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Parque Tecnológico de Andalucía,
c/ Severo Ochoa nº 2 · 29590 Campanillas · Málaga · España
C.I.F. A29 507 456

FCC LISTED,
REGISTRATION NUMBER:
720267

ISED LISTED
REGISTRATION NUMBER
4621A-2

Test report No:
NIE: 54008RRF.002

Test report
USA FCC Part 22

Identification of item tested	RF Transceiver / Mast-mounted Base Station
Trademark	PowerTrunk
Model and /or type reference	MBS Unit -1
Other identification of the product	D148101PT FCC ID: WT7PTMBS450B IC: 8624A-PTMBS450B
Features	<u>Power Supply:</u> MBS Unit -1 with DC power supply: - Nominal voltage: 24 VDC - Operational voltage range: [21.6 - 31.2 VDC] MBS Unit -1 with AC power supply: - Nominal voltage: 110/220 VAC. 50/60 Hz - Operational voltage range: [90 - 264 VAC] <u>Frequency band:</u> TX: 425-430 MHz, 450-470 MHz RX: 425-430 MHz, 450-470 MHz <u>Modulation scheme:</u> TETRA TI D-LMR <u>RF output power (nominal):</u> TETRA: 40 dBm (10 W) TI D-LMR: 40 dBm (10 W) See full details on pages 6 and 7
Applicant	TELTRONIC S.A.U. Polígono Malpica, C/F Oeste, 50016 Zaragoza, SPAIN
Test method requested, standard	USA FCC Part 22 10-01-17 Edition ANSI C63.26-2015
Summary	IN COMPLIANCE

Approved by (name / position & signature)	A. Llamas RF Lab. Manager Firmado digitalmente por ALEJANDRO LLAMAS RODRIGUEZ Fecha: 2019.01.14 10:20:01 +01'00'
Date of issue	2019-01-14
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Index

Competences and guarantees 4
General conditions 4
Uncertainty 4
Data provided by the client 4
Usage of samples 5
Test sample description 5
Identification of the client 7
Testing period and place 8
Document history 8
Environmental conditions 8
Remarks and comments 9
Testing verdicts 10
Summary 10
Appendix A: Test results 11

Competences and guarantees

DEKRA Testing and Certification is a testing laboratory accredited by the National Accreditation Body (ENAC - Entidad Nacional de Acreditación), to perform the tests indicated in the Certificate No. 51/LE 147.

DEKRA Testing and Certification is a laboratory with a measurement facility in compliance with the requirements of Section 2.948 of the FCC rules and has been added to the list of facilities whose measurements data will be accepted in conjuction with applications for Certification under Parts 15 or 18 of the Commission's Rules. Registration Number: 720267.

DEKRA Testing and Certification is a laboratory with a measurement site in compliance with the requirements of RSS 212, Issue 1 (Provisional) and has been added to the list of filed sites of the Canadian Certification and Engineering Bureau. Reference File Number: ISED 4621A-2.

In order to assure the traceability to other national and international laboratories, DEKRA Testing and Certification has a calibration and maintenance program for its measurement equipment.

DEKRA Testing and Certification guarantees the reliability of the data presented in this report, which is the result of the measurements and the tests performed to the item under test on the date and under the conditions stated on the report and, it is based on the knowledge and technical facilities available at DEKRA Testing and Certification at the time of performance of the test.

DEKRA Testing and Certification is liable to the client for the maintenance of the confidentiality of all information related to the item under test and the results of the test.

The results presented in this Test Report apply only to the particular item under test established in this document.

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General conditions

1. This report is only referred to the item that has undergone the test.
2. This report does not constitute or imply on its own an approval of the product by the Certification Bodies or competent Authorities.
3. This document is only valid if complete; no partial reproduction can be made without previous written permission of DEKRA Testing and Certification.
4. This test report cannot be used partially or in full for publicity and/or promotional purposes without previous written permission of DEKRA Testing and Certification and the Accreditation Bodies.

Uncertainty

Uncertainty (factor k=2) was calculated according to the DEKRA Testing and Certification internal document PODT000.

Data provided by the client

The test sample consists of a TETRA and TI D-LMR single-carrier module (digital RF transceiver) that has been designed for indoor or outdoor installation in different locations such as walls, towers or masts. Up to two MBS Units can be interconnected to deploy a full-featured Mast-mounted Base Station (MBS). It can be either DC or AC power-supplied. The MBS Unit -1 operates and provides an RF output power of 10 W in the frequency bands 425-430 MHz and 450-470 MHz. Only TI D-LMR modulation is under the scope of this test report, as the FCC Part 22 rule limits the authorized channel bandwidth to 20 KHz.

DEKRA declines any responsibility with respect to the information provided by the client and that may affect the validity of results.

Usage of samples

Samples undergoing test have been selected by: the client.

Sample S/01 is composed of the following elements:

Control Nº	Description	Model	Serial Nº	Date of reception
54008C/001	Base Station with AC power supply	MBS Unit -1	918439	2017-10-02
54008C/002	Base Station with DC power supply	MBS Unit -1	915849	2017-10-02
54008C/003	Ethernet cable	208595	---	2017-10-02
54008C/004	POE/ETH cable with 100 ohm Ethernet termination	208595	---	2017-10-02
54008C/005	POE cable with 100 ohm Ethernet termination	208595	---	2017-10-02
54008C/006	SYNC cable	---	---	2017-10-02
54008C/007	DIV cable	---	---	2017-10-02
54008C/008	Power cable AC	225122	---	2017-10-02
54008C/012	Power cable DC	225124	---	2018-06-27
54008C/010	Cavity duplexer Tx band: 450-455 MHz	P/N: ICBA462F452F462S5D80TS	1744#0001	2018-06-20
54008C/011	Cavity duplexer Tx band: 455-460 MHz	P/N: ICBA467F457F467S5D80TS	1815#0001	2018-06-20

1. Sample S/01 has undergone the test(s).

   All tests indicated in appendix A.

Test sample description

Ports……:	Port name and description	
	Ethernet ports	IEEE 802.3u,x. PoE and PoE/Eth
	Synchronism ports	SYNC IN and SYNC OUT
	Rx diversity ports	DIV IN and DIV OUT. Not required for testing
	Tx/Rx antenna port	ANT. RF input/output
	Output power supply port	POWER OUT. Not required for testing
	Power supply port	POWER IN. AC or DC depending on the supply option
Rated power supply .....:	Voltage and Frequency	
	☒	AC: Nominal voltage: 110/220 VAC. 50/60 Hz. Operational voltage range: [90 - 264 VAC]
	☒	DC: Nominal voltage: 24 VDC. Operational voltage range: [21.6 - 31.2 VDC]
Software version .....:	CCP: 00.11.12.10	
Hardware version .....:	CCP: 00.11.12.10	

Dimensions in cm (L x W x D).....:	680 mm x 370 mm x 278 mm	
Mounting position .....:	☐	Table top equipment
	☒	Wall/Ceiling mounted equipment
	☐	Floor standing equipment
	☐	Hand-held equipment
	☒	Other: Mast-mounted Base Station
Features supported .....:	Power Supply: MBS Unit -1 with DC power supply: - Nominal voltage: 24 VDC - Operational voltage range: [21.6 - 31.2 VDC] MBS Unit -1 with AC power supply: - Nominal voltage: 110/220 VAC. 50/60 Hz - Operational voltage range: [90 - 264 VAC] Access scheme: TDMA with 4 physical channels (time slots) per RF channel. Modulation scheme: π/4-DQPSK with a modulation rate of 18 Ksym/s, equivalent to 36 Kbits/s. Based upon it, two digital communication systems are supported: ○ TETRA: Modulation low-pass filter: Square-root raised cosine filter with a roll-off factor of 0.35. ○ TI D-LMR: Modulation low-pass filter: Square-root raised cosine filter with a roll-off factor of 0.2. RF channel bandwidth (channel spacing): 25 KHz Spectral efficiency: One voice & data physical channel with a rate of 9 Kbits/s is allocated a 6.25 KHz equivalent channel bandwidth. Frequency band: TX: 425-430 MHz, 450-470 MHz RX: 425-430 MHz, 450-470 MHz RF output power (nominal): TETRA: 40 dBm (10 W) TI D-LMR: 40 dBm (10 W) RF authorized bandwidth: TETRA: 22 KHz TI D-LMR: 20 KHz Emission designators: TETRA: 22K0D7D, 22K0D7E, 22K0D7W TI D-LMR: 20K0D7D, 20K0D7E, 20K0D7W Additional features: Audio low-pass filter (root-raised cosine filter).	

Features supported (cont.) ..... :

Options:

EQUIPMENT	CODE+OPTIONS	SERIAL NUMBER
MBS Unit -1 VAC	D148101PT O148017PT O148015PT O148032PT O148016PT O148057PT O485002PT	918439
MBS Unit -1 VDC	D148101PT O148018PT O148015PT O148032PT O148016PT O148057PT O485002PT	915849

D148101PT - MBS 425-470 MHz POWERTRUNK-T

O148017PT - VAC OPTION (power supply: 220/110 VAC)

O148018PT - VDC OPTION (power supply: 24 VDC)

O148015PT - SUBBAND MBS TX450-RX460-BW5 OPTION

O148032PT - SUBBAND MBS TX453-RX459-BW2 OPTION

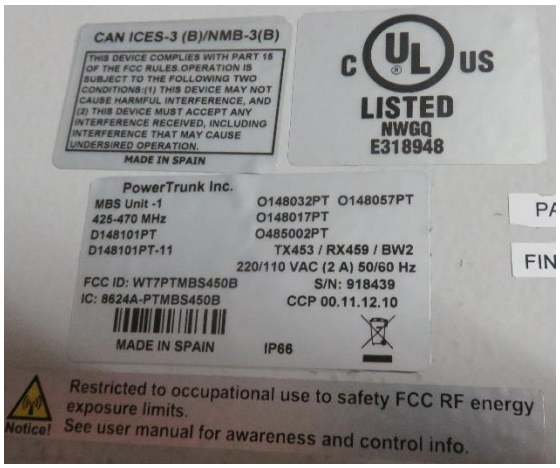
O148016PT - SUBBAND MBS TX455-RX465-BW5 OPTION

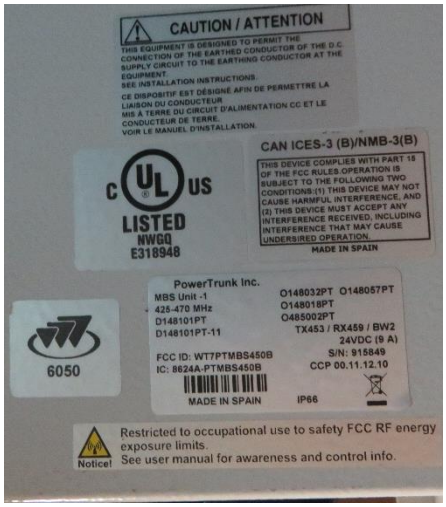
O148057PT - LITE OPTION

O485002PT - TETRA CARRIER AIR INTERFACE ENCRYPTION OPTION

Note: Three subband options have been considered to cover all test frequencies being required by FCC Part 22, but only one of them can be chosen for a single MBS Unit to operate in a real in-field application.

Copy of marking plate:





Identification of the client

TELTRONIC S.A.U.

Polígono Malpica, C/F Oeste, 50016 Zaragoza, SPAIN

Testing period and place

Test Location	DEKRA Testing and Certification S.A.U.
Date (start)	2018-09-14
Date (finish)	2018-09-27

Document history

Report number	Date	Description
54008RRF.002	2019-01-14	First release

Environmental conditions

In the control chamber, the following limits were not exceeded during the test:

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 20 % Max. = 75 %
Shielding effectiveness	> 100 dB
Electric insulation	> 10 kΩ
Reference resistance to earth	< 1 Ω

In the semianechoic chamber, the following limits were not exceeded during the test.

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 20 % Max. = 75 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar
Shielding effectiveness	> 100 dB
Electric insulation	> 10 kΩ
Reference resistance to earth	< 1 Ω
Normal site attenuation (NSA)	< ±4 dB at 10 m distance between item under test and receiver antenna, (30 MHz to 1000 MHz)
Field homogeneity	More than 75% of illuminated surface is between 0 and 6 dB (26 MHz to 1000 MHz).

In the chamber for conducted measurements, the following limits were not exceeded during the test:

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 20 % Max. = 75 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar
Shielding effectiveness	> 100 dB
Electric insulation	> 10 kΩ
Reference resistance to earth	< 1 Ω

Remarks and comments

The tests have been performed by the technical personnel: Jose Alberto Aranda, Ignacio Cabra and Carolina Postigo.

Used instrumentation:

Conducted Measurements

		Last Cal. date	Cal. due date
1.	Climatic chamber CTS C-70/600	2018/07	2019/07
2.	DC power supply AGILENT TECHNOLOGIES N5770A	---	---
3.	Digital multimeter FLUKE 113	2017/05	2019/05
4.	Power sensor R&S NRP-Z81	2017/04	2019/04
5.	Spectrum analyser R&S FSV40	2017/07	2019/07
6.	Radiocommunication analyzer HP 8920A	2017/04	2019/04
7.	Spectrum analyser Agilent E4440A	2017/10	2019/10
8.	AC power supply ELGAR CS-AC35(351SL)	2016/05	2019/05

Radiated Measurements

		Last Cal. date	Cal. due date
1.	Semianechoic Absorber Lined Chamber ETS FACT3 200STP	N.A.	N.A.
2.	BiconicalLog antenna ETS LINDGREN 3142E	2017/04	2020/04
3.	Multi Device Controller EMCO 2090	N.A.	N.A.
4.	Double-ridge Guide Horn antenna 1-18 GHz SCHWARZBECK BBHA 9120 D	2016/11	2019/11
5.	Spectrum analyser Rohde & Schwarz FSW50	2018/02	2020/02
6.	EMI Test Receiver R&S ESU 26	2018/02	2020/02
7.	RF pre-amplifier 30 MHz-6 GHz BONN ELEKTRONIK BLNA 0360-01N	2018/07	2019/07
8.	RF pre-amplifier 1-18 GHz BONN ELEKTRONIK BLMA 0118-1M	2018/03	2019/03
9.	DC power supply Rohde & Schwarz NGPE 40/40	2018/02	2021/02

Testing verdicts

Not applicable :	N/A
Pass :	P
Fail :	F
Not measured :	N/M

Summary

FCC PART 22 Requirement – Test case	Verdict	Remark
Clause 2.1047, 90.207. Modulation characteristics	N/M	(1)
Clause 2.1046 and 22.565, 22.727, 22.809: RF output power	P	
Clause 2.1055, 22.355 and 22.863: Frequency stability	P	
Clause 2.1049 and 22.863: Occupied Bandwidth	P	
Clause 22.357, 22.359, 22.731, 22.861: Spurious emissions at antenna terminals	P	
Clause 22.357, 22.359, 22.731, 22.861: Band-edge emissions compliance	P	
Clause 22.357, 22.359, 22.731, 22.861: Radiated emissions	P	
Supplementary information and remarks: (1): This information has been provided by the applicant.		

Appendix A: Test results

INDEX

TEST CONDITIONS 13
Modulation Characteristics 14
RF Output Power (conducted) 16
Occupied Bandwidth 18
Frequency Stability 22
Spurious emissions at antenna terminals 25
Band-edge emissions compliance (Transmitter) 30
Radiated emissions 34

TEST CONDITIONS

Power supply (V):

AC voltage	DC voltage
V_{nom} = 110.0 Vac	V_{nom} = 24.0 Vdc
V_{max} = 126.5 Vac	V_{max} = 31.2 Vdc
V_{min} = 93.5 Vac	V_{min} = 20.4 Vdc

The subscripts nom, min and max indicate voltage test conditions (nominal, minimum and maximum respectively, as declared by the applicant).

Type of power supply = AC or DC Voltage from external power supply

Type of antenna = external connectable antenna

Rated RF Output Power:

- Mode TI D-LMR (20 kHz bandwidth): 40 dBm (10 W)

TEST FREQUENCIES:

Lowest channel: 454.350 MHz - covering the frequency band [454.025 - 454.650 MHz] (FCC Part 22, Subparts E, F).

Middle channel: 454.825 MHz - covering the frequency band [454.675 - 454.975 MHz] (FCC Part 22, Subpart G for ground stations).

Highest channel: 459.350 MHz - covering the frequency band [459.025 - 459.650 MHz] (FCC Part 22, Subpart E, §22.567(h)).

Additional tested channels for checking compliance with Frequency stability requirements (§22.863):

454.675 MHz

454.975 MHz

CONDUCTED MEASUREMENTS

The equipment under test (EUT) was set up in a shielded room and it is connected to the spectrum analyzer or power meter through a calibrated attenuator and a low loss RF cable. The reading of the instrument is corrected taking into account the attenuator and cable loss.

For frequency stability test the EUT was placed inside a climatic chamber and connected to a frequency meter using a low loss cable. An external AC or DC power supply was connected to the EUT for voltage variation test.

RADIATED MEASUREMENTS

The equipment under test was scanned for spurious emissions in the frequency range 30 to 5000 MHz.

All radiated tests were performed in a semi-anechoic chamber. The measurement antenna is situated at a distance of 3 m for the frequency range 30 MHz-1000 MHz (30 MHz-1000 MHz Bilog antenna) and at a distance of 3 m for the frequency range 1 GHz-5 GHz (1 GHz-18 GHz Double ridge horn antenna).

The equipment under test was set up on a non-conductive platform and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360º and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

Measurements were made in both horizontal and vertical planes of polarization.

Modulation Characteristics

SPECIFICATION

FCC §2.1047

(a) Voice modulated communication equipment. A curve or equivalent data showing the frequency response of the audio modulating circuit over a range of 100 to 5000 Hz shall be submitted. For equipment required to have an audio low-pass filter, a curve showing the frequency response of the filter, or of all circuitry installed between the modulation limiter and the modulated stage shall be submitted.

(b) Equipment which employs modulation limiting. A curve or family of curves showing the percentage of modulation versus the modulation input voltage shall be supplied. The information submitted shall be sufficient to show modulation limiting capability throughout the range of modulating frequencies and input modulating signal levels employed.

(c) Single sideband and independent sideband radiotelephone transmitters which employ a device or circuit to limit peak envelope power. A curve showing the peak envelope power output versus the modulation input voltage shall be supplied. The modulating signals shall be the same in frequency as specified in paragraph (c) of § 2.1049 for the occupied bandwidth tests.

(d) Other types of equipment. A curve or equivalent data which shows that the equipment will meet the modulation requirements of the rules under which the equipment is to be licensed.

RESULTS (The following information has been provided by the applicant).

The EUT only operates in TI D-LMR under the FCC Part 22 rule (subparts E, F, G).

The TI D-LMR standard supports digital transmission and reception with the following modulation features:

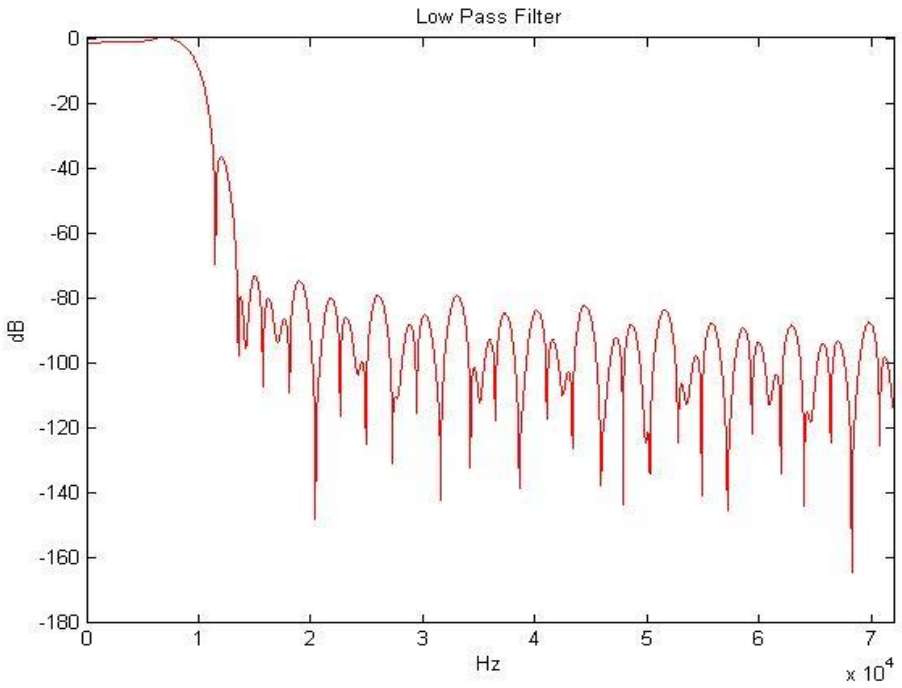
- TDMA access method with 4 physical channels per carrier.
- π/4-DQPSK digital modulation (π/4-shifted Differential Quaternary Phase Shift Keying) with a modulation rate of 18 ksym/s (36 kbits/s).
- 20 KHz channel bandwidth limitation, which fits to the FCC Part 22 authorized modulation bandwidth.

The channel bandwidth limitation is achieved by employing a matched filtering technique. The combined response of two root-raised-cosine filters (RRC), one of which is used in the EUT transmitter and another in the receiver, leads to a raised-cosine filter.

This kind of filter is often used in digital modulations for pulse-shaping and minimizing intersymbol interference (ISI).

The picture below shows the RRC transfer function.

MBS Unit -1 transmitter low pass filter for TI D-LMR (20 KHz authorized bandwidth):



RF Output Power (conducted)

SPECIFICATION

§2.1046, 22.565, 22.727, 22.809.

FCC §22.565 (Subpart E, One-way or two-way mobile operation)

(a) *Maximum ERP.* The effective radiated power (ERP) of base and fixed transmitters must not exceed the applicable limits in this paragraph under any circumstances.

Frequency range (MHz)	Maximum ERP (watts)
152-153	1400
157-159	150
454-455	3500
459-460	150

(b) *Basic power limit.* Except as provided in paragraph (d) of this section, the ERP of base transmitters must not exceed 500 Watts.

FCC §22.727 (Subpart F, Conventional rural radiotelephone stations)

(a) The Effective Radiated Power (E.R.P.) of central office and rural subscriber station transmitters must not exceed the applicable limits in this paragraph under any circumstances.

Frequency range (MHz)	Maximum ERP (watts)
152-153	1400
157-159	150
454-455	3500
459-460	150

(b) *Basic power limit.* Except as provided in paragraph (d) of this section, the ERP of central office station transmitters must not exceed 500 Watts.

FCC §22.809 (Subpart G, Air-ground radiotelephone service)

The transmitting power of ground and airborne mobile transmitters operating on the channels listed in §22.805 must not exceed the limits:

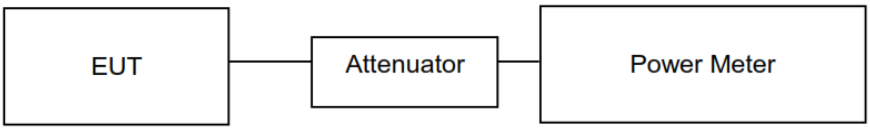
(a) Ground station transmitters. The effective radiated power of ground stations must not exceed 100 Watts and must not be less than 50 Watts, except as provided in §22.811.
(b) Airborne mobile transmitters. The transmitter power output of airborne mobile transmitters must not exceed 25 Watts and must not be less than 4 Watts.

METHOD

The EUT was controlled via a terminal emulator of the PC.

The conducted RF output power measurements were made at the RF output terminals of the EUT using an attenuator and a calibrated wideband power sensor.

TEST SETUP



RESULTS

MAXIMUM OUTPUT POWER (CONDUCTED).

20 kHz Bandwidth Modulation	Frequency (MHz)	Maximum average power (dBm) / W
FCC Part 22, Subparts E (§22.565) and F (§22.727)	454.350	40.91 / 12.33
FCC Part 22, Subpart G (§22.809)	454.825	40.65 / 11.61
FCC Part 22, Subpart E (§22.565, §22.567(h))	459.350	40.95 / 12.45
Measurement uncertainty (dB)	<±0.33	

The sum of the system loss (dB) and antenna gain (dBd) shall be such that the Effective Radiated Power (E.R.P.) shall not exceed the limit indicated above.

Verdict: PASS

Occupied Bandwidth

SPECIFICATION

FCC §2.1049, §22.561, §22.725, §22.805, §22.863.

FCC §22.561 (Subpart E, One-way or two-way mobile operation).

Unless otherwise indicated, all channels have a bandwidth of 20 kHz and are designated by their center frequencies in MegaHertz.

FCC §22.725 (Subpart F, Conventional rural radiotelephone stations).

All channels have a bandwidth of 20 kHz and are designated by their center frequencies in MegaHertz.

FCC §22.805 (Subpart G, Air-ground radiotelephone service).

These channels have a bandwidth of 20 kHz and are designated by their center frequencies in MegaHertz.

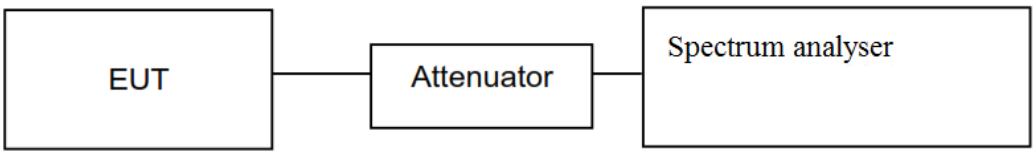
FCC §22.863 (Subpart G, Air-ground radiotelephone service).

The occupied bandwidth of the fundamental emissions shall remain within the authorized frequency bands of operation.

METHOD

The EUT was configured to transmit a modulated carrier signal. An IF bandwidth of 300 Hz was used to determine the occupied bandwidth of the modulated emission. The 99% occupied bandwidth and the -26 dBc bandwidth were measured directly using the built-in bandwidth measuring option of spectrum analyzer.

TEST SETUP

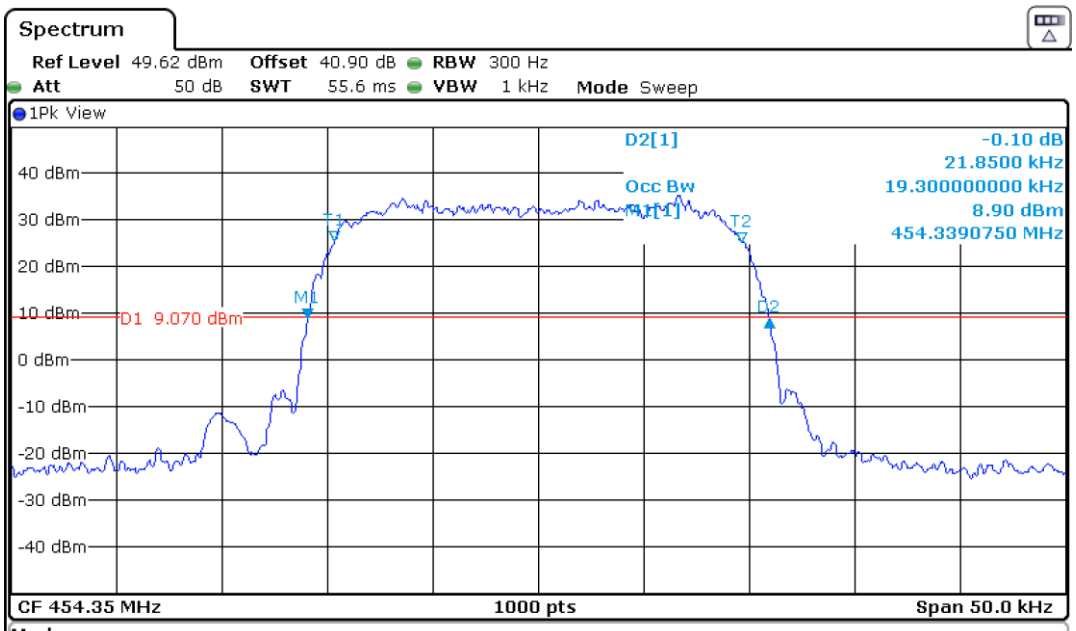


RESULTS (see next plots)

Channel	454.350 MHz	454.675 MHz	454.825 MHz	454.975 MHz	459.350 MHz
99% Occupied bandwidth (kHz)	19.30	19.25	19.25	19.20	19.30
-26 dBc bandwidth (kHz)	21.85	21.60	21.80	21.55	21.80
Measurement uncertainty (kHz)	<±0.03				

Verdict: PASS

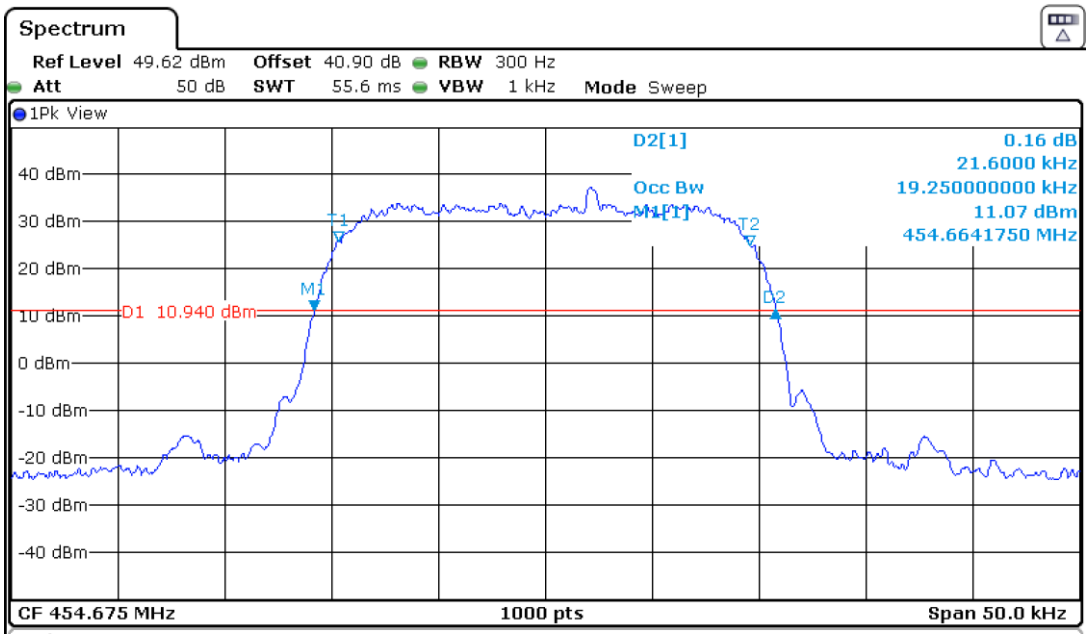
Channel: 454.350 MHz



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	454.339075 MHz	8.90 dBm		
T1		1	454.340325 MHz	25.35 dBm	Occ Bw	19.3 kHz
T2		1	454.359625 MHz	25.01 dBm		
D2	M1	1	21.85 kHz	-0.10 dB		

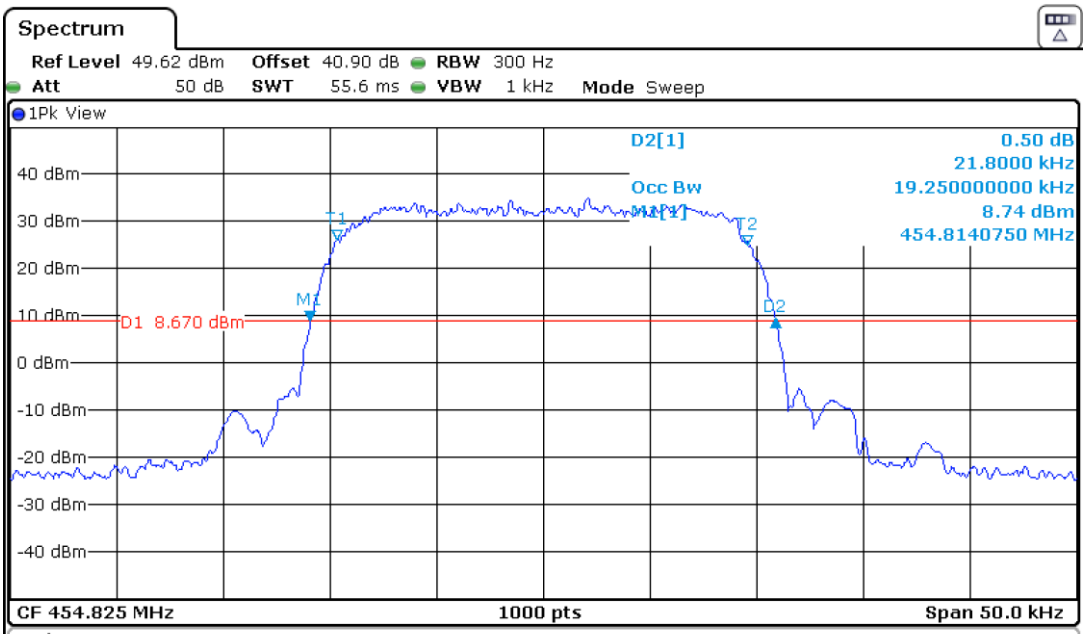
Channel: 454.675 MHz



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	454.664175 MHz	11.07 dBm		
T1		1	454.665325 MHz	25.71 dBm	Occ Bw	19.25 kHz
T2		1	454.684575 MHz	24.80 dBm		
D2	M1	1	21.6 kHz	0.16 dB		

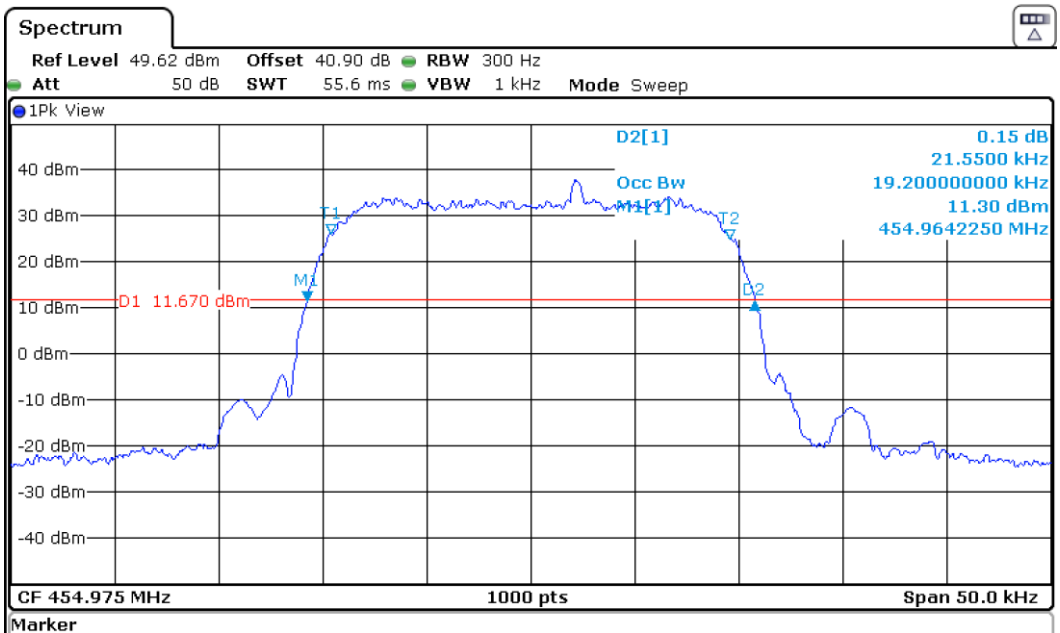
Channel: 454.825 MHz



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	454.814075 MHz	8.74 dBm		
T1		1	454.815325 MHz	25.93 dBm	Occ Bw	19.25 kHz
T2		1	454.834575 MHz	24.88 dBm		
D2	M1	1	21.8 kHz	0.50 dB		

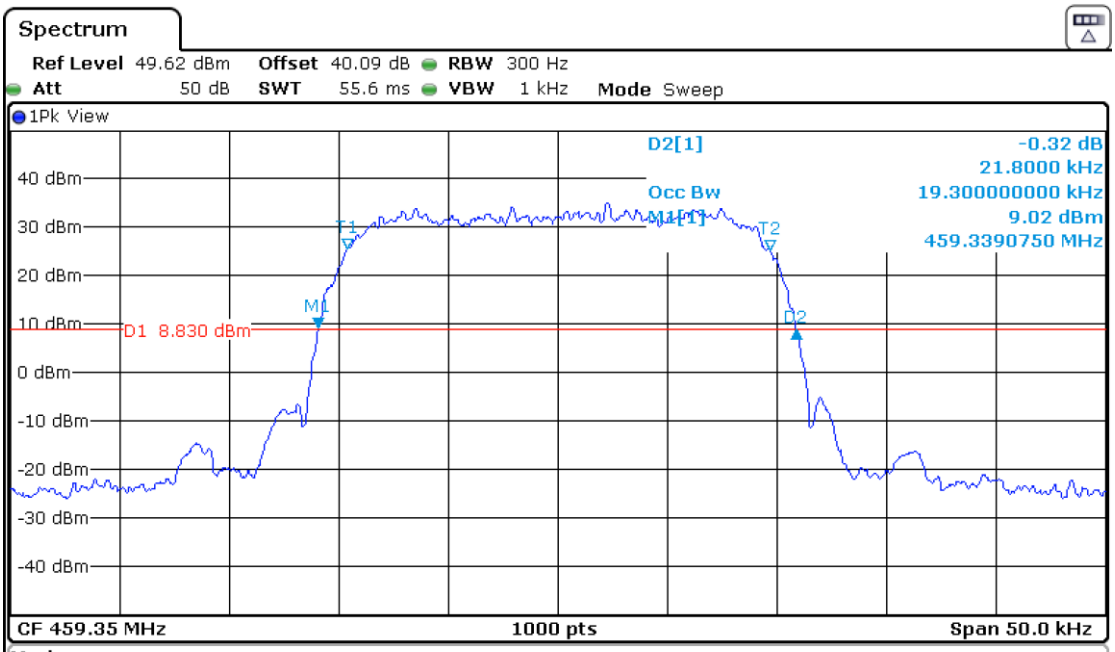
Channel: 454.975 MHz



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	454.964225 MHz	11.30 dBm		
T1		1	454.965375 MHz	25.80 dBm	Occ Bw	19.2 kHz
T2		1	454.984575 MHz	24.66 dBm		
D2	M1	1	21.55 kHz	0.15 dB		

Channel: 459.350 MHz



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	459.339075 MHz	9.02 dBm		
T1		1	459.340375 MHz	25.39 dBm	Occ Bw	19.3 kHz
T2		1	459.359675 MHz	25.03 dBm		
D2	M1	1	21.8 kHz	-0.32 dB		

Frequency Stability

SPECIFICATION

FCC §2.1055, §22.355, §22.863:

FCC §22.355 (Subpart C, Operational and technical requirements, applicable to Subparts E, F and G).

Except as otherwise provided in this part, the carrier frequency of each transmitter in the Public Mobile Services must be maintained within the tolerances given in Table C-1 of this section.

Table C-1—Frequency Tolerance for Transmitters in the Public Mobile Services

Frequency range (MHz)	Base, fixed(ppm)	Mobile >3 watts (ppm)	Mobile ≤3 watts (ppm)
25 to 50	20.0	20.0	50.0
50 to 450	5.0	5.0	50.0
450 to 512	2.5	5.0	5.0
821 to 896	1.5	2.5	2.5
928 to 929	5.0	n/a	n/a
929 to 960	1.5	n/a	n/a
2110 to 2220	10.0	n/a	n/a

FCC §22.863, (Subpart G, Air-ground radiotelephone service.

The frequency stability of equipment used under this subpart shall be sufficient to ensure that, after accounting for Doppler frequency shifts, the occupied bandwidth of the fundamental emissions remains within the authorized frequency bands of operation.

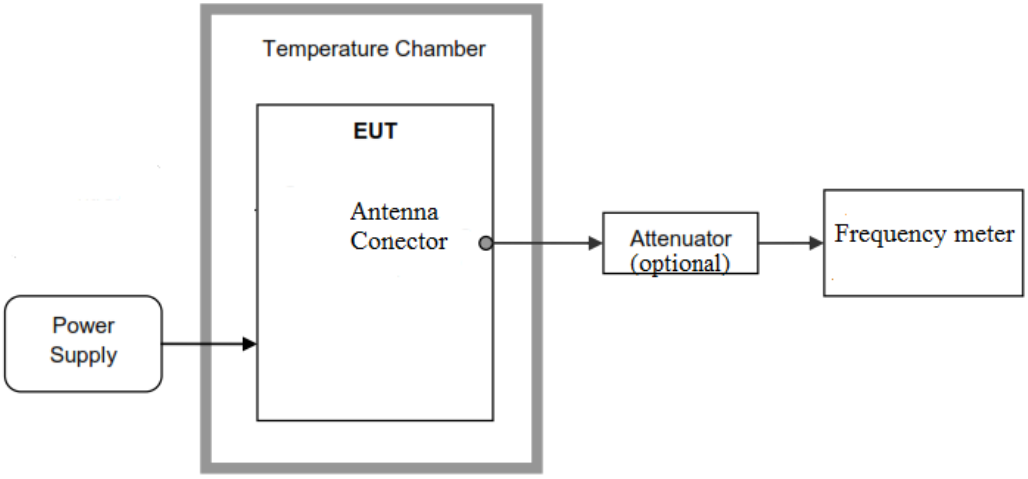
METHOD

The frequency tolerance measurements over temperature variations were made over the temperature range of –30ºC to +50ºC. The EUT was placed inside a climatic chamber and the temperature was raised hourly in 10ºC steps from –30ºC up to +50ºC.

Frequency Stability vs Voltage: The frequency stability was also measured at a fixed temperature of +20ºC with the EUT being powered at the extreme voltage values (see test conditions on page 13). The voltage range that has been considered covers ±15% of the manufacturer's rated supply voltage.

The EUT is set in continuous transmission without modulation (only carrier) and the frequency is measured with the frequency meter of Radiocommunication analyzer HP 8920A.

TEST SETUP



RESULTS

Channel: 454.825 MHz.

Voltage (Vac)	Temperature (ºC)	Frequency Error (Hz)	Frequency Error (ppm)
Frequency stability with Temperature			
110	+50	50	0.10993
	+40	50	0.10993
	+30	50	0.10993
	+20	49	0.10773
	+10	37	0.08135
	0	47	0.10334
	-10	42	0.09234
	-20	51	0.11213
	-30	51	0.11213
Frequency stability with Supply Voltage			
93.5	20	40	0.08795
126.5	20	48	0.10554

Voltage (Vdc)	Temperature (ºC)	Frequency Error (Hz)	Frequency Error (ppm)
Frequency stability with Supply Voltage			
20.4	20	46	0.10114
31.2	20	46	0.10114

Measurement uncertainty	$<\pm 1 \times 10^{-6}$

FCC Part 22, Subpart G, Air-ground radiotelephone service:
The maximum frequency error was 0.11213 ppm (51 Hz). This error subtracted from and added to the extreme frequencies measured in the Occupied Bandwidth (454.665325 MHz and 454.984575 MHz, respectively) is sufficient to ensure that the Occupied Bandwidth of the fundamental emission remains within the authorized frequency band of operation.

Verdict: PASS

Spurious emissions at antenna terminals

SPECIFICATION
FCC §22.357. §22.359. §22.731. §22.861.

FCC §22.357 (Subpart C, Operational and technical requirements, applicable to Subparts E, F and G):

Any authorized station in the Public Mobile Services may transmit emissions of any type(s) that comply with the applicable emission rule, i.e. §22.359 or §22.861.

FCC §22.359 (Subpart C, Operational and technical requirements, applicable to Subparts E and F):

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

FCC §22.731 (Subpart F, Conventional rural radiotelephone stations):

Upon application for multichannel operation, the FCC may authorize emission bandwidths wider than those specified in §22.357, provided that spectrum utilization is equal to or better than that achieved by single channel operation.

FCC §22.861 (Subpart G, Air-ground radiotelephone service):

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

METHOD

FCC §22.359 (Subpart C, Operational and technical requirements, applicable to Subparts E and F):

(b) Measurement procedure. Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 30 kHz or more.

FCC §22.861 (Subpart G, Air-ground radiotelephone service):

(b) Measurement procedure. Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater.

The EUT RF output connector was connected to a spectrum analyser using a 50 ohm attenuator and the resolution bandwidth of the spectrum analyser was set to 100 kHz for frequencies < 1GHz and 1 MHz for frequencies > 1GHz. The spectrum was investigated from 9 kHz to 5 GHz.

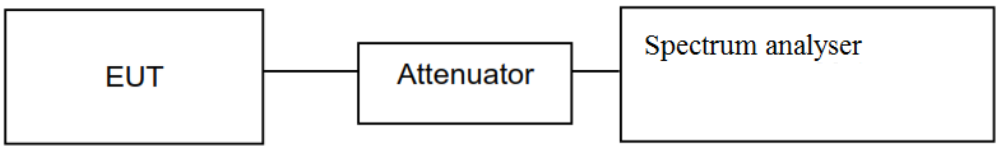
The reading of the spectrum analyser is corrected with the attenuation loss of connection between output terminal of EUT and input of the spectrum analyser.

Measurement Limit**:**

According to specification. the power of emissions shall be attenuated below the transmitter power (P) by a factor of at least 43 + 10 log (P) dB. P in watts.
At Po transmitting power the specified minimum attenuation becomes 43+10log (Po) and the level in dBm relative Po becomes:

Po (dBm) – [43 + 10 log (Po in mwatts) - 30] = - 13 dBm

TEST SETUP



RESULTS (see plots in next pages)

A preliminary measurement determined that there is no difference between the unit with AC power supply and the unit with DC power supply. The measurement was performed with the unit with DC power supply.

1. CHANNEL: 454.350 MHz

No spurious signals were found at less than 20 dB below the limit in all the range.

2. CHANNEL: 454.825 MHz

No spurious signals were found at less than 20 dB below the limit in all the range.

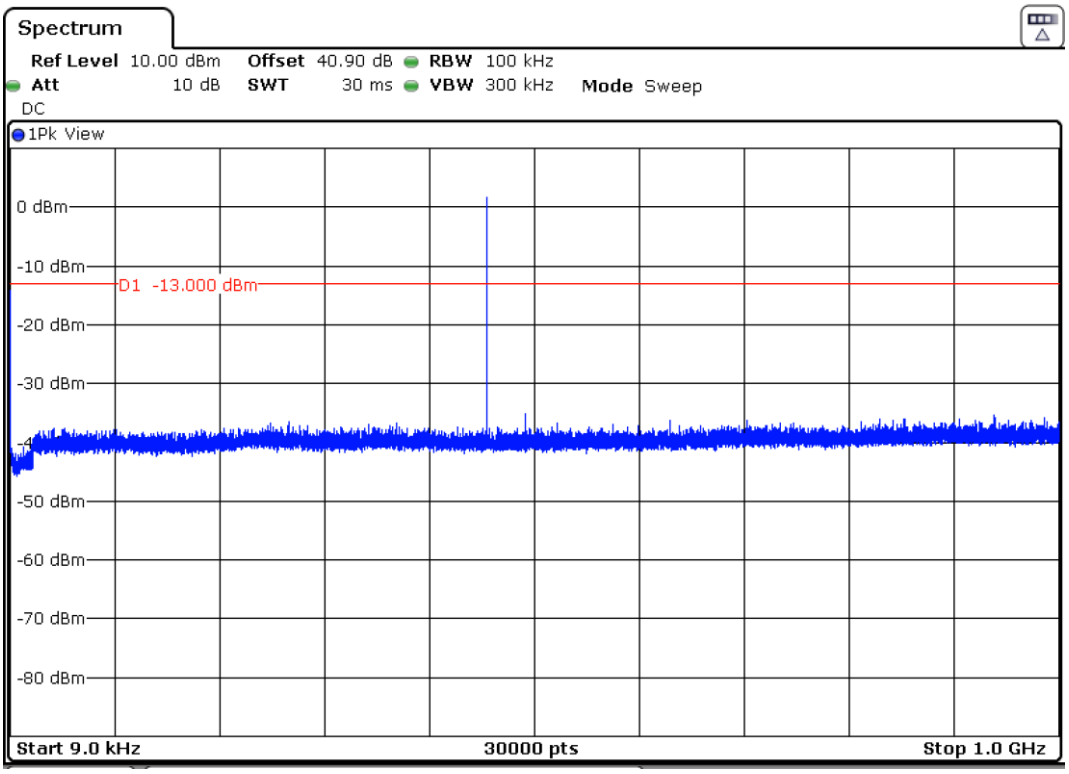
3. CHANNEL: 459.350 MHz

No spurious signals were found at less than 20 dB below the limit in all the range.

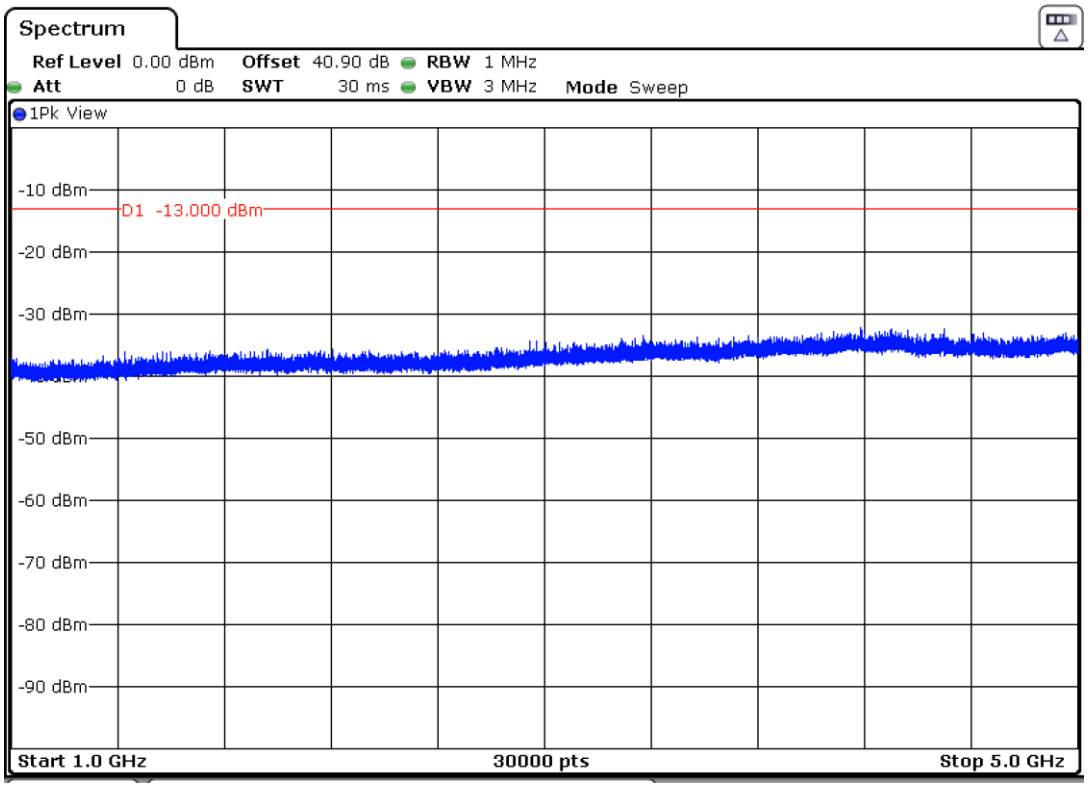
Measurement uncertainty (dB)	<±0.34

Verdict: PASS

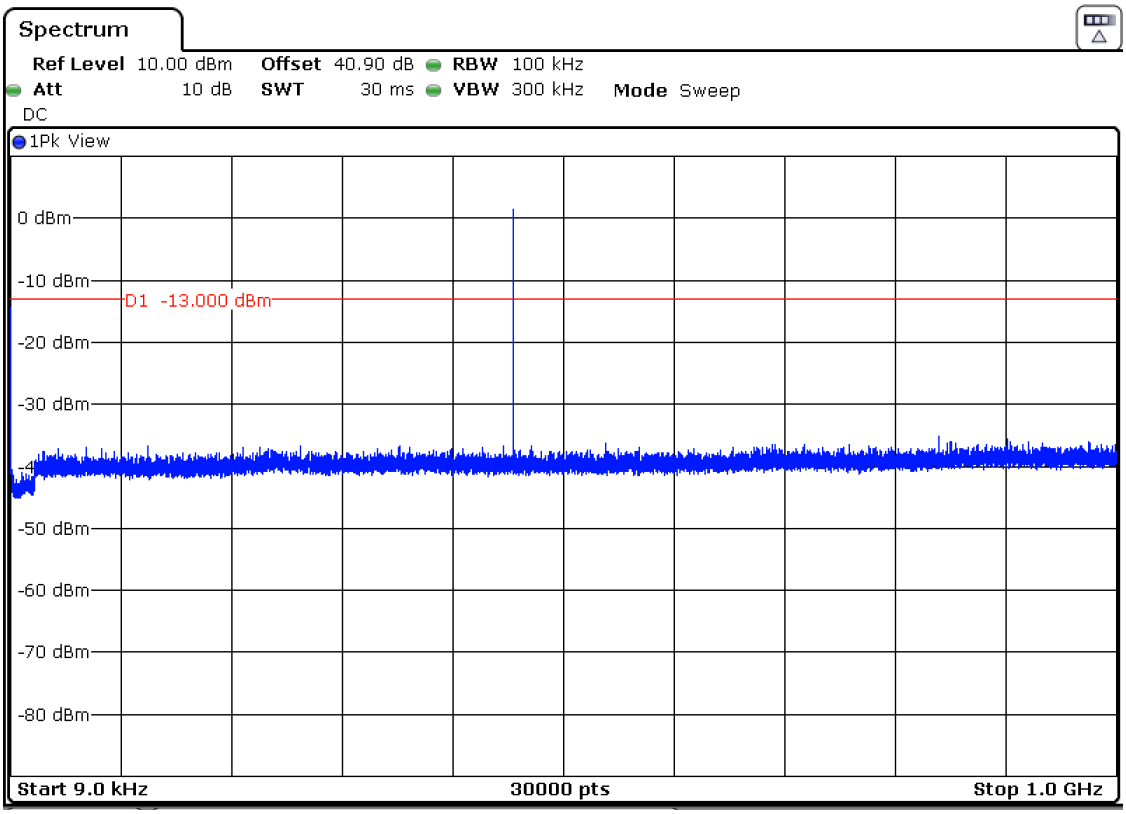
1. CHANNEL: 454.350 MHz.



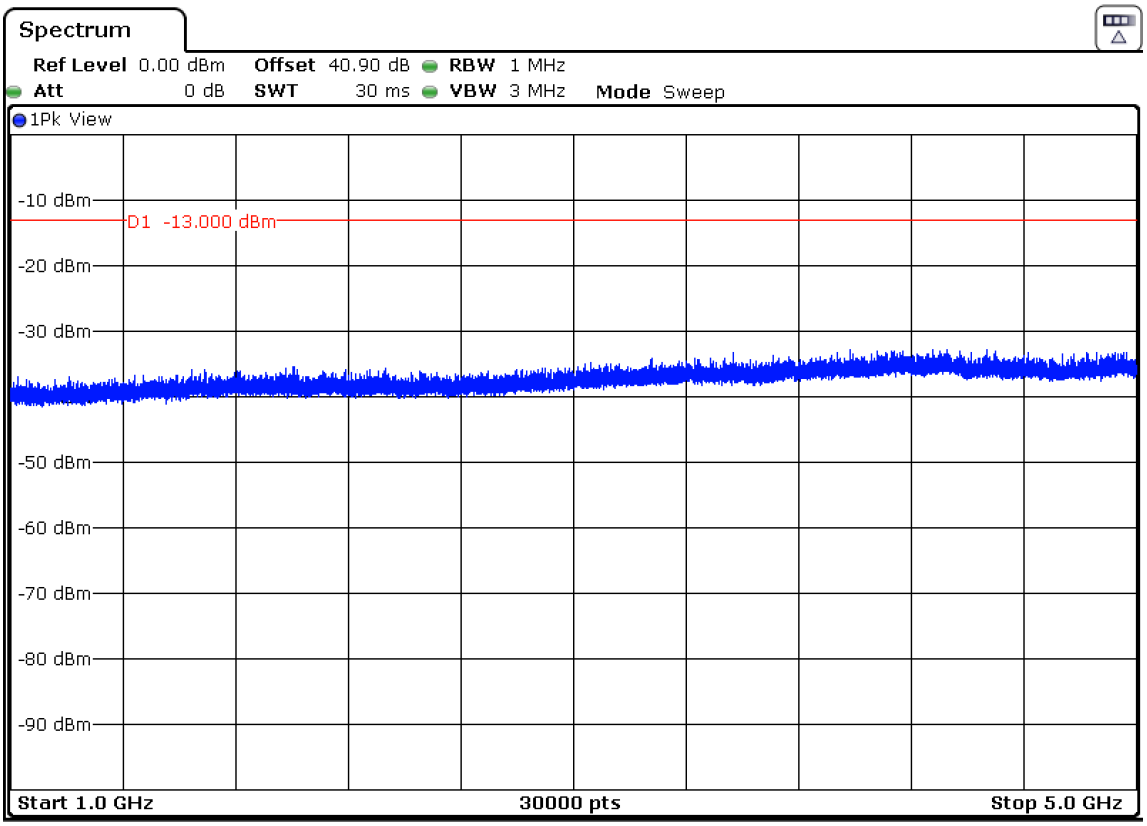
Note: The peak above the limit is the carrier frequency. The carrier was attenuated using a notch filter.



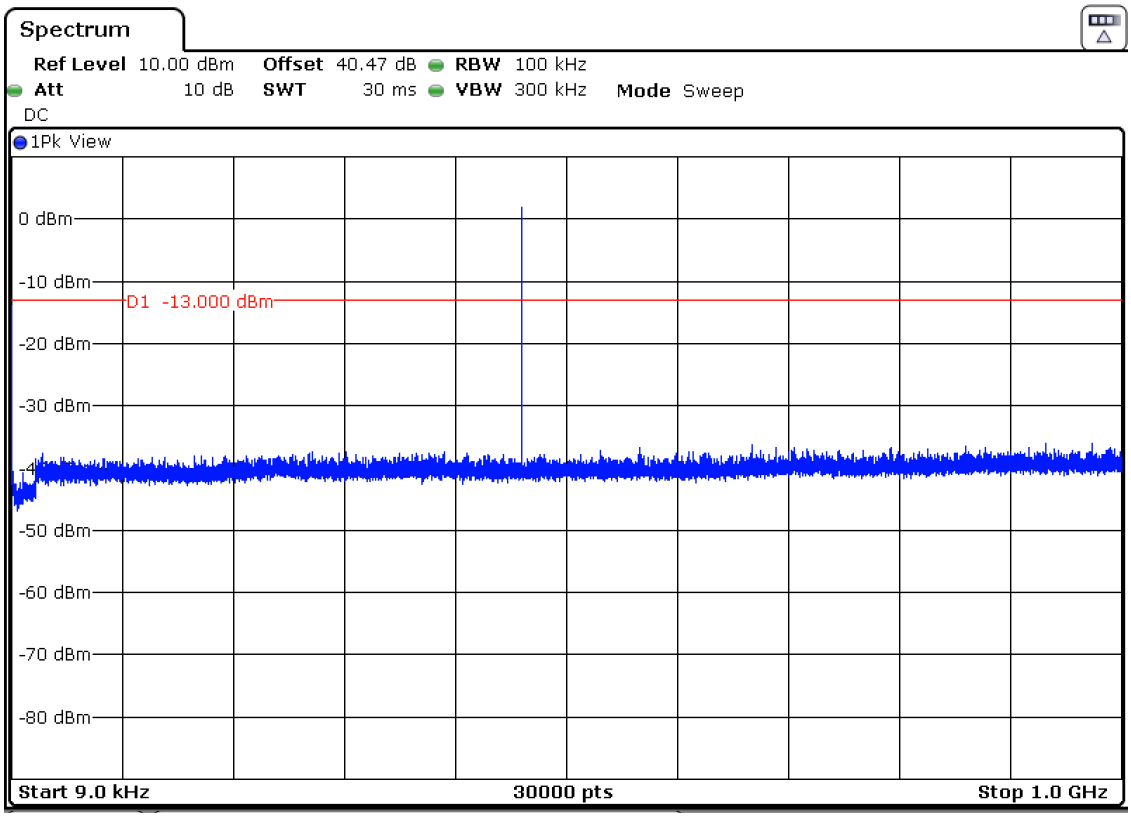
2. CHANNEL: 454.825 MHz.



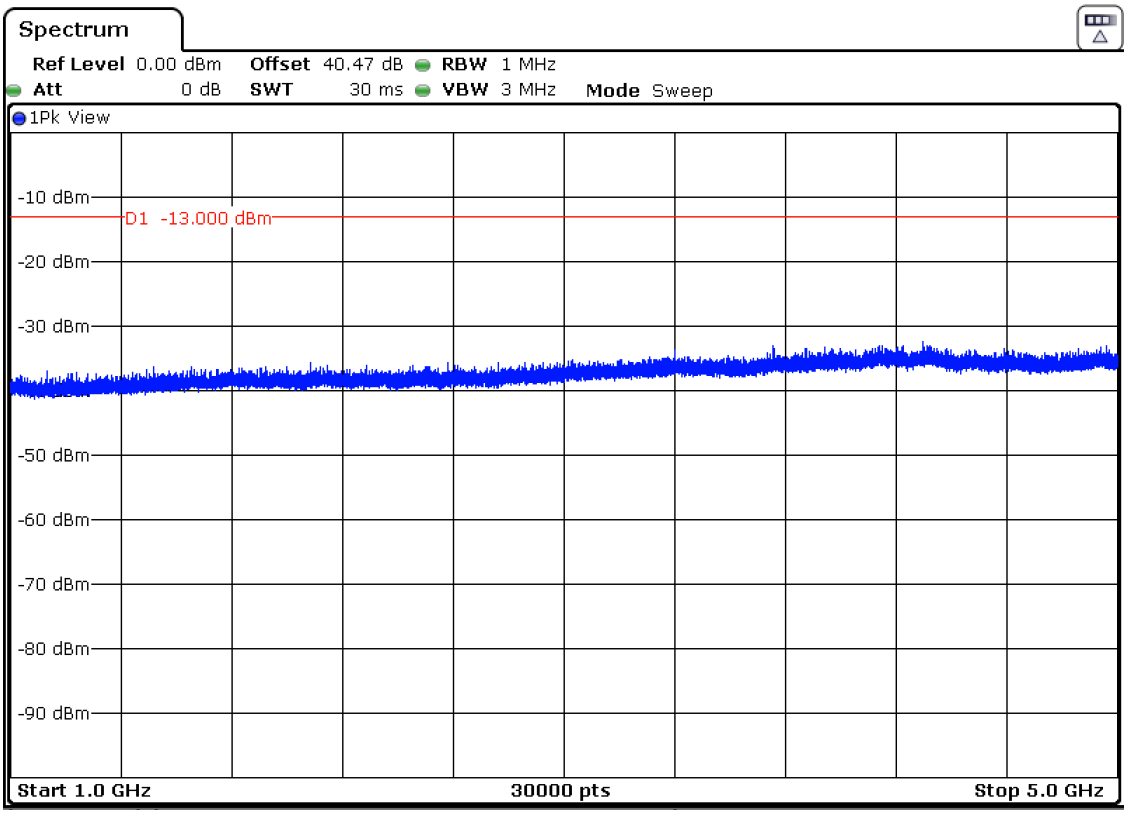
Note: The peak above the limit is the carrier frequency. The carrier was attenuated using a notch filter.



3. CHANNEL: 459.350 MHz.



Note: The peak above the limit is the carrier frequency. The carrier was attenuated using a notch filter.



Band-edge emissions compliance (Transmitter)

SPECIFICATION
FCC §22.357. §22.359. §22.731. §22.861.

FCC §22.357 (Subpart C, Operational and technical requirements, applicable to Subparts E, F and G):

Any authorized station in the Public Mobile Services may transmit emissions of any type(s) that comply with the applicable emission rule, i.e. §22.359 or §22.861.

FCC §22.359 (Subpart C, Operational and technical requirements, applicable to Subparts E and F):

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

FCC §22.731 (Subpart F, Conventional rural radiotelephone stations):

Upon application for multichannel operation, the FCC may authorize emission bandwidths wider than those specified in §22.357, provided that spectrum utilization is equal to or better than that achieved by single channel operation.

FCC §22.861 (Subpart G, Air-ground radiotelephone service):

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

METHOD

FCC §22.359 (Subpart C, Operational and technical requirements, applicable to Subparts E and F)

As indicated in FCC part 22.359. in the 60 kHz bands immediately outside and adjacent to the authorized frequency range or channel. a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power. A resolution bandwidth of 300 Hz was used.

FCC §22.861 (Subpart G, Air-ground radiotelephone service)

As indicated in FCC part 22.861. in the 1 MHz bands immediately outside and adjacent to the frequency block. a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power. A resolution bandwidth of 300 Hz was used.

The reading of the spectrum analyser is corrected with the attenuation loss of connection between output terminal of EUT and input of the spectrum analyzer.

Channel edges:
The reference standard to perform all measurements is ANSI C63.26. According to it and considering that the channel spacing for TI D-LMR is 25 KHz, the channel edges are defined as follows:

- Lower channel edge = Fc - CS/2 - RBW/2 [MHz]
- Upper channel edge = Fc + CS/2 + RBW/2 [MHz]

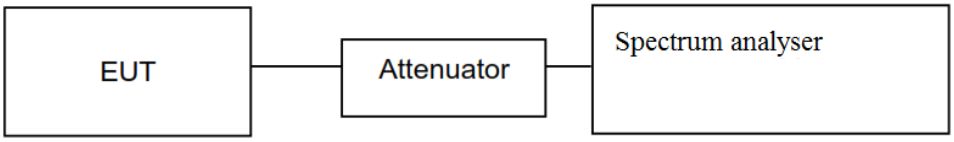
Where:
- Fc is the carrier frequency.
- CS is the channel spacing (25 KHz for TI D-LMR).
- RBW is the resolution bandwidth employed when measuring (300 Hz).

Measurement Limit**:**

According to specification. the power of emissions shall be attenuated below the transmitter power (P) by a factor of at least 43 + 10 log (P) dB. P in watts.
At Po transmitting power the specified minimum attenuation becomes 43+10log (Po) and the level in dBm relative Po becomes:

Po (dBm) – [43 + 10 log (Po in mwatts) - 30] = - 13 dBm

TEST SETUP



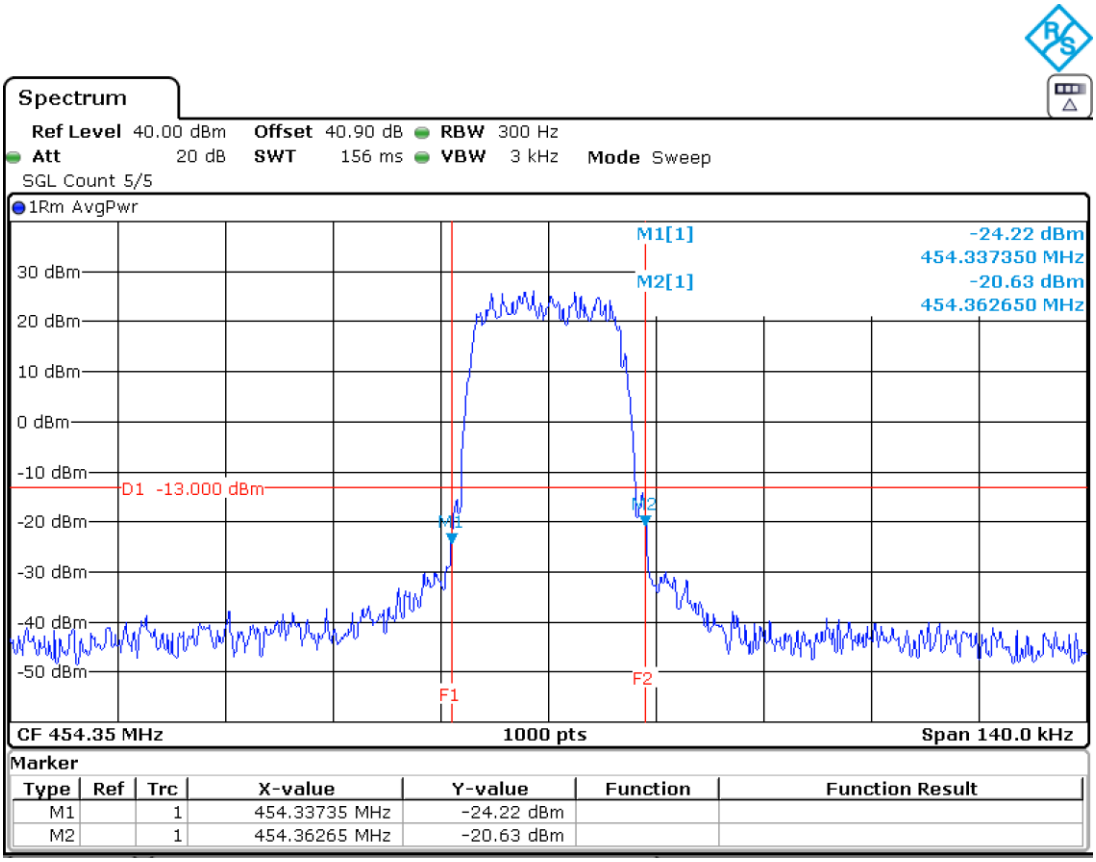
RESULTS (See next plots):

A preliminary measurement determined that there is no difference between the unit with AC power supply and the unit with DC power supply. The measurement was performed with the unit with DC power supply.

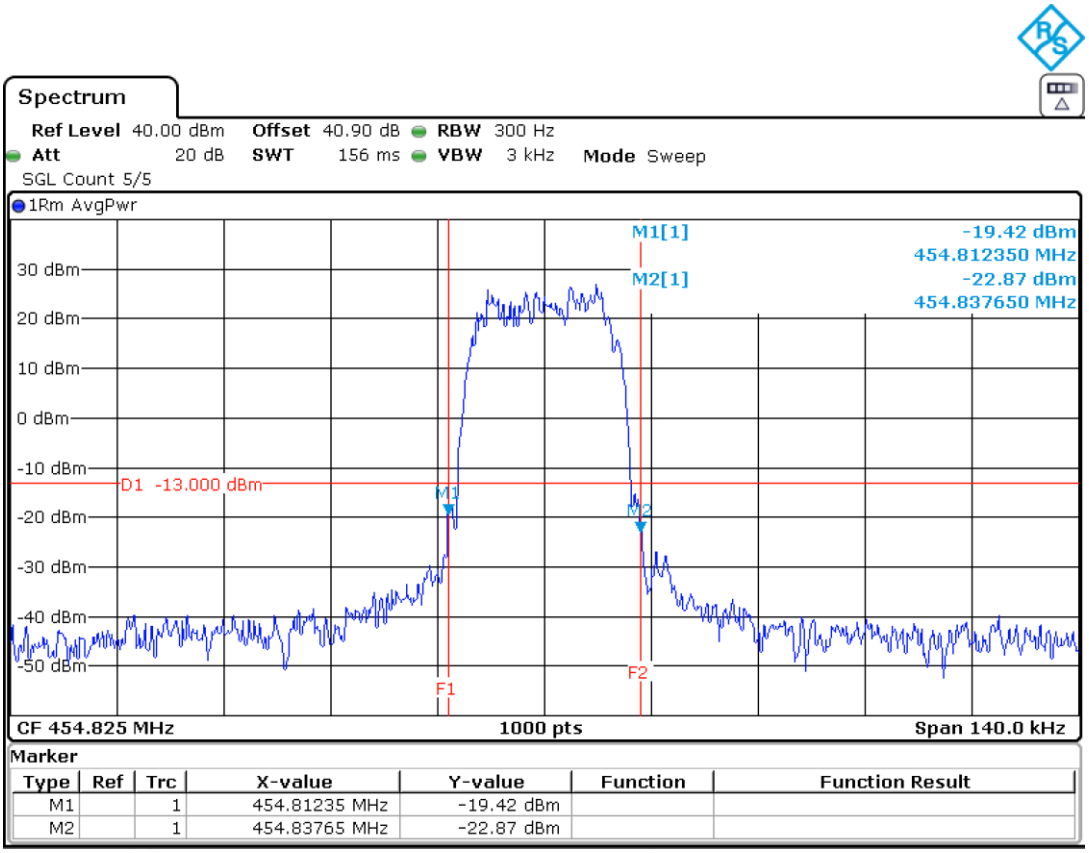
	Lower channel edge	Upper channel edge
Channel 454.350 MHz. Maximum measured level at channel edges at antenna port (dBm)	-24.22	-20.63
Channel 454.825 MHz. Maximum measured level at channel edges at antenna port (dBm)	-19.42	-22.87
Channel 459.350 MHz. Maximum measured level at channel edges at antenna port (dBm)	-22.74	-22.17
Measurement uncertainty (dB):	< ± 0.34	

Verdict: PASS

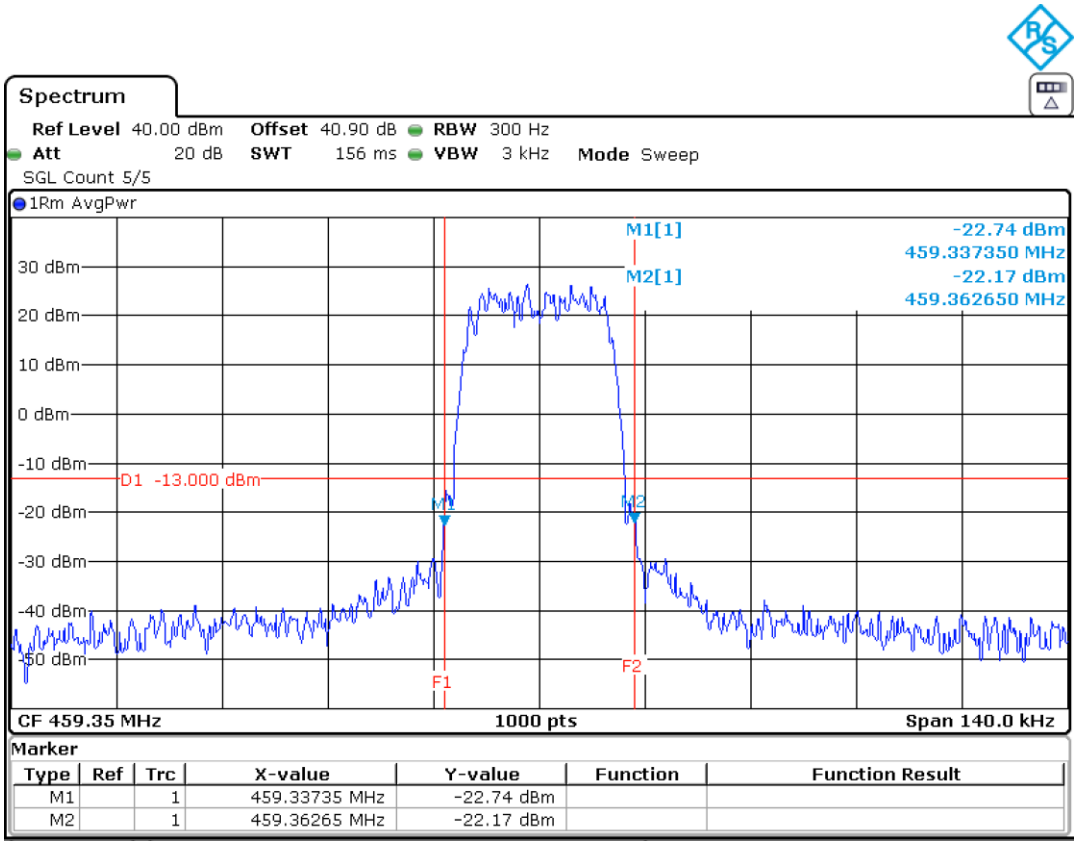
1. Channel: 454.350 MHz.



2. Channel: 454.825 MHz.



3. Channel: 459.350 MHz.



Radiated emissions

SPECIFICATION
FCC §22.357. §22.359. §22.731. §22.861.

FCC §22.357 (Subpart C, Operational and technical requirements, applicable to Subparts E, F and G):

Any authorized station in the Public Mobile Services may transmit emissions of any type(s) that comply with the applicable emission rule, i.e. §22.359 or §22.861.

FCC §22.359 (Subpart C, Operational and technical requirements, applicable to Subparts E and F):

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

FCC §22.731 (Subpart F, Conventional rural radiotelephone stations):

Upon application for multichannel operation, the FCC may authorize emission bandwidths wider than those specified in §22.357, provided that spectrum utilization is equal to or better than that achieved by single channel operation.

FCC §22.861 (Subpart G, Air-ground radiotelephone service):

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

METHOD

FCC §22.359 (Subpart C, Operational and technical requirements, applicable to Subparts E and F):

(b) Measurement procedure. Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 30 kHz or more.

FCC §22.861 (Subpart G, Air-ground radiotelephone service):

(b) Measurement procedure. Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater.

The measurement was performed with the EUT inside an anechoic chamber. The RF output connector of the EUT is terminated with an attenuator and a 50 ohm load.
The spectrum was scanned from 30 MHz to at least the 10th harmonic of the highest frequency generated within the equipment.
The EUT was placed on a non-conductive stand at a 3 meter distance from the measuring antenna.
Detected emissions were maximized at each frequency by rotating the EUT and adjusting the measuring antenna height and polarization. The maximum meter reading was recorded.
Each detected emission at less than 20 dB below the limit is substituted by the Substitution method.

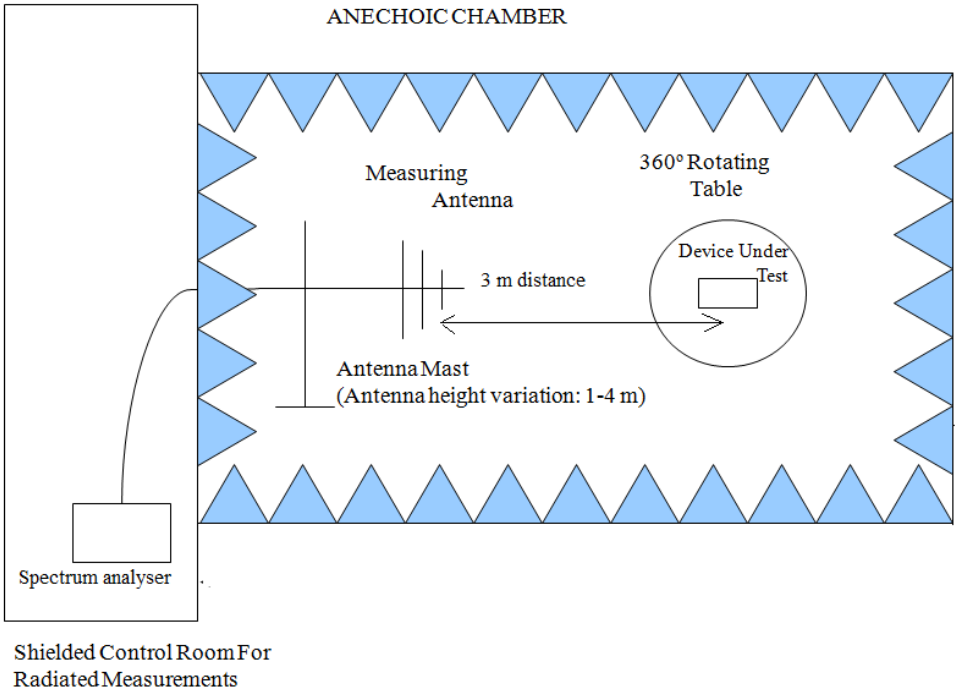
Measurement Limit**:**

According to specification. the power of emissions shall be attenuated below the transmitter power (P) by a factor of at least 43 + 10 log (P) dB. P in watts.
At Po transmitting power the specified minimum attenuation becomes 43+10log (Po) and the level in dBm relative Po becomes:

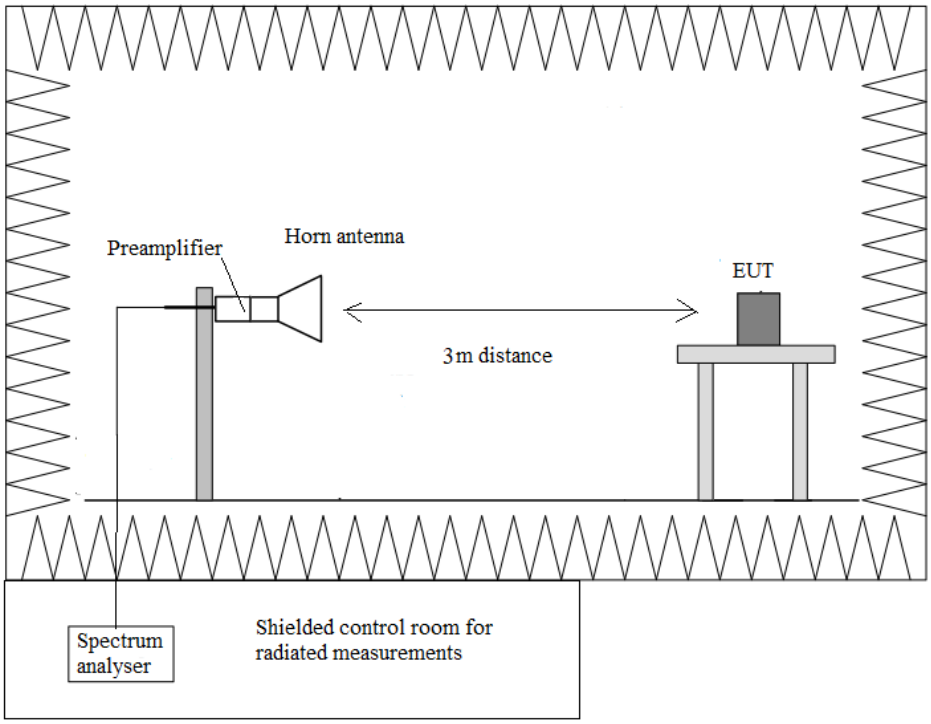
Po (dBm) – [43 + 10 log (Po in mwatts) - 30] = - 13 dBm

TEST SETUP

Radiated measurements below 1 GHz.



Radiated measurements above 1 GHz.



RESULTS

A preliminary scan determined the unit with DC power supply as the worst case. The following tables and plots show the results for this configuration.

1. CHANNEL: 454.350 MHz.

All peaks found are more than 20 dB below the limit.

2. CHANNEL: 454.825 MHz.

All peaks found are more than 20 dB below the limit.

3. CHANNEL: 459.350 MHz.

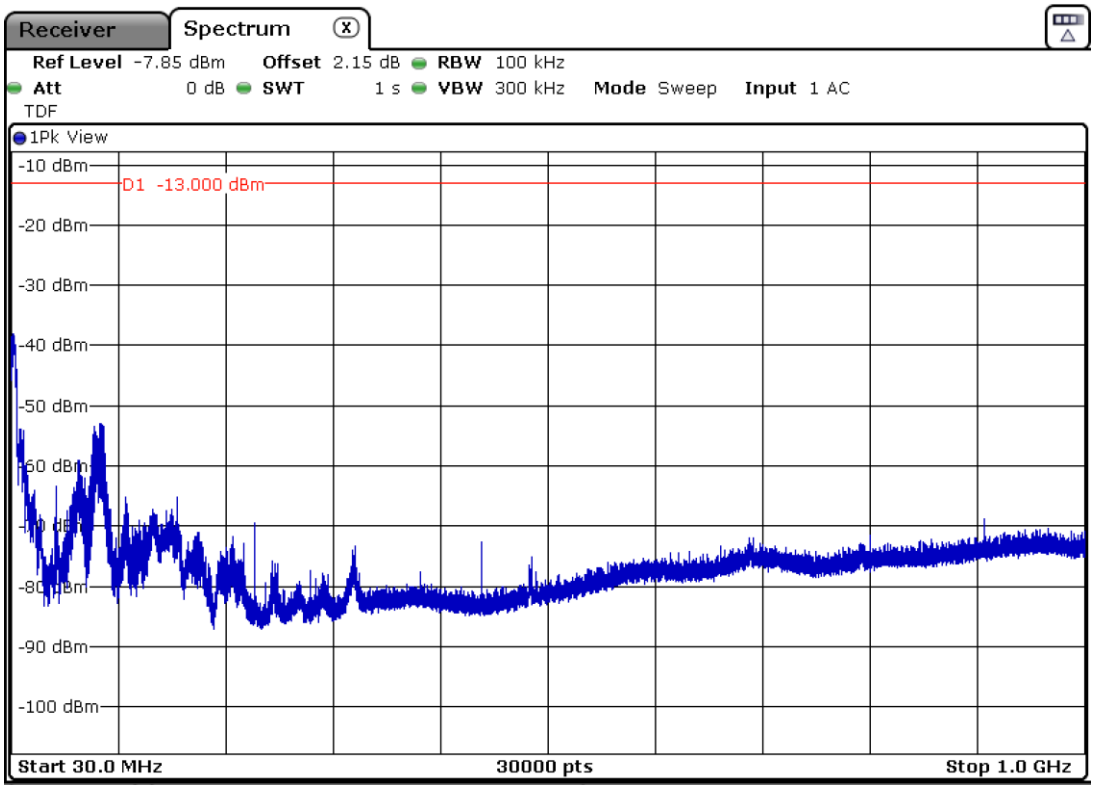
All peaks found are more than 20 dB below the limit.

Measurement uncertainty (dB)	<±3.88 for f < 1GHz <±4.87 for f ≥ 1 GHz up to 18 GHz

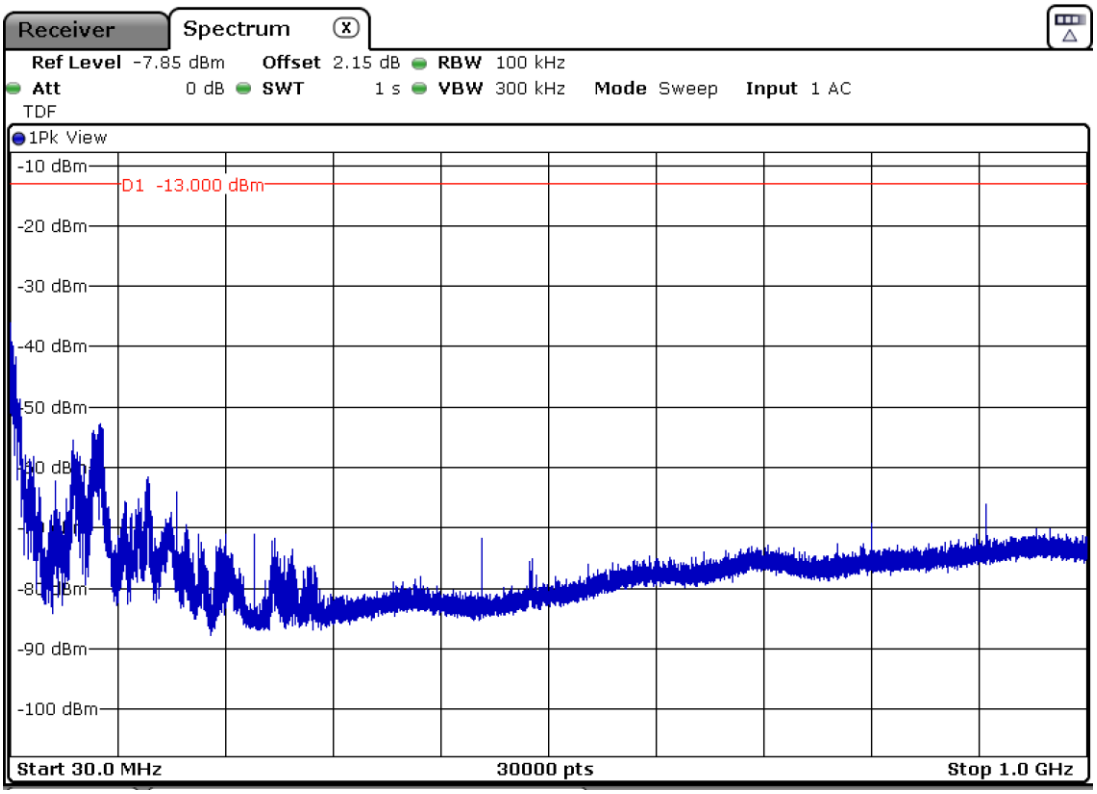
Verdict: PASS

FREQUENCY RANGE 30 MHz-1000 MHz.

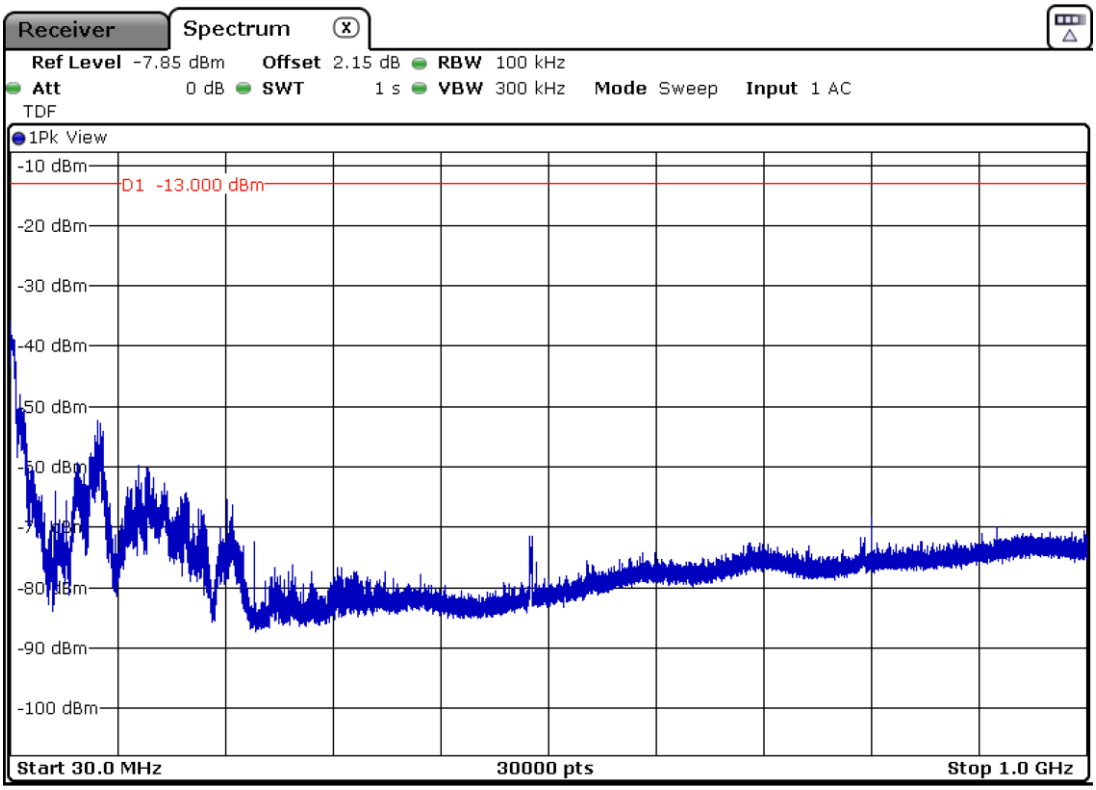
1. CHANNEL: 454.350 MHz.



2. CHANNEL: 454.825 MHz.

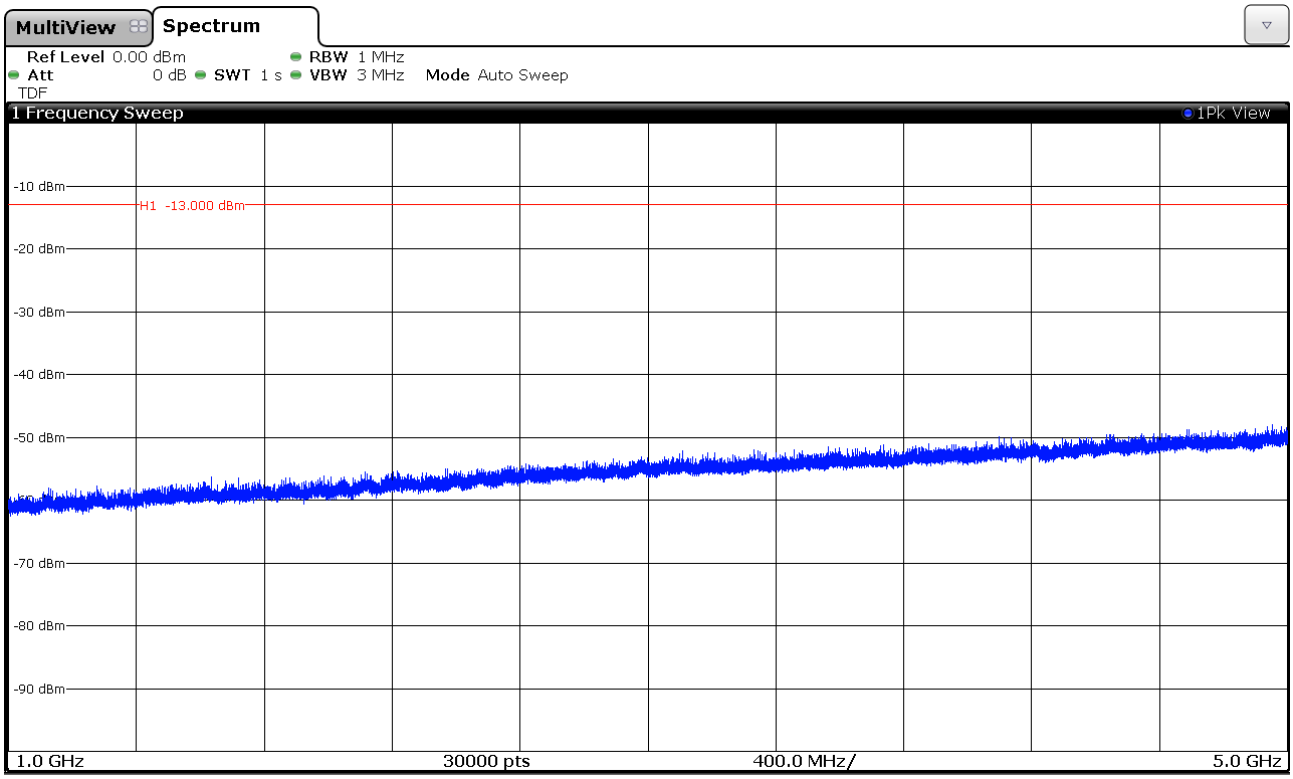


3. CHANNEL: 459.350 MHz.

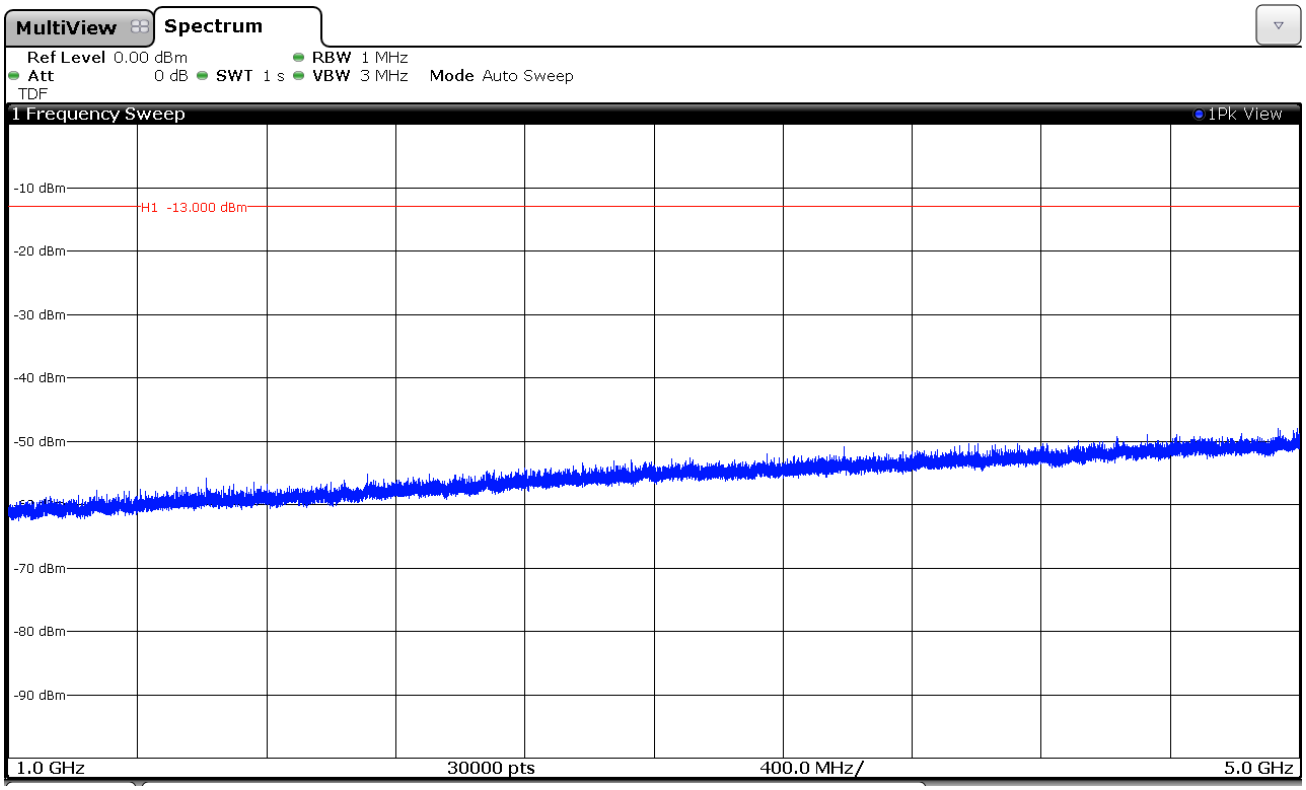
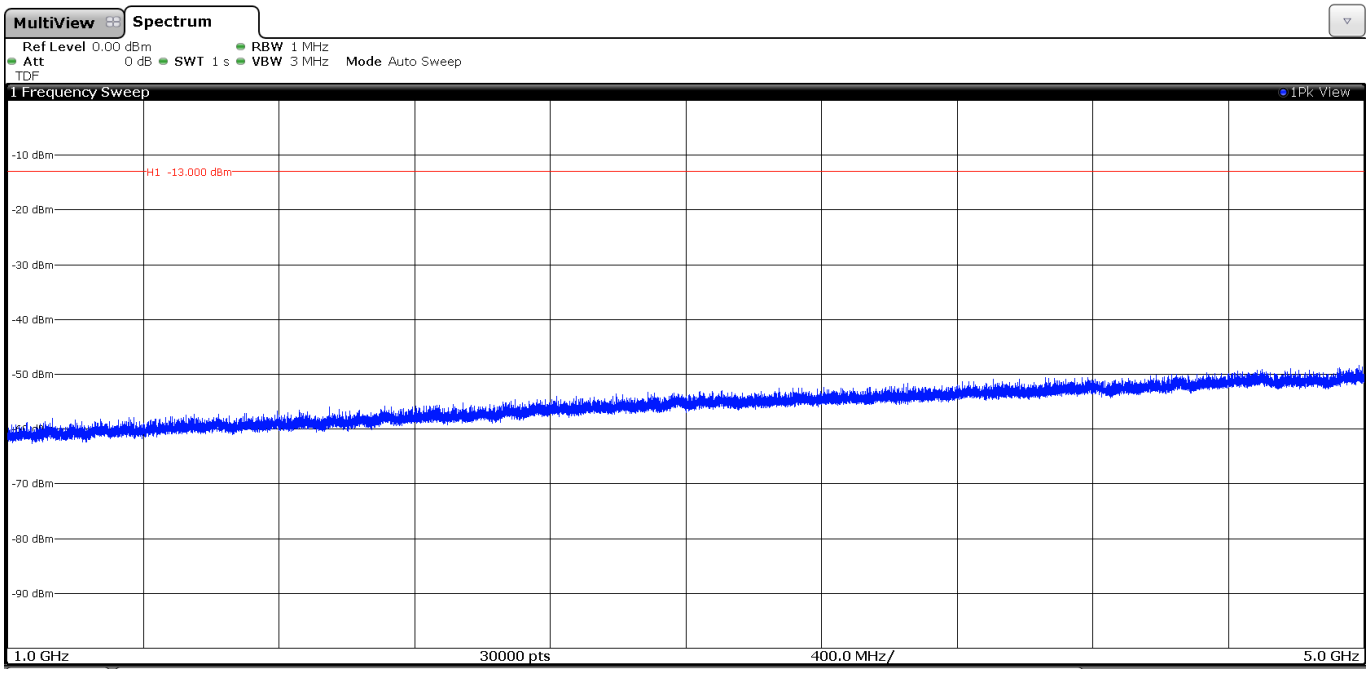


FREQUENCY RANGE 1 GHz to 5 GHz.

1. CHANNEL: 454.350 MHz.



2. CHANNEL: 454.825 MHz.



3. CHANNEL: 459.350 MHz.