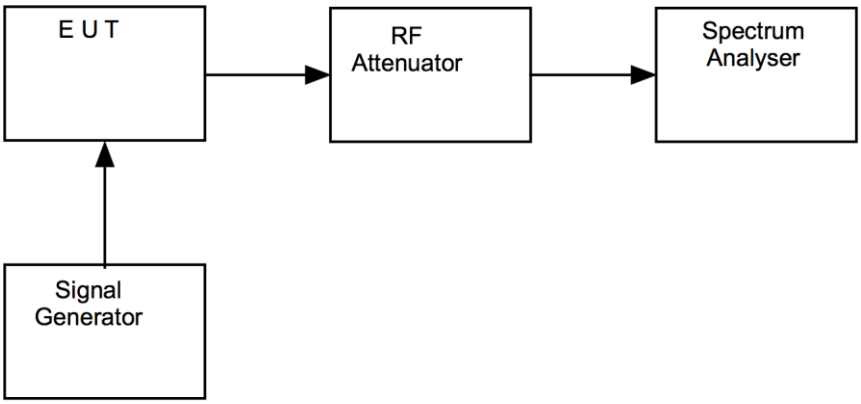
Frequency band (MHz)	Mask for equipment with audio low pass filter	Mask for equipment without audio low pass filter
Below 25 [1]	A or B	A or C
25–50	B	C
72–76	B	C
150–174 [2]	B, D, or E	C, D or E
150 paging only	B	C
220–222	F	F
421–512 [2 5]	B, D, or E	C, D, or E
450 paging only	B	G
806–809/851–854 [6]	B	H
809–824/854–869 [3 5]	B, D	D, G.
896–901/935–940	I	J
902–928	K	K
929–930	B	G
4940–4990 MHz	L or M	L or M
5850–5925 [4].		
All other bands	B	C

[1] Equipment using single sideband J3E emission must meet the requirements of Emission Mask A. Equipment using other emissions must meet the requirements of Emission Mask B or C, as applicable.
[2] Equipment designed to operate with a 25 kHz channel bandwidth must meet the requirements of Emission Mask B or C, as applicable. Equipment designed to operate with a 12.5 kHz channel bandwidth must meet the requirements of Emission Mask D, and equipment designed to operate with a 6.25 kHz channel bandwidth must meet the requirements of Emission Mask E.
[3] Equipment used in this licensed to EA or non-EA systems shall comply with the emission mask provisions of § 90.691 of this chapter.
[4] DSRCS Roadside Units equipment in the 5850–5925 MHz band is governed under subpart M of this part.
[5] Equipment designed to operate on 25 kilohertz bandwidth channels must meet the requirements of either Emission Mask B or G, whichever is applicable, while equipment designed to operate on 12.5 kilohertz bandwidth channels must meet the requirements of Emission Mask D. Equipment designed to operate on 25 kilohertz bandwidth channels may alternatively meet the Adjacent Channel Power limits of § 90.221.
[6] Transmitters utilizing analog emissions that are equipped with an audio low-pass filter must meet Emission Mask B. All transmitters utilizing digital emissions and those transmitters using analog emissions without an audio low-pass filter must meet Emission Mask H.

15.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure iii, the RF spectrum mask was measured on a spectrum analyser and compared to the signal generator output as shown on the plots.
The measurements were performed with EUT set at its nominal / maximum gain.
The measurements were repeated without input signal to measure the noise.

Figure iii Test Setup



15.5 Test Equipment

Equipment Description	*Manufacturer*	*Equipment Type*	*Element No*	*Last Cal Calibration*	*Calibration Period*	*Due For Calibration*
Signal Generator	R&S	SMBV100A	REF916	2021-05-24	12	2022-05-24
Spectrum Analyser	R&S	FSU46	U405	2021-03-31	12	2022-03-31
Attenuator	Bird	6 dB	U073	Cal USE REF916 AND REF910		
Attenuator	Radiall	R417030110 30 dB	U730	Cal USE REF916 AND REF910		

Modulation types and emission designators used for test signals

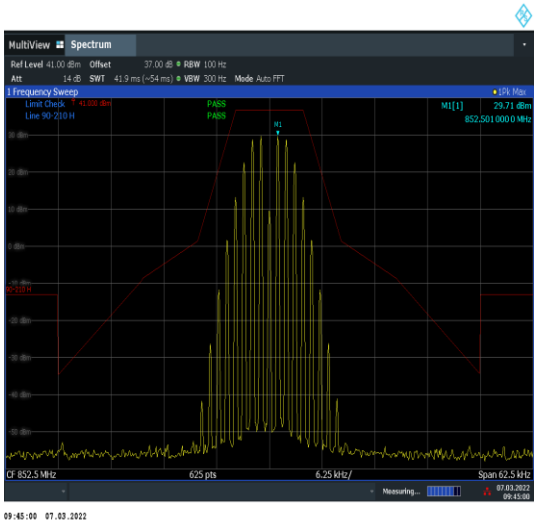
Modulation Type	Emission designator
FM	16K0F3E
FM	11K3F3E
P25	8K10F1E
P25	8K10F1W

15.6 Test Results

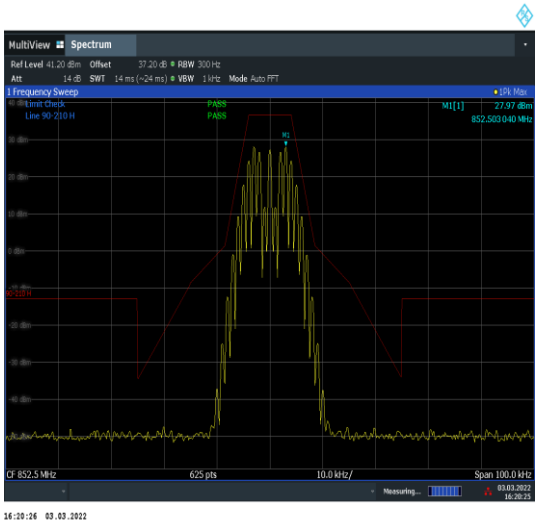
851 MHz – 854 MHz Mask H

851.0 MHz-854 MHz Passband: Emission Mask H @ AGC Threshold					
Channel Centre Frequency (MHz)	***Modulation Type***				***Result***
	16K0F3E	***11K3F3E***	***8K10F1E***	***8K10F1W***	
852.5 MHz	Complies	Complies	Complies	Complies	PASS

12.5 kHz FM Mask H @ AGC

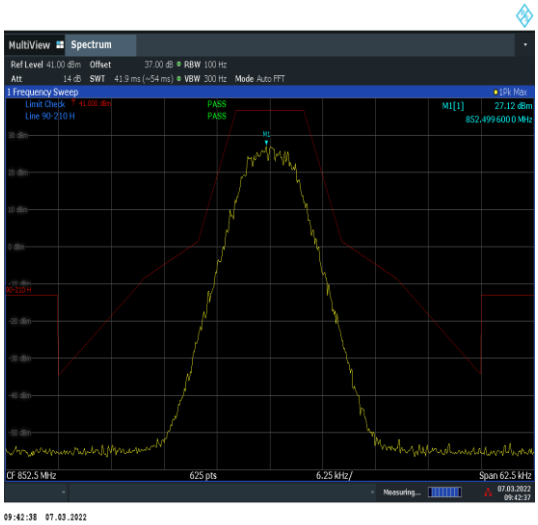


25 kHz FM Mask H @ AGC



P25 C4FM Mask H @ AGC

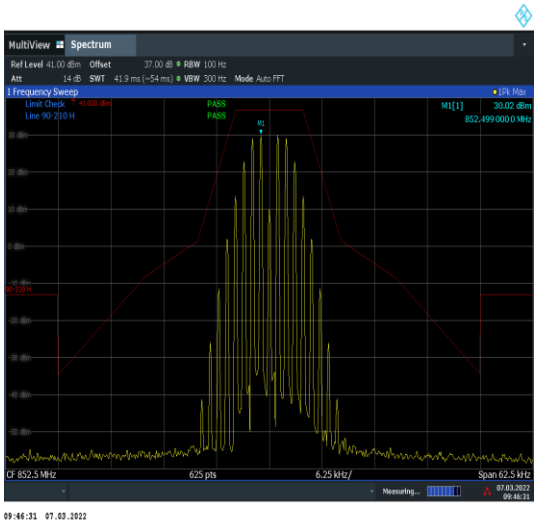
P25 H-CPM Mask H @ AGC



The above plots depicting the output spectra show no obvious distortion visible when compared to the input signal.

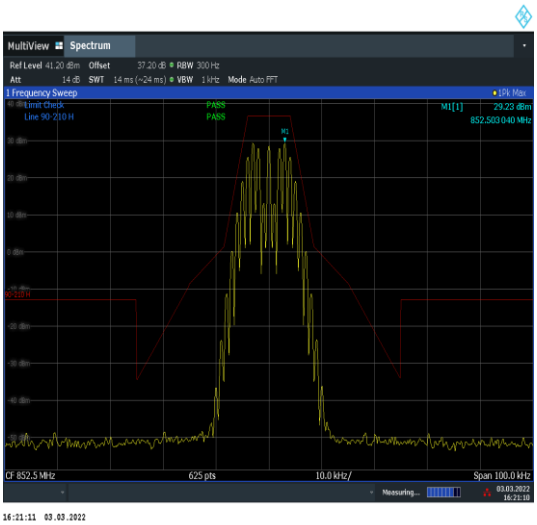
851.0 MHz-854 MHz Passband: Emission Mask H @ AGC+3 dB Threshold					
Channel Centre Frequency (MHz)	Modulation Type				Result
	16K0F3E	11K3F3E	8K10F1E	8K10F1W	
852.5 MHz	Complies	Complies	Complies	Complies	PASS

12.5 kHz FM Mask H @ AGC +3 dB



09:46:31 07.03.2022

25 kHz FM Mask H @ AGC+3 dB

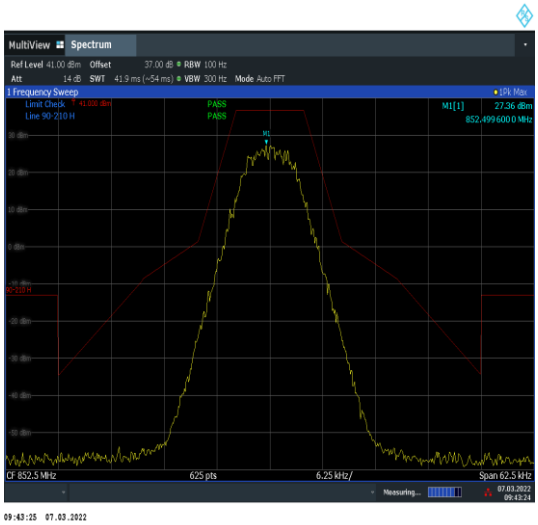


16:21:11 03.03.2022

P25 C4FM Mask H @ AGC+3 dB

09:39:09 07.03.2022

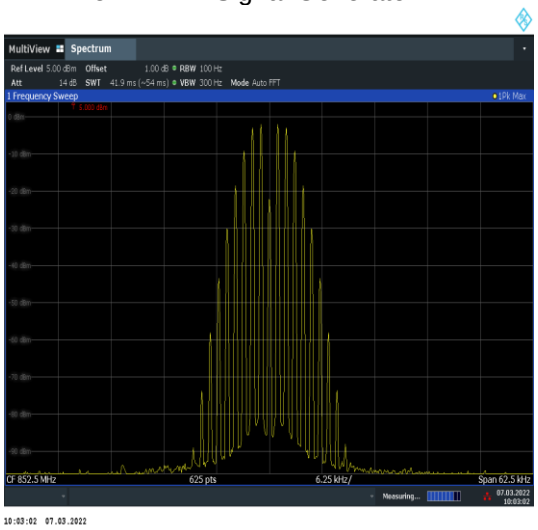
P25 H-CPM Mask H @ AGC+3 dB



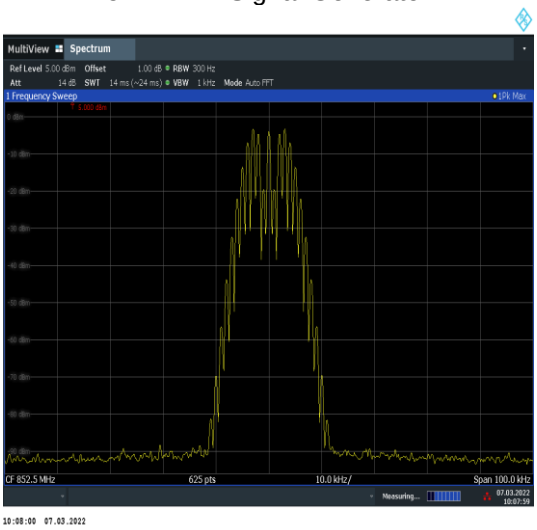
09:43:25 07.03.2022

The above plots depicting the output spectra show no obvious distortion visible when compared to the input signal

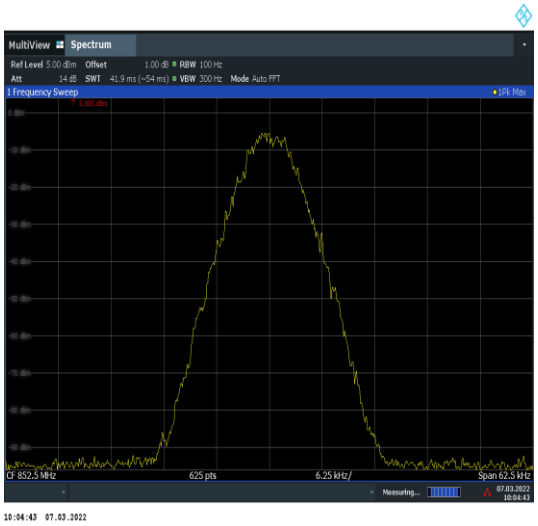
12.5 kHz FM Signal Generator



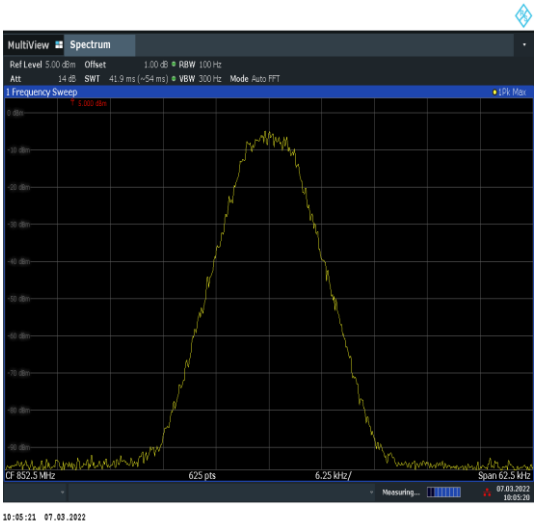
25 kHz FM Signal Generator



P25 C4FM Signal Generator



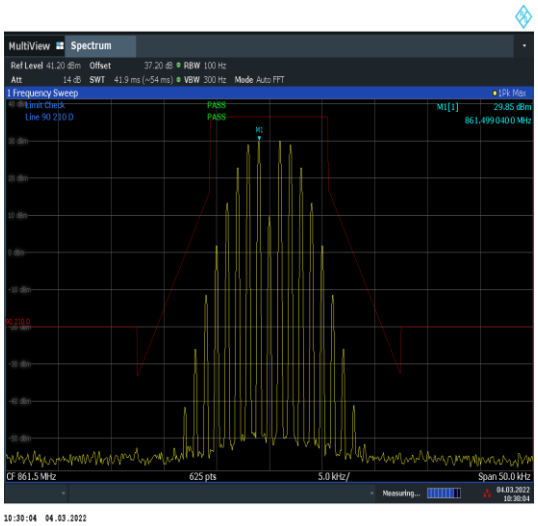
P25 H-CPM Signal Generator



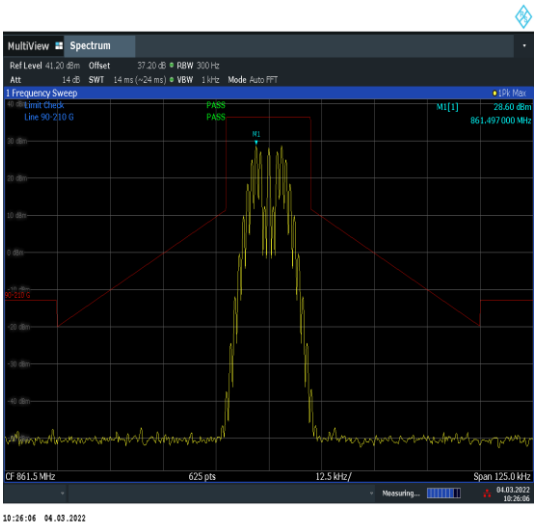
The above plots depicting the output spectra show no obvious distortion visible when compared to the input signal

854 MHz – 869 MHz Masks

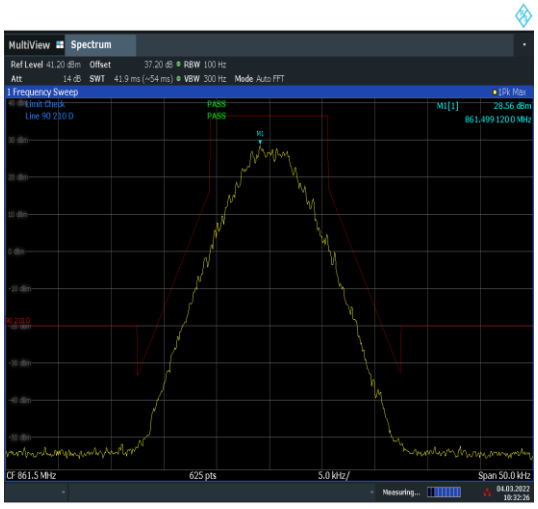
12.5 kHz FM Mask D @ AGC



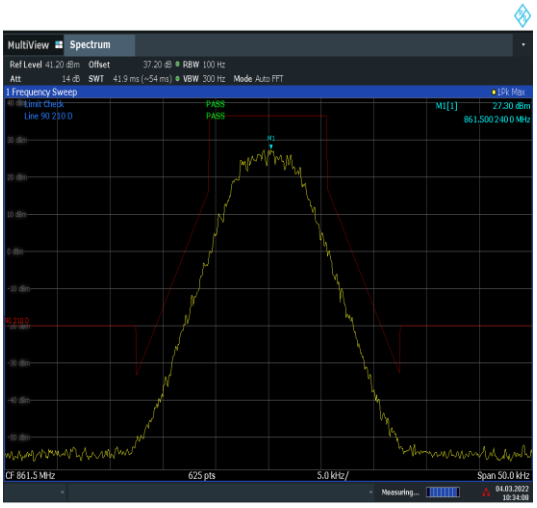
25 kHz FM Mask G @ AGC



P25 C4FM Mask D @ AGC



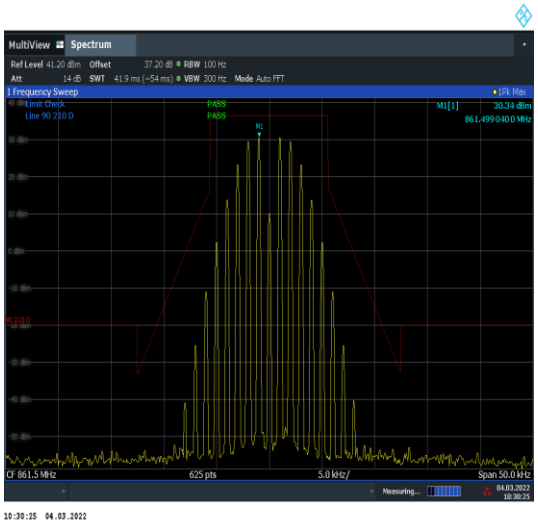
P25 H-CPM Mask D @ AGC



The above plots depicting the output spectra show no obvious distortion visible when compared to the input signal

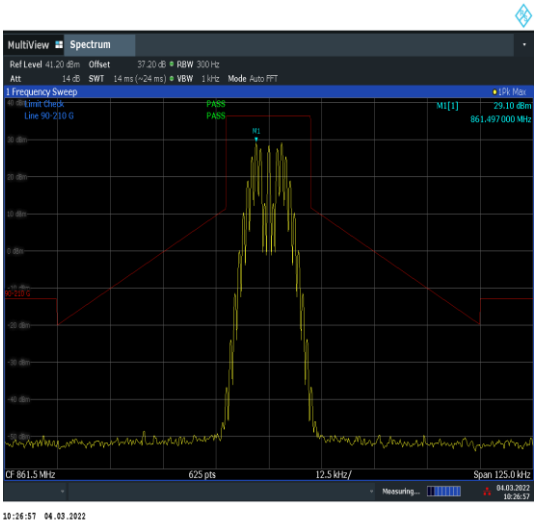
854 MHz – 869 MHz Masks

12.5 kHz FM Mask D @ AGC+3 dB



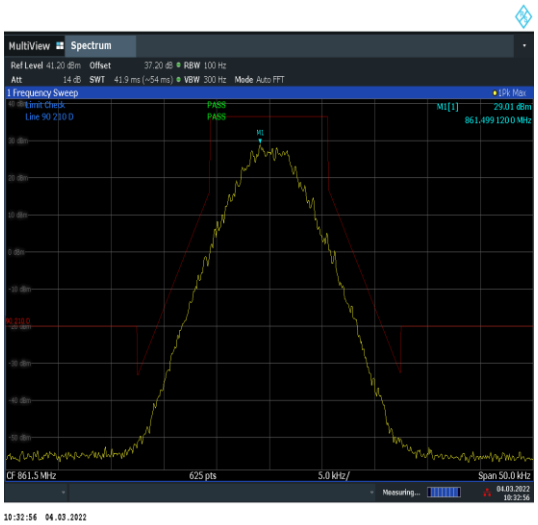
10:30:25 04.03.2022

25 kHz FM Mask G @ AGC+3 dB



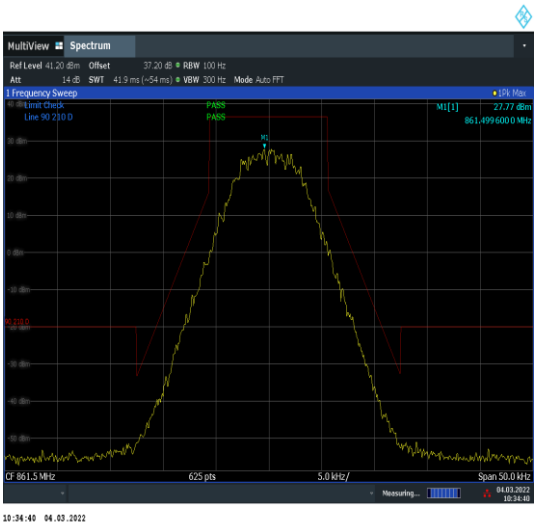
10:26:57 04.03.2022

P25 C4FM Mask D @ AGC+3 dB



10:32:56 04.03.2022

P25 H-CPM Mask D @ AGC+3 dB



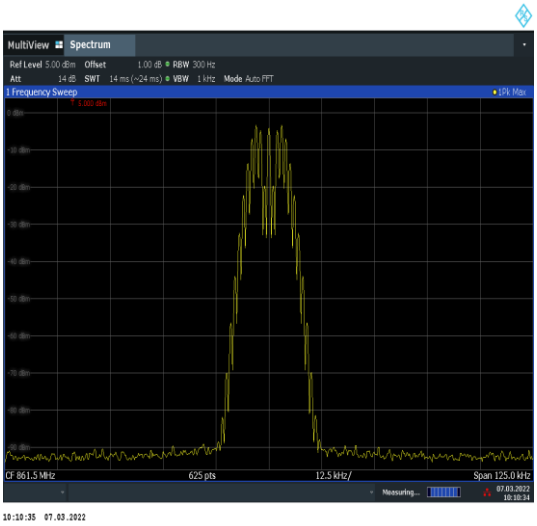
10:34:40 04.03.2022

The above plots depicting the output spectra show no obvious distortion visible when compared to the input signal

12.5 kHz FM Signal Generator

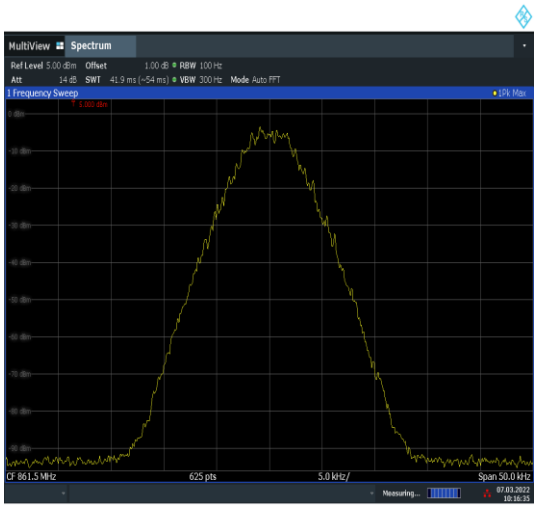
10:13:20 07.03.2022

25 kHz FM Signal Generator



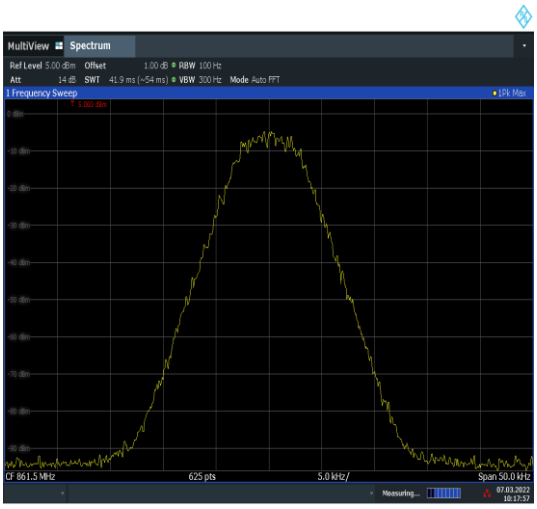
10:10:35 07.03.2022

P25 C4FM Signal Generator



10:16:36 07.03.2022

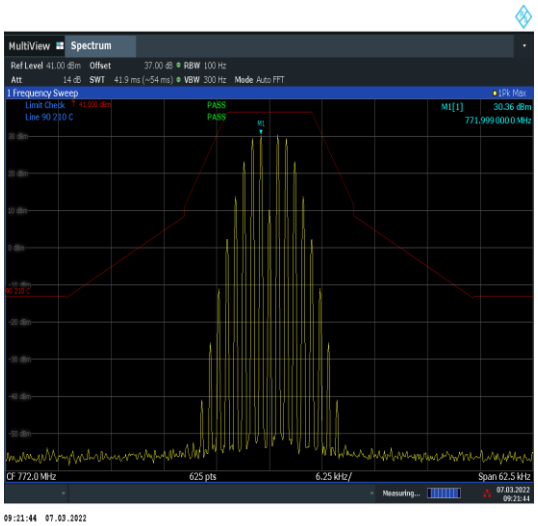
P25 H-CPM Signal Generator



10:17:58 07.03.2022

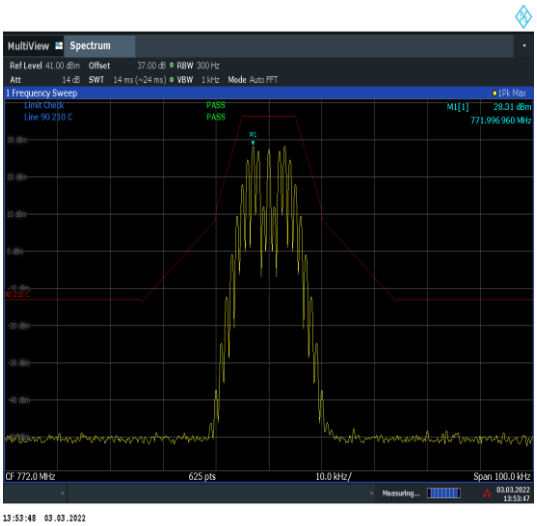
769 MHz – 775 MHz Masks

12.5 kHz FM Mask C @ AGC



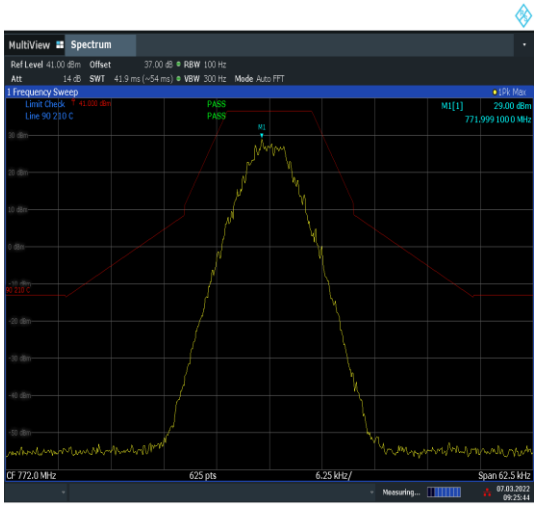
09:21:44 07.03.2022

25 kHz FM Mask C @ AGC



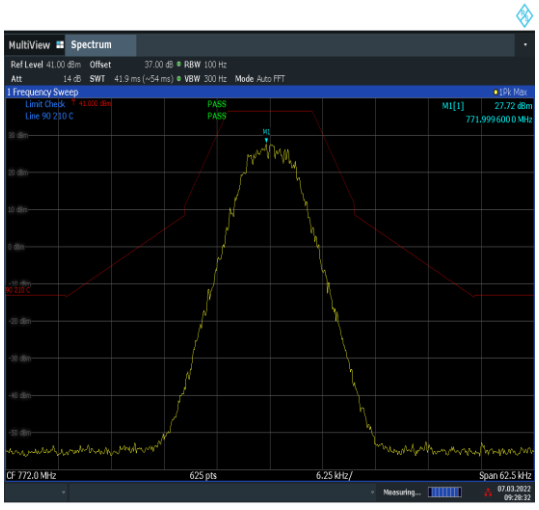
13:53:48 03.03.2022

P25 C4FM Mask C @ AGC



09:25:44 07.03.2022

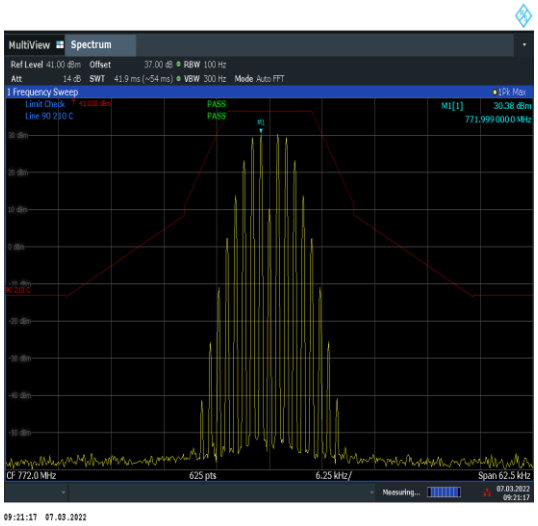
P25 H-CPM Mask C @ AGC



09:28:32 07.03.2022

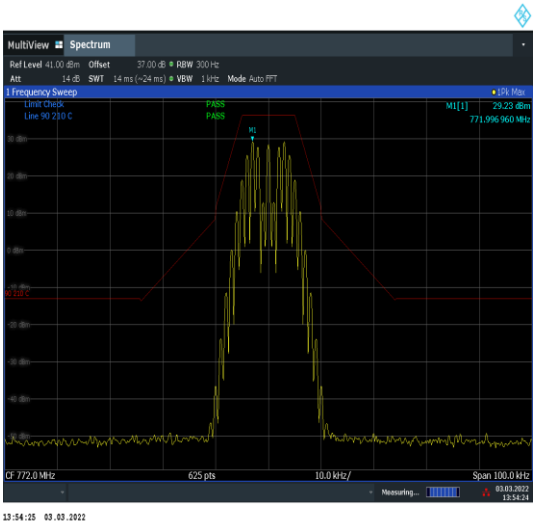
The above plots depicting the output spectra show no obvious distortion visible when compared to the input signal

12.5 kHz FM Mask C @ AGC+3 dB



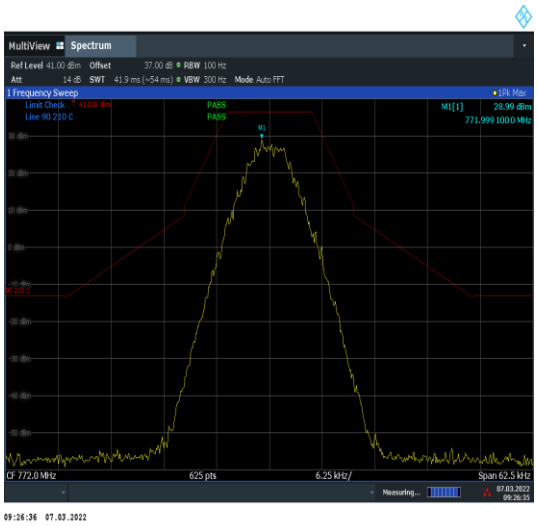
09:21:17 07.03.2022

25 kHz FM Mask C @ AGC+3 dB



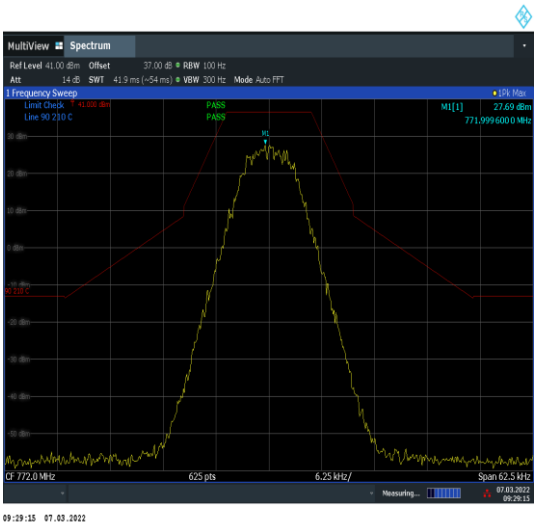
13:54:25 03.03.2022

P25 C4FM Mask C @ AGC+3 dB



09:26:36 07.03.2022

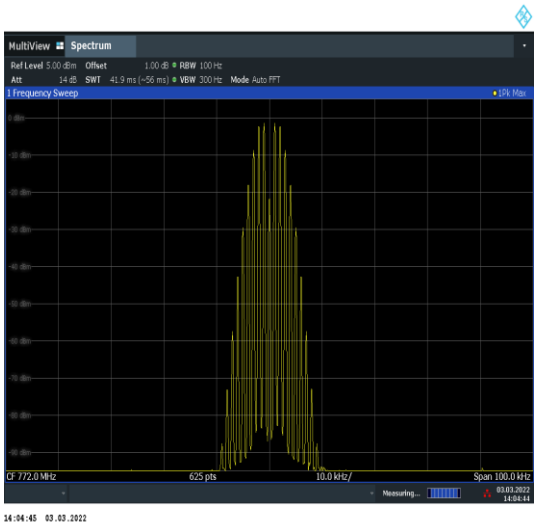
P25 H-CPM Mask C @ AGC+3 dB



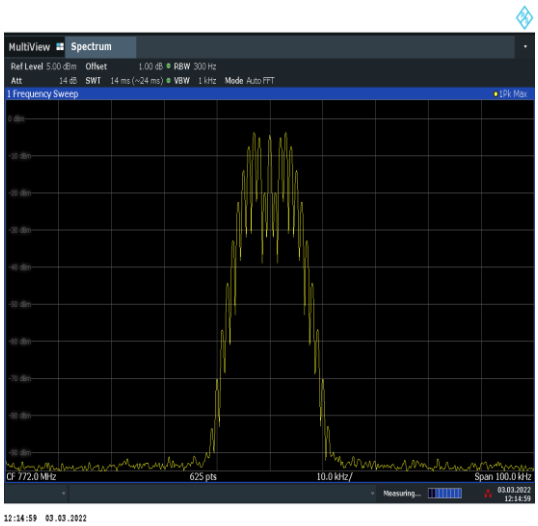
09:29:15 07.03.2022

The above plots depicting the output spectra show no obvious distortion visible when compared to the input signal

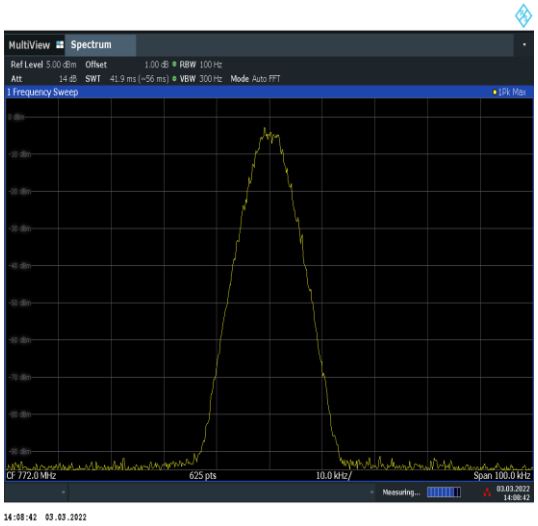
12.5 kHz FM Signal Generator



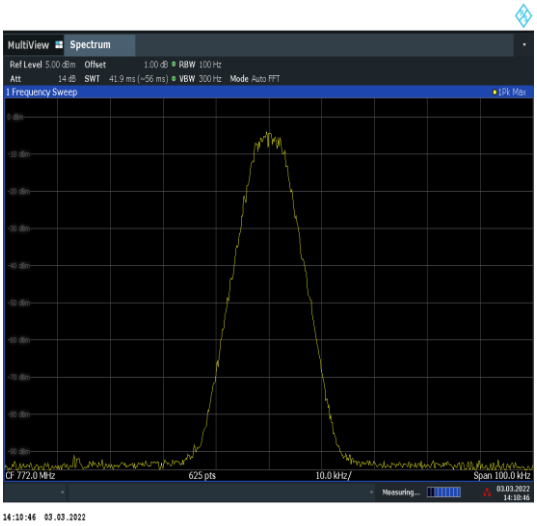
25 kHz FM Signal Generator



P25 C4FM Signal Generator



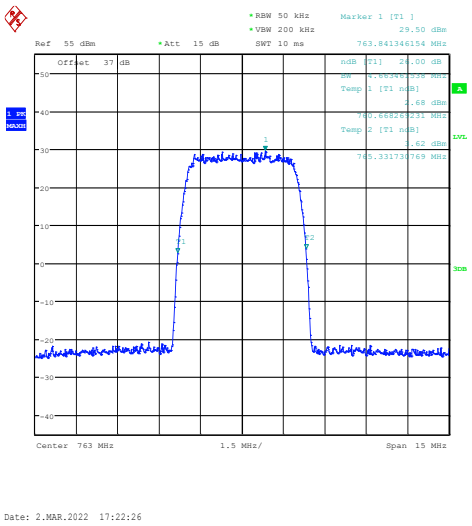
P25 H-CPM Signal Generator



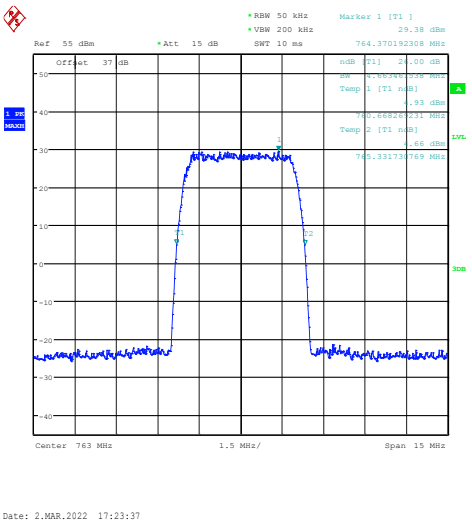
758 MHz –768 MHz

26 dB Bandwidth

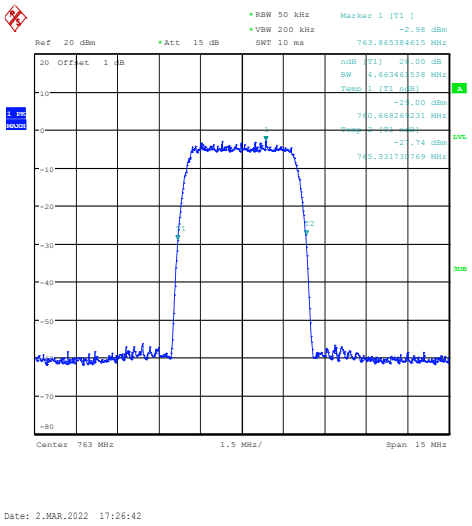
AWGN at AGC



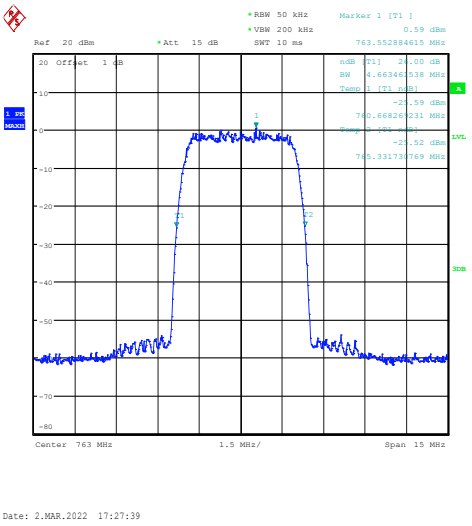
AWGN at AGC+3 dB



AWGN Signal Generator AGC



AWGN Signal Generator AGC+3 dB



Modulation	fl (MHz)	fh (MHz)	26 dB Bandwidth (MHz)
AWGN EUT @ AGC	760.668269	765.331730	4.66
AWGN EUT @ AGC+ 3 dB	760.668269	765.331730	4.66
AWGN Signal Generator@ AGC	760.668269	765.331730	4.66
AWGN Signal Generator@ AGC+ 3 dB	760.668269	765.331730	4.66

The above plots depicting the output spectra show no obvious distortion visible when compared to the input signal

16 Noise figure

16.1 Definition

A measure of the noise generated within (or degradation in signal/noise ratio as a signal passes through) the device expressed as the ratio of signal/noise power ratio at the input to signal/noise ratio at the output.

16.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Laboratory
Test Standard and Clause:	Part 90.219(e)(2) KDB 935210 D05 v01, clause 4.6:
EUT Operating Frequencies Tested:	758 MHz-775 MHz/851 MHz-869 MHz
Deviations from Standard:	None
Bandwidth:	RBW 10 kHz

Environmental Conditions (Normal Environment)

Temperature: 23°C	+15 ºC to +35 ºC (as declared)
Humidity: 30%RH	20%RH to 75%RH (as declared)
Supply: 115Vac	

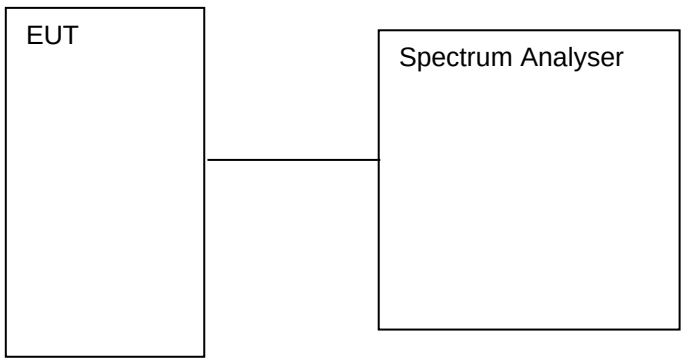
16.3 Test Limits

For the remote unit of a conventional fiber-connected host/remote DAS booster system, it is acceptable to submit compliance information and test data consistent with Section 90.219(d)(6)(ii) (i.e., ERP of noise ≤ −43 dBm in 10 kHz RBW) for the downlink path only, in place of Section 90.219(e)(2) noise figure test data (i.e., NF ≤ 9 dB for both UL and DL).

16.4 Test Method

The equipment was setup as shown in Figure ii. A spectrum analyser with a noise figure measurement capability was used. The spectrum analyser provided the on/off control of the noise source as well as measuring the result at its RF input. Prior to measuring the EUT, a calibration of the measurement network was performed with the EUT removed.

Figure ii Test Setup

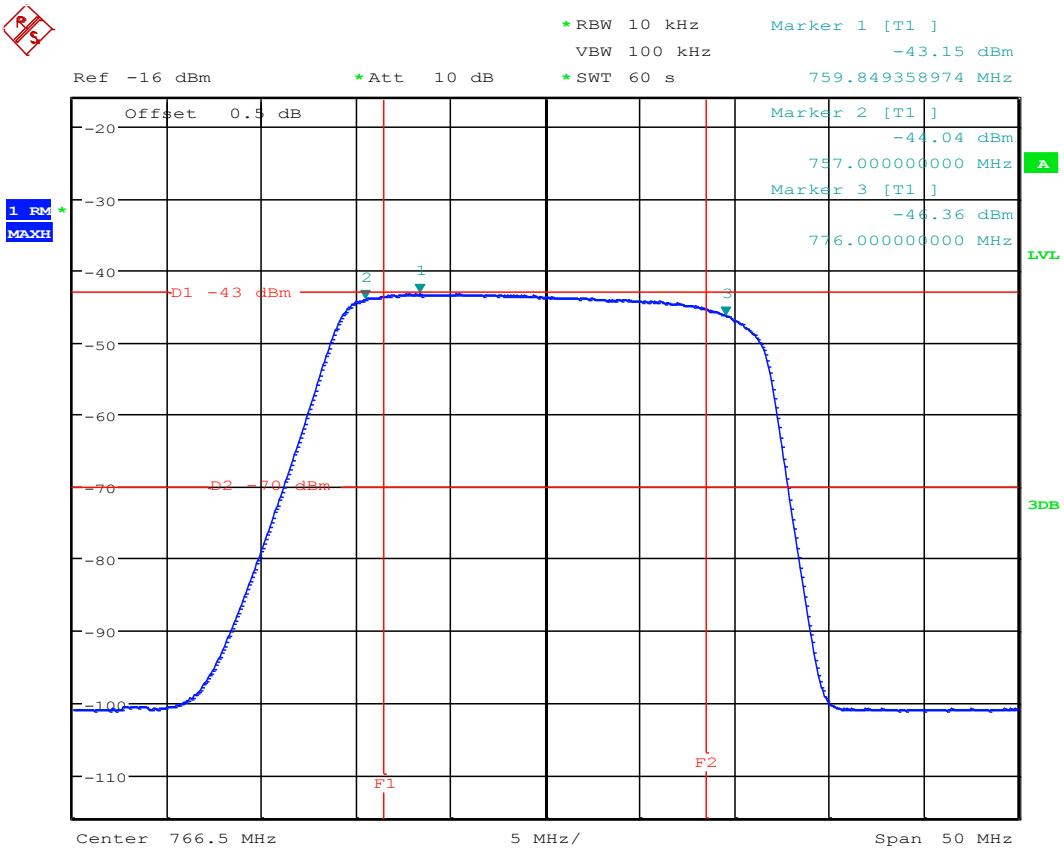


16.5 Test Equipment

Equipment Description	*Manufacturer*	*Equipment Type*	*Element No*	*Last Cal Calibration*	*Calibration Period*	*Due For Calibration*
Signal Generator	R&S	SMBV100A	REF916	2021-05-24	12	2022-05-24
Multimeter	Agilent	34405a	REF976	2021-12-21	12	2022-12-21
Power Supply	Kikusui	PCR4000L	UH580	USE REF976		
Attenuator	Bird	6 dB	U073	USE REF916 AND U405		
Attenuator	Radiall	R417030110 30 dB	U730	USE REF916 AND U405		

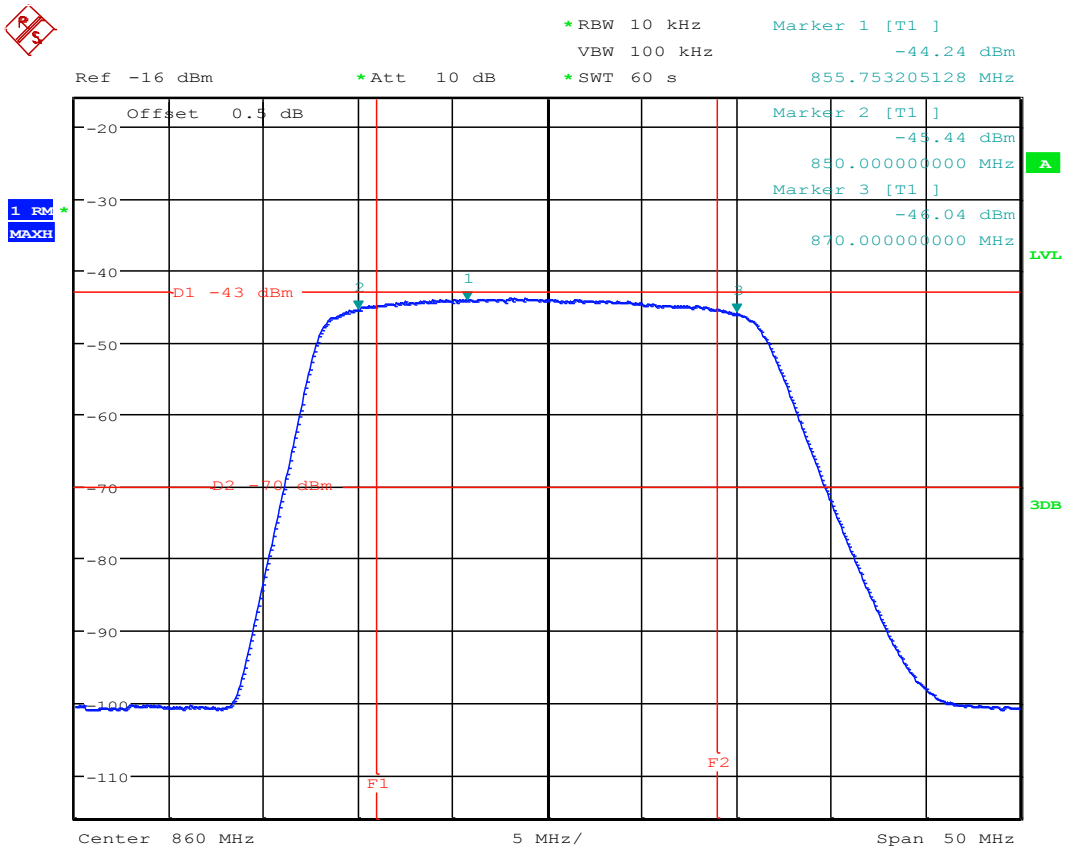
16.6 Test Results

700 MHz Pass band



Date: 15.FEB.2022 12:41:21

800 MHz Passband



Date: 15.FEB.2022 13:02:36

The ERP of noise in the spectrum more than 1 MHz outside of the passband should not exceed -70 dBm in a 10 kHz measurement bandwidth.

To show compliance with the -70 dBm limit the following calculation shall be used

Note: The Cable Loss (dB) + Splitter Loss (dB) - antenna gain (dBi) - 2.15 dB (EIRP to ERP conversion) must be greater than or equal to 26.0 dB.

Downlink	Test Result (dBm)	System Loss (dB)	ERP (dBm)	Limit = -70 (dBm)
700 MHz	- 44.04	≥ 26.0 dB	-70.04	Pass
800 MHz	- 45.44	≥ 26.0 dB	-71.44	Pass

17 Out-of-band/Out-of-block conducted spurious emissions

17.1 Definition

Emission on a frequency or frequencies which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out-of-band emissions.

17.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Laboratory
Test Standard and Clause:	Part 90.219(d)(7)(3) Part 90.543(f) KDB 935210 D05 v01, clause 4.7.3 KDB 935210 D05 v01, clause 3.6.3
EUT Operating Frequencies Tested:	851 MHz-869 MHz, 769.0MHz-775 MHz, 758.0 MHz-768.0 MHz
Source Modulations:	CW, AWGN
Source Level:	3.0 dBm (maximum input rating / AGC threshold)
Deviations from Standard:	None
Bandwidth:	RBW 100 kHz; VBW 3xRBW
Frequency Range Examined:	30 MHz – 10 GHz (10 x highest passband)
Measurement Detector:	Peak

Environmental Conditions (Normal Environment)

Temperature: 20°C	+15 ºC to +35 ºC (as declared)
Humidity: 36%RH	20%RH to 75%RH (as declared)
Supply: 115V ac	

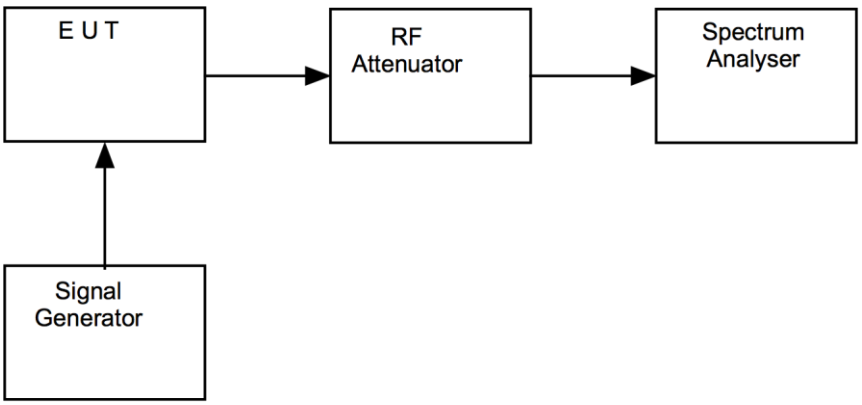
17.3 Test Limits

Spurious emissions from a signal booster (zone enhancer) must not exceed -13 dBm within any 100 kHz measurement bandwidth.

17.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure v, the emissions of the EUT were calculated by taking into account any cable and attenuator calibration factors. It was confirmed that at the maximum input level there was no compression.

Figure v Test Setup



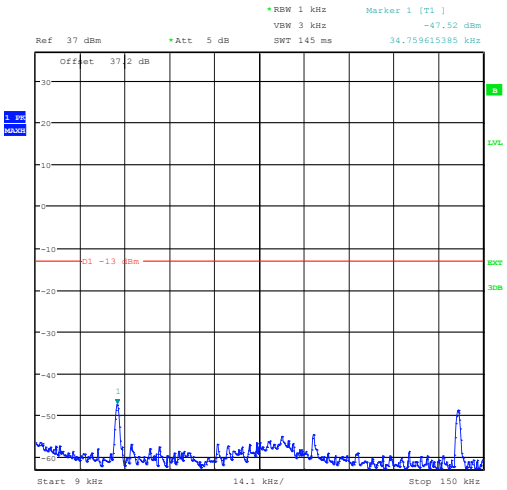
17.5 Test Equipment

Equipment Description	*Manufacturer*	*Equipment Type*	*Element No*	*Last Cal Calibration*	*Calibration Period*	*Due For Calibration*
Signal Generator	R&S	SMBV100A	REF916	2021-05-24	12	2022-05-24
Multimeter	Agilent	34405a	REF976	2021-12-21	12	2022-12-21
Power Supply	Kikusui	PCR4000L	UH580	USE REF976		
Attenuator	Bird	6 dB	U073	USE REF916 AND U405		
Attenuator	Radiall	R417030110 30 dB	U730	USE REF916 AND U405		

17.6 Test Results

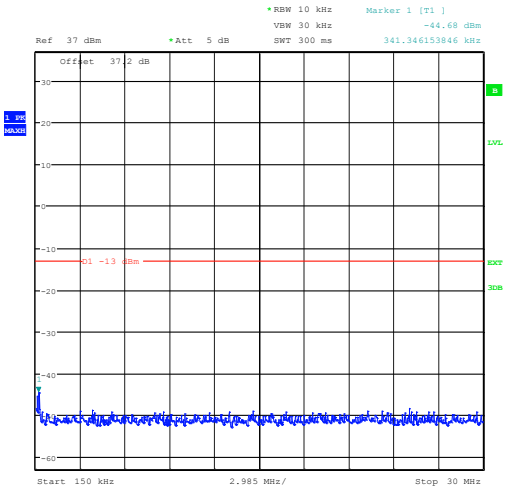
851 MHz-869 MHz

9 kHz-150 kHz



Date: 1.FEB.2022 14:46:59

150 kHz-30 MHz



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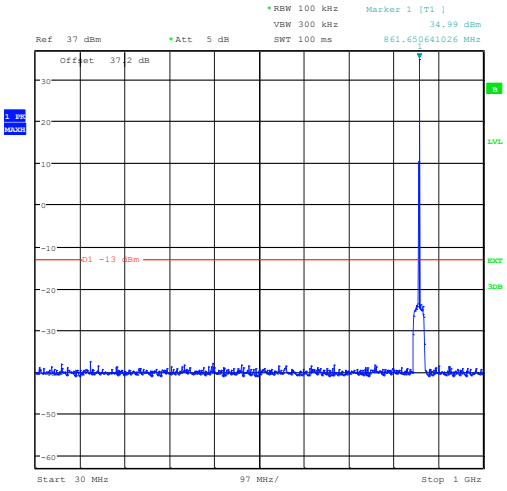
30 MHz-1 GHz



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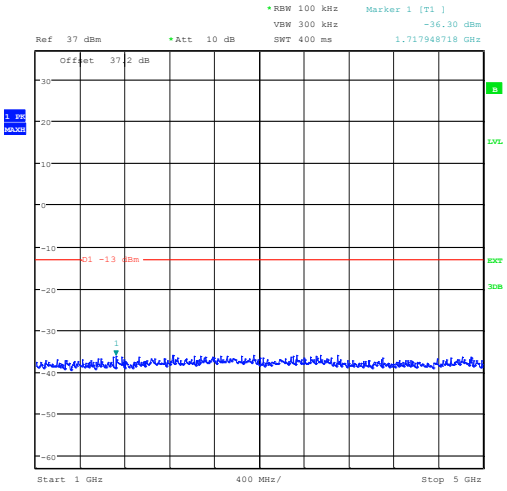
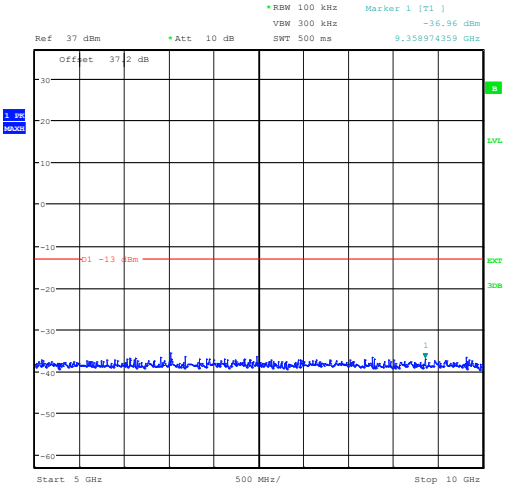
1 GHz-5 GHz



Date: 1.FEB.2022 14:50:37

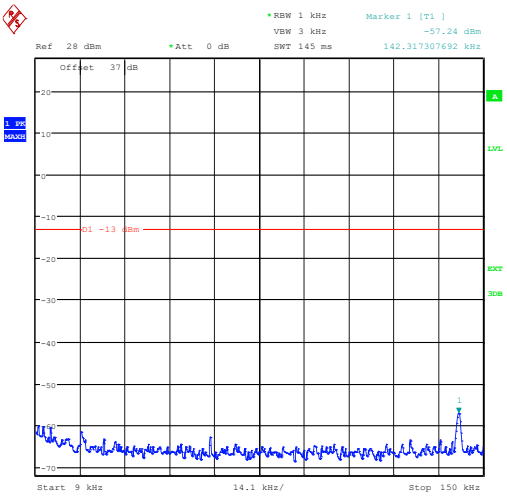
5 GHz-10 GHz



Date: 1.FEB.2022 14:51:11

769.0MHz-775 MHz

9 kHz-150 kHz



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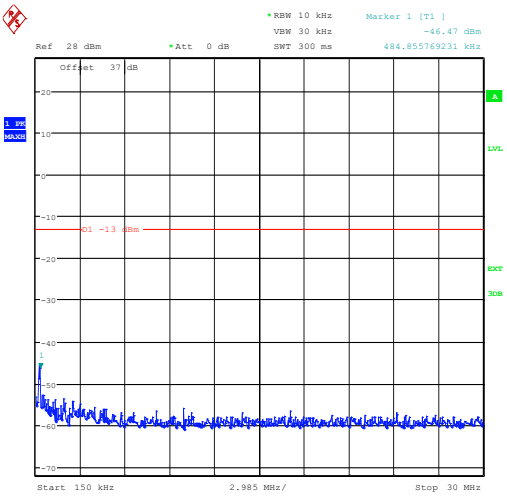
150 kHz-30 MHz



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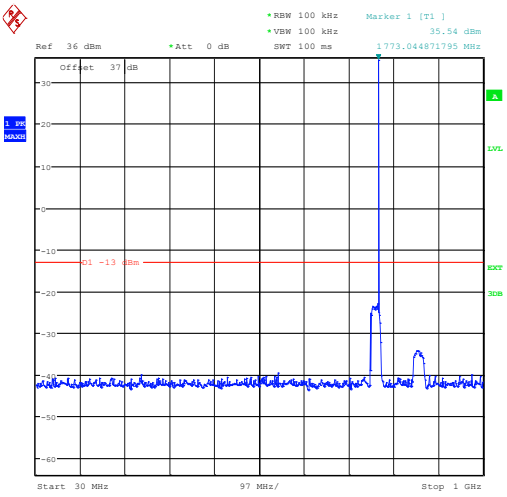
30 MHz-1 GHz



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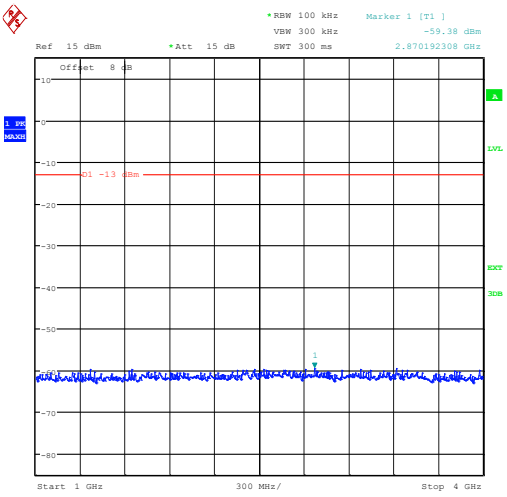
1 GHz-4 GHz



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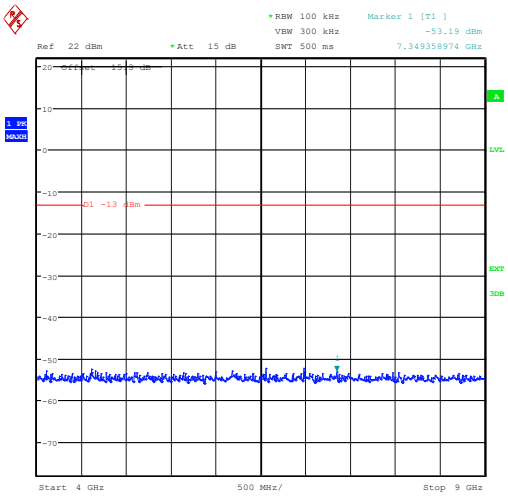
4 GHz-9 GHz



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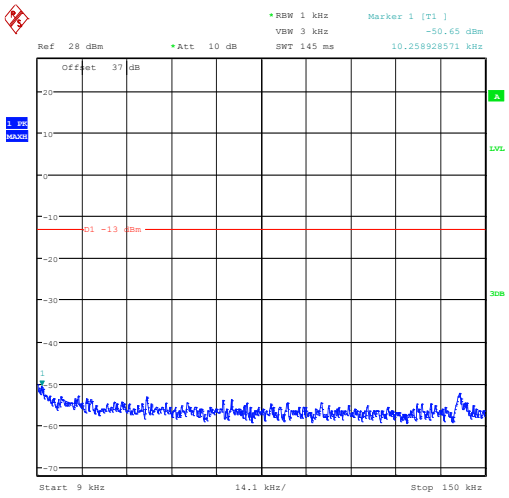
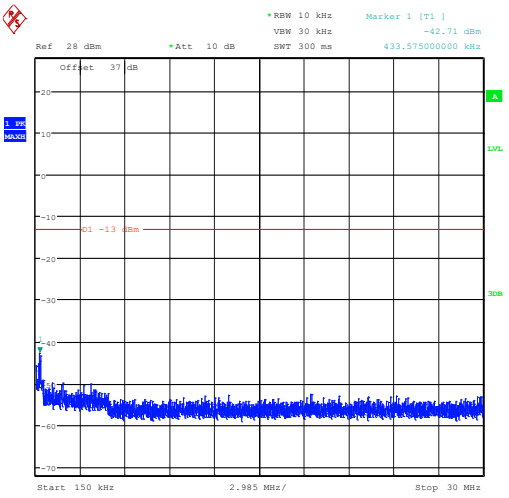
758.0 MHz-768.0 MHz bottom Channel

9 kHz-150 kHz



Date: 17.FEB.2022 13:09:08

150 kHz-30 MHz



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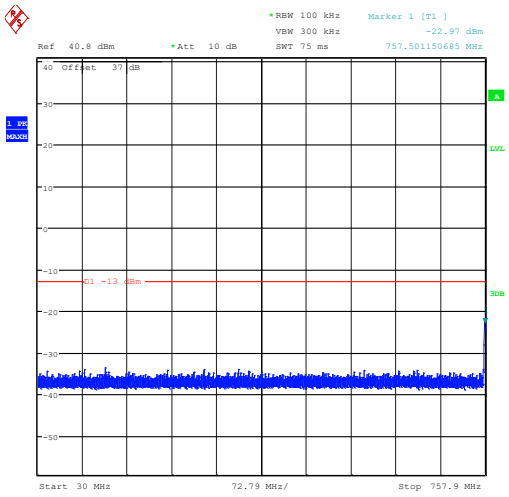
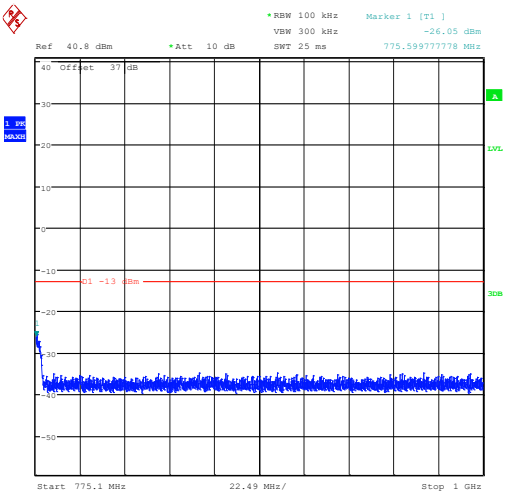
30 MHz-757.9 MHz



Date: 17.FEB.2022 11:00:32

775.1 MHz-1 GHz



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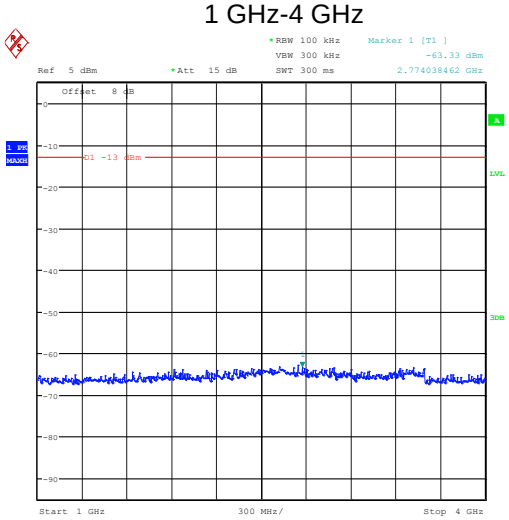
1 GHz-4 GHz



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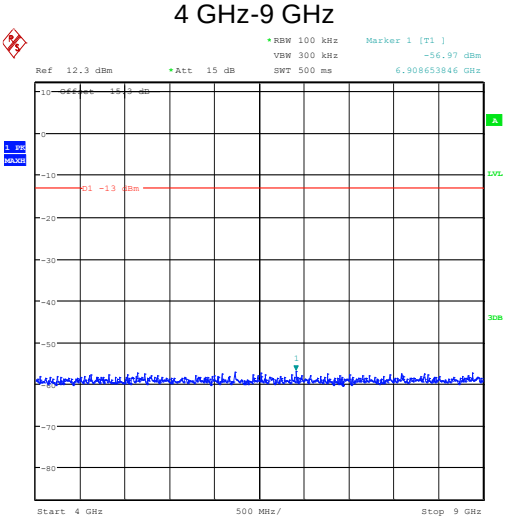
4 GHz-9 GHz



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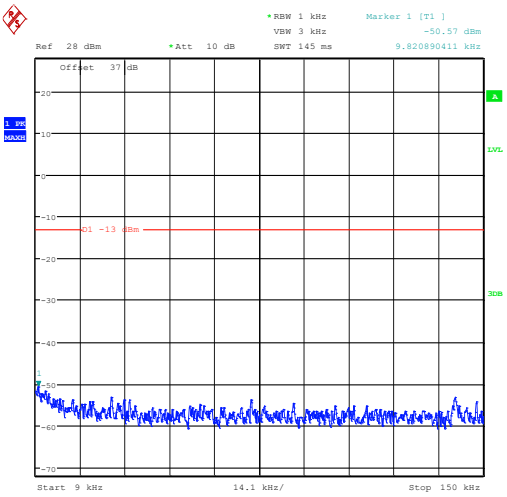
758.0 MHz-768.0 MHz Mid Channel

9 kHz-150 kHz



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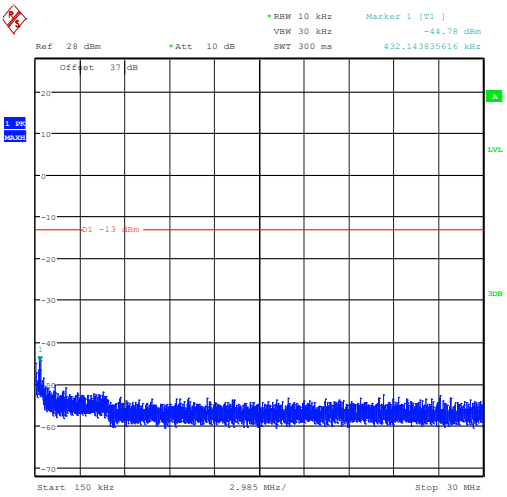
150 kHz-30 MHz



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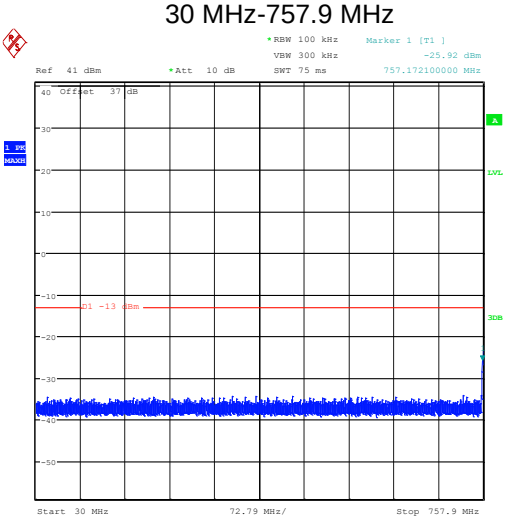
30 MHz-757.9 MHz



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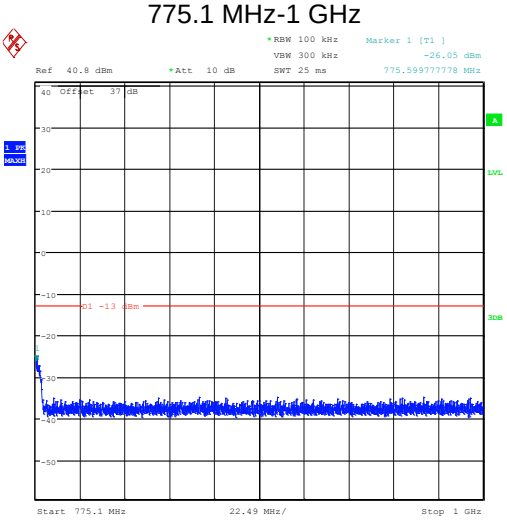
775.1 MHz-1 GHz



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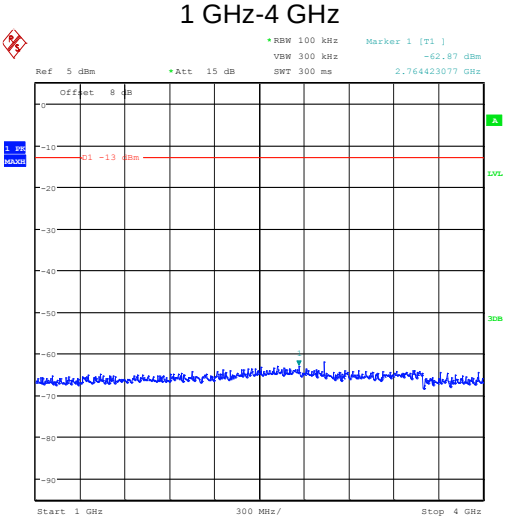
1 GHz-4 GHz



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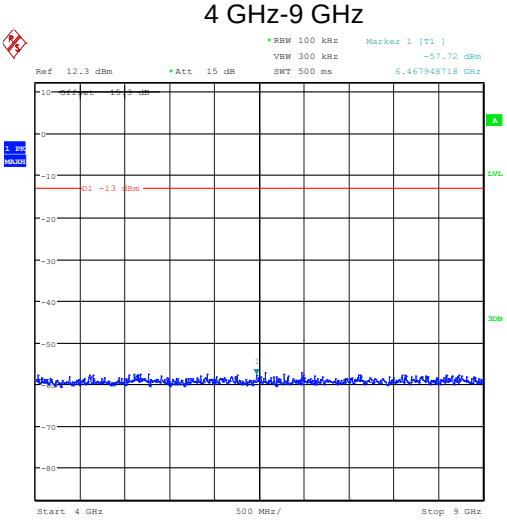
4 GHz-9 GHz



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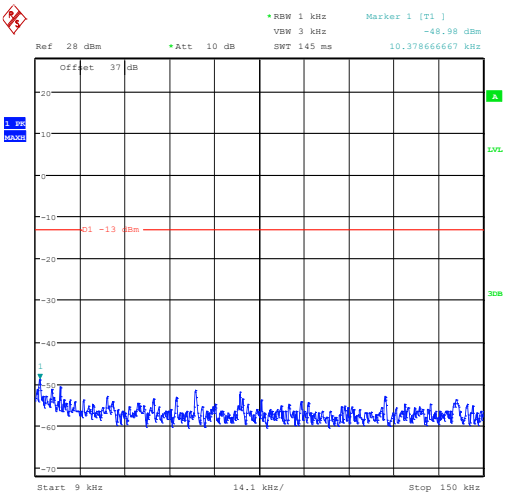
758.0 MHz-768.0 MHz Top Channel

9 kHz-150 kHz



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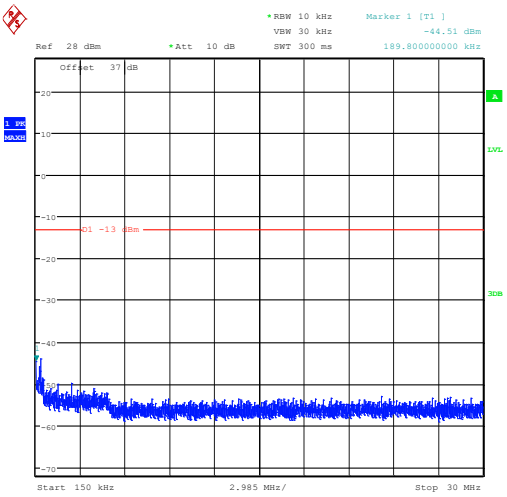
150 kHz-30 MHz



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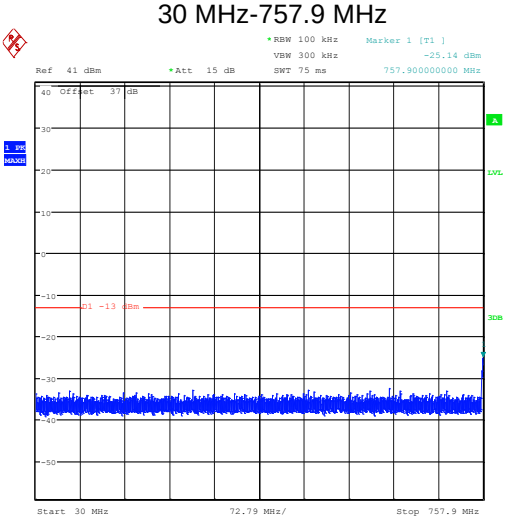
30 MHz-757.9 MHz



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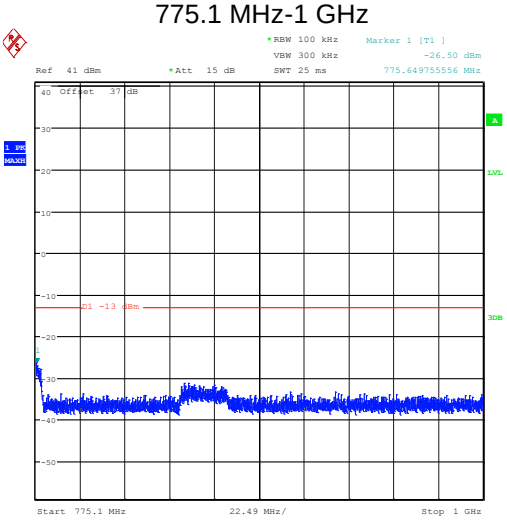
775.1 MHz-1 GHz



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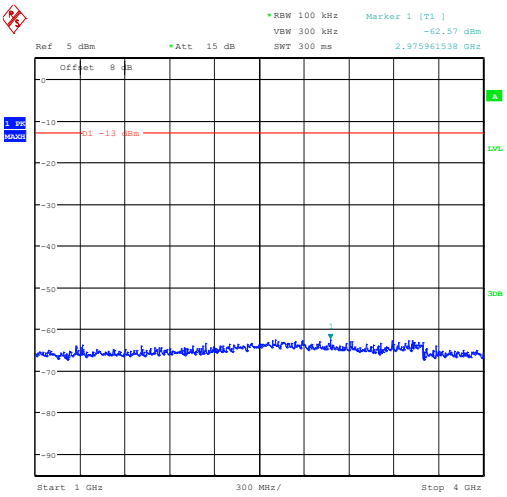
1 GHz-4 GHz



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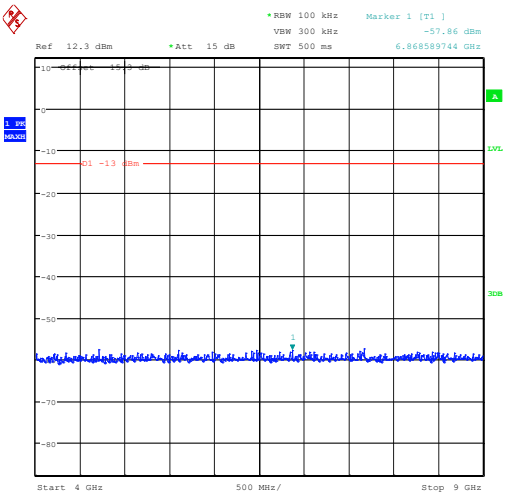
4 GHz-9 GHz



Date: 18.FEB.2022 11:52:29

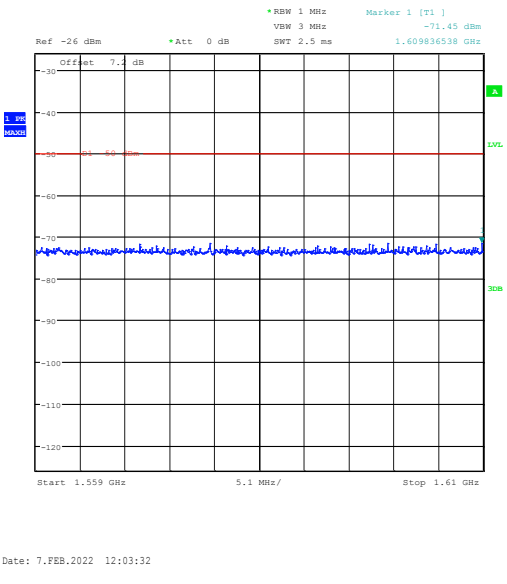
Frequency Band (MHz)	Spurious emission Level (dBm)	Limit (dBm)	Result
851.0 - 869.0	No Significant Emissions within 20 dBm of the limit	-13.0	Pass
769.0 - 775.0	No Significant Emissions within 20 dBm of the limit	-13.0	Pass

Frequency Band (MHz)	Frequency of spurious emission (dBm)	Spurious emission Level (dBm)	Limit (dBm)	Result
758.0 - 768.0	757.501150	-22.97	-13.0	Pass
758.0 - 768.0	775.599777	-26.05	-13.0	Pass
758.0 - 768.0	757.172100	-25.92	-13.0	Pass
758.0 - 768.0	775.599777	-26.05	-13.0	Pass
758.0 - 768.0	757.900000	-25.14	-13.0	Pass
758.0 - 768.0	775.649755	-26.50	-13.0	Pass

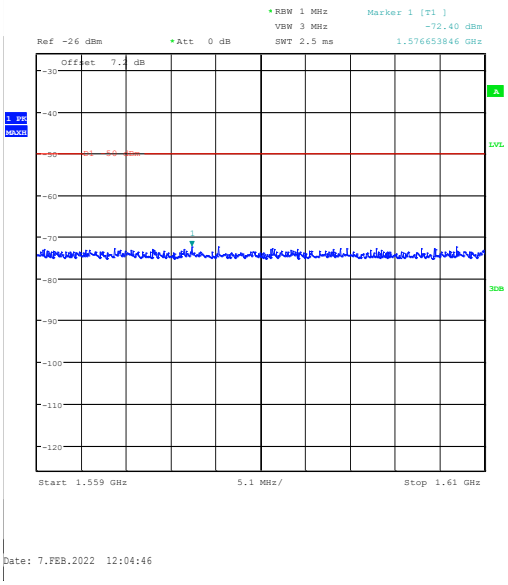
(f) For operations in the 758–775 MHz and 788–805 MHz bands, all emissions including harmonics in the band 1559–1610 MHz shall be limited to -70 dBW/MHz equivalent isotropically radiated power (EIRP) for wideband signals, and - 80 dBW EIRP for discrete emissions of less than 700 Hz bandwidth. For the purpose of equipment authorization, a transmitter shall be tested with an antenna that is representative of the type that will be used with the equipment in normal operation.

769 MHz-775 MHz

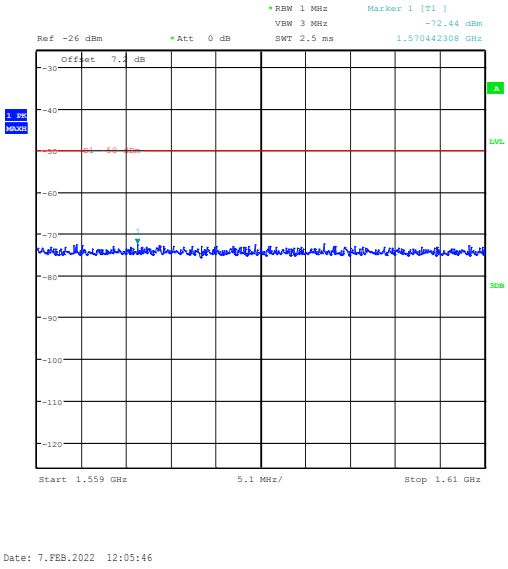
bottom channel 1559 MHz–1610 MHz



Middle channel 1559 MHz–1610 MHz

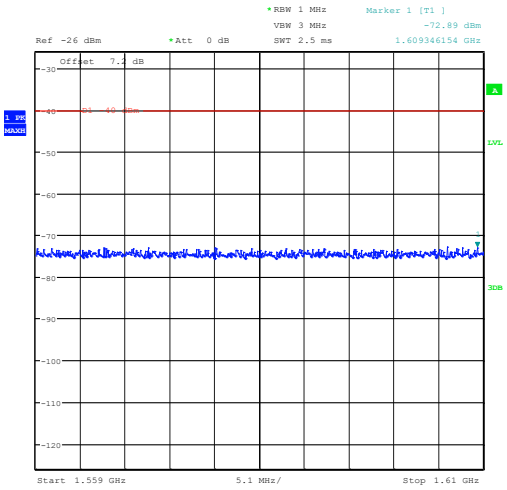


Top channel 1559 MHz–1610 MHz



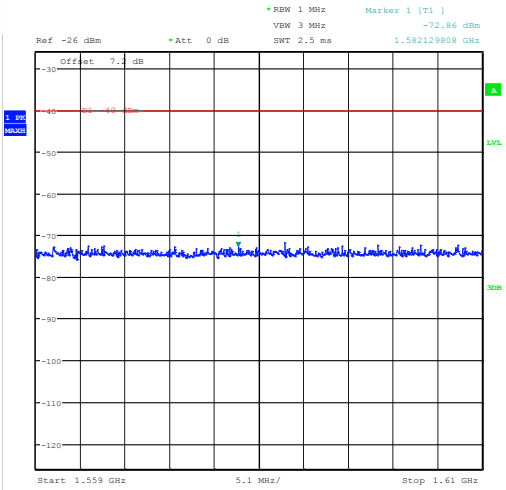
758 MHz-768 MHz

bottom channel 1559 MHz–1610 MHz



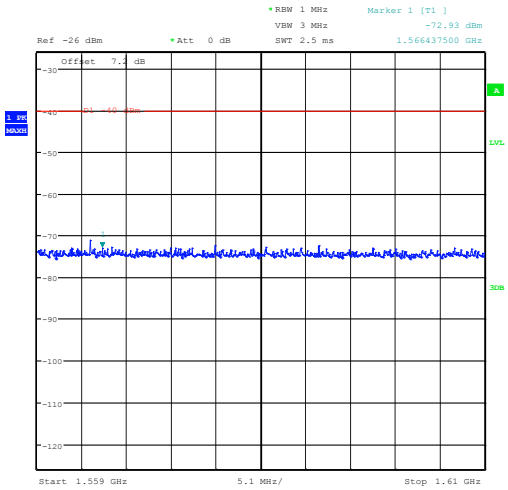
Date: 7.FEB.2022 12:10:49

Middle channel 1559 MHz–1610 MHz



Date: 7.FEB.2022 12:11:43

Top channel 1559 MHz–1610 MHz



Date: 7.FEB.2022 12:13:12

Frequency Band	Spurious emission Level (dBm)	Limit (dBm)	Result
758.0 - 768.0	No Significant Emissions within 20 dBm of the limit	-50.0	Pass
769.0 - 775.0	No Significant Emissions within 20 dBm of the limit	-40.0	Pass

18 Field strength of spurious radiation

18.1 Definitions

Spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation.

18.2 Test Parameters

Test Location:	Element Skelmersdale
Test Chamber:	Radio Chamber 3
Test Standard and Clause:	2.1053, KDB 935210 D05 (3.8)(4.9)
EUT Operating Frequencies Tested:	700.0 MHz Band: 758.0125 MHz / 766.5 MHz / 774.9875 MHz 800.0 MHz Band: 851.0125 MHz / 860.0 MHz / 868.9875 MHz
Source Modulations:	CW,
Source Level:	3.0 dBm (maximum input rating / AGC threshold)
Deviations from Standard:	None
Frequency Range Examined:	30 MHz – 10 GHz (10 x highest passband)
Measurement BW:	30 MHz to 1 GHz: 120 kHz Above 1 GHz: 1 MHz
Measurement Detector:	Up to 1 GHz: quasi-peak Above 1 GHz: Peak

Environmental Conditions (Normal Environment)

Temperature: 20 °C	+15 ºC to +35 ºC (as declared)
Humidity: 34 %RH	20%RH to 75%RH (as declared)
Supply: 115 Vac -48 Vdc	

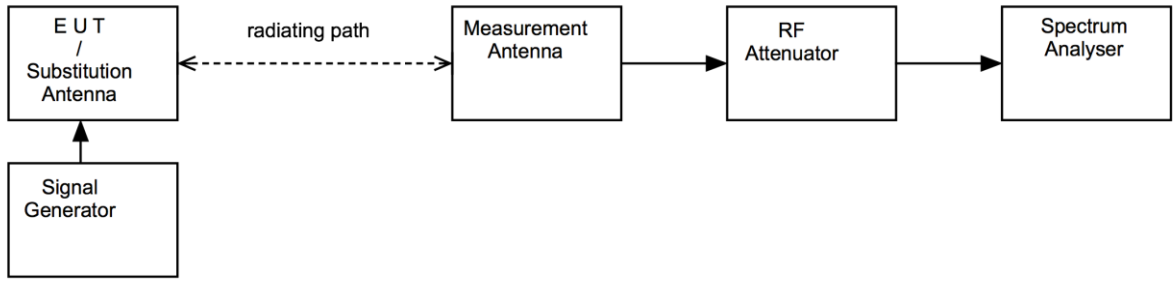
18.3 Test Limits

Spurious emissions from a signal booster (zone enhancer) must not exceed -13 dBm within any 100 kHz measurement bandwidth.

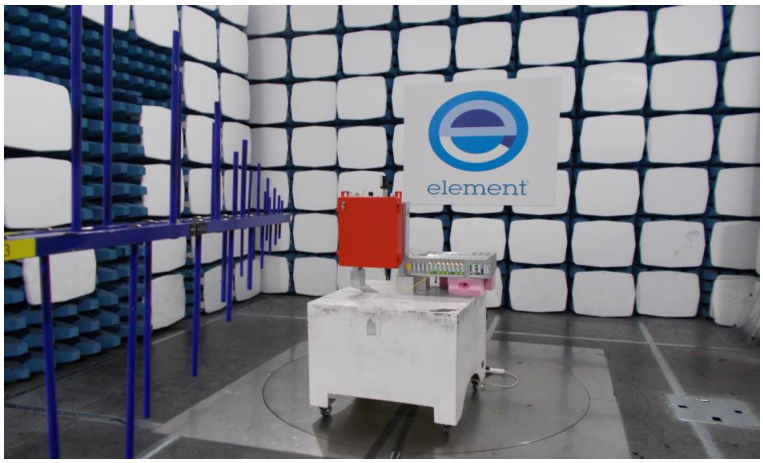
18.4 Test Method

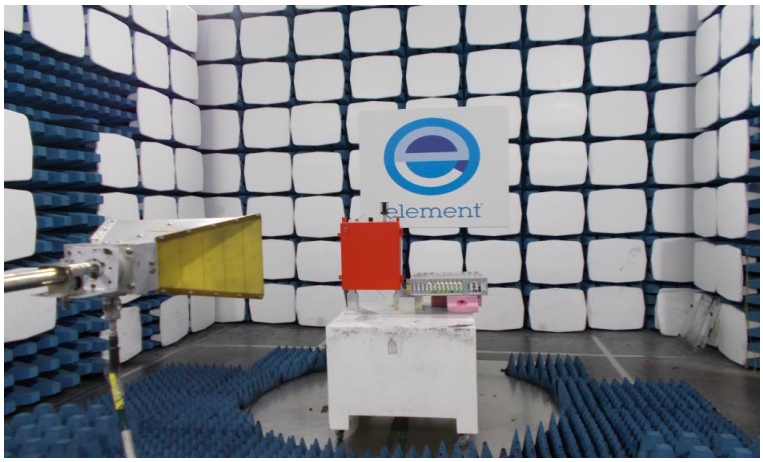
With the EUT setup as per section 9 of this report and connected as per Figure vii and with the EUT's antenna replaced by a non-radiating load, the emissions from the EUT were measured on a spectrum analyzer / EMI receiver. The EUT was rotated in three orthogonal planes and the measurement antenna height scanned (below 1GHz, from 1 to 4 m; above 1GHz as necessary) in order to maximise emissions.
The measurements were performed with EUT set at its maximum gain. All modulation schemes, data rates and power settings were used to observe the worst-case configuration at each frequency.
The EUT was substituted with a known generator and antenna and for the same level achieved at the analyser, the effective radiated power was recorded.
Pre-scan plots are shown with a peak detector and 100kHz RBW.

Figure vii Test Setup



Test Setup Photograph(s)





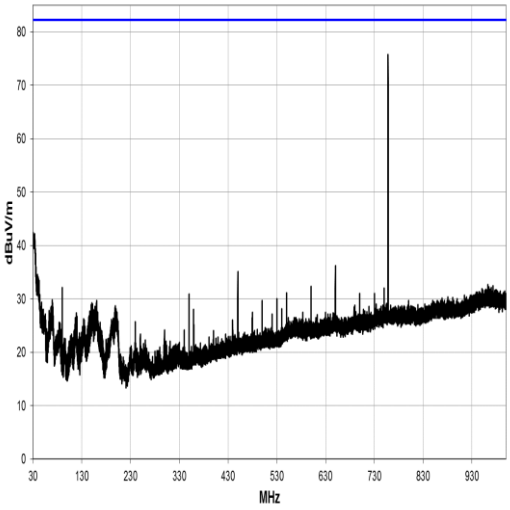
18.5 Test Equipment

Equipment Description	*Manufacturer*	*Equipment Type*	*Element No*	*Last Cal Calibration*	*Calibration Period*	*Due For Calibration*
PreAmp	Watkins Johnson	6201-69	U372	2022-03-01	12	2023-03-01
Bilog	Chase	CBL611/B	U573	2021-01-28	24	2023-01-28
Pre Amp	Agilent	8449B	L572	2021-10-29	12	2022-10-29
1-18GHz Horn	EMCO	3115	U223	2021-12-13	24	2023-12-13

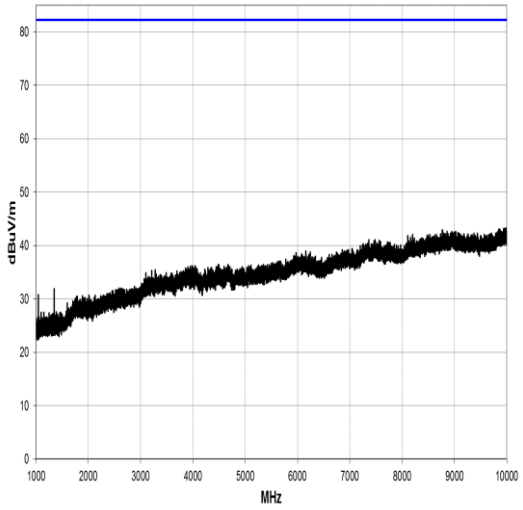
18.6 Test Results

DC power Supply 758 MHz-775 MHz

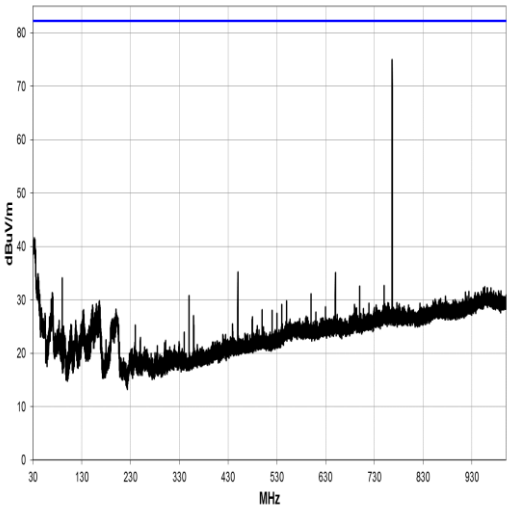
30 MHz-1 GHz bottom channel



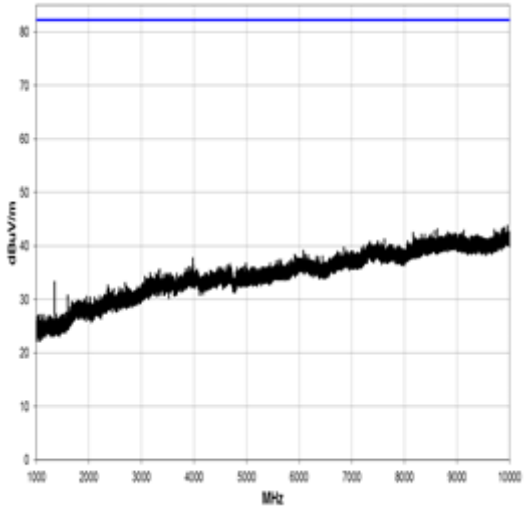
1 GHz-10 GHz bottom channel



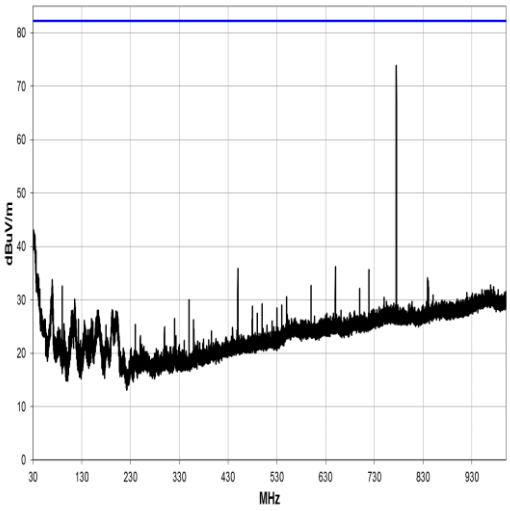
30 MHz-1 GHz Mid channel



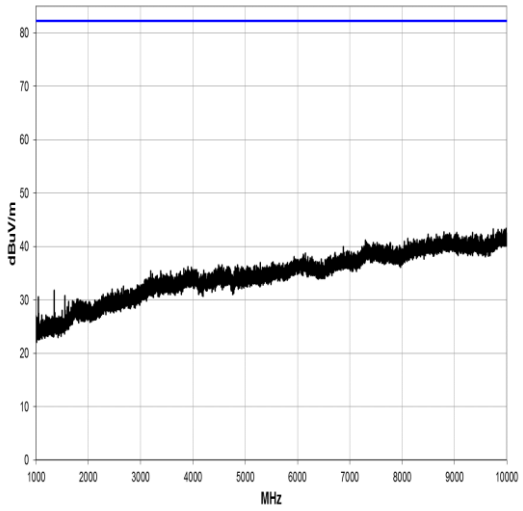
1 GHz-10 GHz Mid channel



30 MHz-1 GHz Top channel

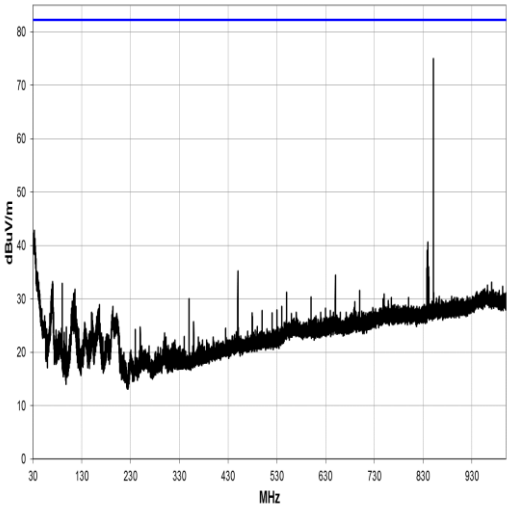


1 GHz-10 GHz Top channel

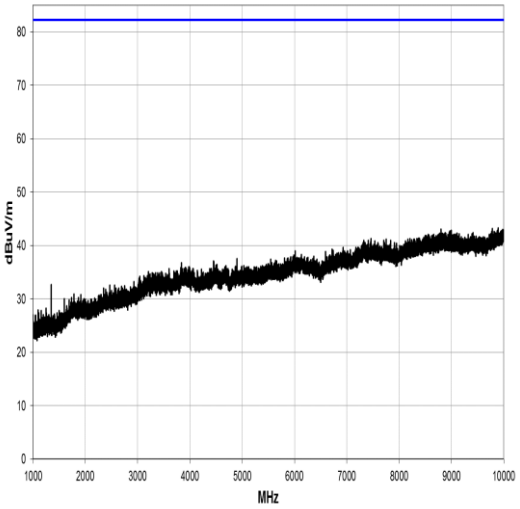


DC power Supply 851 MHz-869 MHz

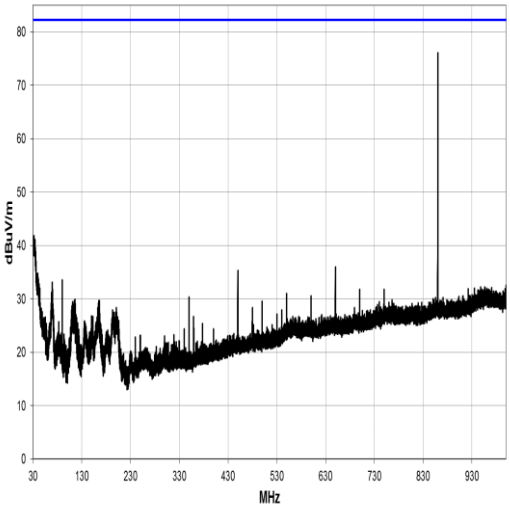
30 MHz-1 GHz bottom channel



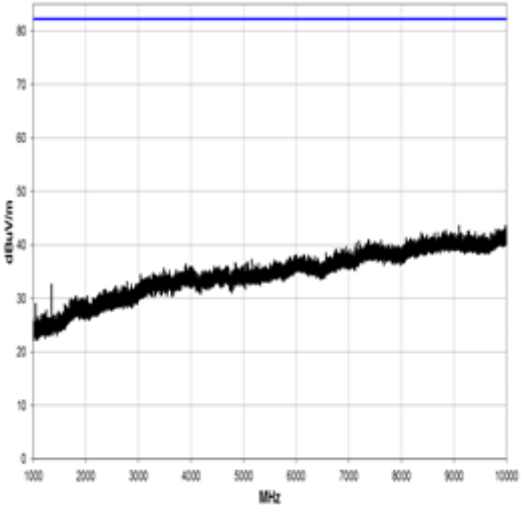
1 GHz-10 GHz bottom channel



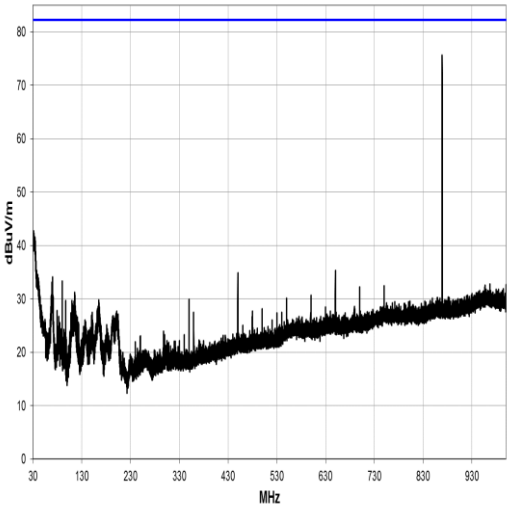
30 MHz-1 GHz Mid channel



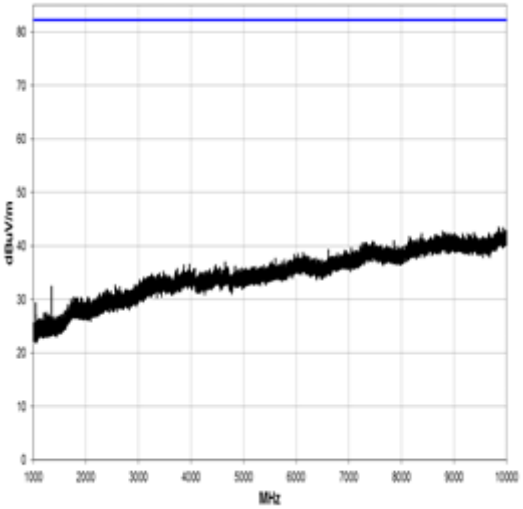
1 GHz-10 GHz Mid channel



30 MHz-1 GHz Top channel

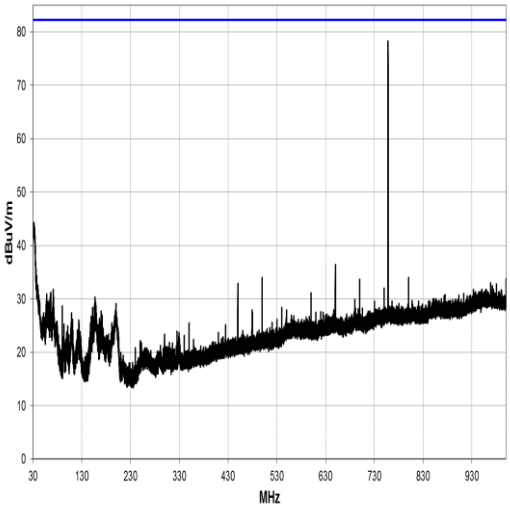


1 GHz-10 GHz Top channel

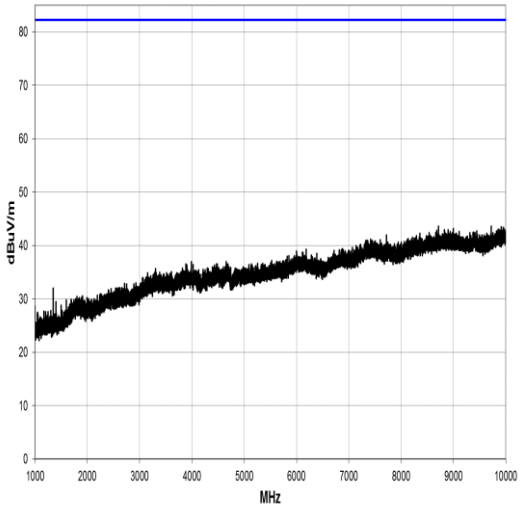


AC power Supply 758 MHz-775 MHz

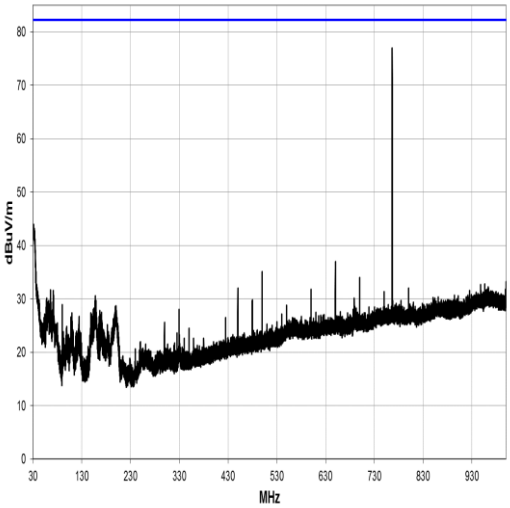
30 MHz-1 GHz bottom channel



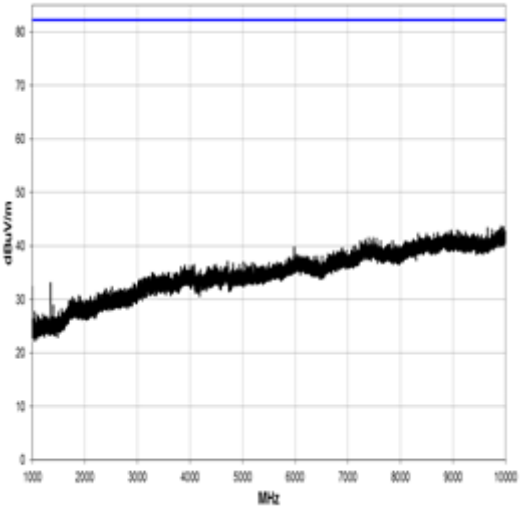
1 GHz-10 GHz bottom channel



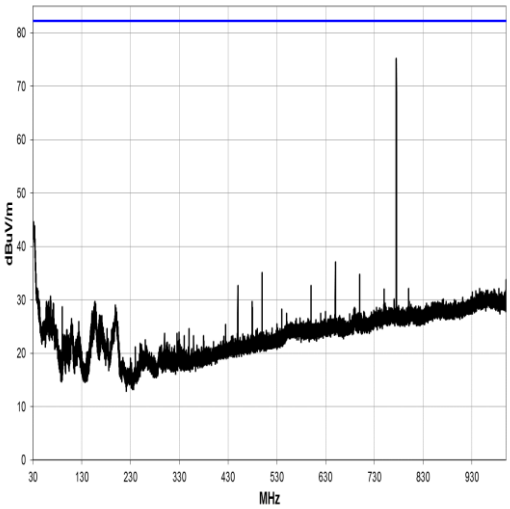
30 MHz-1 GHz Mid channel



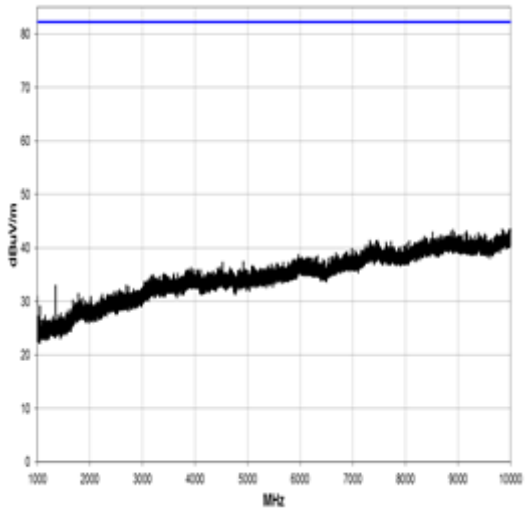
1 GHz-10 GHz Mid channel



30 MHz-1 GHz Top channel

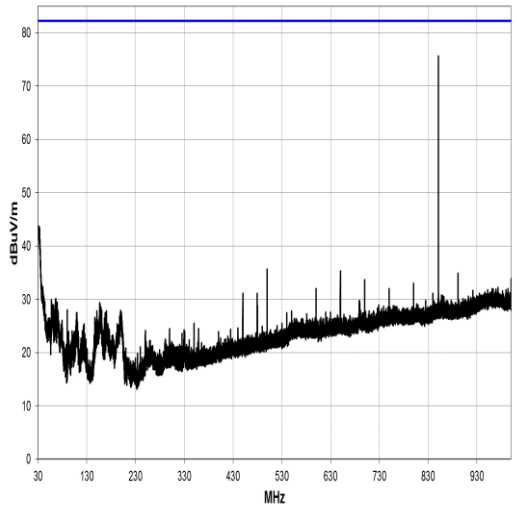


1 GHz-10 GHz Top channel

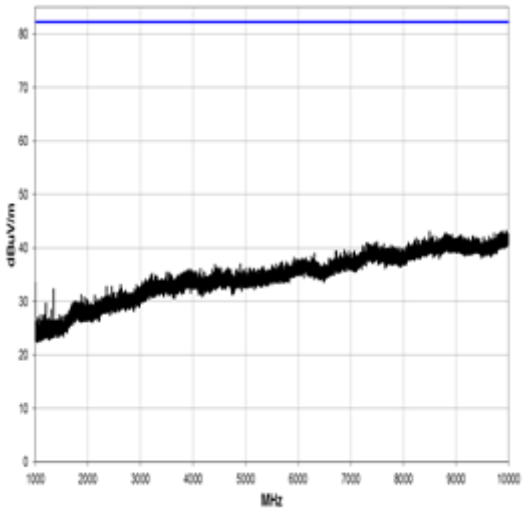


AC power Supply 851 MHz-869 MHz

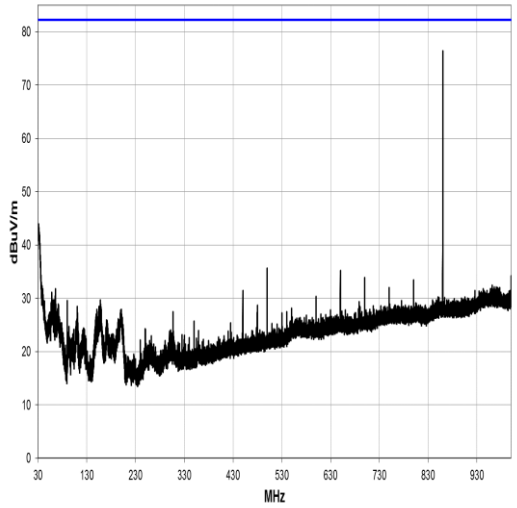
30 MHz-1 GHz bottom channel



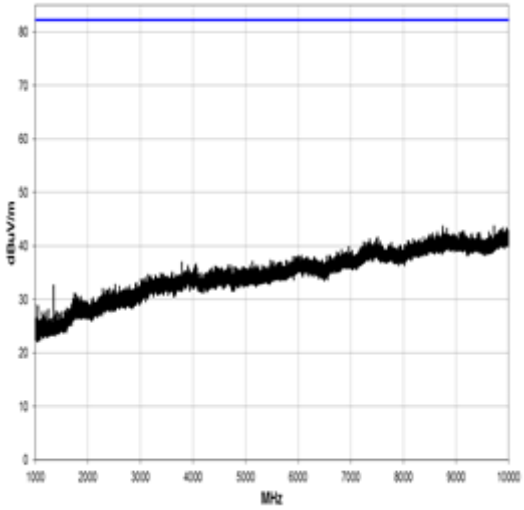
1 GHz-10 GHz bottom channel



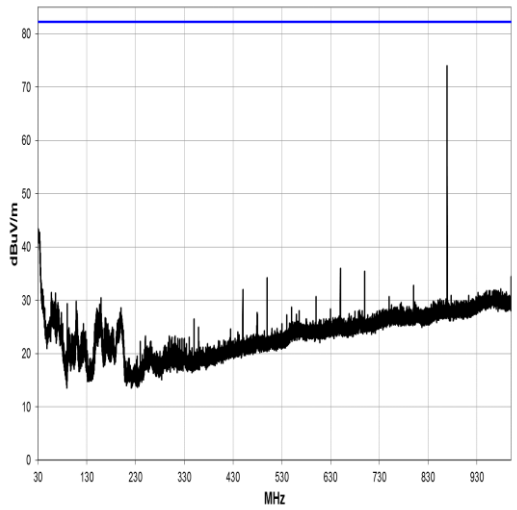
30 MHz-1 GHz Mid channel



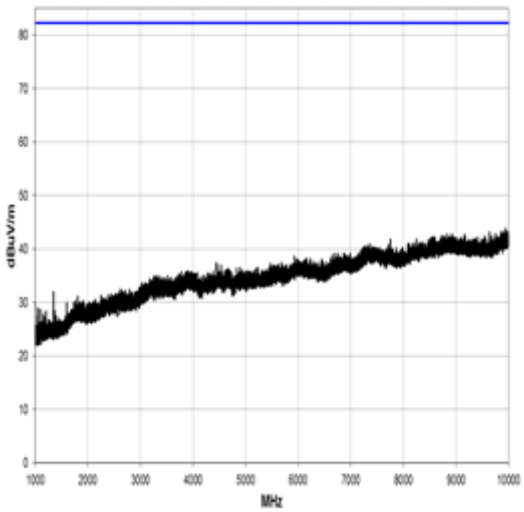
1 GHz-10 GHz Mid channel



30 MHz-1 GHz Top channel



1 GHz-10 GHz Top channel



Spurious Frequency (MHz)	Spurious level (dBµV/m)	Limit ERP (dBm)	Result
No significant emissions within 20 dB of the limit		-13.0 dBm	Pass

19 RF Exposure

MPE Calculation

Prediction of MPE limit at a given distance

For purposes of these requirements mobile devices are defined by the FCC as transmitters designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between radiating structures and the body of the user or nearby persons. These devices are normally evaluated for exposure potential with relation to the MPE limits. As the 20 cm separation specified under FCC rules may not be achievable under normal operation of the EUT, an RF exposure calculation is needed to show the minimum distance required to be less than the power density limit, as required under FCC rules.

Equation from IEEE C95.1

$$S = \frac{EIRP}{4\pi R^2} \quad \text{re-arranged} \quad R = \sqrt{\frac{EIRP}{S4\pi}}$$

Where:

S = power density
R = distance to the centre of radiation of the antenna
EIRP = EUT Maximum power

Result

Channel Frequency (MHz)	*EIRP (mW)*	*Power density limit (S) (mW/cm^2)*	*Distance (R) cm required to be less than the power density limit*
759.989102	13.03	0.506	1.33
857.982371	11.32	0.571	1.22

Note*: The above calculations take into account the overall system loss. The system loss must be greater than or equal to 26 dB.

The rated output power 37 dBm and a 26 dB pathloss (cables and antenna gain) taken into account above.

20 Radio Testing – General Uncertainty Schedule

All statements of uncertainty are expanded standard uncertainty using a coverage factor of 1.96 to give a 95 % confidence where no required test level exists.

Test/Measurement	Budget Number	MU
Conducted RF Power, Power Spectral Density, Adjacent Channel Power and Spurious emissions		
Absolute RF power (via antenna connecter) Dare RPR3006W Power Head	MU4001	**0.9 dB**
Carrier Power and PSD - Spectrum Analysers	MU4004	**0.9 dB**
Adjacent Channel Power	MU4002	**1.9 dB**
Transmitter conducted spurious emissions	MU4041	**0.9 dB**
Conducted power and spurious emissions 40 GHz to 50 GHz	MU4042	**2.4 dB**
Conducted power and spurious emissions 50 GHz to 75 GHz	MU4043	**2.5 dB**
Conducted power and spurious emissions 75 GHz to 110 GHz	MU4044	**2.4 dB**
Radiated RF Power and Spurious emissions ERP and EIRP		
Effective Radiated Power Reverb Chamber	MU4020	**3.7 dB**
Effective Radiated Power	MU4021	**4.7 dB**
TRP Emissions 30 MHz to 1 GHz using CBL6111 or CBL6112 Bilog Antenna	MU4046	**5.3 dB**
TRP Emissions 1 GHz to 18 GHz using HL050 Log Periodic Antenna	MU4047	**5.1 dB**
TRP Emissions 18 GHz to 26.5 GHz using Standard Gain Horn	MU4048	**2.7 dB**
TRP Emissions 26.5 GHz to 40 GHz using Standard Gain Horn	MU4049	**2.7 dB**
Spurious Emissions Electric and Magnetic Field		
Radiated Spurious Emissions 30 MHz to 1 GHz	MU4037	**4.7 dB**
Radiated Spurious Emissions 1-18 GHz	MU4032	**4.5 dB**
E Field Emissions 18GHz to 26 GHz	MU4024	**3.2 dB**
E Field Emissions 26GHz to 40 GHz	MU4025	**3.3 dB**
E Field Emissions 40GHz to 50 GHz	MU4026	**3.5 dB**
E Field Emissions 50GHz to 75 GHz	MU4027	**3.6 dB**
E Field Emissions 75GHz to 110 GHz	MU4028	**3.6 dB**
Radiated Magnetic Field Emissions	MU4031	**2.3 dB**
Frequency Measurements		
Frequency Deviation	MU4022	**0.316 kHz**
Frequency error using CMTA test set	MU4023	**113.441 Hz**
Frequency error using GPS locked frequency source	MU4045	**0.0413 ppm**
Bandwidth/Spectral Mask Measurements		
Channel Bandwidth	MU4005	**3.87 %**
Transmitter Mask Amplitude	MU4039	**1.3 dB**
Transmitter Mask Frequency	MU4040	**2.59 %**
Time Domain Measurements		
Transmission Time	MU4038	**4.40 %**
Dynamic Frequency Selection (DFS) Parameters)		
DFS Analyser - Measurement Time	MU4006	**679 µs**
DFS Generator - Frequency Error	MU4007	**92 Hz**
DFS Threshold Conducted	MU4008	**1.3 dB**
DFS Threshold Radiated	MU4009	**3.2 dB**

Test/Measurement	Budget Number	MU
Receiver Parameters		
EN300328 Receiver Blocking	MU4010	**1.1 dB**
EN301893 Receiver Blocking	MU4011	**1.1 dB**
EN303340 Adjacent Channel Selectivity	MU4012	**1.1 dB**
EN303340 Overloading	MU4013	**1.1 dB**
EN303340 Receiver Blocking	MU4014	**1.1 dB**
EN303340 Receiver Sensitivity	MU4015	**0.9 dB**
EN303372-1 Image Rejection	MU4016	**1.4 dB**
EN303372-1 Receiver Blocking	MU4017	**1.1 dB**
EN303372-2 Adjacent Channel Selectivity	MU4018	**1.1 dB**
EN303372-2 Dynamic Range	MU4019	**0.9 dB**
Receiver Blocking Talk Mode Conducted	MU4033	**1.2 dB**
Receiver Blocking Talk Mode- radiated	MU4034	**3.4 dB**
Rx Blocking, listen mode, blocking level	MU4035	**3.2 dB**
Rx Blocking, listen mode, radiated Threshold Measurement	MU4036	**3.4 dB**
Adjacent Sub Band Selectivity	MU4003	**4.2 dB**