Choose Scandinavian trust

RADIO TEST REPORT – 464076TRFWL

Type of assessment:

Final product testing

Applicant:

Semco Maritime A/S
Esbjerg Brygge 30
6700 Esbjerg
Denmark

Product:

TETRA pico-repeater

Model:

BRTS33-US-L1

FCC ID:

2A782-BRTS33-L1

Specifications:

- FCC 47 CFR Part 90

Date of issue: July 13, 2022

P. Barbieri	
Tested by	Signature
D. Guarnone	
Reviewed by	Signature

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Doc. n. TRF001; Rev. 0; Date: 2020-11-30

Lab locations

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Facsimile	+39 039 220 12 21
Website	www.nemko.com
Site number	682159 (10 m semi anechoic chamber)

Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report. This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contain in this report are within Nemko Spa ISO/IEC 17025 accreditation.

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Section 1 Report summary

1.1 Test specifications

FCC 47 CFR Part 2	Frequency Allocations and Radio Treaty Maters; General Rules and Regulations
FCC 47 CFR Part 90	Private Land Mobile Radio Services

1.2 Test methods

ANSI C63.26-2015	American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services
KDB 935210 D05	Indus Booster Basic Meas v01r04
KDB 662911 D01	Multiple Transmitter Output v02r01
KDB 662911 D02	MIMO with Cross-Polarized Antennas v01

1.3 Exclusions

None

1.4 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was performed against all relevant requirements of the test standard except as noted in section 1.3 above. Results obtained indicate that the product under test complies In full with the requirements tested. The test results relate only to the items tested.

See "Summary of test results" for full details.

1.5 Test report revision history

Table 1.5-1: *Test report revision history*

Revision #	Date of issue	Details of changes made to test report
464076TRFWL	July 13, 2022	Original report issued

Section 2 Engineering considerations

2.1 Modifications incorporated in the EUT for compliance

There were no modifications performed to the EUT during this assessment.

2.2 Technical judgment

None

2.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 3 Test conditions

3.1 Atmospheric conditions

Temperature	15 °C – 35 °C
Relative humidity	20 % – 75 %
Air pressure	86 kPa (860 mbar) – 106 kPa (1060 mbar)

When it is impracticable to carry out tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests shall be recorded and stated.

The following instruments are used to monitor the environmental conditions:

Equipment	Manufacturer	Model no.	Asset no.	Cal date	Next cal.
Thermo-hygrometer data loggers	Testo	175-H2	20012380/305	2020-12	2022-12
Thermo-hygrometer data loggers	Testo	175-H2	38203337/703	2020-12	2022-12
Barometer	Castle	GPB 3300	072015	2022-04	2023-04

3.2 Power supply range

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages ±5 %, for which the equipment was designed.

Section 4 Measurement uncertainty

4.1 Uncertainty of measurement

The measurement uncertainty was calculated for each test and quantity listed in this test report, according to CISPR 16-4-2 and other specific test standard and is documented in Nemko Spa working manual WML1002.
The assessment of conformity for each test performed on the equipment is performed not taking into account the measurement uncertainty. The two following possible verdicts are stated in the report:
P (Pass) - The measured values of the equipment respect the specification limit at the points tested. The specific risk of false accept is up to 50% when the measured result is close to the limit.
F (Fail) - One or more measured values of the equipment do not respect the specification limit at the points tested. The specific risk of false reject is up to 50% when the measured result is close to the limit.
Hereafter Nemko's measurement uncertainties are reported:

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

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

Section 5 Information provided by the applicant

5.1 Disclaimer

This section contains information provided by the applicant and has been utilized to support the test plan. Inaccurate information provided by the applicant can affect the validity of the results contained within this test report. Nemko accepts no responsibility for the information contained within this section and the impact it may have on the test plan and resulting measurements.

5.2 Applicant/Manufacture

Applicant name	Semco Maritime A/S
Applicant address	Esbjerg Brygge 30 6700 Esbjerg Denmark
Manufacture name	Same as applicant
Manufacture address	Same as applicant

5.3 EUT information

Product name	TETRA pico-repeater
Model	BRTS33-US-L1
Serial number	00246
Power supply requirements	24 V DC – 25 W max
Product description and theory of operation	The EUT is a TETRA repeater. The RF part of the TETRA repeater is a band selective and due to its duplex operation, it consists of two identical designed modules such as uplink and downlink. The in- and output of the two modules are combined by duplexers. The uplink and downlink modules are placed on separate circuit boards on the two sides of the internal box. The internal DC power is generated by a DC/DC converter unit. Remote control (setting and reading of parameters) of the repeater can be done through either Ethernet port. For these features the repeater contains microprocessor control. On the outside of the equipment box there are N connectors for joining the cable to antennas.

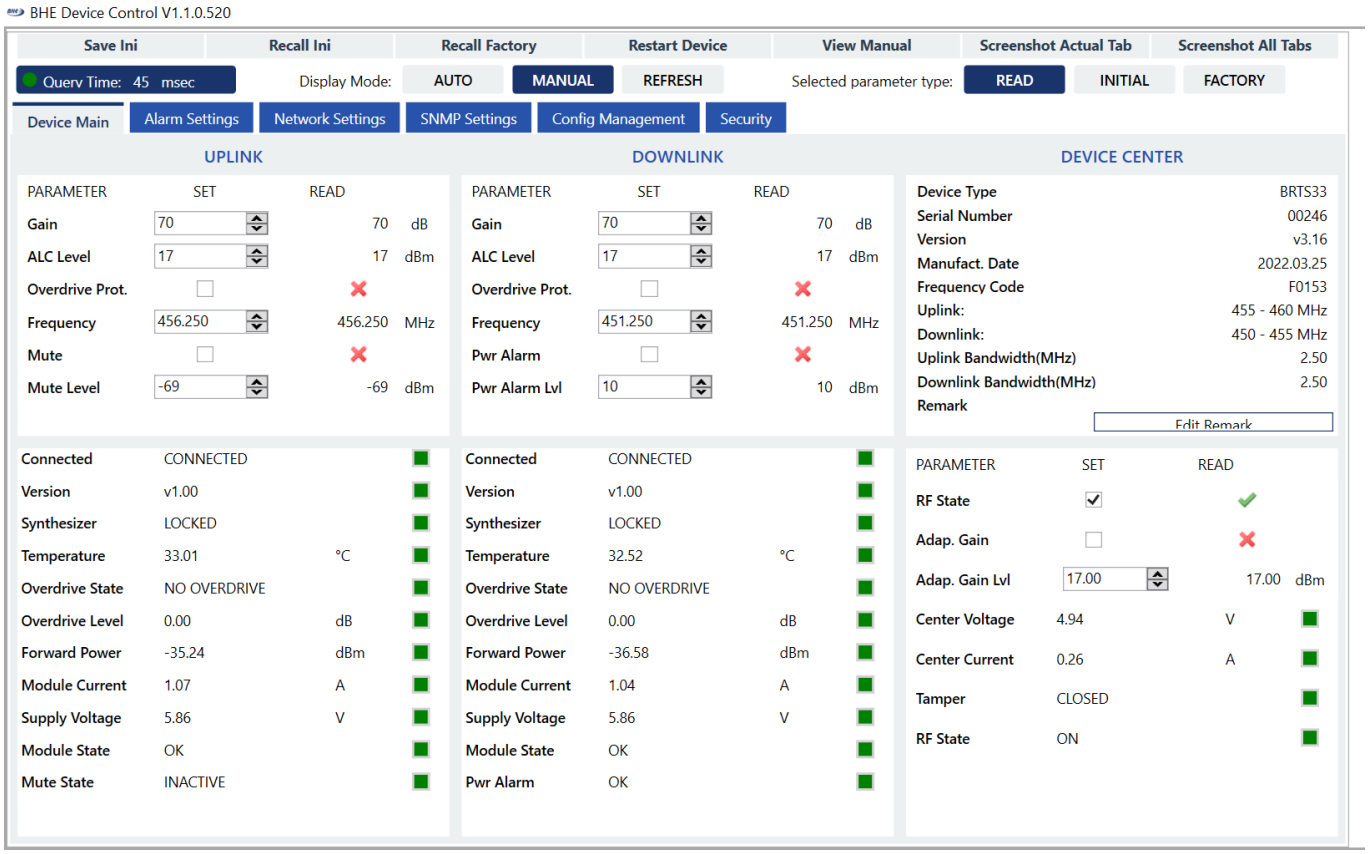
5.4 Technical information

Frequency band	Down-link: 450 MHz to 452.5 MHz Up-link: 455 MHz to 457.5 MHz
RF power Max (W), Conducted	0.057 W (17.6 dBm)
Measured BW (kHz), 99% OBW	20 kHz
Type of modulation	π/4-DQPSK with Symbol rate of 18 Ksymbol/s and Roll-off factor of 0.2
Emission classification	D7W
Transmitter spurious, dBm @ 3 m	-38.0 dBm @ 3.649 GHz
Antenna information	N type RF connector (antenna not provided)

5.5 EUT setup details

5.5.1 Radio exercise details

Operating conditions	The EUT has been tested connected to a PC with the following software, used for configuration and supervision. A signal generator with an TREATA or CW signal was connected to the RF input of the EUT in up-link and down-link direction. The RF output port of the EUT was connected to a spectrum analyzer or a dummy load.



5.5.2 EUT setup configuration

Table 5.5-1: *EUT sub assemblies*

Description	Brand name	Model, Part number, Serial number, Revision level
--	--	--
--	--	--
--	--	--
--	--	--

The EUT is composed by a single unit

Table 5.5-2: *EUT interface ports*

Description	Qty.
Mains	1
Control	1
Donor	1
Mobile CPL.	1
Mobile	1
GND	1

Table 5.5-3: *Support equipment*

Description	Manufacturer	Model
Notebook	Dell	Latitude 7480
Signal generator	R&S	SMBV100A
DC power supply	GW Instek	GPS-3030DD

Table 5.5-4: *Inter-connection cables*

Cable description	From	To	Length (m)
DC power cable	EUT	DC power source	1.5 m
Ethernet cable	EUT	Notebook	1.5 m
RF Coaxial cable	EUT	Spectrum analyzer	0.5 m
RF Coaxial cable	EUT	Signal generator	1.0 m

EUT setup configuration, continued

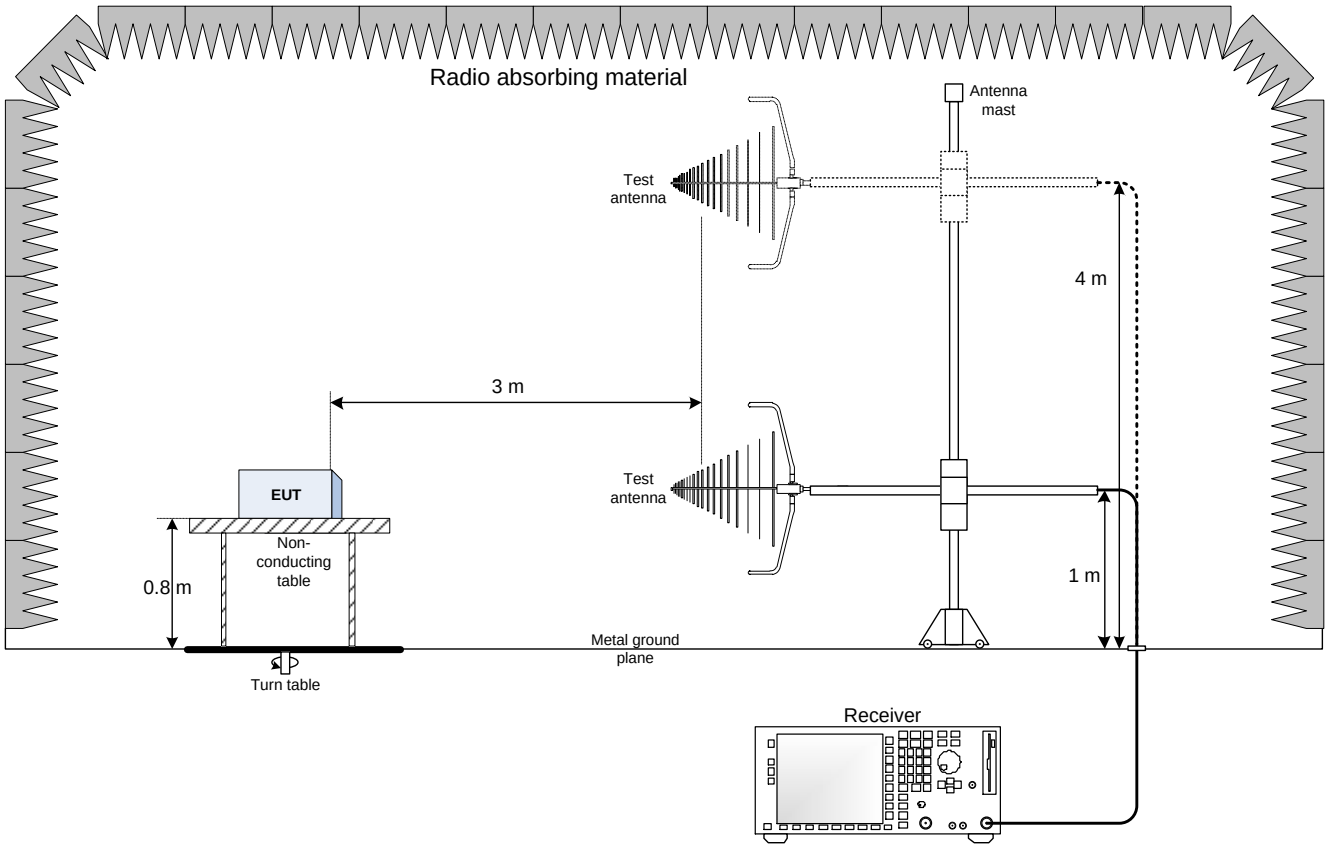


Figure 5.5-1: *Radiated emissions set-up for frequencies below 1 GHz*

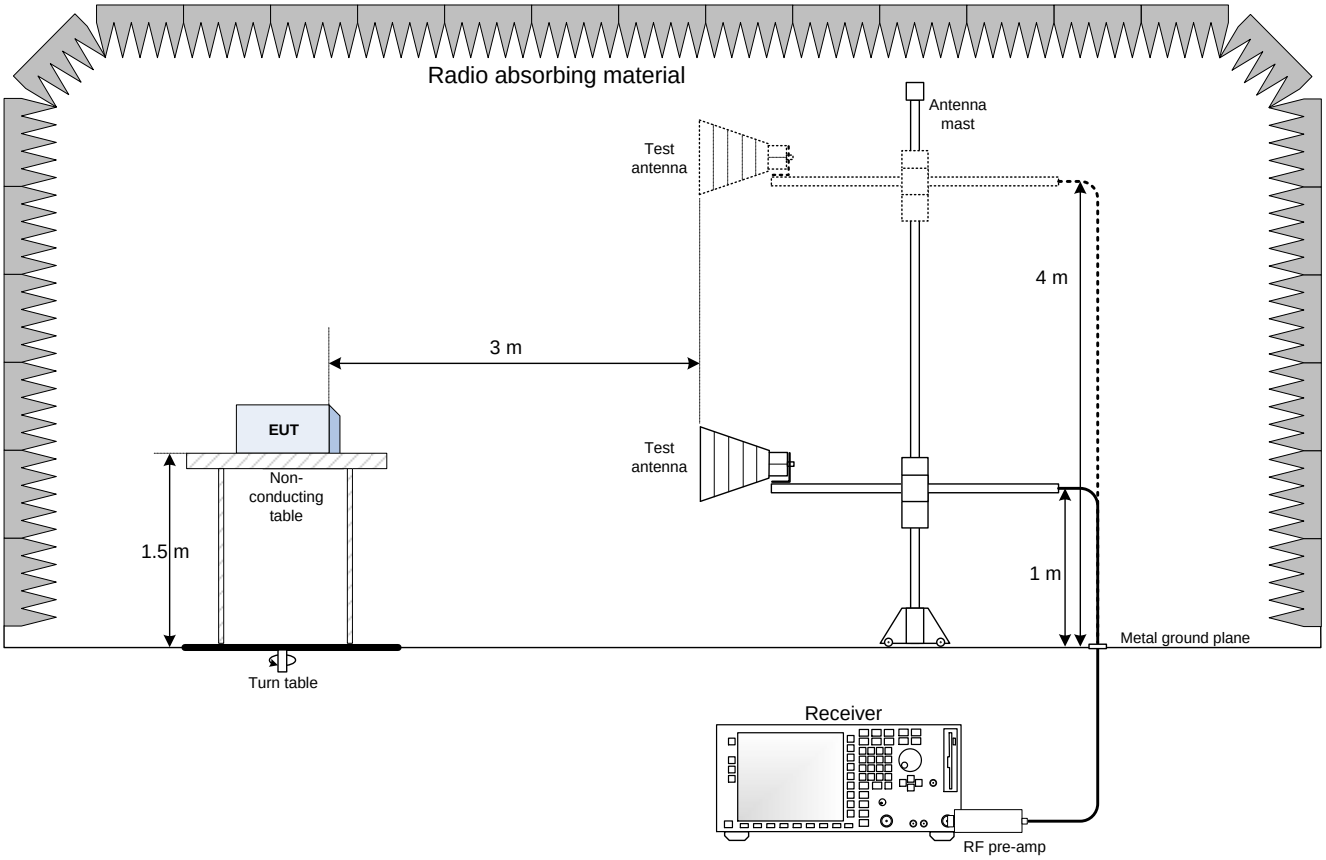


Figure 5.5-2: *Radiated emissions set-up for frequencies above 1 GHz*

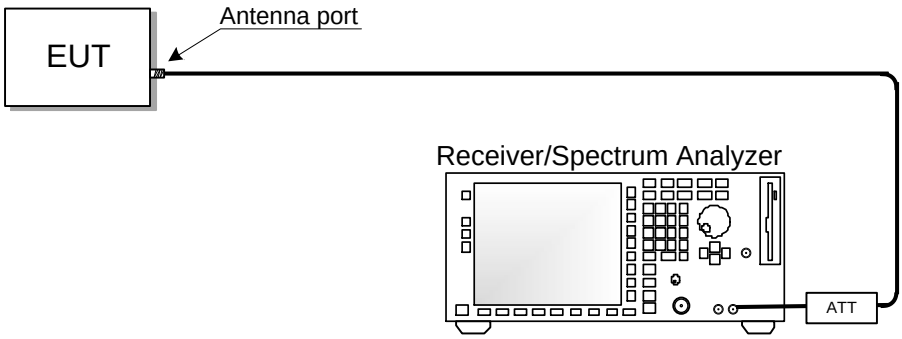


Figure 5.5-3: *Antenna port testing set-up*

Section 6 Summary of test results

6.1 Testing location

Test location (s)	Nemko Spa Via del Carroccio, 4 – 20853 Biassono (MB) - Italy

6.2 Testing period

Test start date	July 4, 2022	Test end date	July 13, 2022

6.3 Sample information

Receipt date	June 21, 2022	Nemko sample ID number(s)	4656120001

6.4 FCC Part 90 test requirements results

Table 6.4-1: *FCC requirements results*

Part	Method (clause)	Test description	Verdict
--	935210 (4.2)	Measuring AGC threshold level	Pass
--	935210 (4.3)	Out-of-band-rejection	Pass
90.219(e)(4)	935210 (4.4)	Input-versus-output signal comparison	Pass
90.205(h), 90.219(e)(1)	935210 (4.5)	Mean output power and amplifier/booster gain	Pass
90.219(e)(2)	935210 (4.6)	Noise figure measurements	Pass
90.219(e)(3)	935210 (4.7.2)	Out-of-band/out-of-block emissions conducted measurements	Pass
90.210(b), 90.219(e)(3)	935210 (4.7.3)	Spurious emissions conducted measurements	Pass
90.213(a)	935210 (4.8)	Frequency stability measurements	Pass
90.210(b), 90.219(e)(3)	935210 (4.9)	Spurious emissions radiated measurements	Pass

Notes:

Section 7 Test equipment

7.1 Test equipment list

Table 7.1-1: *Equipment list*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
Spectrum Analyzer	Rohde & Schwarz	FSW43	101767	2022-01	2023-01
EMI Receiver	Rohde & Schwarz	ESU8	100202	2021-09	2022-09
EMI Receiver	Rohde & Schwarz	ESW44	101620	2021-08	2022-08
Noise generator	Rohde & Schwarz	FS-SNS26	112614	VOU	VOU
RF Vector Signal Generator	Rohde & Schwarz	SMBV100A	263254	2022-05	2023-05
RF Vector Signal Generator	Rohde & Schwarz	SMBV100A	263397	2021-09	2022-09
Climatic chamber	Espec	ARS-1100	4100000067	2022-02	2023-02
Antenna Trilog 25MHz - 8GHz	Schwarzbeck Mess-Elektronik	VULB9162	9162-025	2021-07	2024-07
Antenna 1 - 18 GHz	Schwarzbeck Mess-Elektronik	STLP9148	STLP 9148-152	2021-09	2024-09
Double Ridge Horn Antenna	RFSpin	DRH40	061106A40	2020-04	2023-04
Broadband Amplifier	Schwarzbeck Mess-Elektronik	BBV9718C	00121	2022-01	2023-01
Broadband Bench Top Amplifier	Sage	STB-1834034030-KFKF-L1	18490-01	2022-05	2023-05
Controller	Maturo	FCU3.0	10041	NCR	NCR
Tilt antenna mast	Maturo	TAM4.0-E	10042	NCR	NCR
Turntable	Maturo	TT4.0-5T	2.527	NCR	NCR
Semi-anechoic chamber	Nemko S.p.a.	10m semi-anechoic chamber	530	2021-09	2023-09

Notes: NCR - no calibration required, VOU - verify on use

Section 8 Testing data

8.1 Measuring AGC threshold level

8.1.1 References, definitions and limits

935210 D05 Indus Booster Basic Meas v01r04, Clause 4.2
Testing at and above the AGC threshold will be required.6 The AGC threshold shall be determined by applying the procedure of 3.2, but with the signal generator configured to produce a test signal defined in Table 1, a CW input signal, or a digitally modulated signal, consistent with the discussion about signal types in 4.1.

8.1.2 Test summary

Verdict	Pass		
Tested by	P. Barbieri	Test date	July 5, 2022

8.1.3 Observations, settings and special notes

TETRA and CW signal used

Spectrum analyzer settings:

Resolution bandwidth	100 kHz
Video bandwidth	300 kHz
Detector mode	Peak
Trace mode	Max hold
Measurement time	Auto

Input signal frequency

Down link	451.25 MHz
Up link	456.25 MHz

8.1.4 Test equipment used

Equipment	Manufacturer	Model no.	Asset no.
Spectrum Analyzer	Rohde & Schwarz	FSW43	101767
RF Vector Signal Generator	Rohde & Schwarz	SMBV100A	263254

Notes: NCR - no calibration required, VOU - verify on use

8.1.5 Test data

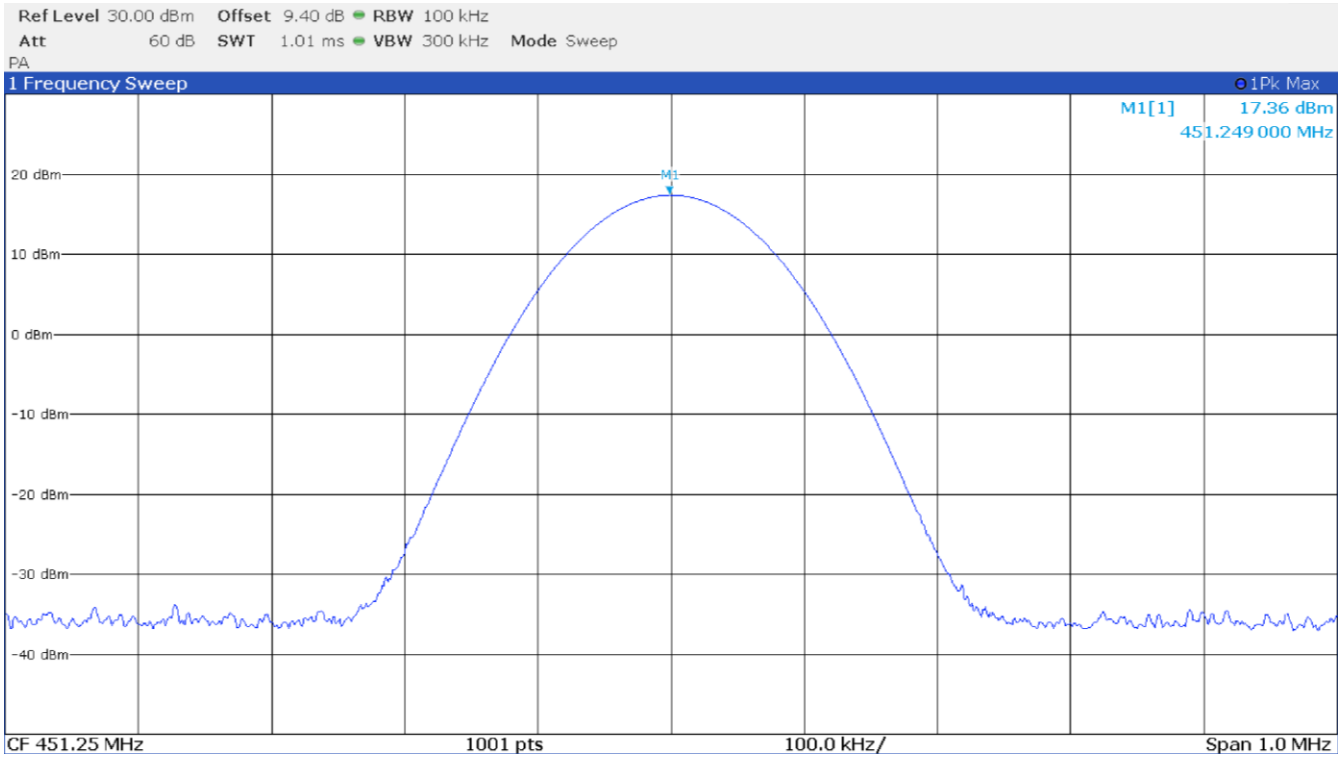


Figure 8.1-1: *Down link - output spectral plot with input at AGC threshold – CW signal*

Test data, continued

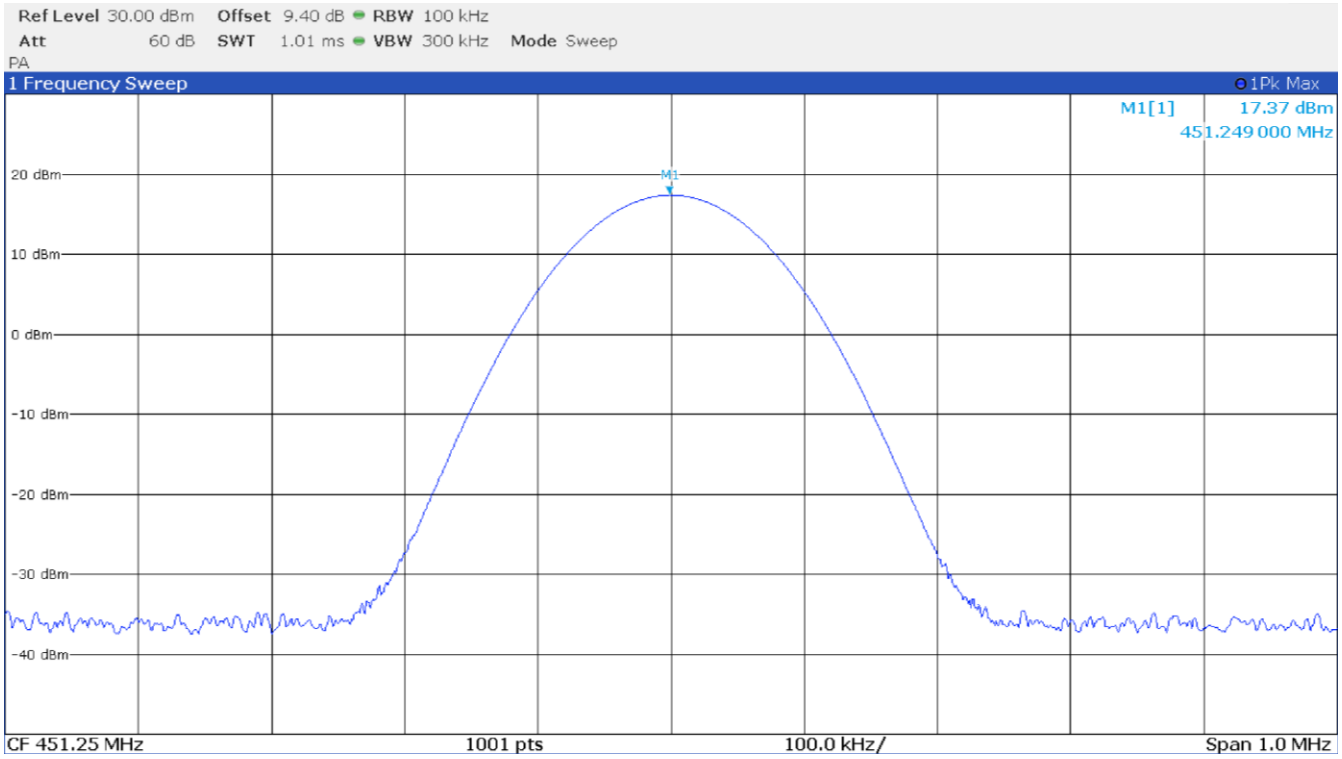


Figure 8.1-2: *Down link - output spectral plot with input at AGC threshold + 1 dB – CW signal*

Test data, continued

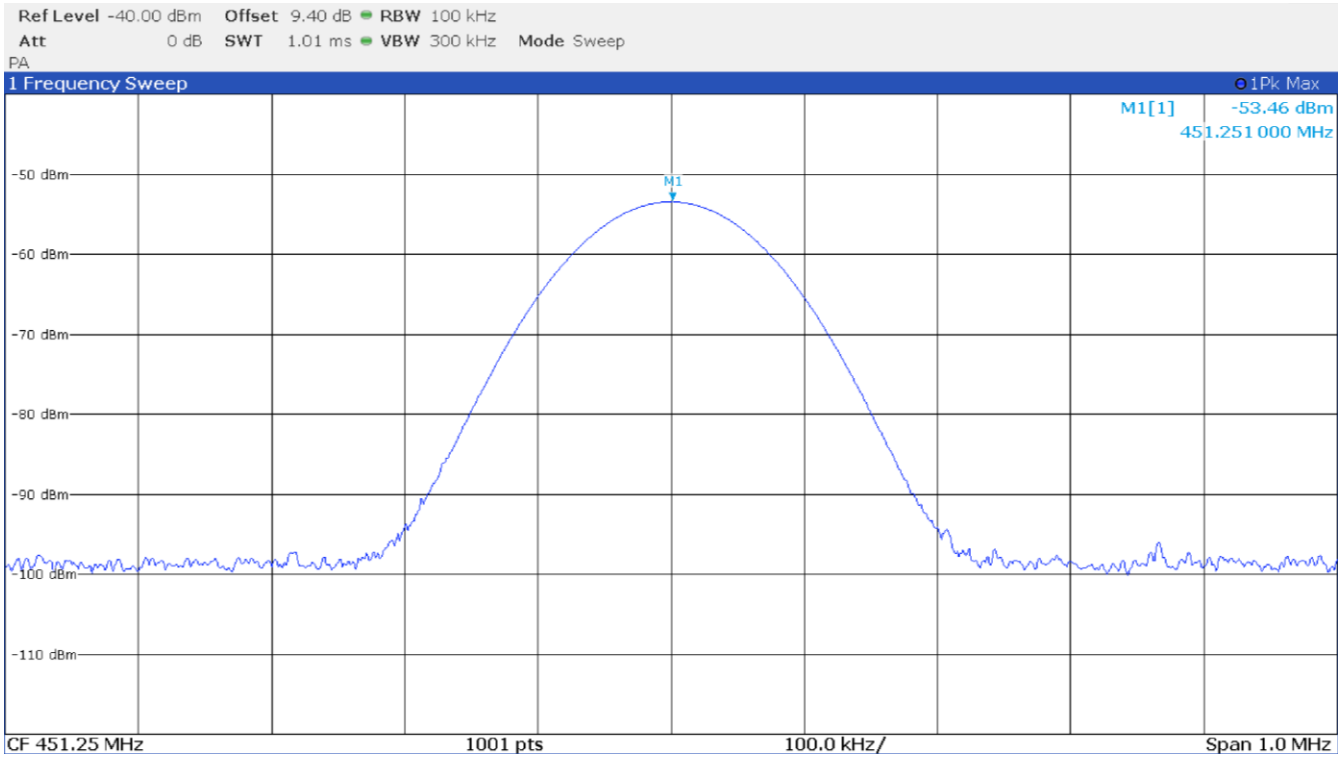


Figure 8.1-3: *Down link - input spectral plot with input at AGC threshold – CW signal*

Test data, continued

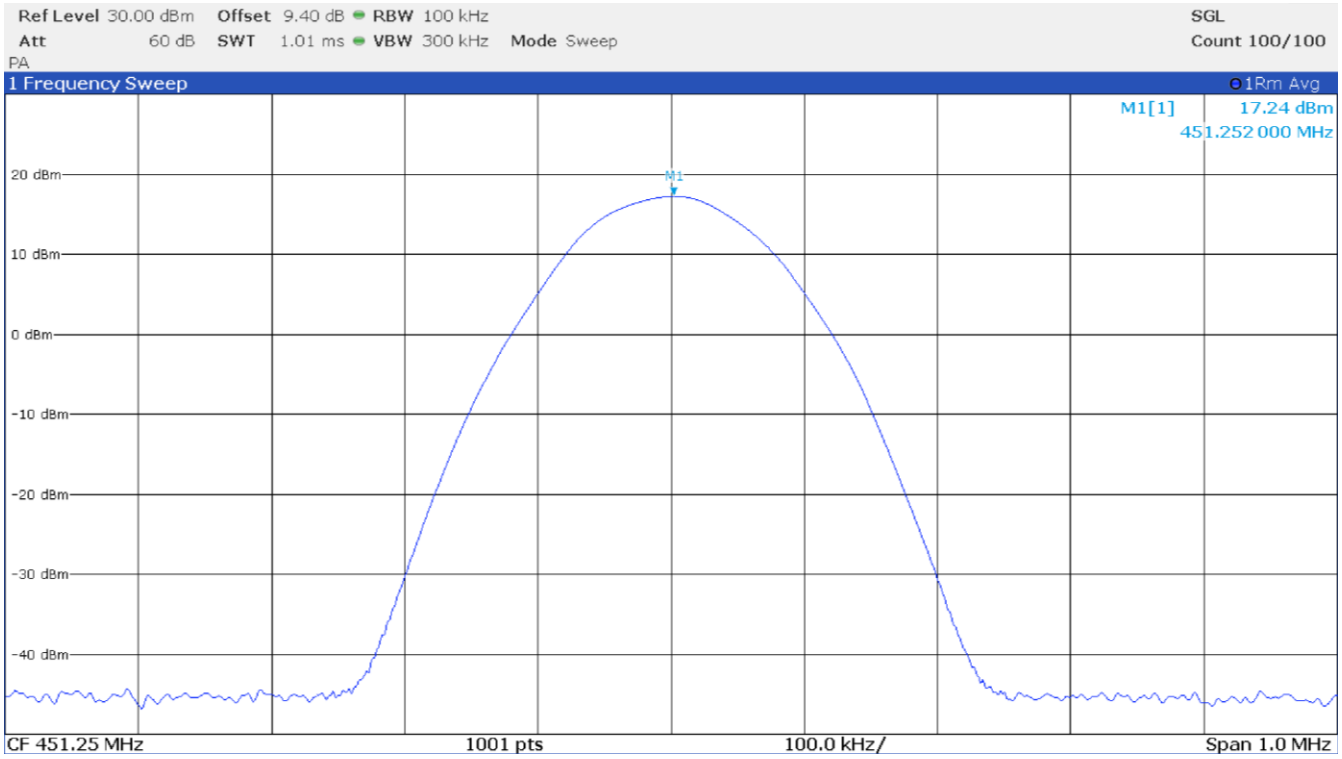


Figure 8.1-4: *Down link - output spectral plot with input at AGC threshold – TETRA signal*

Test data, continued

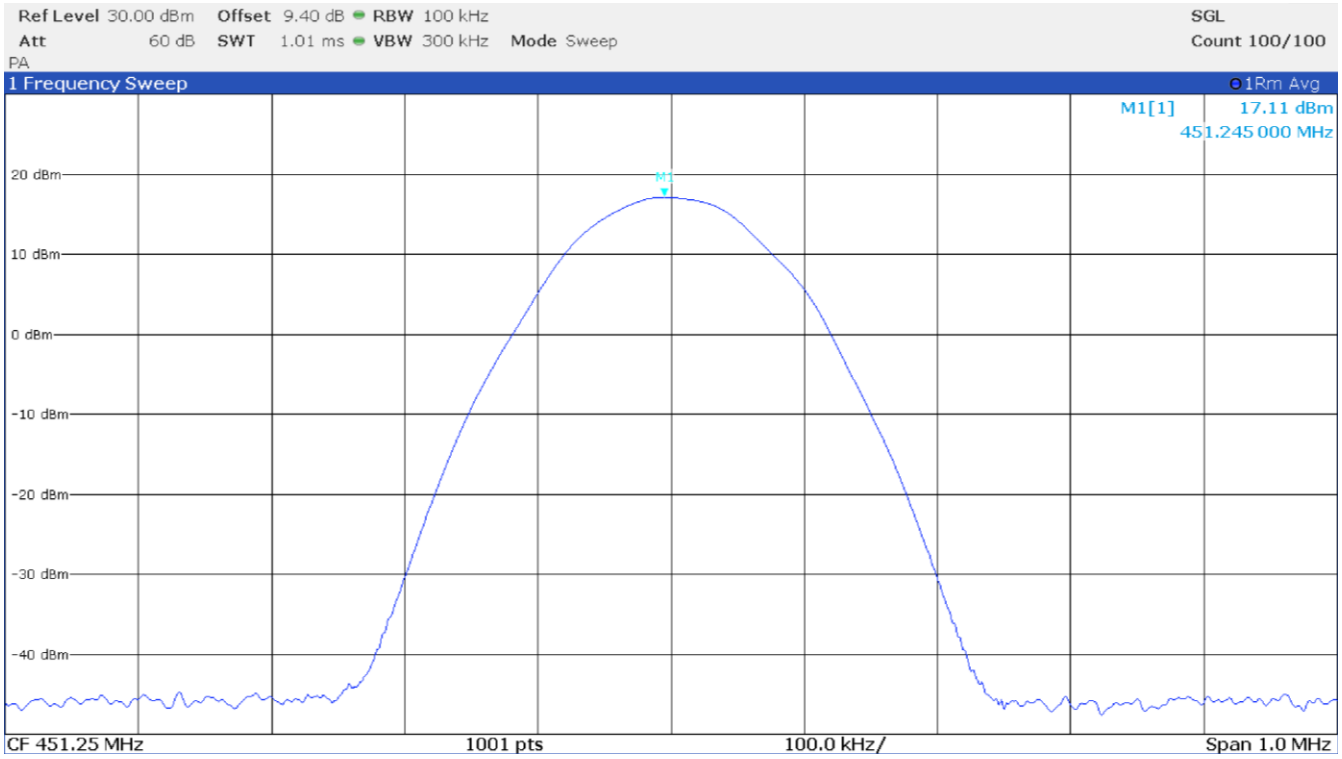


Figure 8.1-5: *Down link - output spectral plot with input at AGC threshold + 1 dB – TETRA signal*

Test data, continued

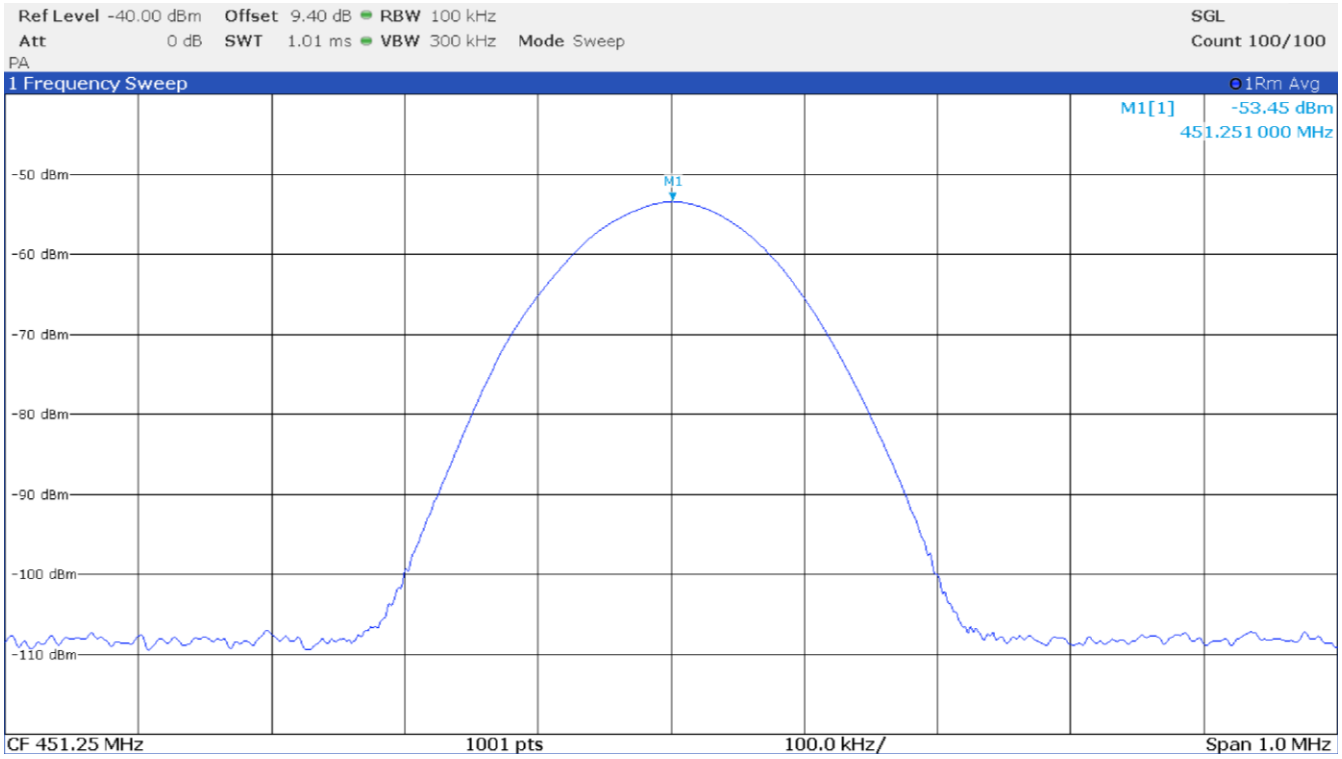


Figure 8.1-6: *Down link - input spectral plot with input at AGC threshold – TETRA signal*

Test data, continued

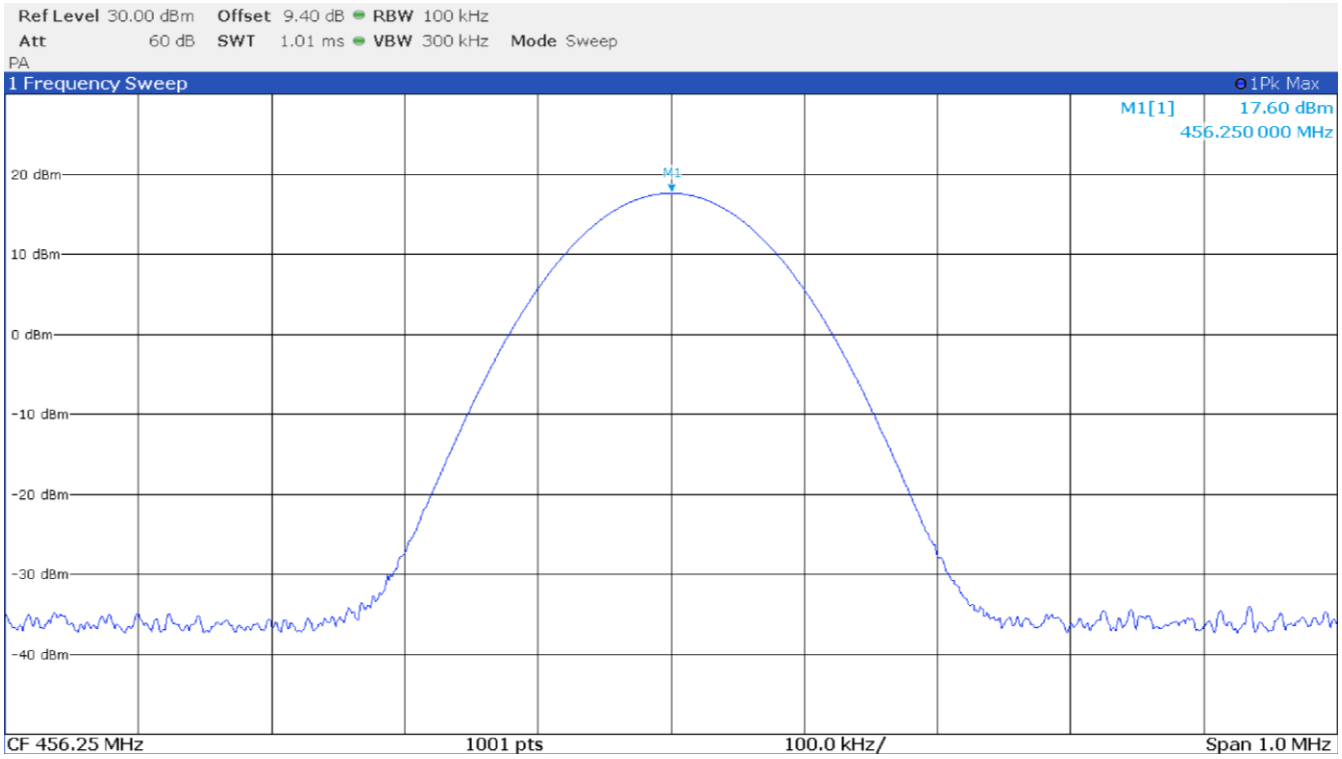


Figure 8.1-7: *Up link - output spectral plot with input at AGC threshold – CW signal*

Test data, continued

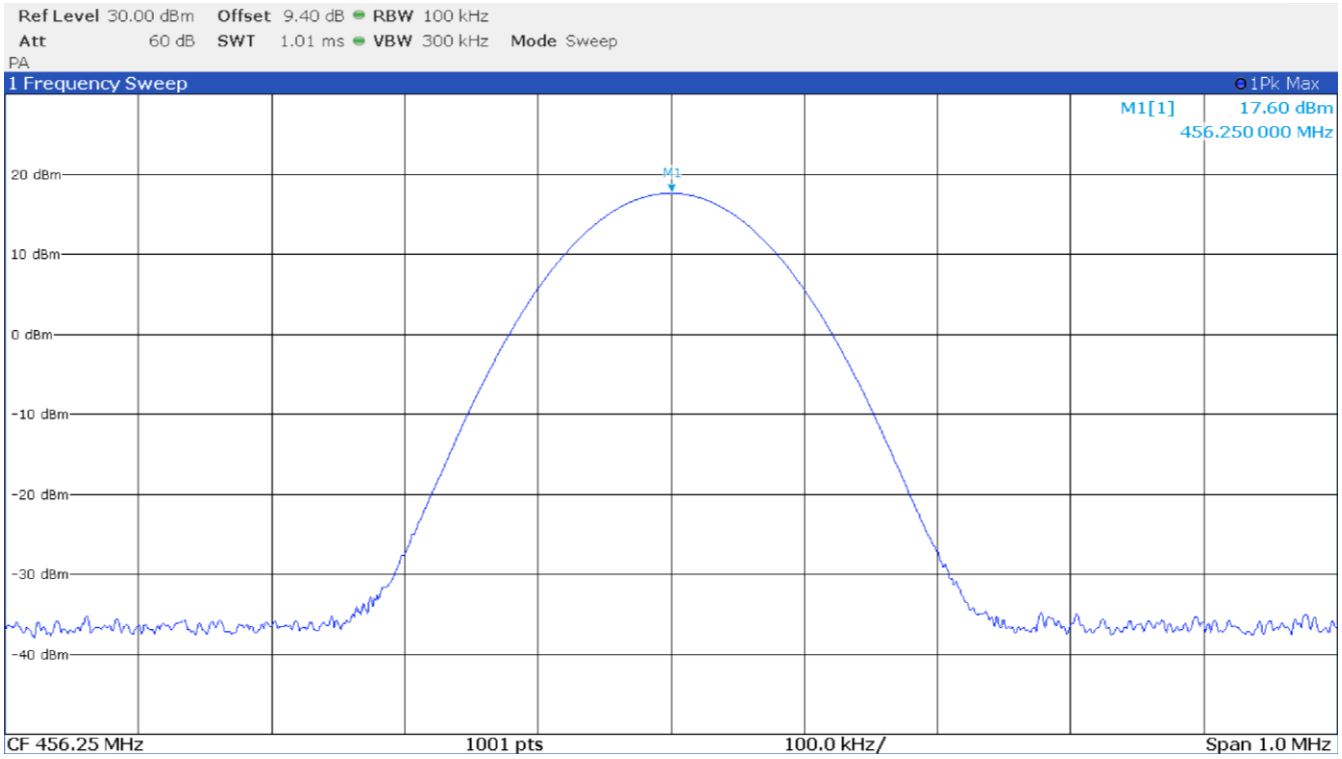


Figure 8.1-8: *Up link - output spectral plot with input at AGC threshold + 1 dB – CW signal*

Test data, continued

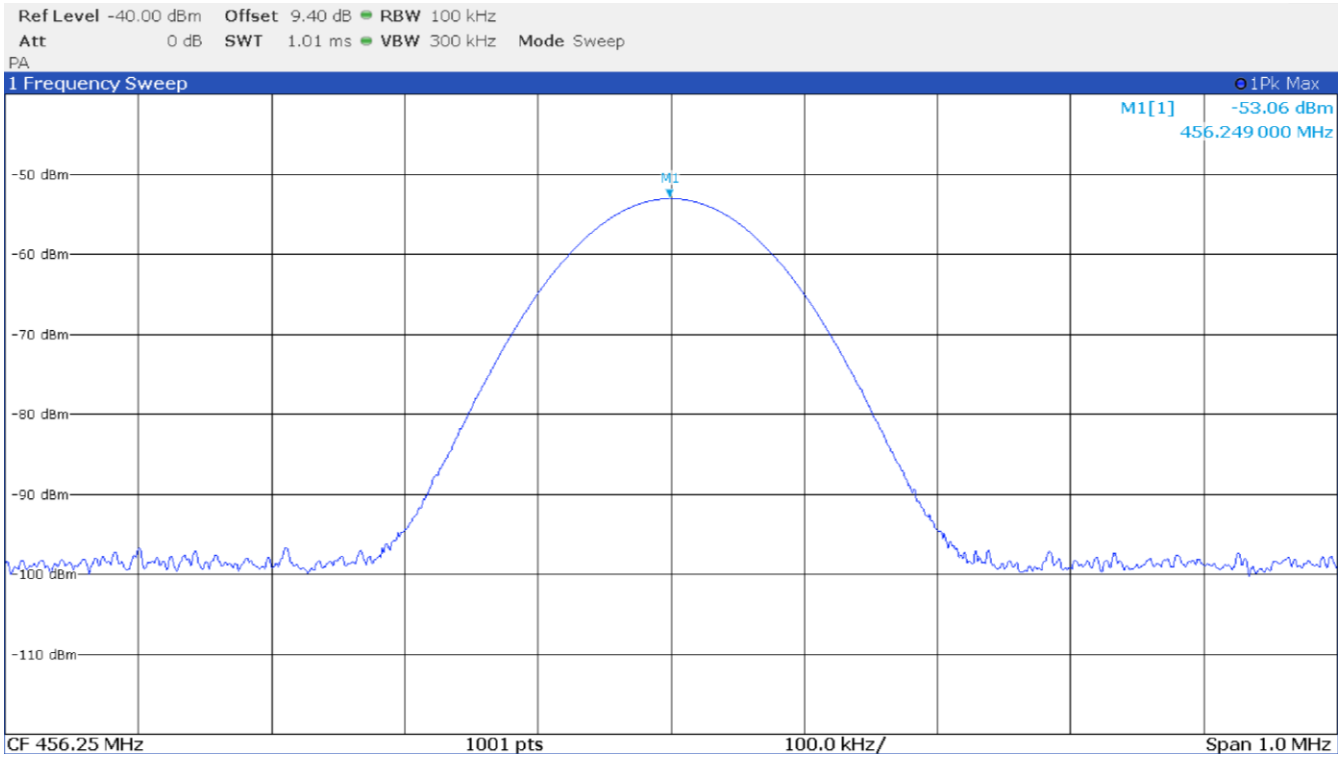


Figure 8.1-9: *Up link - input spectral plot with input at AGC threshold – CW signal*

Test data, continued

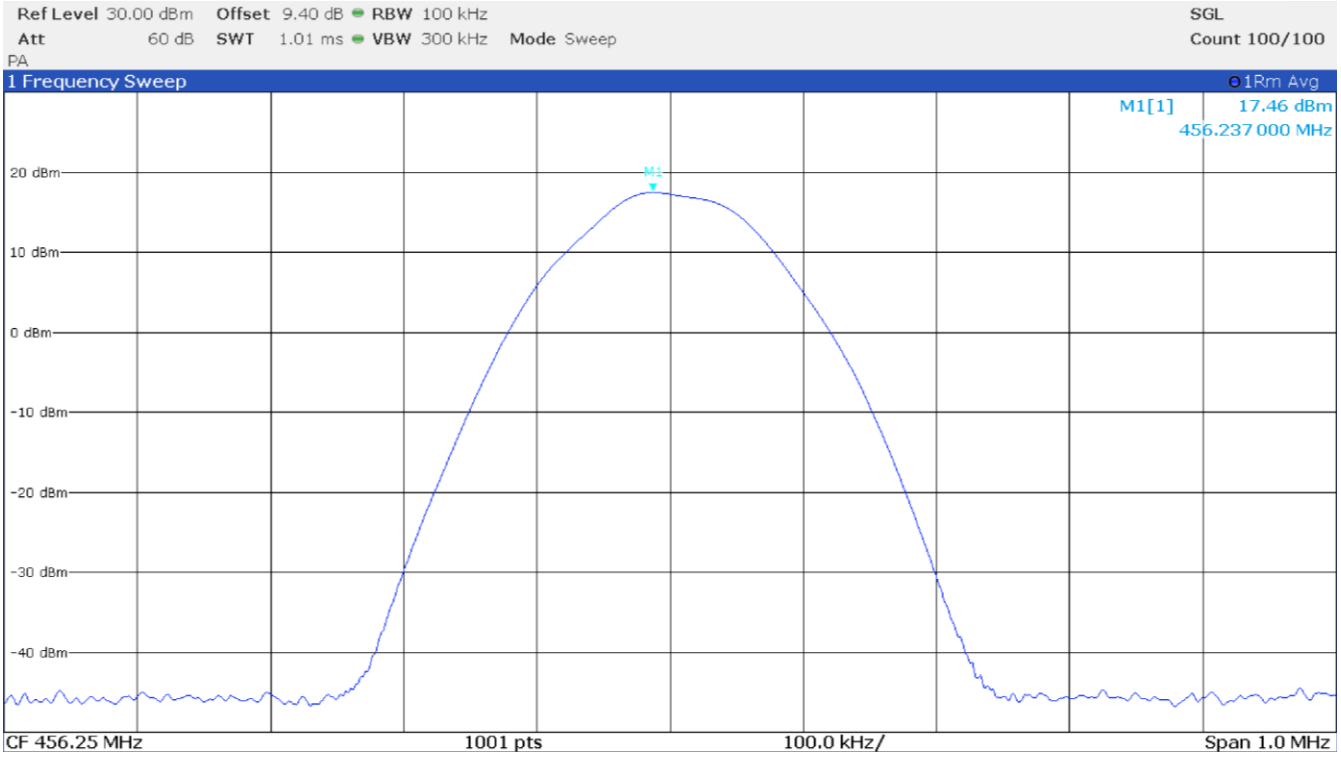


Figure 8.1-10: *Up link - output spectral plot with input at AGC threshold – TETRA signal*

Test data, continued

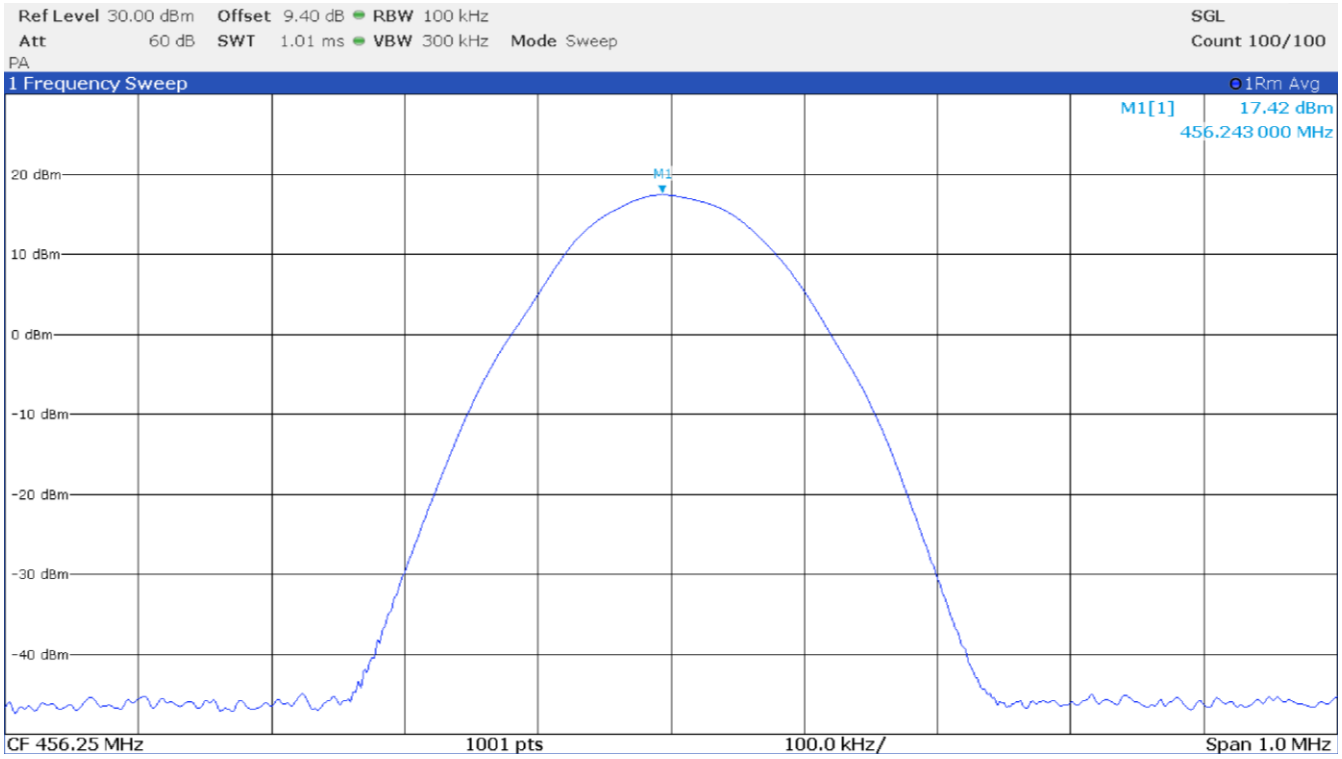


Figure 8.1-11: *Up link - output spectral plot with input at AGC threshold + 1 dB – TETRA signal*

Test data, continued

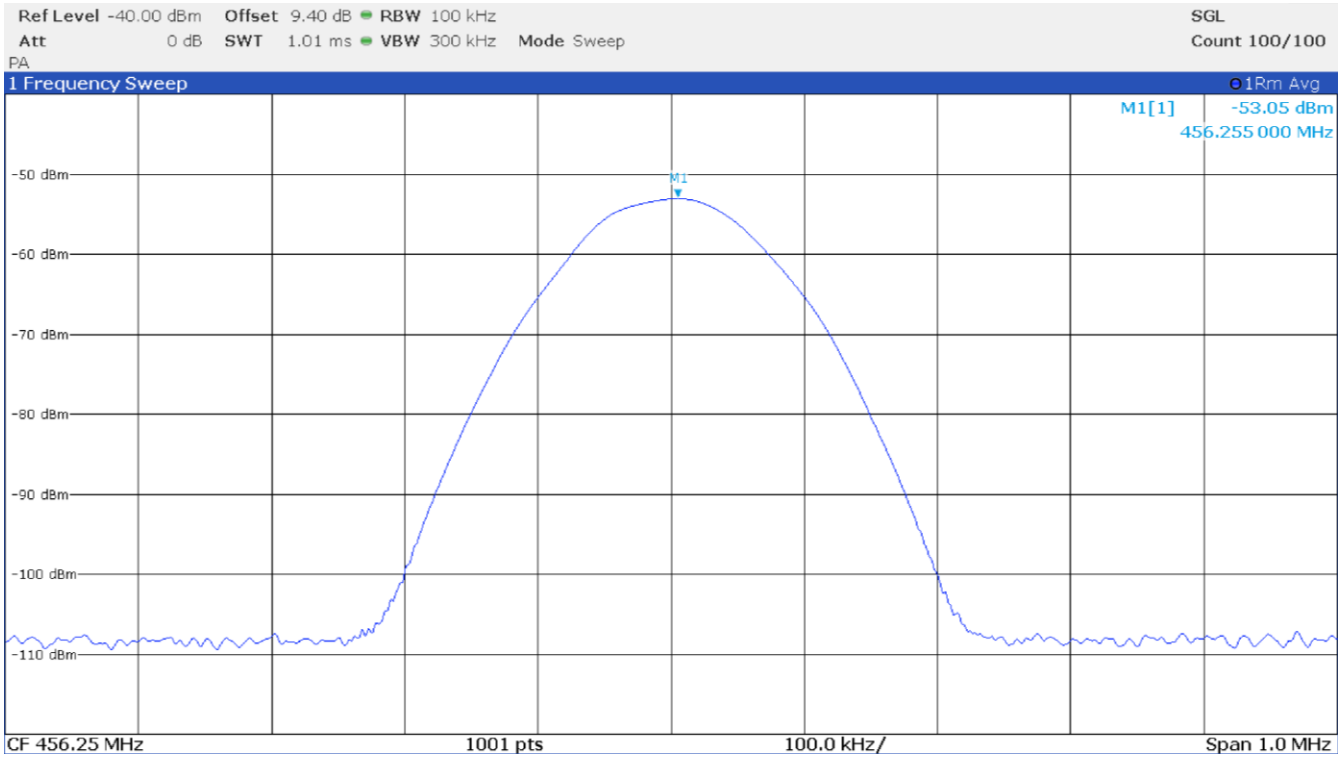


Figure 8.1-12: *Up link - input spectral plot with input at AGC threshold – TETRA signal*

8.2 Out-of-band-rejection

8.2.1 References, definitions and limits

935210 D05 Indus Booster Basic Meas v01r04, Clause 4.3
A signal booster shall reject amplification of other signals outside of its passband.

8.2.2 Test summary

Verdict	Pass		
Tested by	P. Barbieri	Test date	July 5, 2022

8.2.3 Observations, settings and special notes

CW signal used with a frequency sweep in the range ± 250 % of the passband with a dwell time of 10 ms. The CW amplitude shall be 3 dB below the AGC threshold.

Spectrum analyzer settings:

Resolution bandwidth	1 % to 5 % of the EUT passband
Video bandwidth	≥3 × RBW
Frequency span	± 250 % of the passband
Detector mode	Peak
Trace mode	Max Hold

Input signal frequency

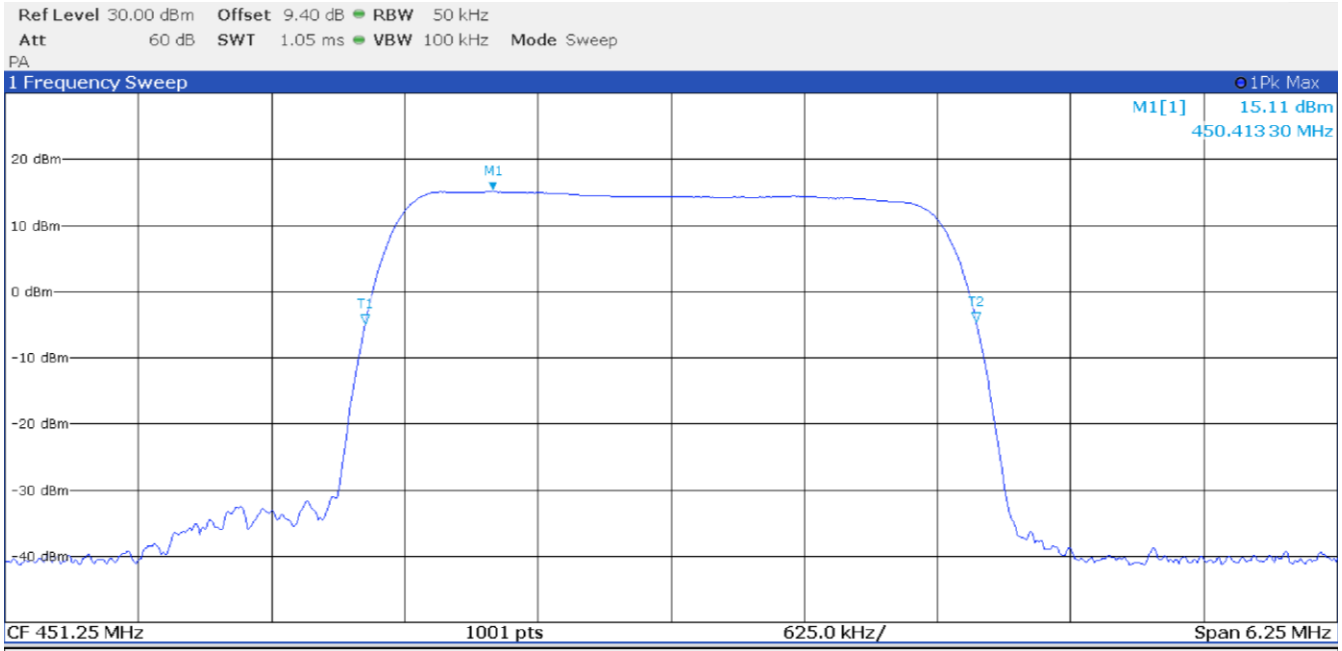
Down link	451.25 MHz
Up link	456.25 MHz

8.2.4 Test equipment used

Equipment	Manufacturer	Model no.	Asset no.
Spectrum Analyzer	Rohde & Schwarz	FSW43	101767
RF Vector Signal Generator	Rohde & Schwarz	SMBV100A	263254

Notes: NCR - no calibration required, VOU - verify on use

8.2.5 Test data

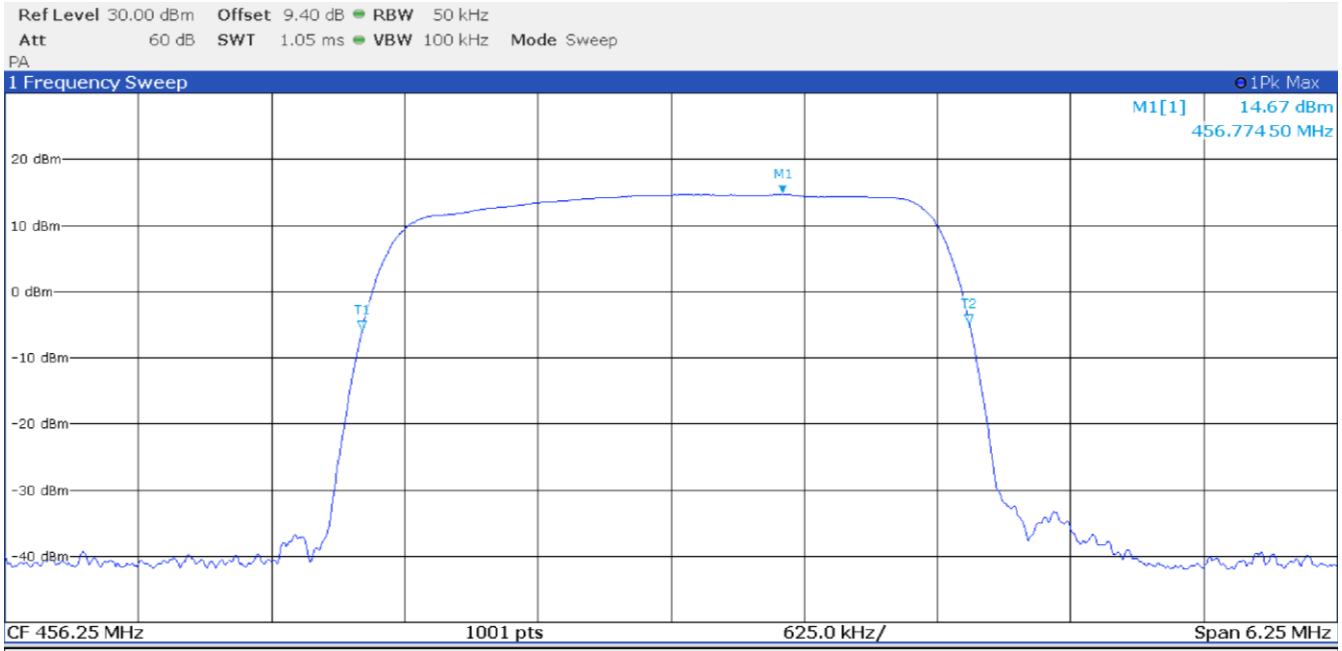


2 Marker Table

Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	**450.413 3 MHz**	**15.11 dBm**	ndB	20.0 dB
T1		1	449.813 9 MHz	-4.87 dBm	ndB down BW	**2.87 MHz**
T2		1	452.679 8 MHz	-4.64 dBm	Q Factor	157.2

Figure 8.2-1: *Out-of-band-rejection 20dB BW spectral plot for down link*

Test data, continued



2 Marker Table

Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	**456.774 5 MHz**	**14.67 dBm**	ndB	20.0 dB
T1		1	454.801 4 MHz	-5.88 dBm	ndB down BW	**2.85 MHz**
T2		1	457.648 6 MHz	-4.88 dBm	Q Factor	160.4

Figure 8.2-2: *Out-of-band-rejection 20dB BW spectral plot for up link*

8.3 Input-versus-output signal comparison

8.3.1 References, definitions and limits

FCC § 90.219(e)(4)

(e) Device Specifications. In addition to the general rules for equipment certification in § 90.203(a)(2) and part 2, subpart J of this chapter, a signal booster must also meet the rules in this paragraph.

(4) A signal booster must be designed such that all signals that it retransmits meet the following requirements:

(i) 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.

(ii) There is no change in the occupied bandwidth of the retransmitted signals.

(iii) 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).

FCC § 90.210(b)

(b) Emission Mask B. For transmitters that are equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier power (P) as follows:

(1) On any frequency removed from the assigned frequency by more than 50 percent, but not more than 100 percent of the authorized bandwidth: At least 25 dB.

(2) On any frequency removed from the assigned frequency by more than 50 percent, but not more than 100 percent of the authorized bandwidth: At least 25 dB.

(3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 + 10 log (P) dB.

FCC § 90.221

(a) For the frequency bands indicated below, operations using equipment designed to operate with a 25 kHz channel bandwidth may be authorized up to a 22 kHz bandwidth if the equipment meets the adjacent channel power (ACP) limits below. The table specifies a value for the ACP as a function of the displacement from the channel center frequency and a measurement bandwidth of 18 kHz.

(b) Maximum adjacent power levels for frequencies in the 450-470 MHz band:

Frequency offset	Maximum ACP (dBc) for devices 1 watt and less	Maximum ACP (dBc) for devices above 1 watt
25 kHz	−55 dBc	−60 dBc
50 kHz	−70 dBc	−70 dBc
75 kHz	−70 dBc	−70 dBc

In any case, no requirement in excess of −36 dBm shall apply.

8.3.2 Test summary

Verdict	Pass		
Tested by	P. Barbieri	Test date	July 6, 2022

8.3.3 Observations, settings and special notes

TETRA signa used.
EUT input power set to a level that is just below the AGC threshold, but not more than 0.5 dB below.
Repeated the test with the input signal amplitude set to 3 dB above the AGC threshold.

Spectrum analyzer settings for the OBW measurement:

Resolution bandwidth	of 1 % to 5 % of the OBW
Video bandwidth	≥3 × RBW
Frequency span	2 × to 5 × the emission bandwidth (EBW) or alternatively, the OBW
Detector mode	Peak
Trace mode	Max Hold

Spectrum analyzer settings for the MASK B measurement:

Resolution bandwidth	300 Hz
Video bandwidth	≥3 × RBW
Frequency span	200 kHz
Detector mode	Peak
Trace mode	Max Hold

Spectrum analyzer settings for the ACP measurement:

Resolution bandwidth	of 1 % to 5 % of the OBW
Video bandwidth	≥3 × RBW
Frequency span	Large enough to include 3 adjacent channels
Detector mode	RMS
Trace mode	Average (Power)

8.3.4 Test equipment used

Equipment	Manufacturer	Model no.	Asset no.
Spectrum Analyzer	Rohde & Schwarz	FSW43	101767
RF Vector Signal Generator	Rohde & Schwarz	SMBV100A	263254

Notes: NCR - no calibration required, VOU - verify on use

Input signal frequency

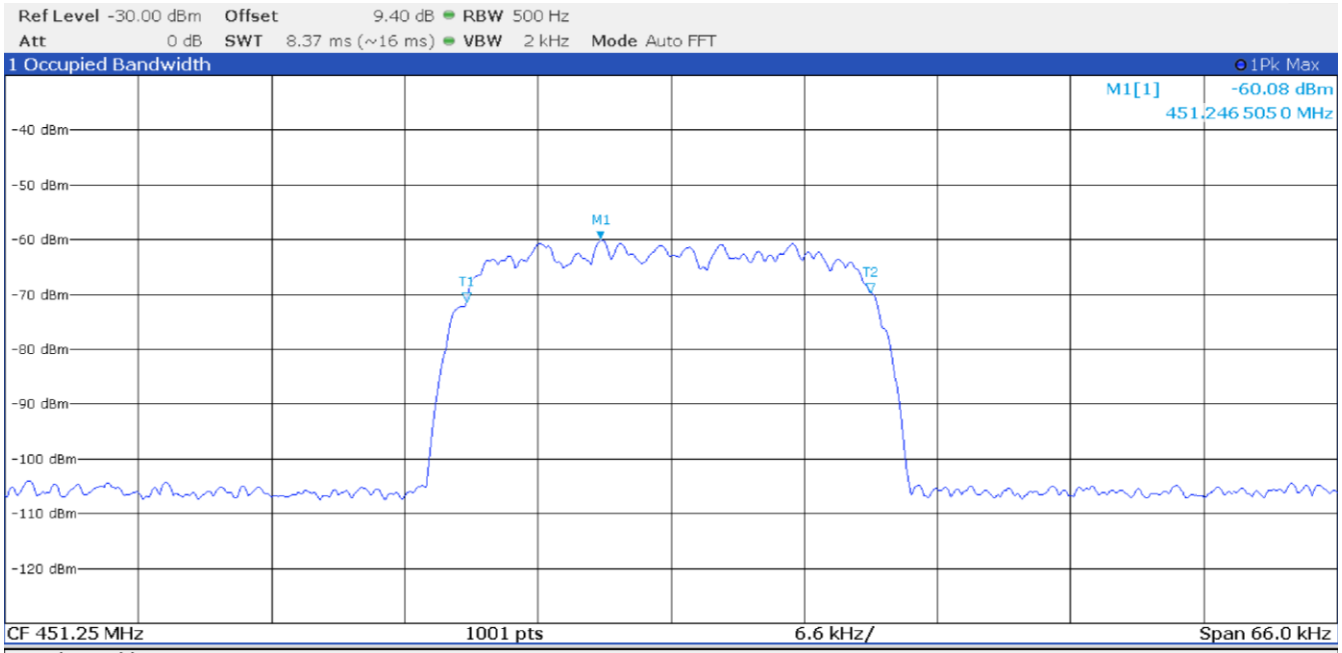
Down link	451.25 MHz
Up link	456.25 MHz

8.3.5 Test data

Table 8.3-1: *Occupied bandwidth results*

Antenna port	Signal measured	Input signal level	Frequency, MHz	99% OBW, kHz	Limit, kHz	Margin, kHz
Down link	Input	AGC threshold	451.25	20.0	22.0	-2.0
Down link	Output	AGC threshold	451.25	20.0	22.0	-2.0
Down link	Input	AGC threshold +3 dB	451.25	20.0	22.0	-2.0
Down link	Output	AGC threshold +3 dB	451.25	20.0	22.0	-2.0
Up link	Input	AGC threshold	456.25	20.0	22.0	-2.0
Up link	Output	AGC threshold	456.25	20.0	22.0	-2.0
Up link	Input	AGC threshold +3 dB	456.25	20.0	22.0	-2.0
Up link	Output	AGC threshold +3 dB	456.25	20.0	22.0	-2.0

Test data, continued

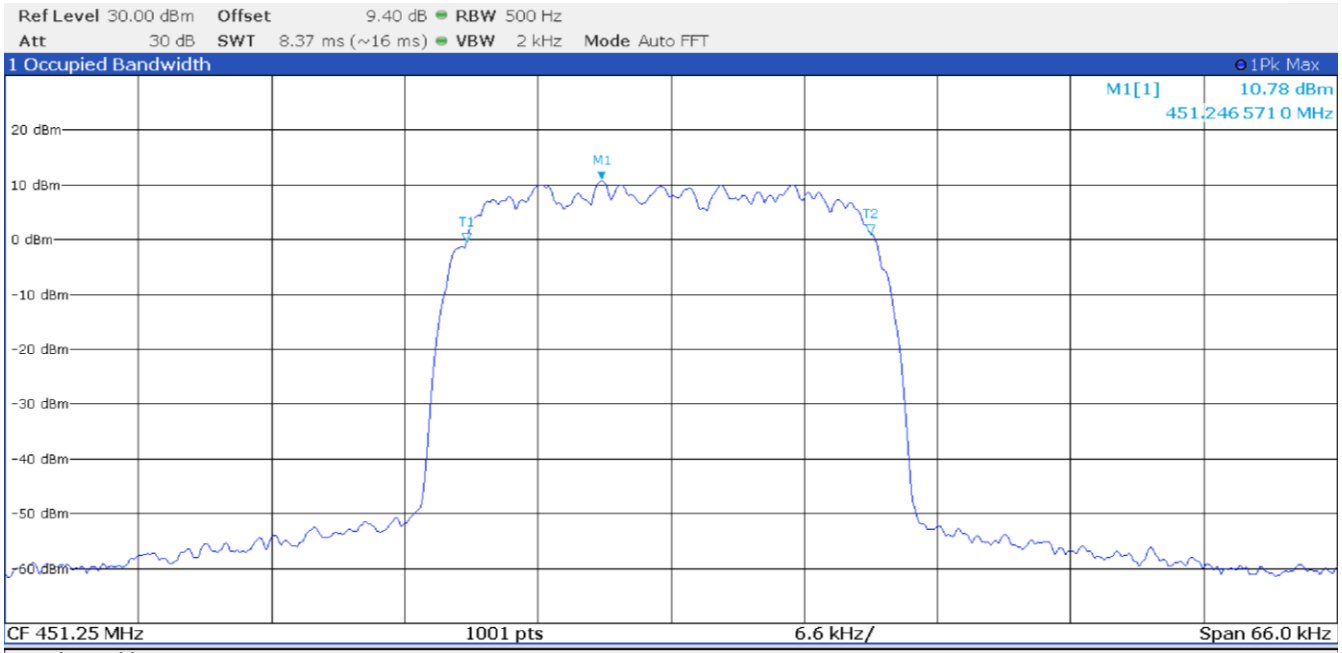


2 Marker Table

Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	**451.246 505 MHz**	**-60.08 dBm**	Occ Bw	**20.020 957 374 kHz**
T1		1	451.239 857 4 MHz	-71.37 dBm	Occ Bw Centroid	451.249 867 912 MHz
T2		1	451.259 878 4 MHz	-69.71 dBm	Occ Bw Freq Offset	-132.088 424 206 Hz

Figure 8.3-1: *99% occupied bandwidth, input signal at AGC threshold spectral plot – down link*

Test data, continued

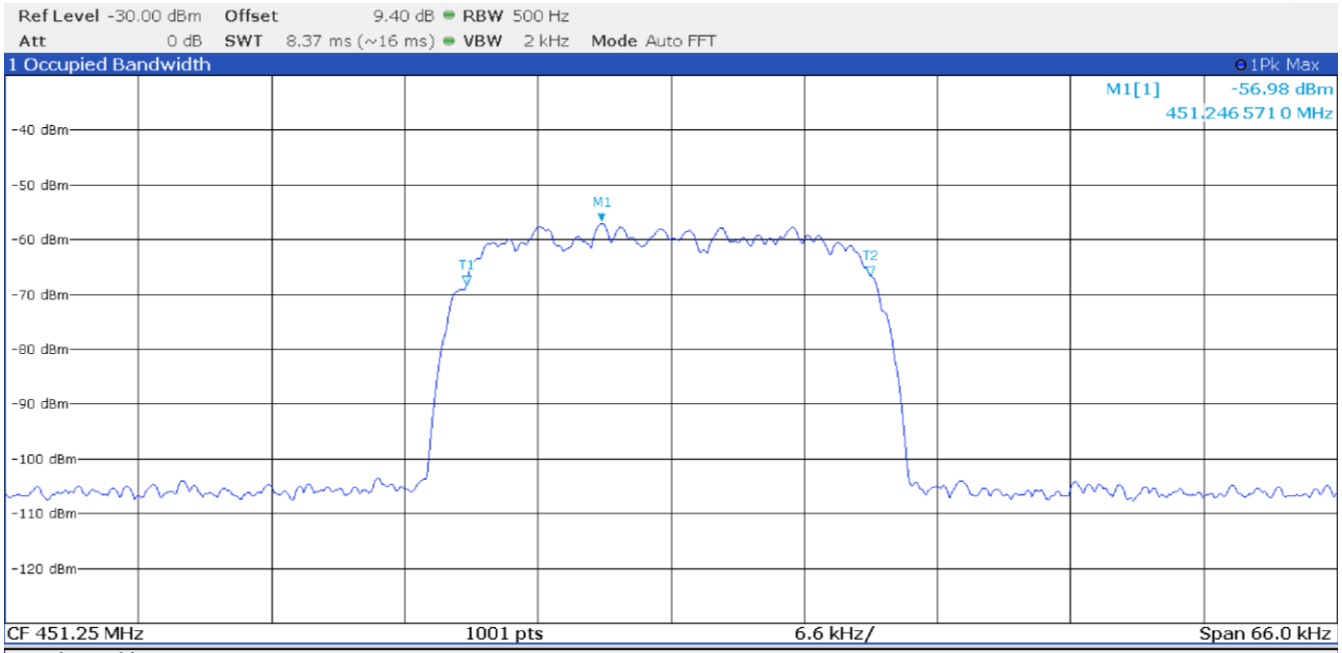


2 Marker Table

Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	**451.246 571 MHz**	**10.78 dBm**	Occ Bw	**20.003 037 105 kHz**
T1		1	451.239 861 6 MHz	-0.58 dBm	Occ Bw Centroid	451.249 863 089 MHz
T2		1	451.259 864 6 MHz	1.07 dBm	Occ Bw Freq Offset	-136.911 334 217 Hz

Figure 8.3-2: *99% occupied bandwidth, output signal at AGC threshold spectral plot – down link*

Test data, continued

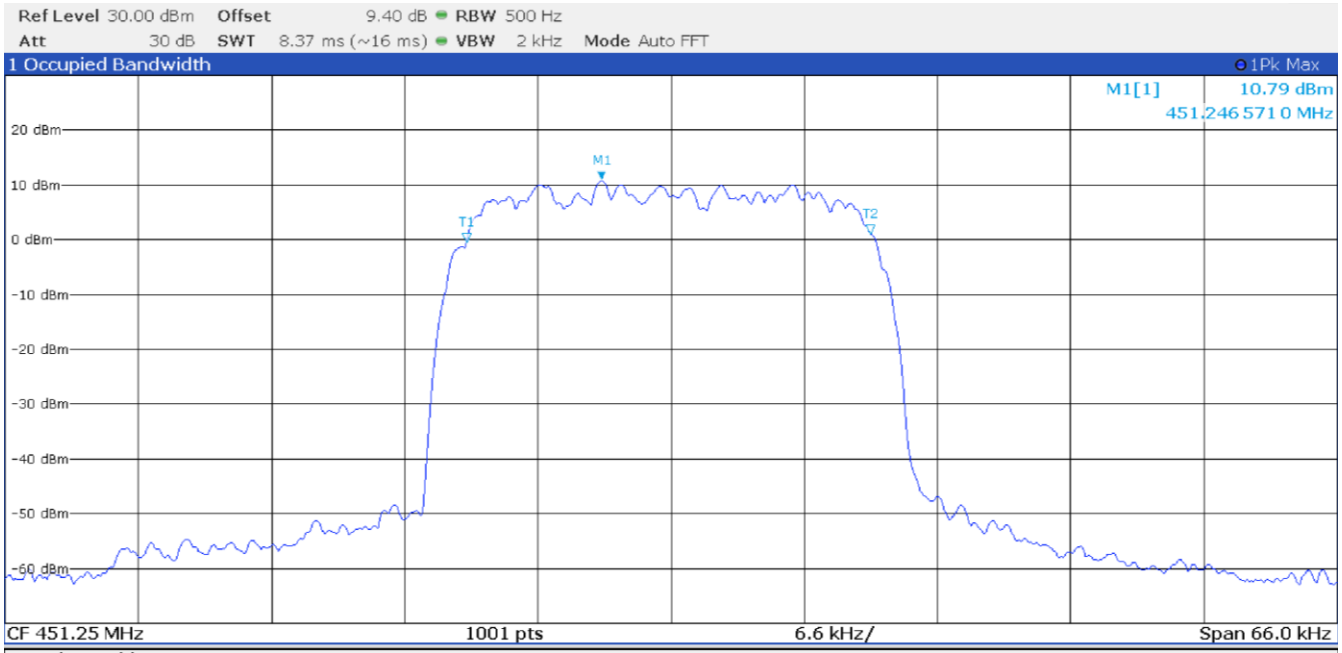


2 Marker Table

Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	**451.246 571 MHz**	**-56.98 dBm**	Occ Bw	**20.016 429 939 kHz**
T1		1	451.239 856 4 MHz	-68.36 dBm	Occ Bw Centroid	451.249 864 62 MHz
T2		1	451.259 872 8 MHz	-66.68 dBm	Occ Bw Freq Offset	-135.380 251 408 Hz

Figure 8.3-3: *99% occupied bandwidth, input signal at AGC threshold +3dB spectral plot – down link*

Test data, continued

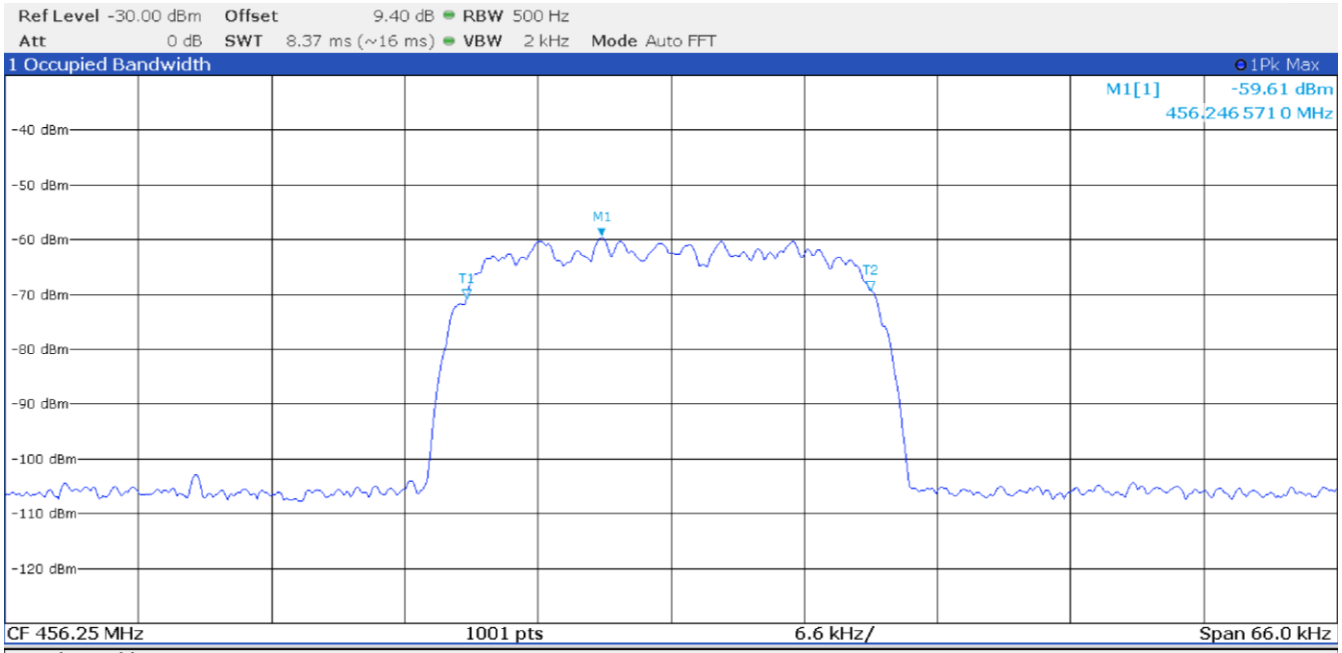


2 Marker Table

Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	**451.246 571 MHz**	**10.79 dBm**	Occ Bw	**19.991 625 885 kHz**
T1		1	451.239 867 8 MHz	-0.60 dBm	Occ Bw Centroid	451.249 863 644 MHz
T2		1	451.259 859 5 MHz	1.03 dBm	Occ Bw Freq Offset	-136.356 481 075 Hz

Figure 8.3-4: *99% occupied bandwidth, output signal at AGC threshold +3 dB spectral plot – down link*

Test data, continued

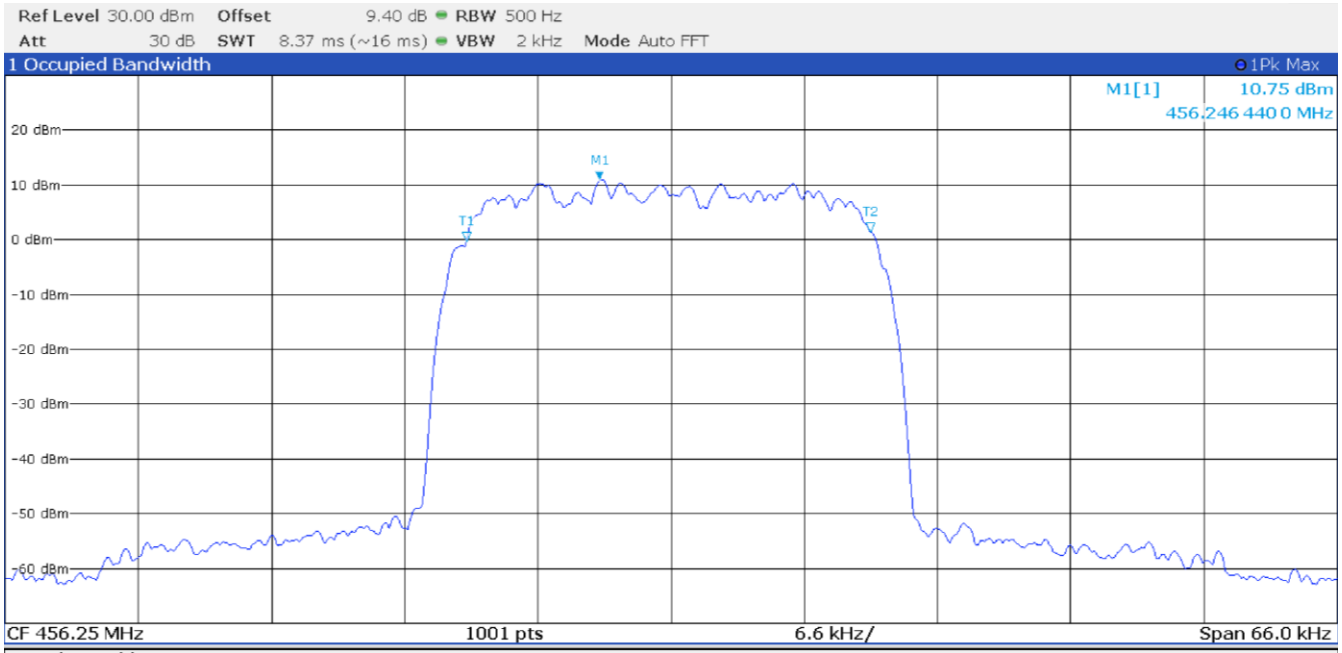


2 Marker Table

Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	**456.246 571 MHz**	**-59.61 dBm**	Occ Bw	**20.020 835 383 kHz**
T1		1	456.239 851 7 MHz	-70.93 dBm	Occ Bw Centroid	456.249 862 082 MHz
T2		1	456.259 872 5 MHz	-69.29 dBm	Occ Bw Freq Offset	-137.917 558 312 Hz

Figure 8.3-5: *99% occupied bandwidth, input signal at AGC threshold spectral plot – up link*

Test data, continued

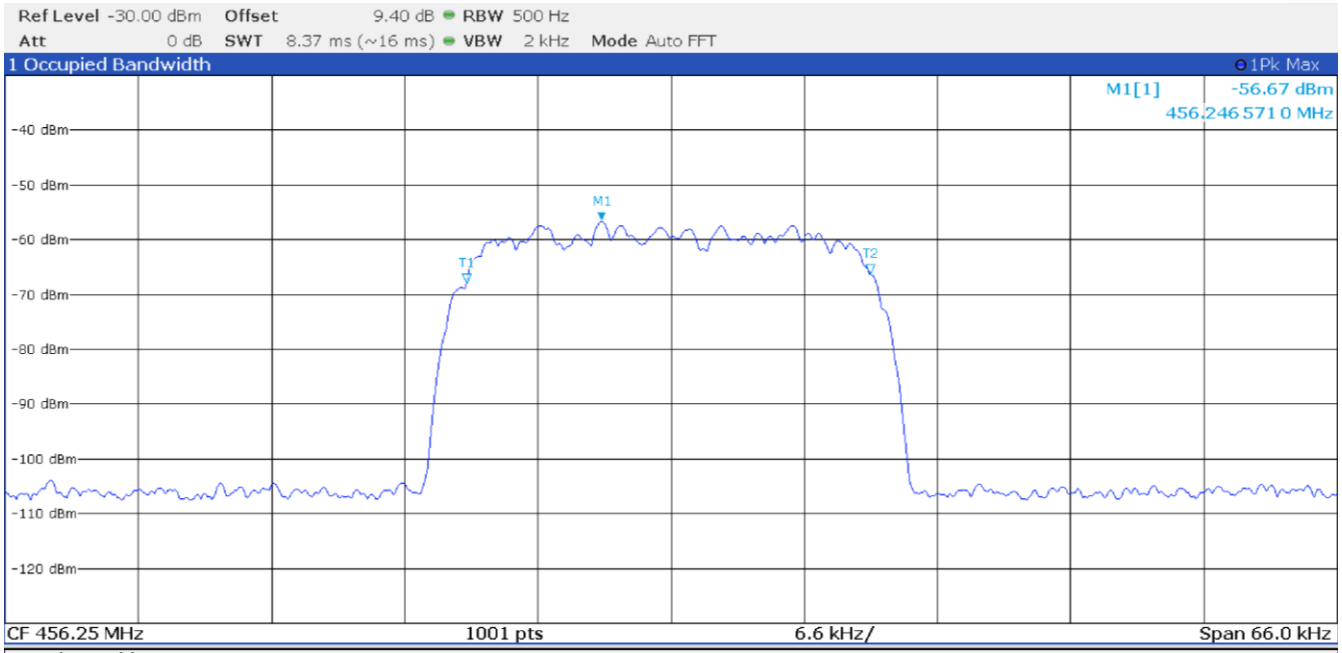


2 Marker Table

Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	**456.246 44 MHz**	**10.75 dBm**	Occ Bw	**20.001 576 637 kHz**
T1		1	456.239 866 9 MHz	-0.38 dBm	Occ Bw Centroid	456.249 867 639 MHz
T2		1	456.259 868 4 MHz	1.33 dBm	Occ Bw Freq Offset	-132.360 870 957 Hz

Figure 8.3-6: *99% occupied bandwidth, output signal at AGC threshold spectral plot – up link*

Test data, continued

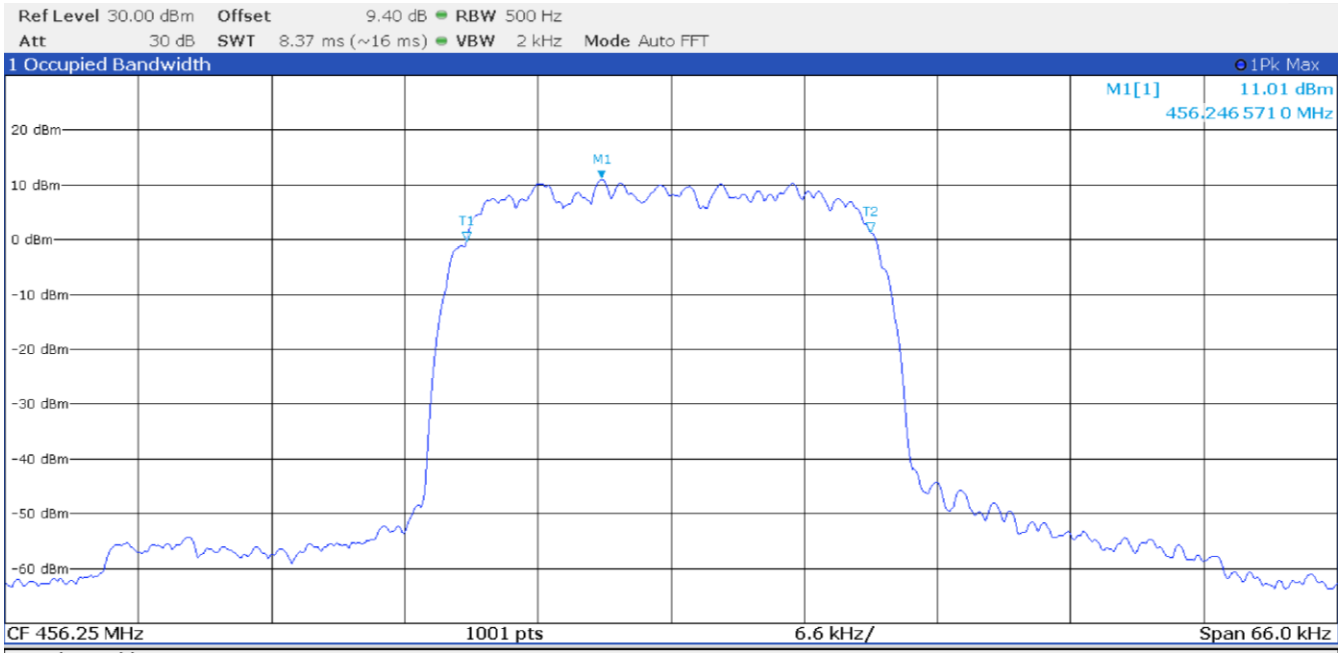


2 Marker Table

Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	**456.246 571 MHz**	**-56.67 dBm**	Occ Bw	**20.013 422 452 kHz**
T1		1	456.239 860 1 MHz	-68.01 dBm	Occ Bw Centroid	456.249 866 772 MHz
T2		1	456.259 873 5 MHz	-66.35 dBm	Occ Bw Freq Offset	-133.228 064 179 Hz

Figure 8.3-7: *99% occupied bandwidth, input signal at AGC threshold +3dB spectral plot – up link*

Test data, continued



2 Marker Table

Type	Ref	Trc	X-Value	Y-Value	Function	Function Result
M1		1	**456.246 571 MHz**	**11.01 dBm**	Occ Bw	**19.987 581 673 kHz**
T1		1	456.239 875 3 MHz	-0.42 dBm	Occ Bw Centroid	456.249 869 049 MHz
T2		1	456.259 862 8 MHz	1.30 dBm	Occ Bw Freq Offset	-130.951 043 963 Hz

Figure 8.3-8: *99% occupied bandwidth, output signal at AGC threshold +3 dB spectral plot – up link*

Test data, continued

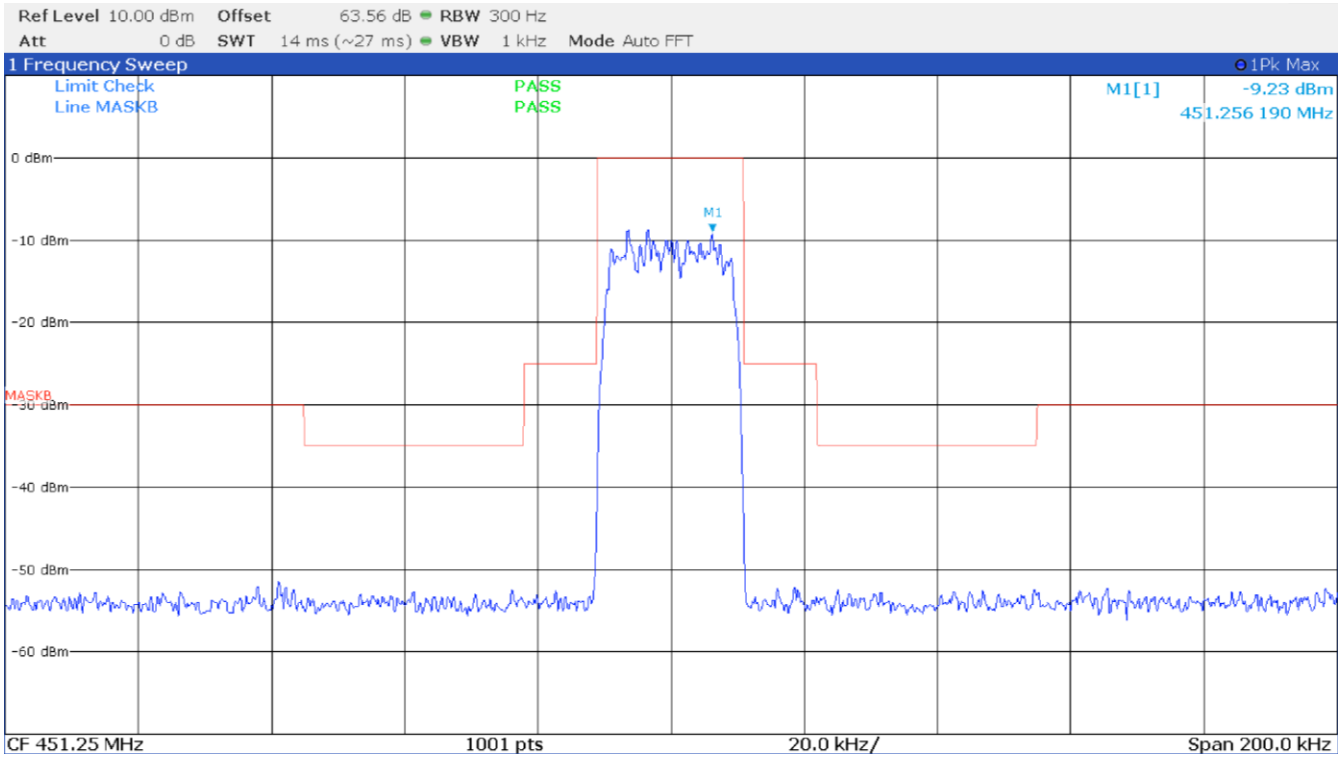


Figure 8.3-9: *Mask B, input signal at AGC threshold spectral plot – down link*

Test data, continued

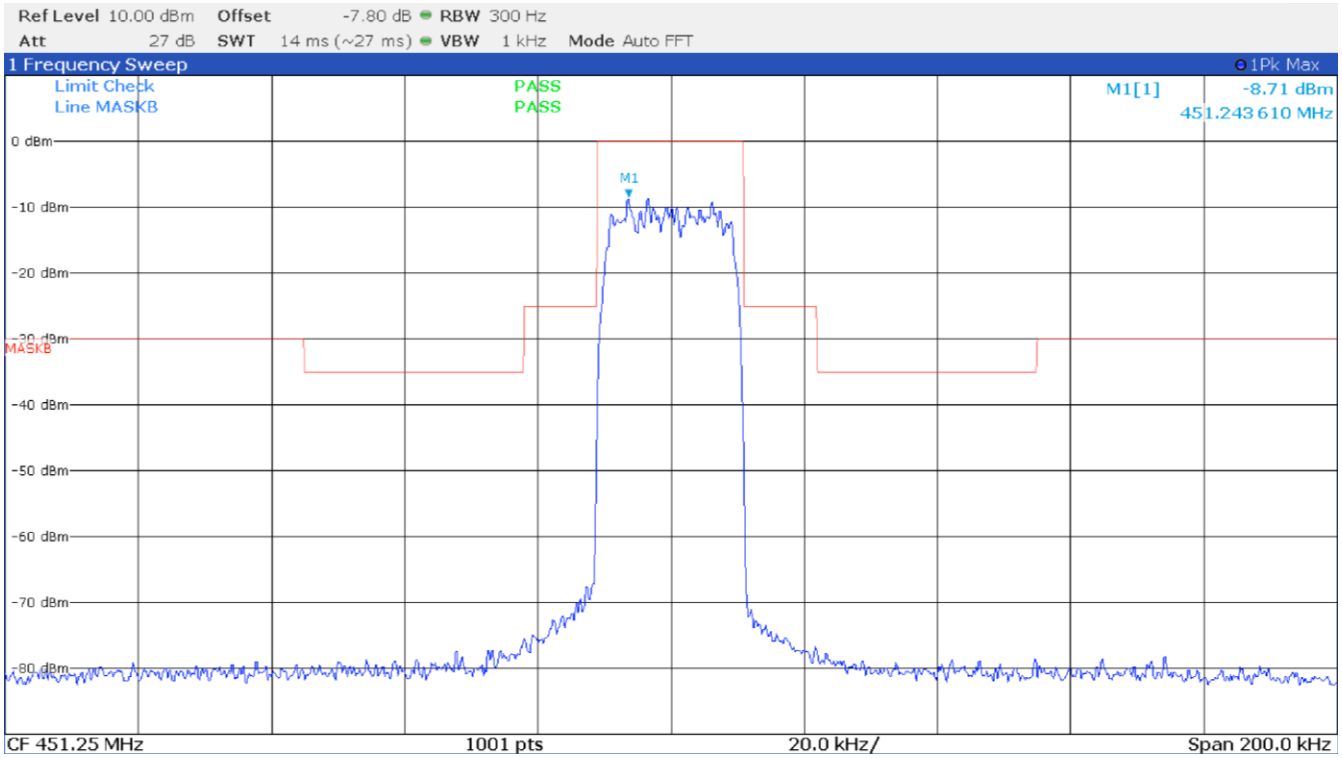


Figure 8.3-10: *Mask B, output signal at AGC threshold spectral plot – down link*

Test data, continued

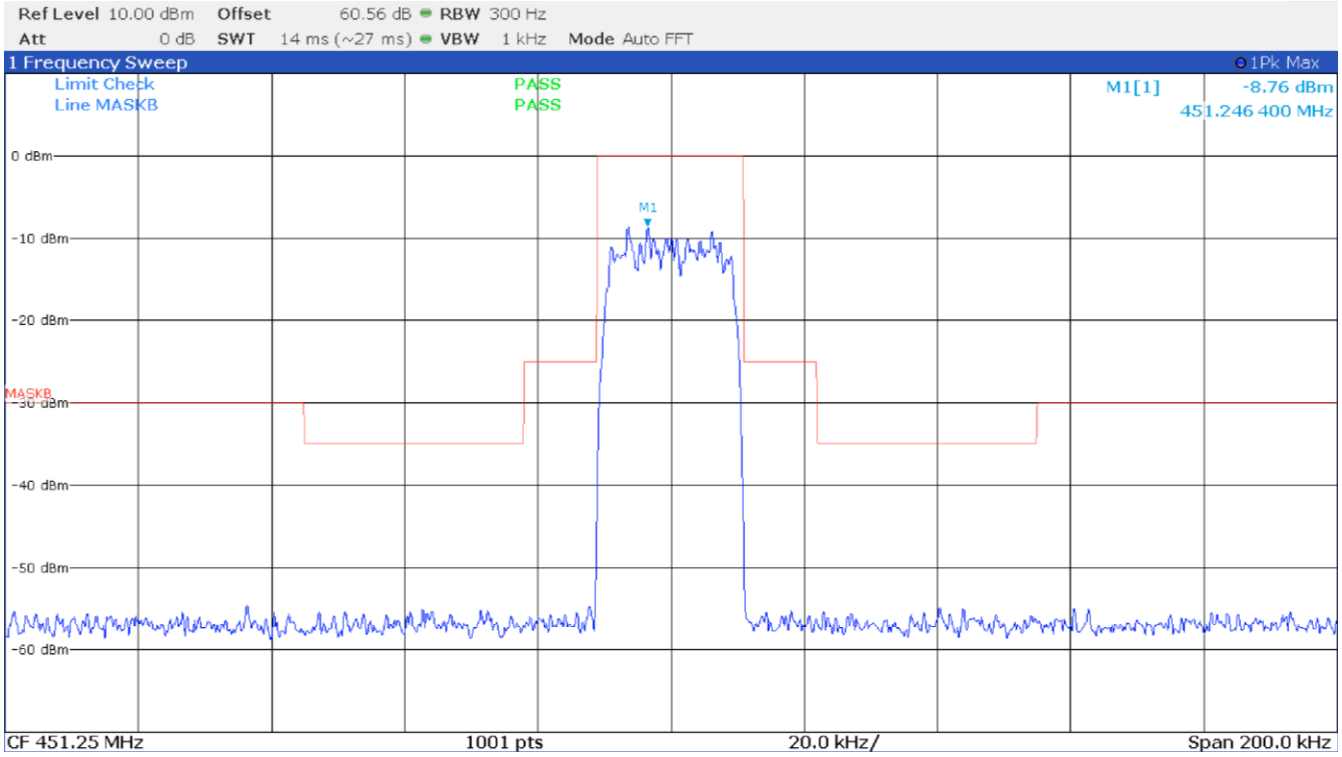


Figure 8.3-11: *Mask B, input signal at AGC threshold +3dB spectral plot – down link*

Test data, continued

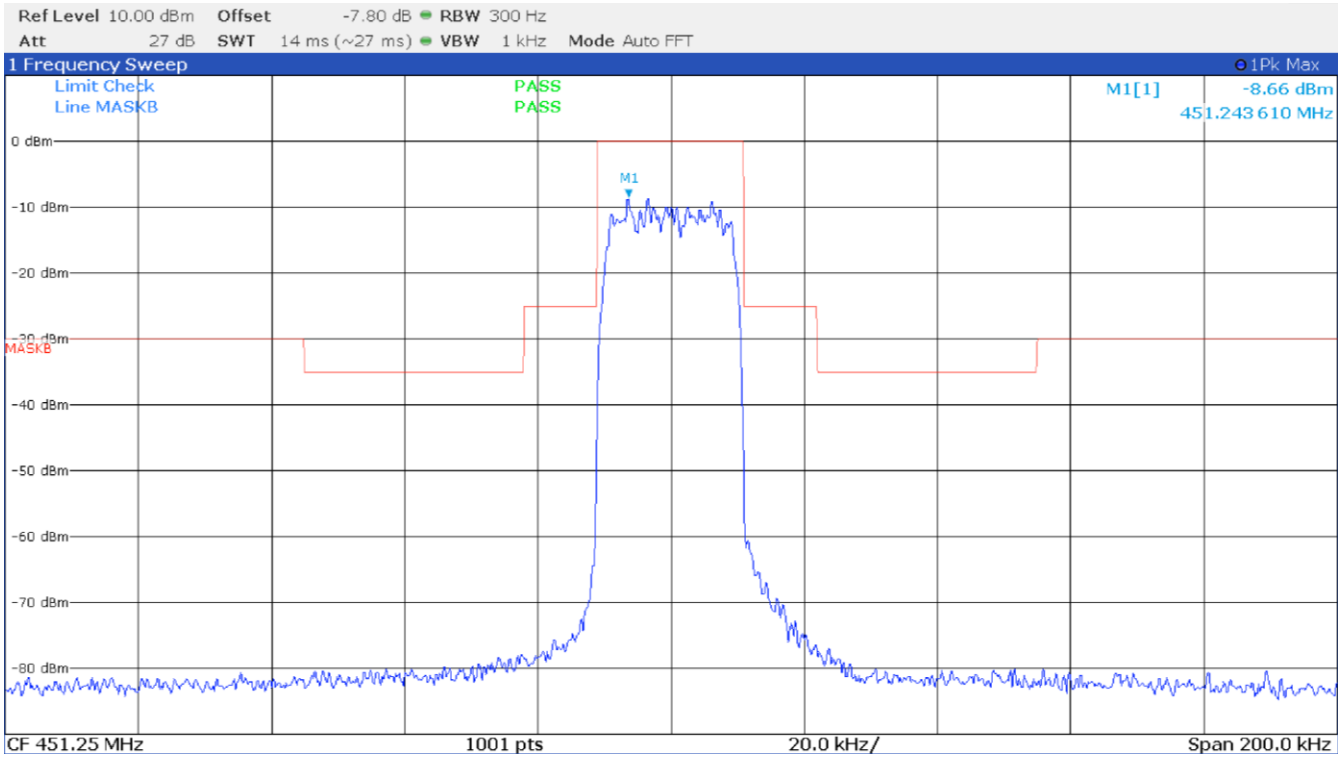


Figure 8.3-12: *Mask B, output signal at AGC threshold +3 dB spectral plot – down link*

Test data, continued

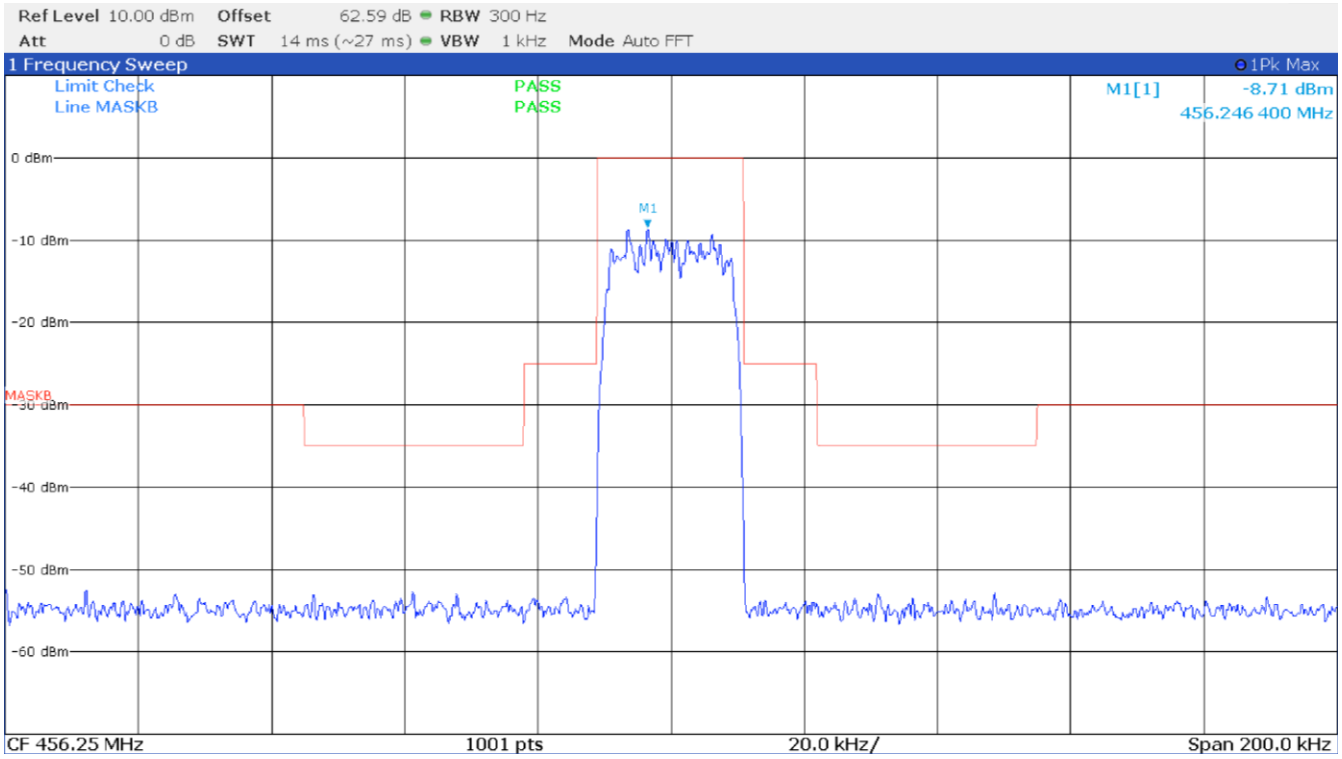


Figure 8.3-13: *Mask B, input signal at AGC threshold spectral plot – up link*

Test data, continued

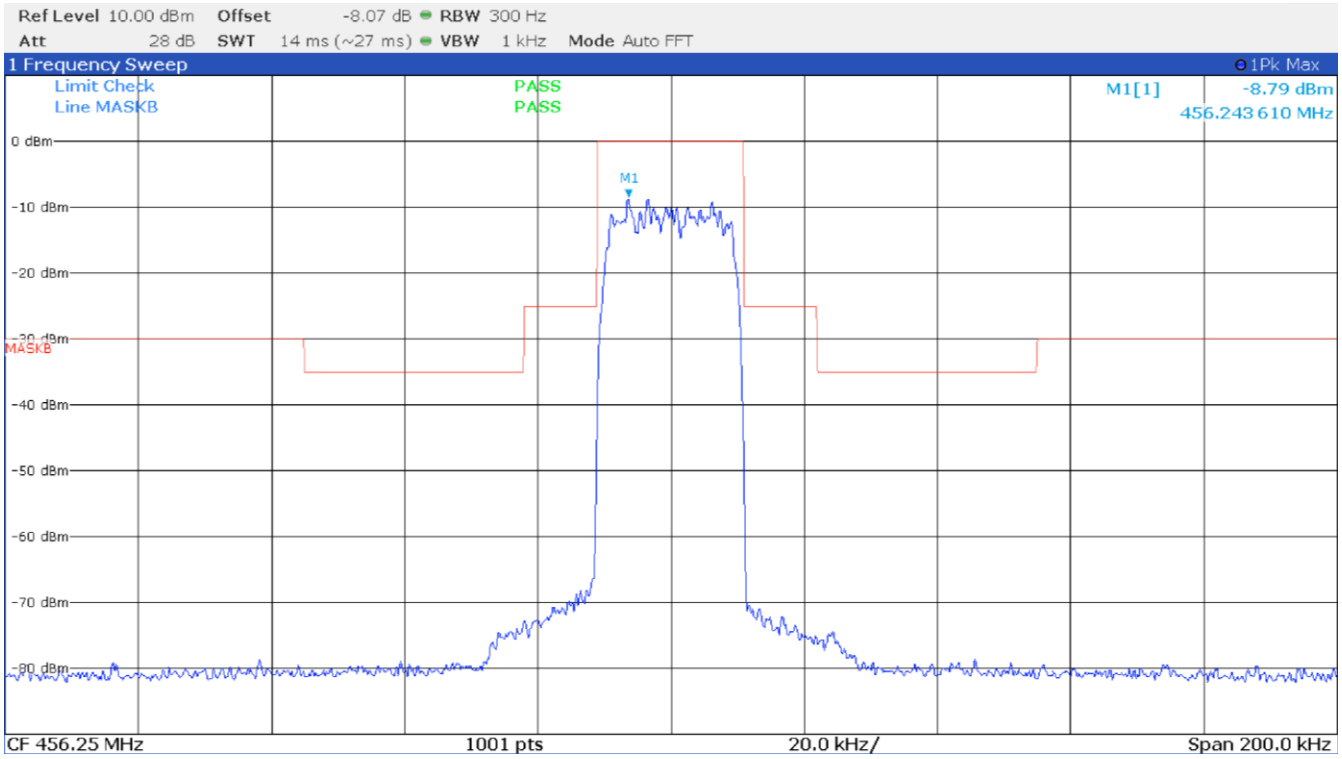


Figure 8.3-14: *Mask B, output signal at AGC threshold spectral plot – up link*

Test data, continued

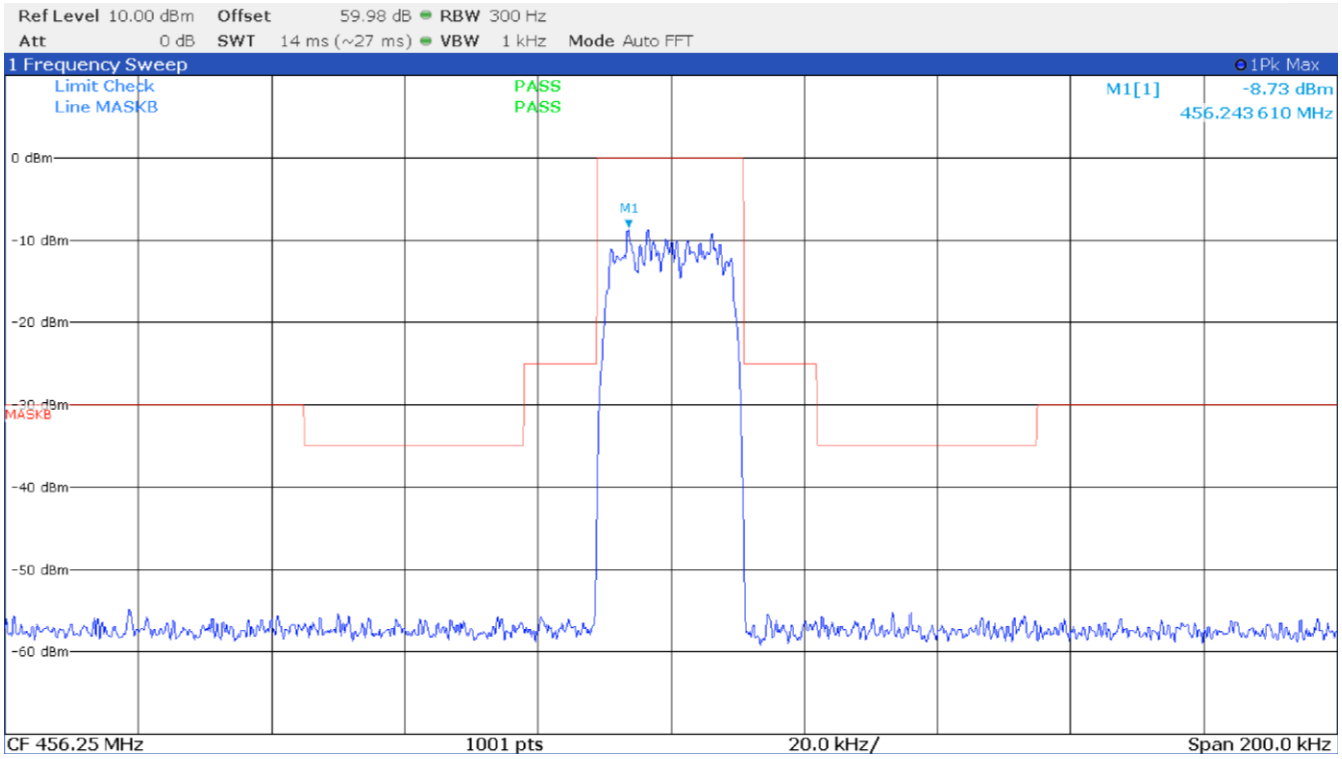


Figure 8.3-15: *Mask B, input signal at AGC threshold +3dB spectral plot – up link*

Test data, continued

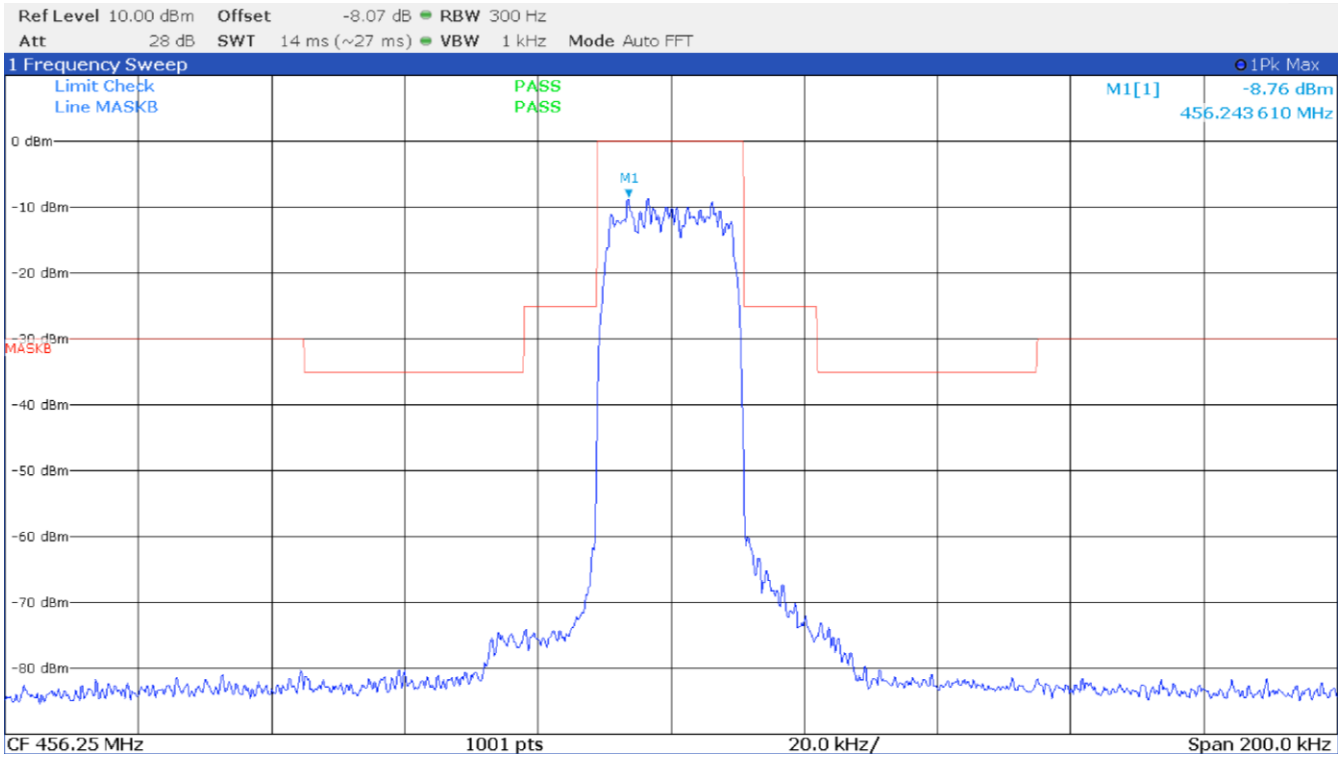
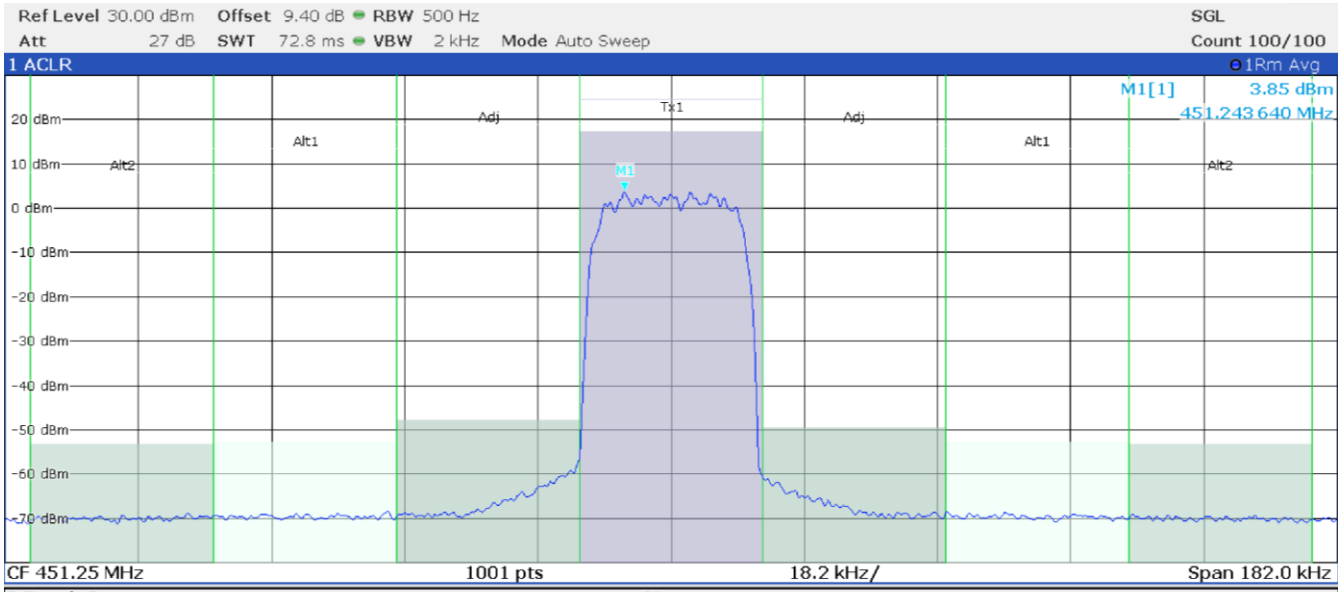


Figure 8.3-16: *Mask B, output signal at AGC threshold +3 dB spectral plot – up link*

Test data, continued

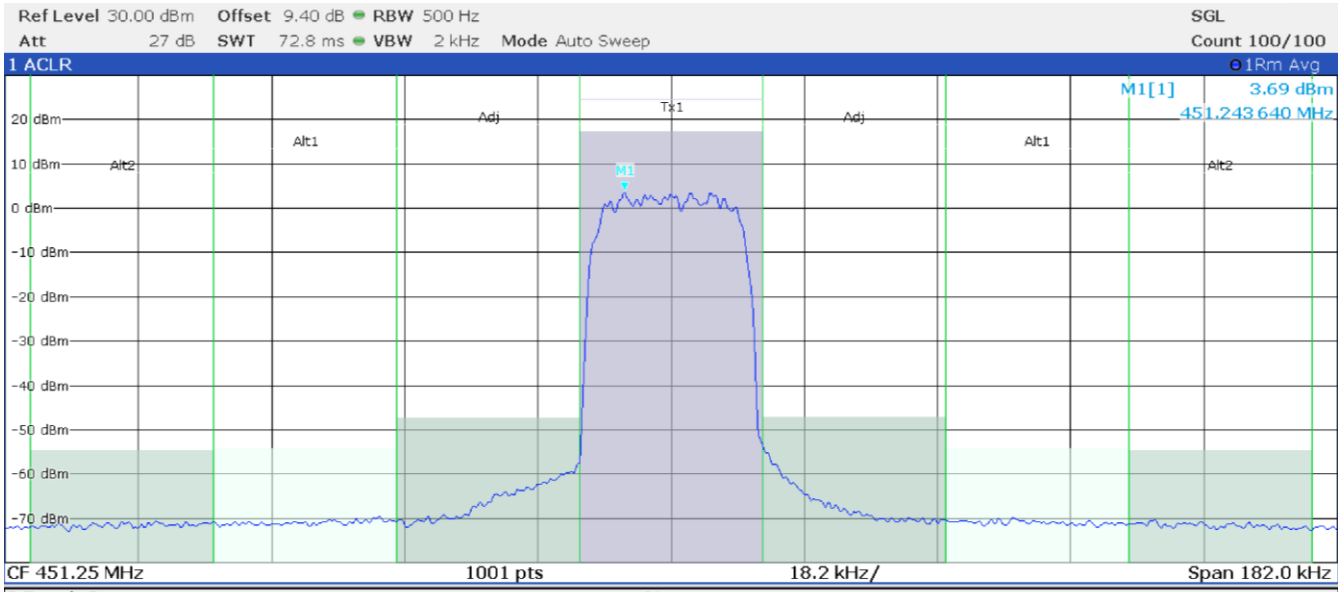


2 Result Summary — None

Channel	Bandwidth	Offset	Power	
Tx1 (Ref)	25.000 kHz		**17.27 dBm**	
Tx Total			**17.27 dBm**	
Channel	**Bandwidth**	**Offset**	**Lower**	**Upper**
Adj	25.000 kHz	25.000 kHz	**-65.15 dBc**	**-66.83 dBc**
Alt1	25.000 kHz	50.000 kHz	**-70.17 dBc**	**-70.18 dBc**
Alt2	25.000 kHz	75.000 kHz	**-70.52 dBc**	**-70.62 dBc**

Figure 8.3-17: *Adjacent channel power, output signal at AGC threshold spectral plot – down link*

Test data, continued

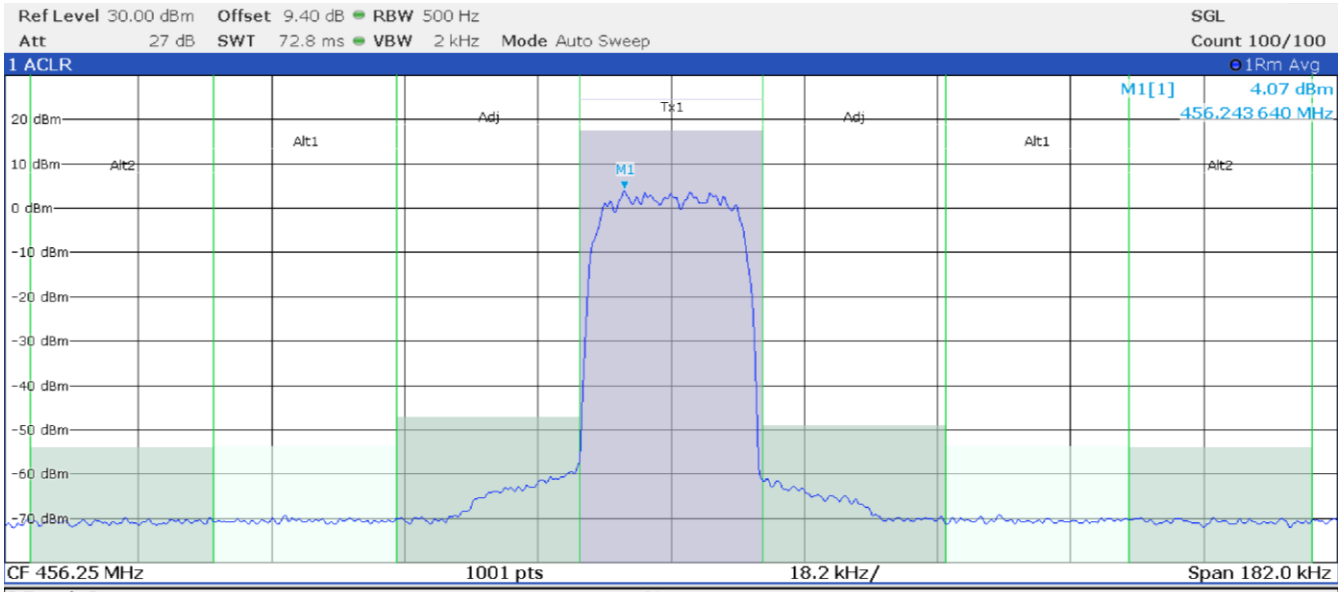


2 Result Summary — None

Channel	Bandwidth	Offset	Power	
Tx1 (Ref)	25.000 kHz		**17.27 dBm**	
Tx Total			**17.27 dBm**	
Channel	**Bandwidth**	**Offset**	**Lower**	**Upper**
Adj	25.000 kHz	25.000 kHz	**-64.77 dBc**	**-64.46 dBc**
Alt1	25.000 kHz	50.000 kHz	**-71.48 dBc**	**-71.48 dBc**
Alt2	25.000 kHz	75.000 kHz	**-72.08 dBc**	**-72.12 dBc**

Figure 8.3-18: *Adjacent channel power, output signal at AGC threshold +3 dB spectral plot – down link*

Test data, continued

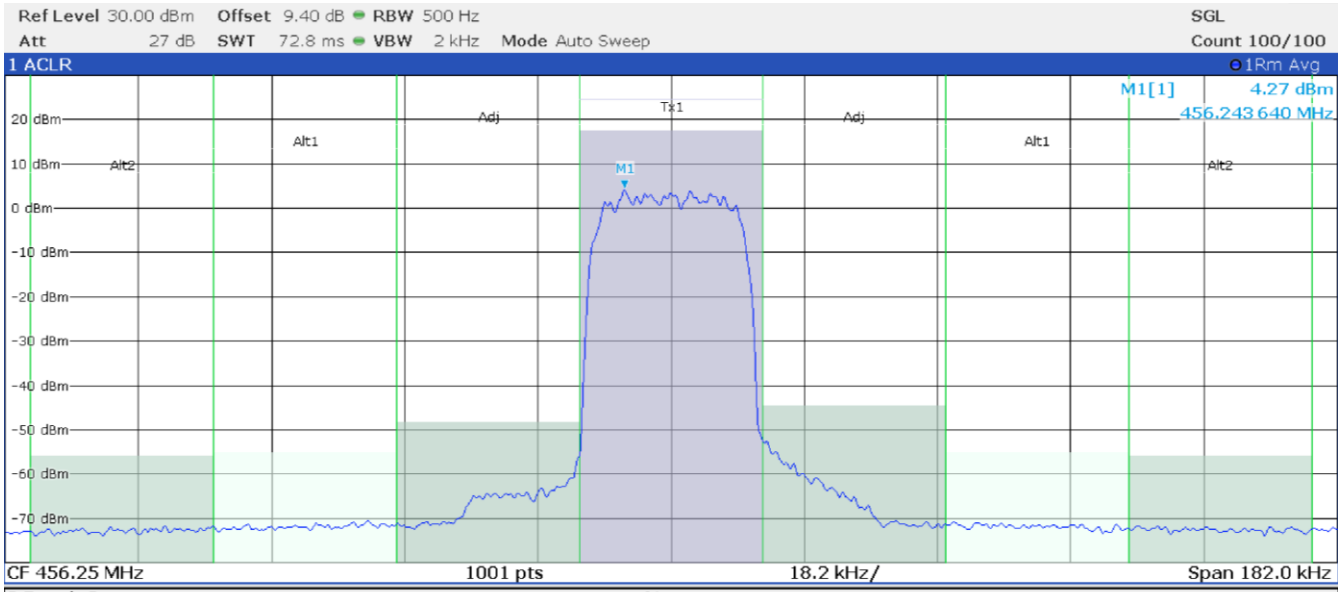


2 Result Summary — None

Channel	Bandwidth	Offset	Power	
Tx1 (Ref)	25.000 kHz		**17.46 dBm**	
Tx Total			**17.46 dBm**	
Channel	**Bandwidth**	**Offset**	**Lower**	**Upper**
Adj	25.000 kHz	25.000 kHz	**-64.64 dBc**	**-66.49 dBc**
Alt1	25.000 kHz	50.000 kHz	**-71.30 dBc**	**-71.21 dBc**
Alt2	25.000 kHz	75.000 kHz	**-71.56 dBc**	**-71.46 dBc**

Figure 8.3-19: *Adjacent channel power, output signal at AGC threshold spectral plot – up link*

Test data, continued



2 Result Summary — None

Channel	Bandwidth	Offset	Power	
Tx1 (Ref)	25.000 kHz		**17.51 dBm**	
Tx Total			**17.51 dBm**	
Channel	**Bandwidth**	**Offset**	**Lower**	**Upper**
Adj	25.000 kHz	25.000 kHz	**-65.81 dBc**	**-62.13 dBc**
Alt1	25.000 kHz	50.000 kHz	**-72.66 dBc**	**-72.62 dBc**
Alt2	25.000 kHz	75.000 kHz	**-73.54 dBc**	**-73.33 dBc**

Figure 8.3-20: *Adjacent channel power, output signal at AGC threshold +3 dB spectral plot – up link*

8.4 Mean output power and amplifier/booster gain

8.4.1 References, definitions and limits

FCC § 90.205(h)

(1) The maximum allowable station effective radiated power (ERP) is dependent upon the station's antenna HAAT and required service area and will be authorized in accordance with table 2. Applicants requesting an ERP in excess of that listed in table 2 must submit an engineering analysis based upon generally accepted engineering practices and standards that includes coverage contours to demonstrate that the requested station parameters will not produce coverage in excess of that which the applicant requires.

(2) Applications for stations where special circumstances exist that make it necessary to deviate from the ERP and antenna heights in Table 2 will be submitted to the frequency coordinator accompanied by a technical analysis, based upon generally accepted engineering practices and standards, that demonstrates that the requested station parameters will not produce a signal strength in excess of 39 dBu at any point along the edge of the requested service area. The coordinator may then recommend any ERP appropriate to meet this condition.

(3) An applicant for a station with a service area radius greater than 32 km (20 mi) must justify the requested service area radius, which may be authorized only in accordance with table 2, note 4. For base stations with service areas greater than 80 km, all operations 80 km or less from the base station will be on a primary basis and all operations outside of 80 km from the base station will be on a secondary basis and will be entitled to no protection from primary operations.

	Service area radius (km)									
	3	8	13	16	24	32	40[4]	48[4]	64[4]	80[4]
Maximum ERP (w)[1]	2	100	[2] 500	[2] 500	[2] 500	[2] 500	[2] 500	[2] 500	[2] 500	[2] 500
Up to reference HAAT (m)[3]	15	15	15	27	63	125	250	410	950	2700

[1] Maximum ERP indicated provides for a 39 dBu signal strength at the edge of the service area per FCC Report R-6602, Fig. 29 (See § 73.699, Fig. 10 b).

[2] Maximum ERP of 500 watts allowed. Signal strength at the service area contour may be less than 39 dBu.

[3] When the actual antenna HAAT is greater than the reference HAAT, the allowable ERP will be reduced in accordance with the following equation: $ERPallow = ERPmax \times (HAATref / HAATactual)^2$.

[4] Applications for this service area radius may be granted upon specific request with justification and must include a technical demonstration that the signal strength at the edge of the service area does not exceed 39 dBu.

FCC §90.219(e)

(1) 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.

8.4.2 Test summary

Verdict	Pass		
Tested by	P. Barbieri	Test date	July 5, 2022

8.4.3 Observations, settings and special notes

EUT input power set to a level that is just below the AGC threshold, but not more than 0.5 dB below.
Repeated the test with the input signal amplitude set to 3 dB above the AGC threshold.

Spectrum analyzer settings:

Resolution bandwidth	100 kHz
Video bandwidth	300 kHz
Detector mode	Peak
Trace mode	Max hold
Measurement time	Auto

Input signal frequency

Down link	451.25 MHz
Up link	456.25 MHz

8.4.4 Test equipment used

Equipment	Manufacturer	Model no.	Asset no.
Spectrum Analyzer	Rohde & Schwarz	FSW43	101767
RF Vector Signal Generator	Rohde & Schwarz	SMBV100A	263254

Notes: NCR - no calibration required, VOU - verify on use

8.4.5 Test data

Table 8.4-1: *Output power measurement results*

Antenna port	Input signal level	Frequency, MHz	RF input power, dBm	RF output power, dBm	RF output power, W	Gain, dB
Down link	AGC threshold	451.25	-53.5	17.3	0.054	70.8
Down link	AGC threshold +3 dB	451.25	-50.5	17.4	0.055	67.9
Up link	AGC threshold	456.25	-53.1	17.6	0.057	70.7
Up link	AGC threshold +3 dB	456.25	-50.1	17.6	0.057	67.7

Amplifier gain = measured RF output power (dBm) – measured RF input power (dBm)

Test data, continued

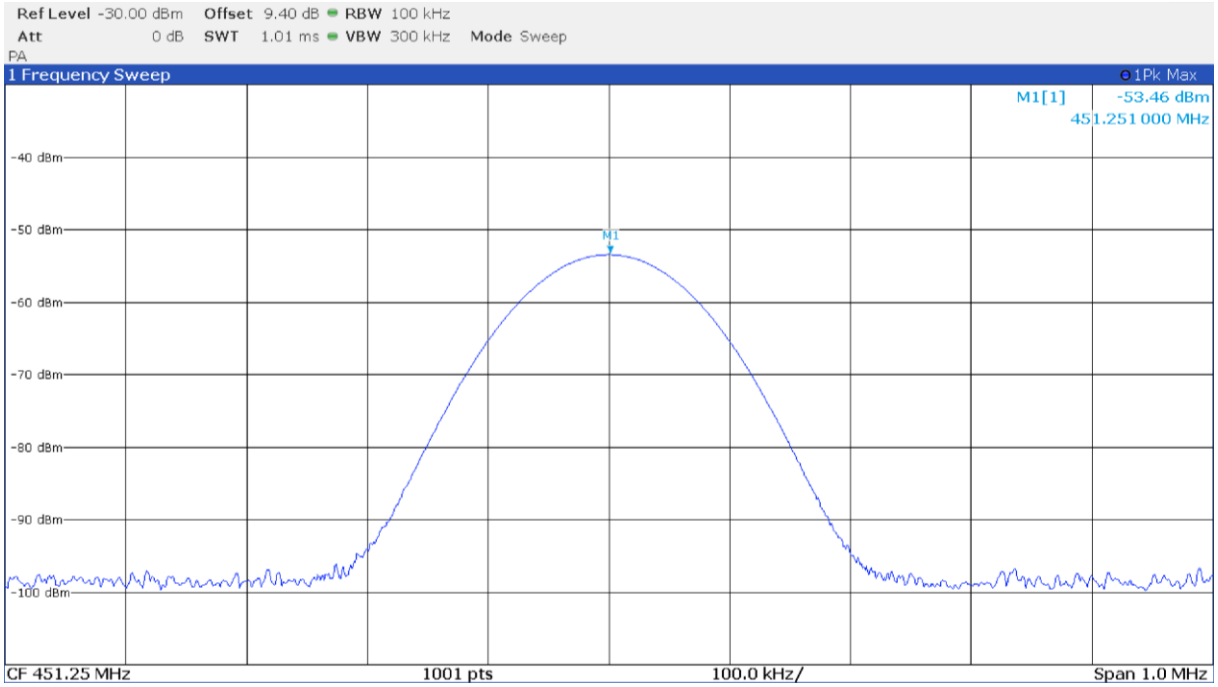


Figure 8.4-1: *Input power with input signal at AGC threshold – down link*

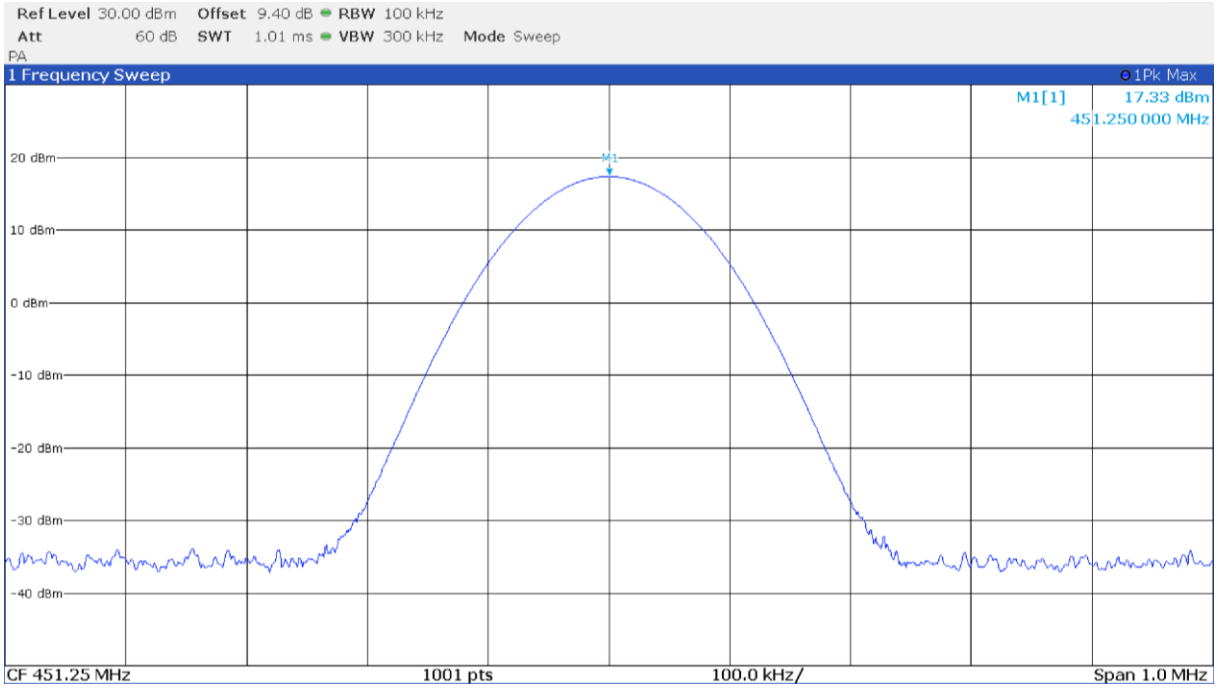


Figure 8.4-2: *Output power with input signal at AGC threshold – down link*

Test data, continued

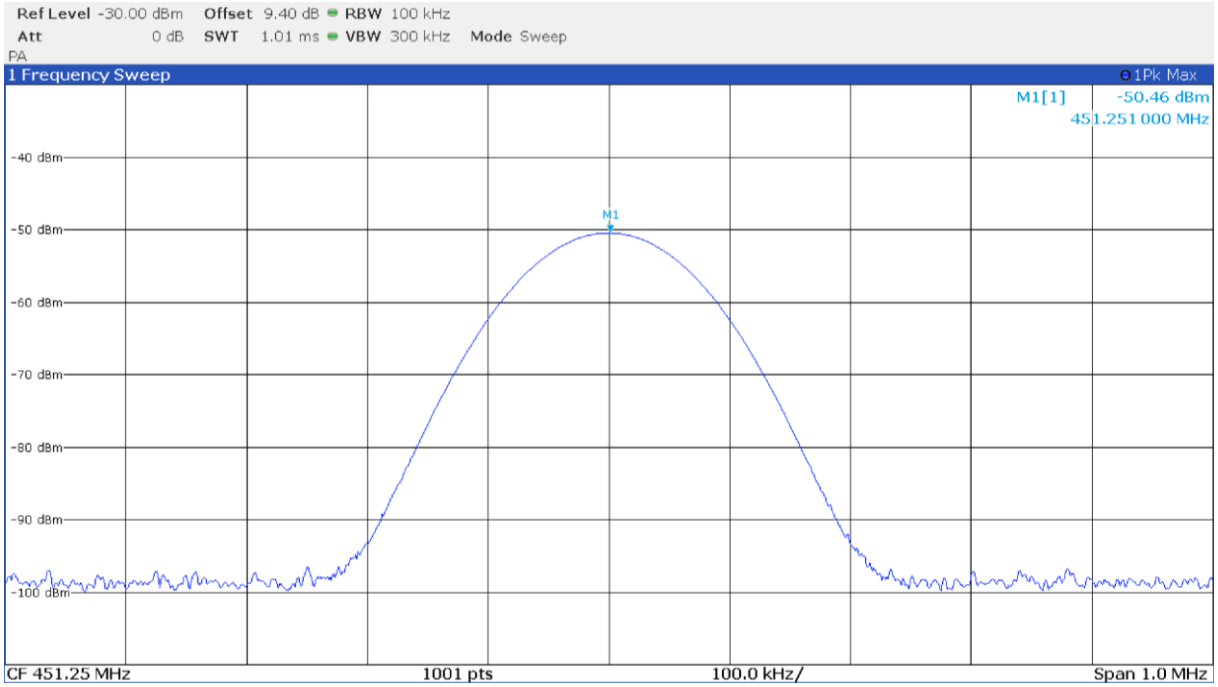


Figure 8.4-3: *Input power with input signal at AGC threshold +3 dB – down link*

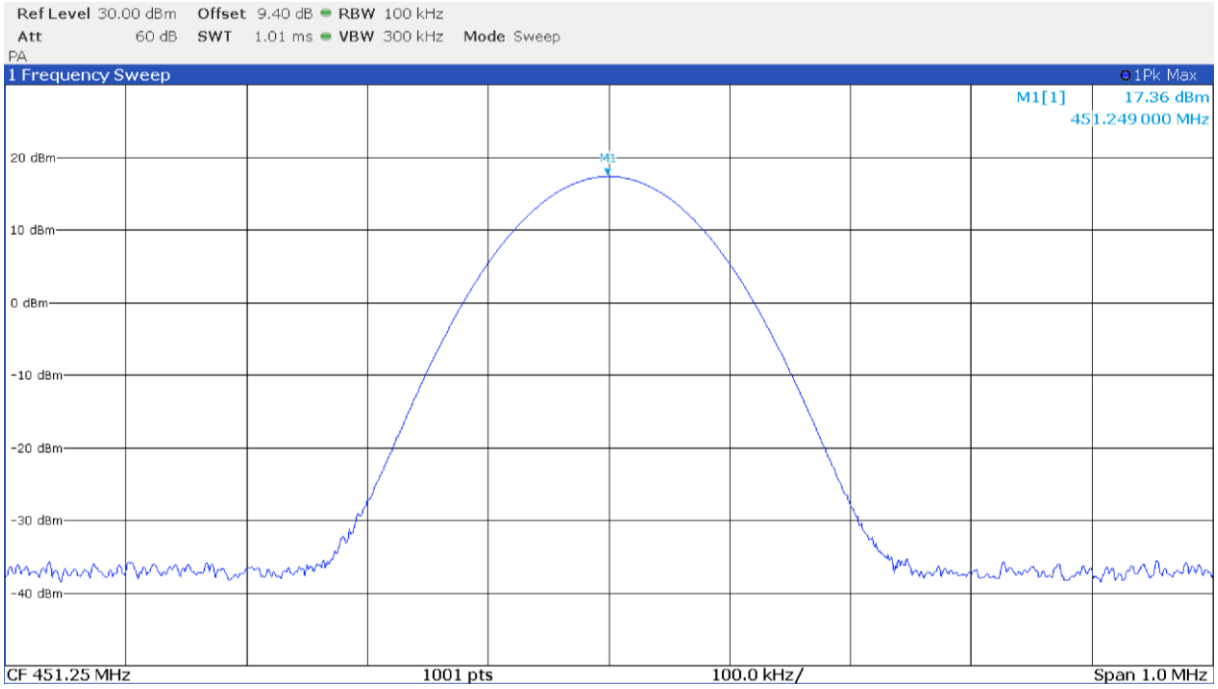


Figure 8.4-4: *Output power with input signal at AGC threshold +3 dB – down link*

Test data, continued

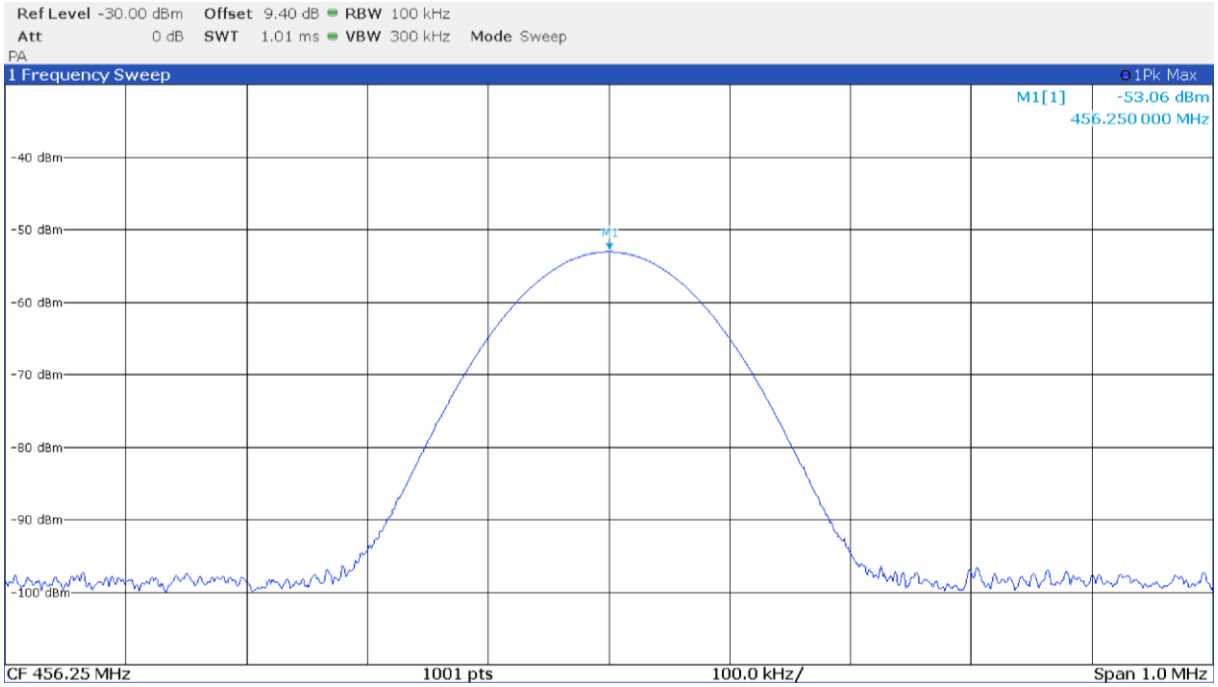


Figure 8.4-5: *Input power with input signal at AGC threshold – up link*

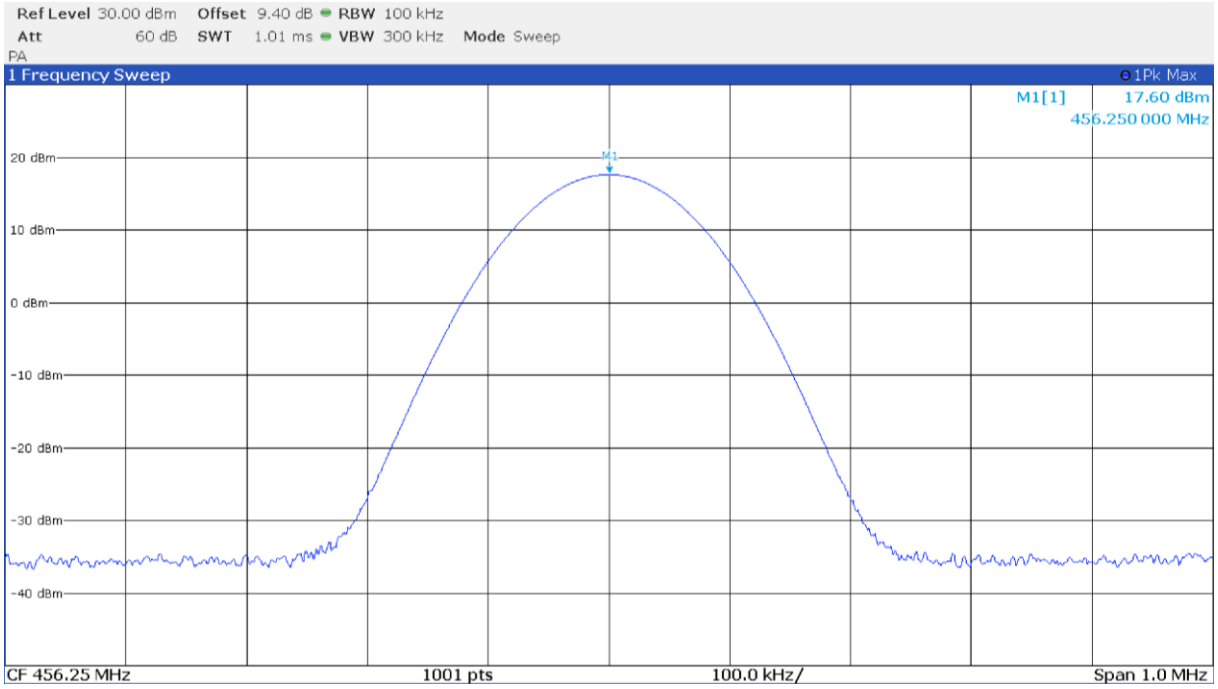


Figure 8.4-6: *Output power with input signal at AGC threshold – up link*

Test data, continued

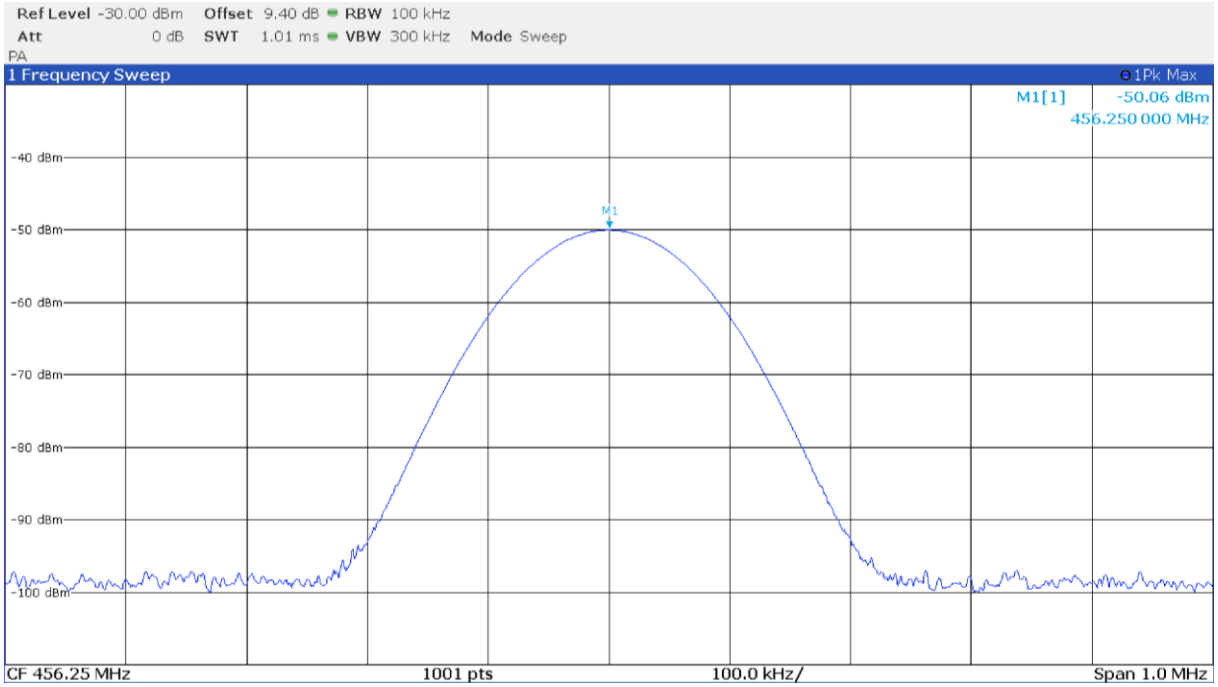


Figure 8.4-7: *Input power with input signal at AGC threshold +3 dB – up link*

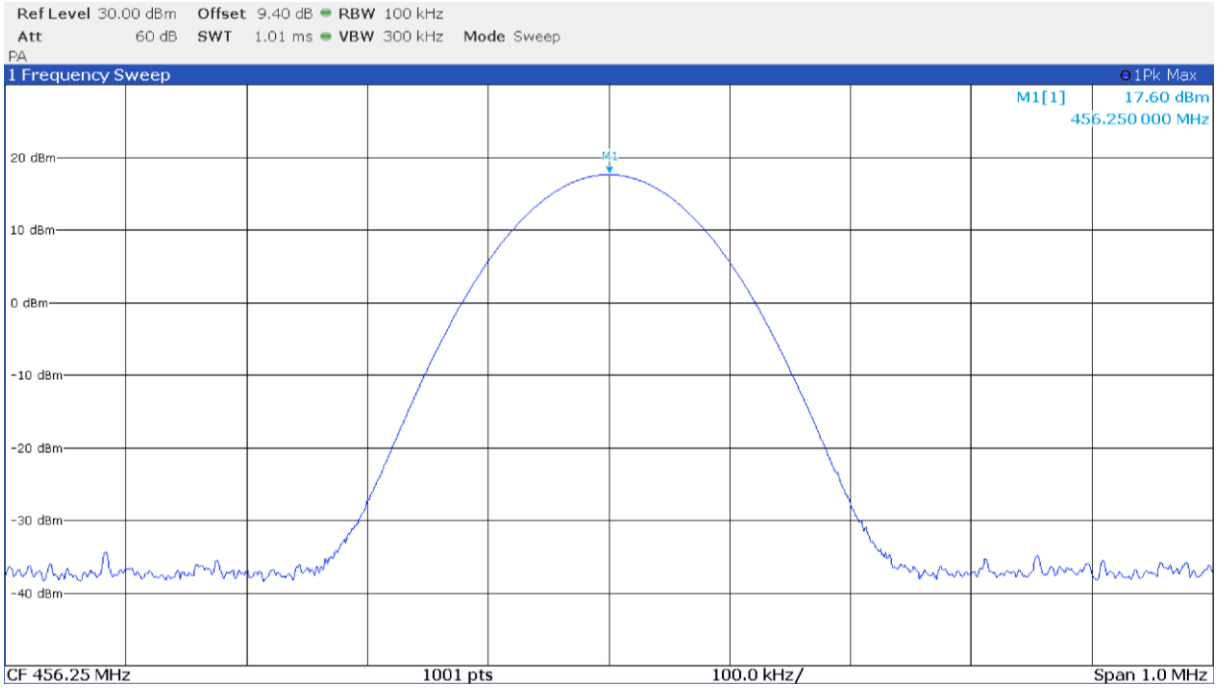


Figure 8.4-8: *Output power with input signal at AGC threshold +3 dB – up link*

8.5 Out-of-band/out-of-block emissions conducted measurements

8.5.1 References, definitions and limits

FCC §90.219(e)

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

8.5.2 Test summary

Verdict	Pass		
Tested by	P. Barbieri	Test date	July 6, 2022

8.5.3 Observations, settings and special notes

EUT input power set to a level that is just below the AGC threshold, but not more than 0.5 dB below.
Repeated the test with the input signal amplitude set to 3 dB above the AGC threshold.
Test performed with two CW carriers set at ±12.5 kHz from the centre frequency.

Spectrum analyser settings for spurious emissions in the 1 MHz bands immediately outside and adjacent to the licensee's frequency block:

Resolution bandwidth:	300 Hz
Video bandwidth:	≥ 3 × RBW
Span:	100 kHz
Detector mode:	RMS
Trace mode:	Average (power)0

Input signal frequency

Down link intermodulation products:	451.25 MHz – 12.5 kHz and 451.25 MHz + 12.5 kHz
Up lin intermodulation products:	456.25 MHz – 12.5 kHz and 456.25 MHz + 12.5 kHz

8.5.4 Test equipment used

Equipment	Manufacturer	Model no.	Asset no.
Spectrum Analyzer	Rohde & Schwarz	FSW43	101767
RF Vector Signal Generator	Rohde & Schwarz	SMBV100A	263254

Notes: NCR - no calibration required, VOU - verify on use

8.5.5 Test data

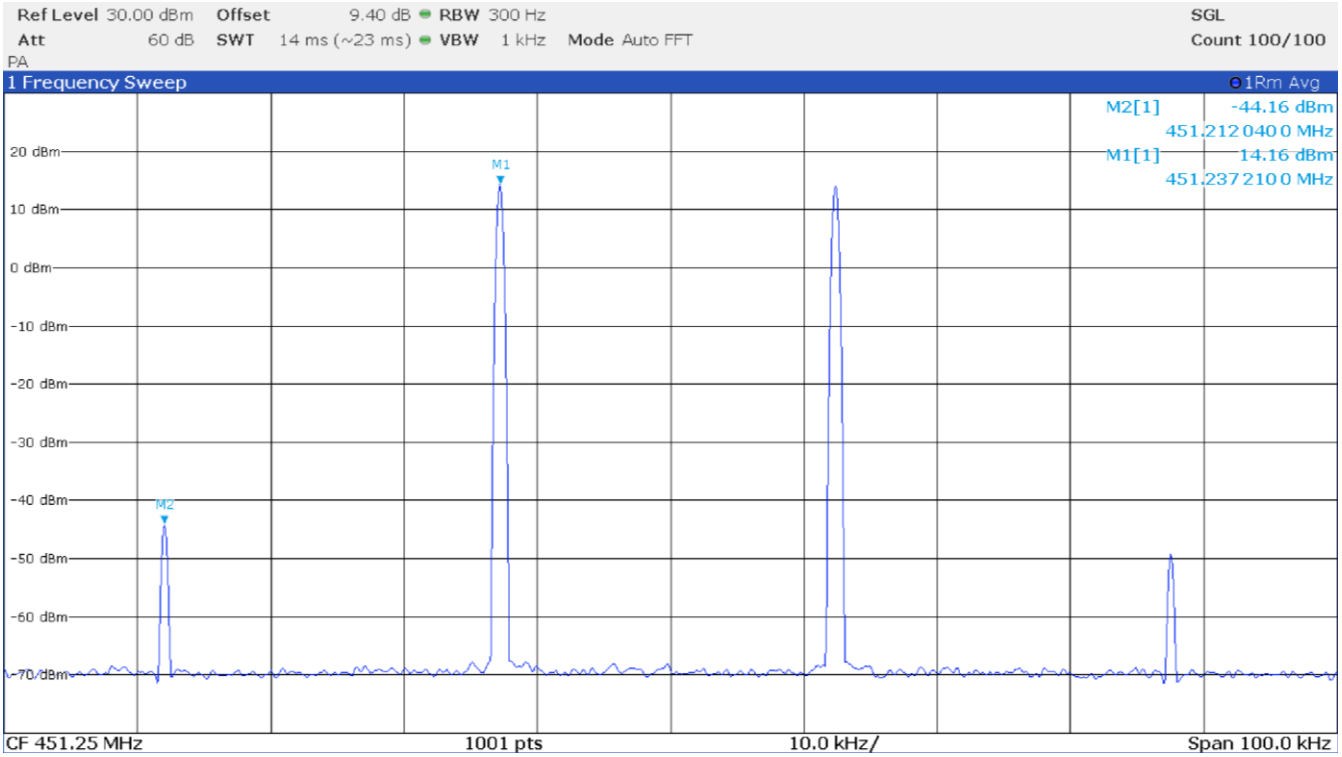


Figure 8.5-1: *Down link intermodulation products with input signal at AGC threshold*