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FCC LISTED, REGISTRATION NUMBER: 720267

IC LISTED REGISTRATION NUMBER IC 4621A-1

Test report No:

NIE: 47275RRF.001

Test report
REFERENCE STANDARD:
USA FCC Part 90
CANADA IC RSS-119

Identificación del objeto ensayado.....: Identification of item tested	Portable Tetra Terminal
Marca .....: Trade	Sepura
Modelo y/o referencia tipo .....: Model and /or type reference	STP8X040 STP8X140
Other identification of the product .....:	FCC ID: XX6STP8X IC: 8739A-STP8X
Final HW version .....:	PSBUW001T400R0001 Full keypad version (STP8X040) PSXUW001T400R0001 Reduced keypad version (STP8X140)
Final SW version .....:	V10
Características .....: Features	Bluetooth
Peticionario .....: Applicant	SEPURA PLC 9000 Cambridge Research Park, Beach Drive Waterbeach Cambridge CB25 9TL UK
Método de ensayo solicitado, norma.....: Test method requested, standard	USA FCC Part 90 10-01-14 Edition. CANADA IC RSS-119 Issue 12, May 2015. Measurement Guidance 971168 D01 v02r02 for certification of Licensed Digital Transmitters. ANSI/TIA-603-D (2010). ANSI C63.26-2015.
Resultado.....: Summary	IN COMPLIANCE
Aprobado por (nombre / cargo y firma) .....: Approved by (name / position & signature)	A. Llamas RF Lab. Manager  Firmado digitalmente por ALEJANDRO LLAMAS RODRIGUEZ Fecha: 2016.03.08 16:31:53 +01'00'
Fecha de realización .....: Date of issue	2016-03-08
Formato de informe No. .....: Report template No	FDT08_15

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Competences and guarantees

AT4 wireless 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.

AT4 wireless 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: IC 4621A-1.

In order to assure the traceability to other national and international laboratories, AT4 wireless has a calibration and maintenance program for its measurement equipment.

AT4 wireless 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 AT4 wireless at the time of performance of the test.

AT4 wireless 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 AT4 wireless.
4. This test report cannot be used partially or in full for publicity and/or promotional purposes without previous written permission of AT4 wireless and the Accreditation Bodies.

Uncertainty

Uncertainty (factor k=2) was calculated according to the AT4 wireless internal document PODT000.

Usage of samples

Samples undergoing test have been selected by: **the client**.

Sample M/01 is composed of the following elements:

Control Nº	Description	Model	Serial Nº	Date of reception
47275/030	Portable Tetra Terminal	STP8X040	1PR201438G9F293	2015-11-16

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

   All tests indicated in appendix A.

Test sample description

The test sample consists of a Portable Tetra 2-way radio terminal for use in TMO, DMO and repeater modes. Model STP8X040 with full keypad and model STP8X140 with reduced keypad.

Identification of the client

SEPURA PLC

9000 Cambridge Research Park, Beach Drive Waterbeach

Cambridge CB25 9TL UK

Testing period

The performed test started on 2015-11-19 and finished on 2016-01-29.

The tests have been performed at AT4 wireless.

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

1: Model STP8X040 with full keypad and model STP8X140 with reduced keypad have the same TETRA radio and antenna. Model STP8X040 was tested as it is considered the most complex of both models.

2: Used instrumentation.

Conducted Measurements

		Last Cal. date	Cal. due date
1.	Spectrum analyser Agilent PSA E4440A	2015/10	2017/10
2.	Climatic chamber HERAEUS VM 04/35	2014/03	2016/03
3.	DC power supply R&S NGPE 40/40	2014/11	2017/11
4.	Spectrum analyser Tektronix RSA3408B	2015/12	2017/12
5.	Wideband Power sensor R&S NRP-Z81	2014/03	2016/03
6.	Tetra Radio test set IFR MI2968-M3	2015/01	2017/01

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	2014/03	2017/03
3.	Multi Device Controller EMCO 2090	N.A.	N.A.
4.	Double-ridge Guide Horn antenna 1-18 GHz SCHWARZBECK BBHA 9120 D	2013/11	2016/11
5.	EMI Test Receiver R&S ESU 26	2015/11	2017/11
6.	EMI Test Receiver R&S ESU 40	2014/02	2017/02
7.	RF pre-amplifier 10 MHz-6 GHz SCHWARZBECK BBV9743	2014/02	2015/02
8.	RF pre-amplifier 1-18 GHz Schwarzbeck BBV 9718	2014/02	2015/02

3: This information has been provided by the applicant.

Testing verdicts

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

FCC PART 90 / IC RSS-119 PARAGRAPH	VERDICT			
	NA	**P**	**F**	**NM**
Clause 90.207 / RSS-119 Clause 5.2: Modulation characteristics				NM[3]
Clause 90.209 / RSS-119 Clause 5.5: Occupied Bandwidth		P		
Clause 90.205 / RSS-119 Clause 5.4: RF output power		P		
Clause 90.210 / RSS-119 Clause 5.5, 5.8: Emission mask		P		
Clause 90.221: Adjacent channel power		P		
Clause 90.213 / RSS-119 Clause 5.3: Frequency stability		P		
Clause 90.210, 90.221 / RSS-119 Clause 5.8: Spurious emissions at antenna terminals		P		
Clause 90.210, 90.221 / RSS-119 Clause 5.8: Radiated emissions		P		
Clause 90.214 / RSS-119 Clause 5.9: Transient frequency behaviour		P		

3: see point “Remarks and comments”.

Appendix A – Test results

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TEST CONDITIONS

Power supply (V):

V_{nom} = 7.6 Vdc

V_{max} = 8.65 Vdc (*)

V_{min} = 6.6 Vdc (battery operating end point) (**)

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

(*): Declared by the applicant.

(**): Measured using a dummy battery supplied by the applicant.

Type of power supply = DC Voltage from rechargeable battery

Type of antenna = external connectable antenna

Nominal declared RF Output Power:

- 22 kHz bandwidth: 29 dBm (0.79 W)

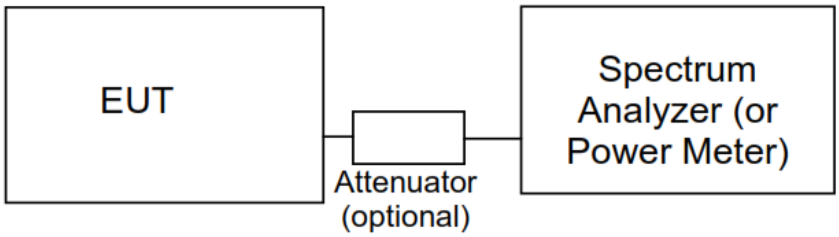
TEST FREQUENCIES:

FCC TETRA 22 kHz bandwidth		**450-470 MHz band**
Lowest channel		450 MHz
Middle channel		460 MHz 460.00225 MHz (see note)
Highest channel		470 MHz
IC TETRA 22 kHz bandwidth	**407-430 MHz band**	**450-470 MHz band**
Lowest channel	407 MHz	450 MHz
Middle channel	418.5 MHz 418.50225 MHz (see note)	460 MHz 460.00225 MHz (see note)
Highest channel	430 MHz	470 MHz

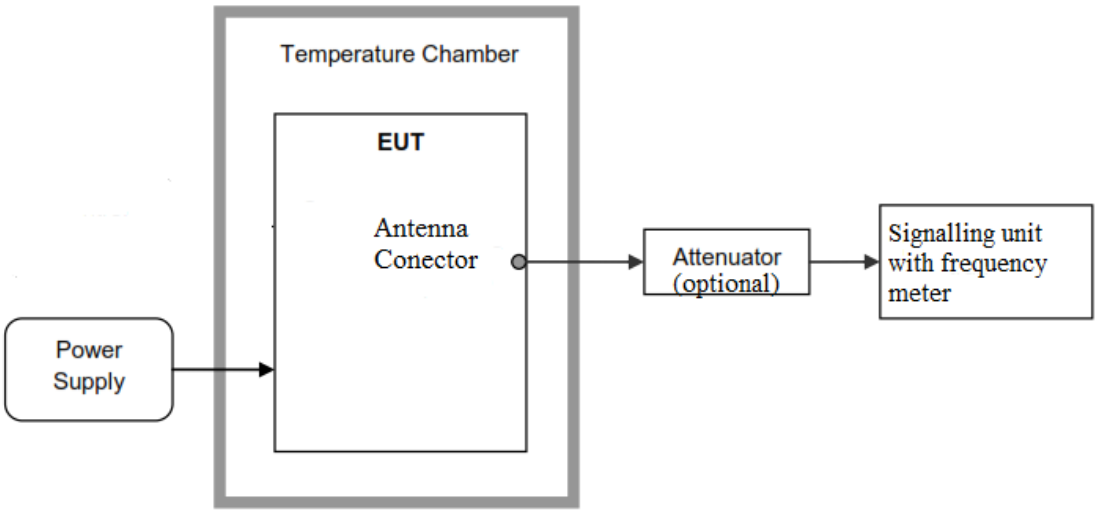
Note: Nominal frequency of the unmodulated carrier for Transient frequency behaviour tests.

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.



For frequency stability test the EUT was placed inside a climatic chamber and connected to the signalling unit with a built-in frequency meter using a low loss cable. A external 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.

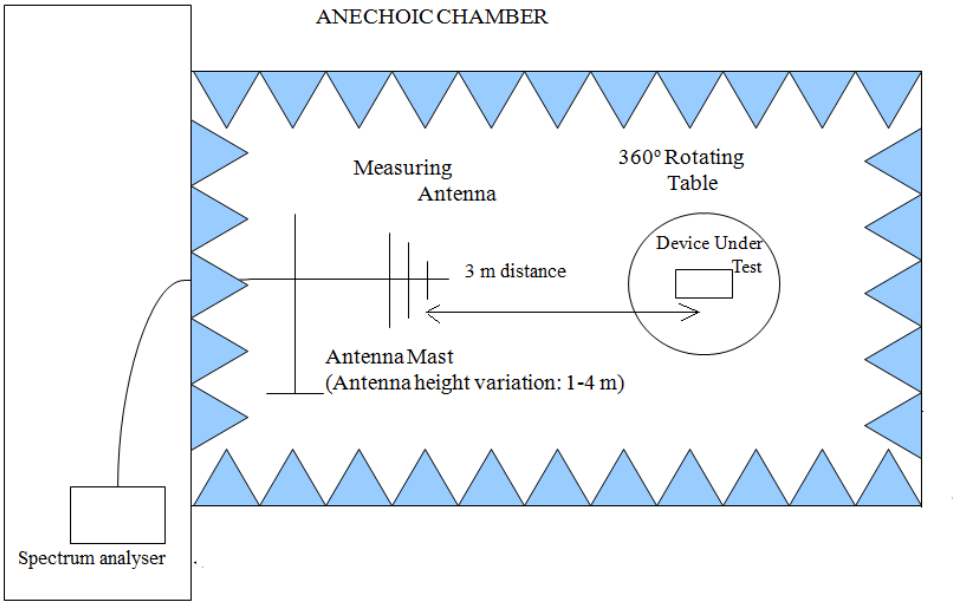
All radiated tests were performed in a semi-anechoic chamber. The measurement antenna is situated at a distance of 3 m for the frequency range 30 MHz-1000 MHz (30 MHz-1000 MHz Bilog antenna) and at a distance of 1m for the frequency range 1 GHz-5 GHz (1 GHz-18 GHz Double ridge horn antenna).

For radiated emissions in the range 1 GHz-5 GHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance. The sample is prepared so that transmits continuously when the batteries are connected.

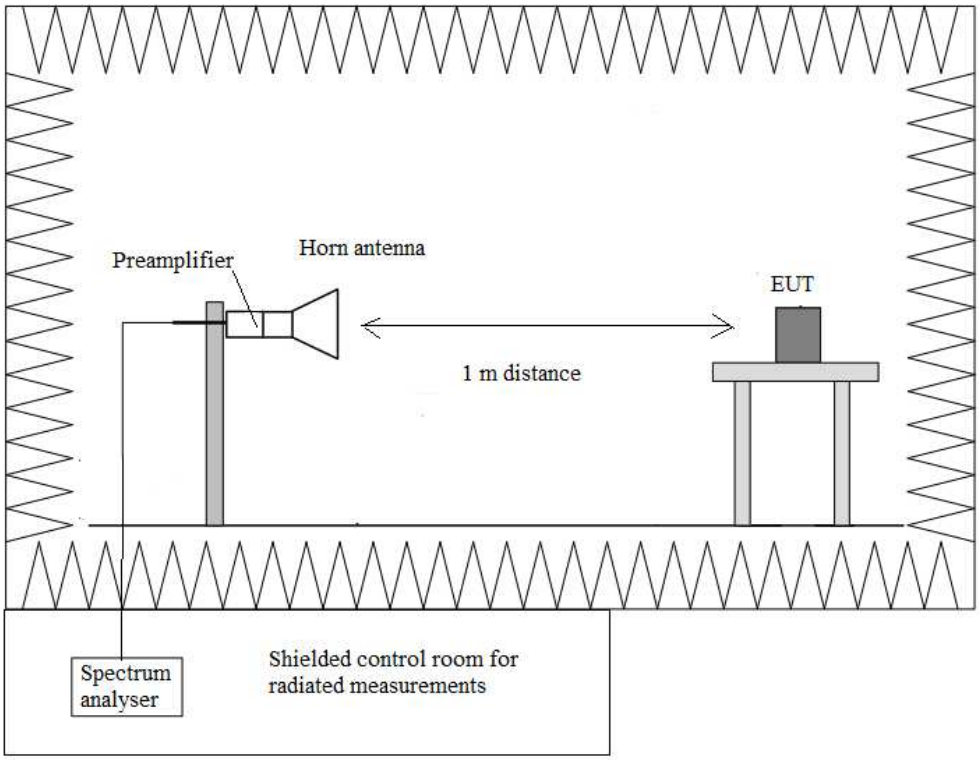
The equipment under test was set up on a non-conductive (wooden) platform 1.5 meter above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360º and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

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

Radiated measurements setup f < 1 GHz



Radiated measurements setup f > 1 GHz



Modulation Characteristics

SPECIFICATION

FCC §2.1047 and §90.207.

(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.

IC RSS-119 5.2.

Equipment that operates in the bands 768-776 MHz and 798-806 MHz shall use digital modulation. Mobile and portable transmitters that operate in these bands may have analogue modulation capability only as a secondary mode in addition to their primary digital mode. However, mobile and portable transmitters that operate only on the low-power channels as defined in SRSP-511 may employ any type of modulation.

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

TRANSMITTER LOW PASS FILTER

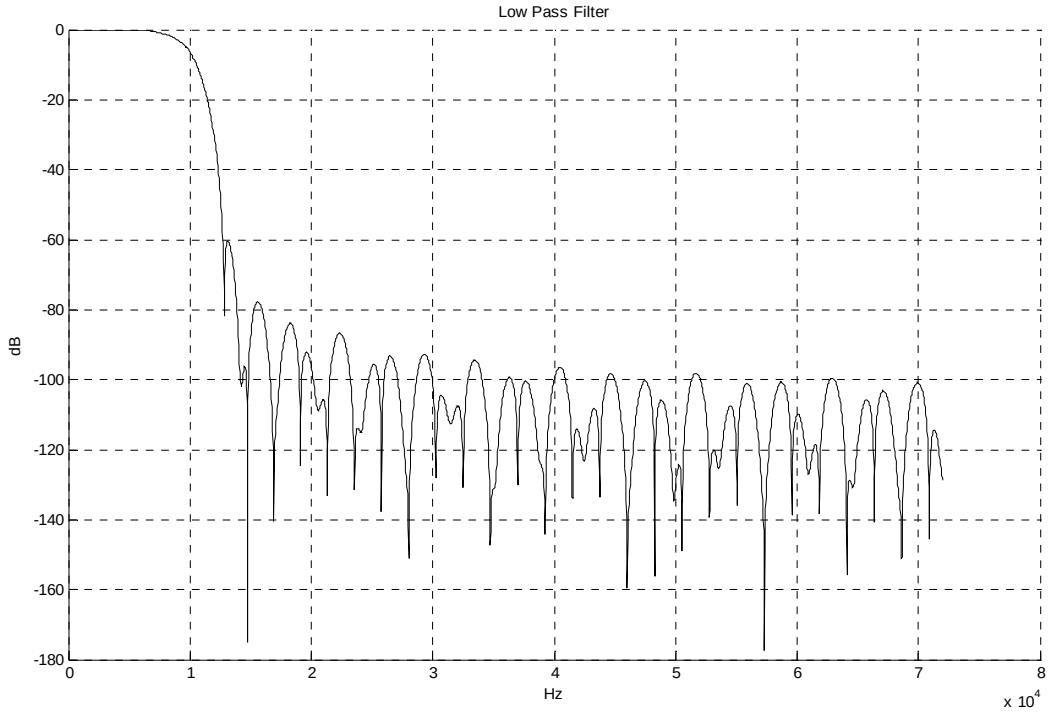
The modulation used is π/4-shifted Differential Quaternary Phase Shift Keying (π/4-DQPSK), with a modulation rate of 18 ksymbols/sec (36 Kbits/sec).

A root-raised-cosine filter (RRC) is used as transmitting and receiving filter in this digital communication system to perform matched filtering. The combined response of such two filters is that of the raised-cosine filter. The raised-cosine filter is a frequently used filter for pulse-shaping in digital modulation, known for its ability to minimize intersymbol interference (ISI).

The access scheme is TDMA with 4 physical channels per carrier.

The following graph shows the transfer function of the aforementioned filter.

Transmitter low pass filter for TETRA modulation.

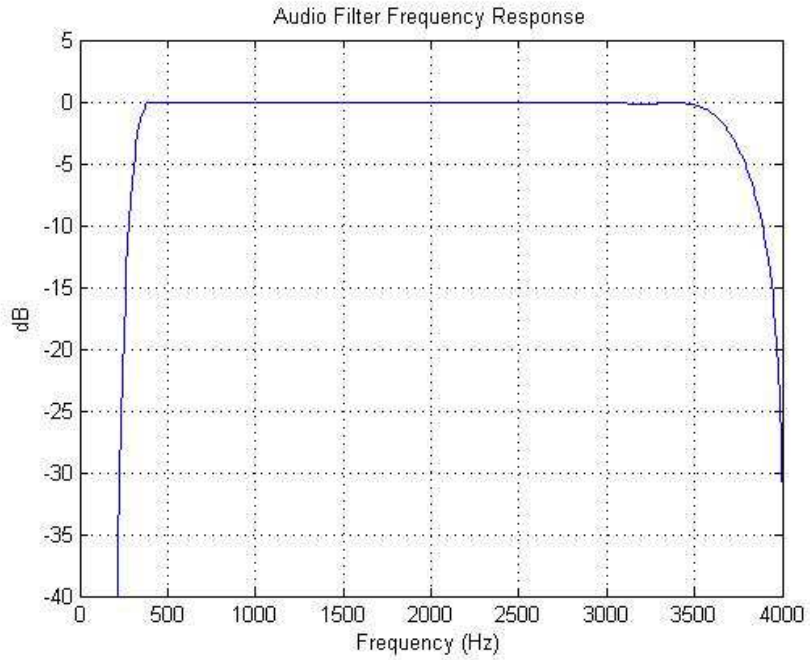


AUDIO LOW PASS FILTER

The modulation is limited by the data characteristics and its filters.

In the previous section the phase and quadrature branches (I and Q) are filtered with a root-raised-cosine filter (RRC) with a symbol rate of 18 k symbols/sec. Then, the signal is π/4-DQPSK modulated (see the plots before).

The signal processing is carried out using a TI TLV320AlC14K codec which contains the following low pass filter.


Audio Filter Frequency Response
dB
Frequency (Hz)
5
0
-5
-10
-15
-20
-25
-30
-35
-40
0
500
1000
1500
2000
2500
3000
3500
4000

Occupied Bandwidth

SPECIFICATION

FCC §2.1049, §90.209.

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 limits of § 90.221.

RSS-Gen 6.6, RSS-119 §5.5.

Frequency Band (MHz)	**Related SRSP for Channelling Plan and e.r.p.**	**Channel Spacing (kHz)**	**Authorized Bandwidth (kHz)**
406.1-430 and 450-470	SRSP-501	25	20 22

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 analyser E4440A.

RESULTS (see next plots)

TETRA 22 kHz. IC 407-430 MHz band.

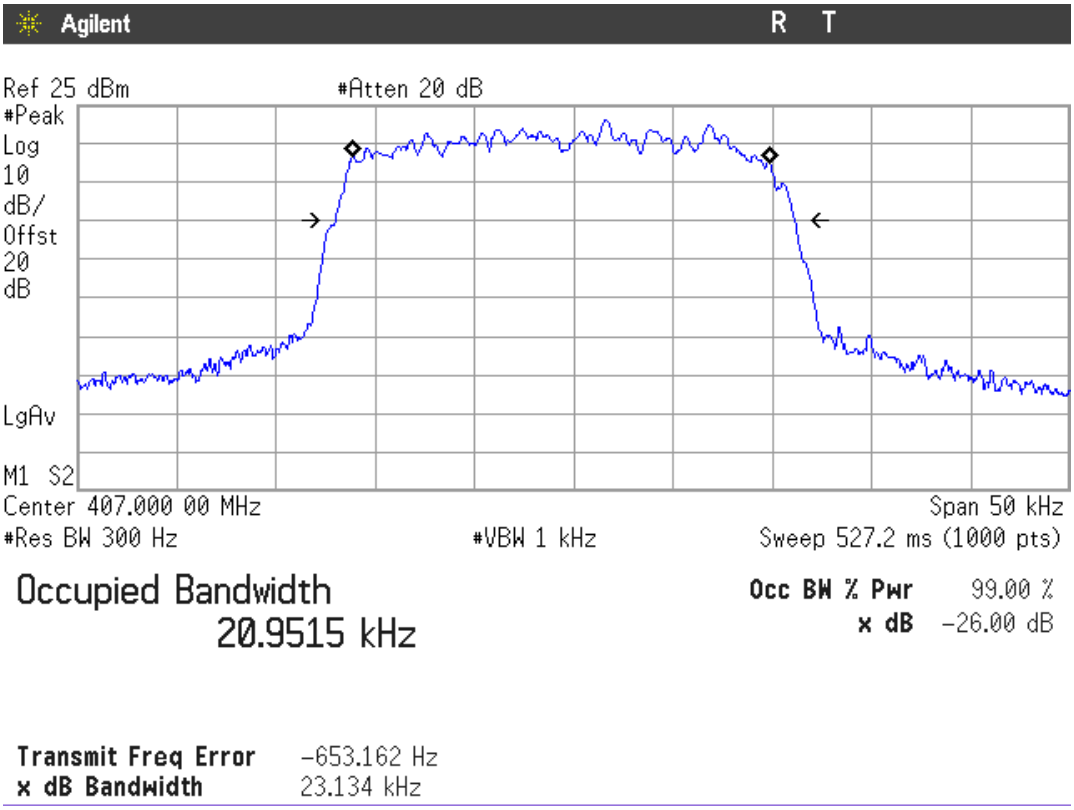
Channel	Lowest	Middle	Highest
99% Occupied bandwidth (kHz)	20.952	20.928	20.941
-26 dBc bandwidth (kHz)	23.134	23.167	23.138
Measurement uncertainty (kHz)	<±0.17		

TETRA 22 kHz. FCC 450-470 MHz band and IC 450-470 MHz band.

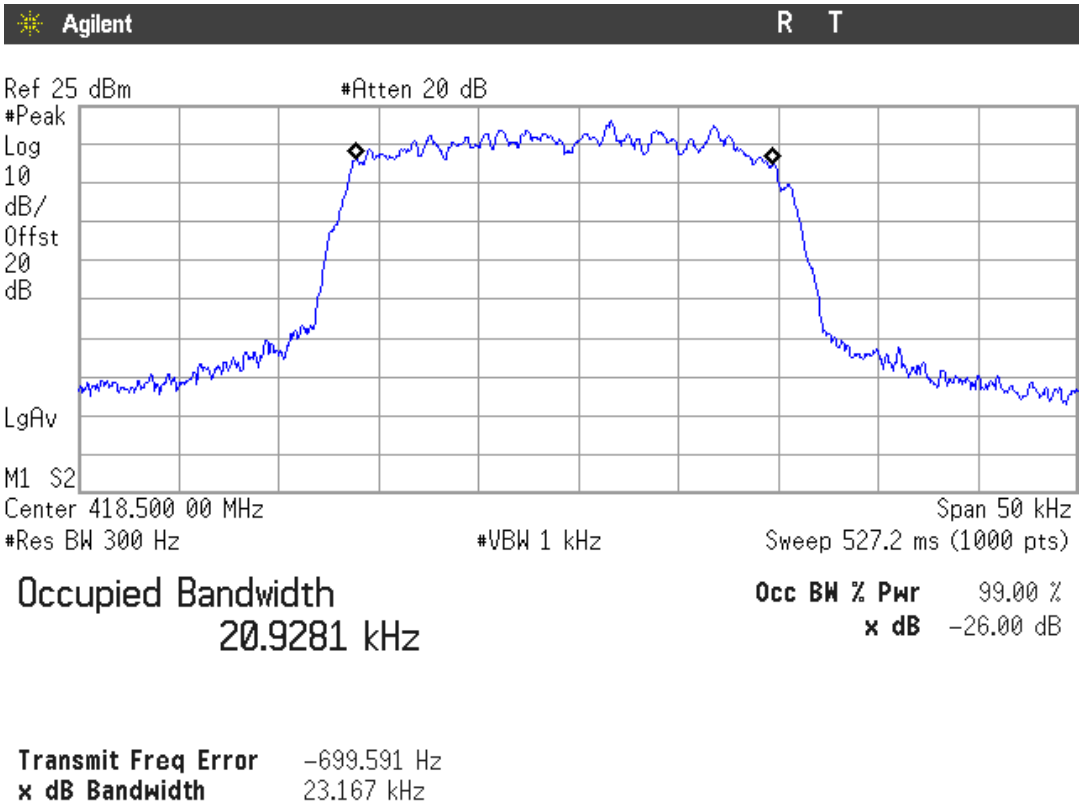
Channel	Lowest	Middle	Highest
99% Occupied bandwidth (kHz)	20.955	20.954	20.935
-26 dBc bandwidth (kHz)	23.142	23.160	23.161
Measurement uncertainty (kHz)	<±0.17		

Verdict: PASS

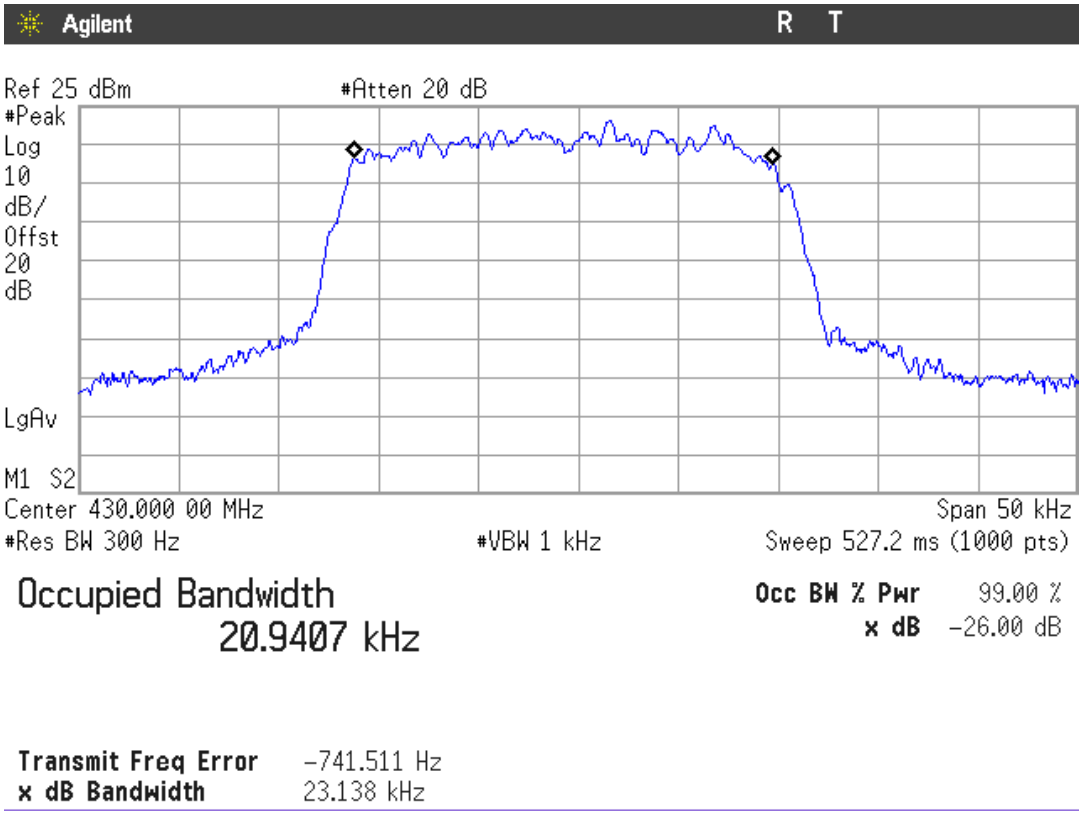
TETRA 22 kHz. IC 407-430 MHz band.
Lowest Channel



Middle Channel

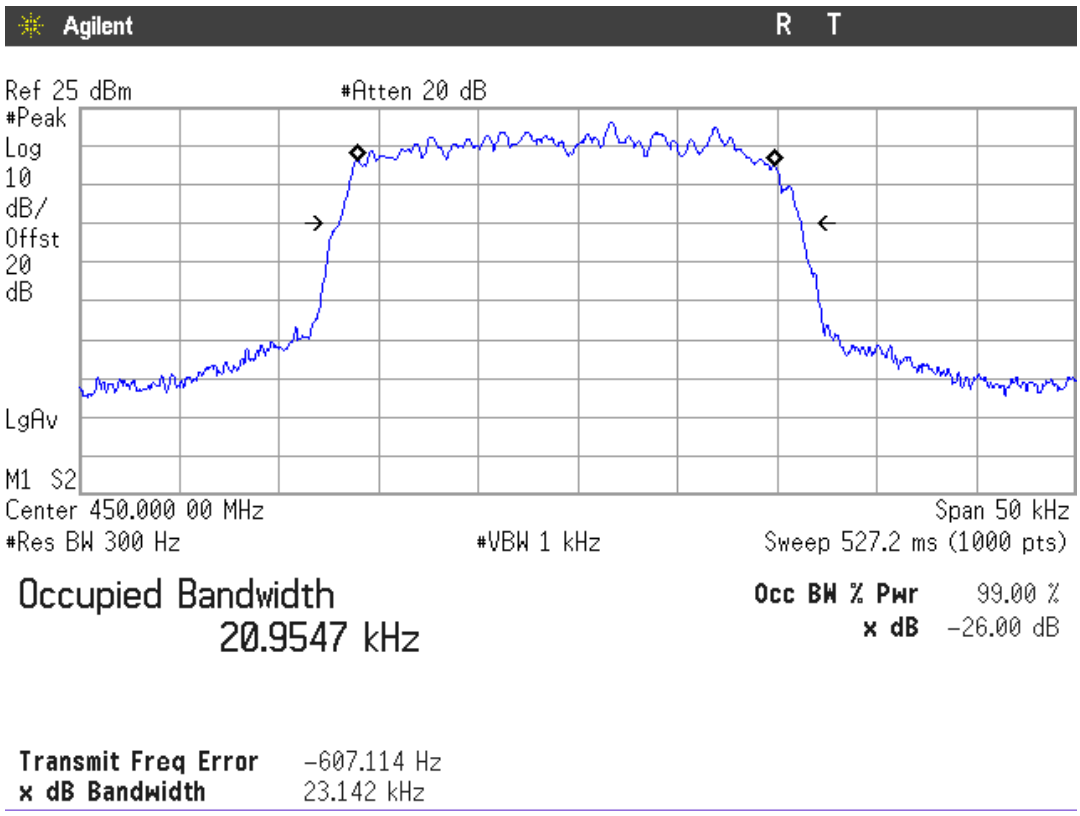


Highest Channel

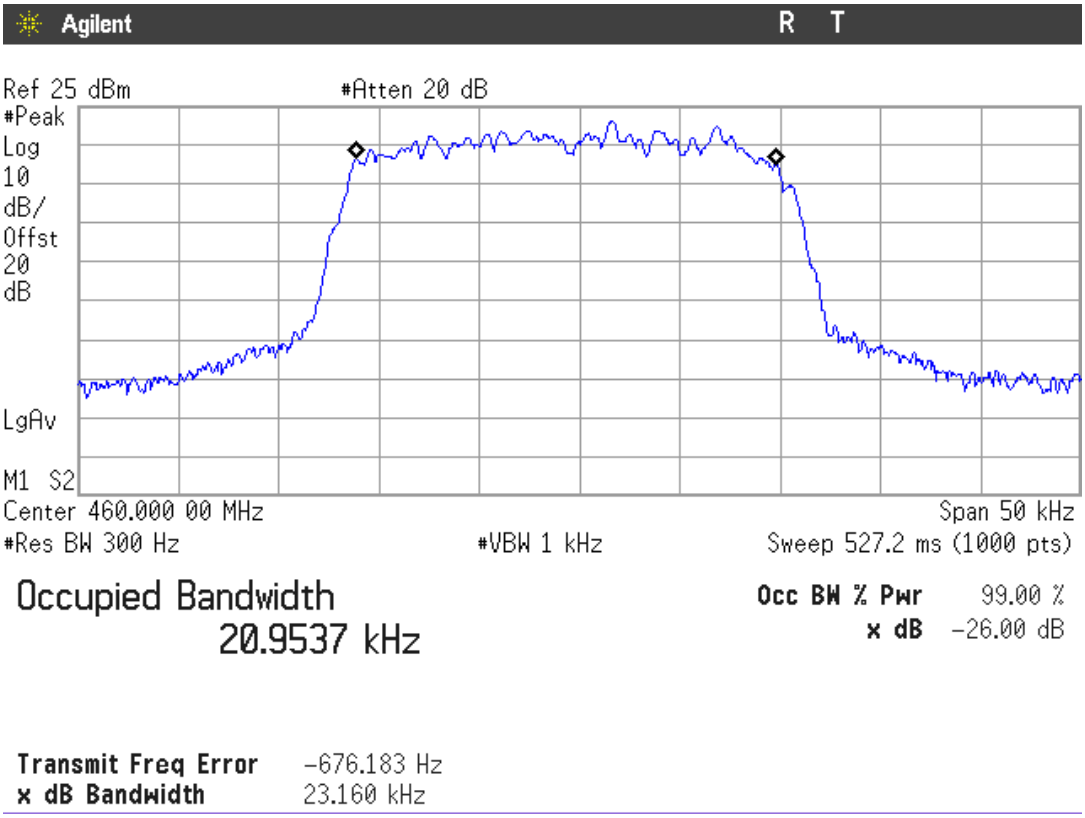


TETRA 22 kHz. FCC 450-470 MHz band and IC 450-470 MHz band.

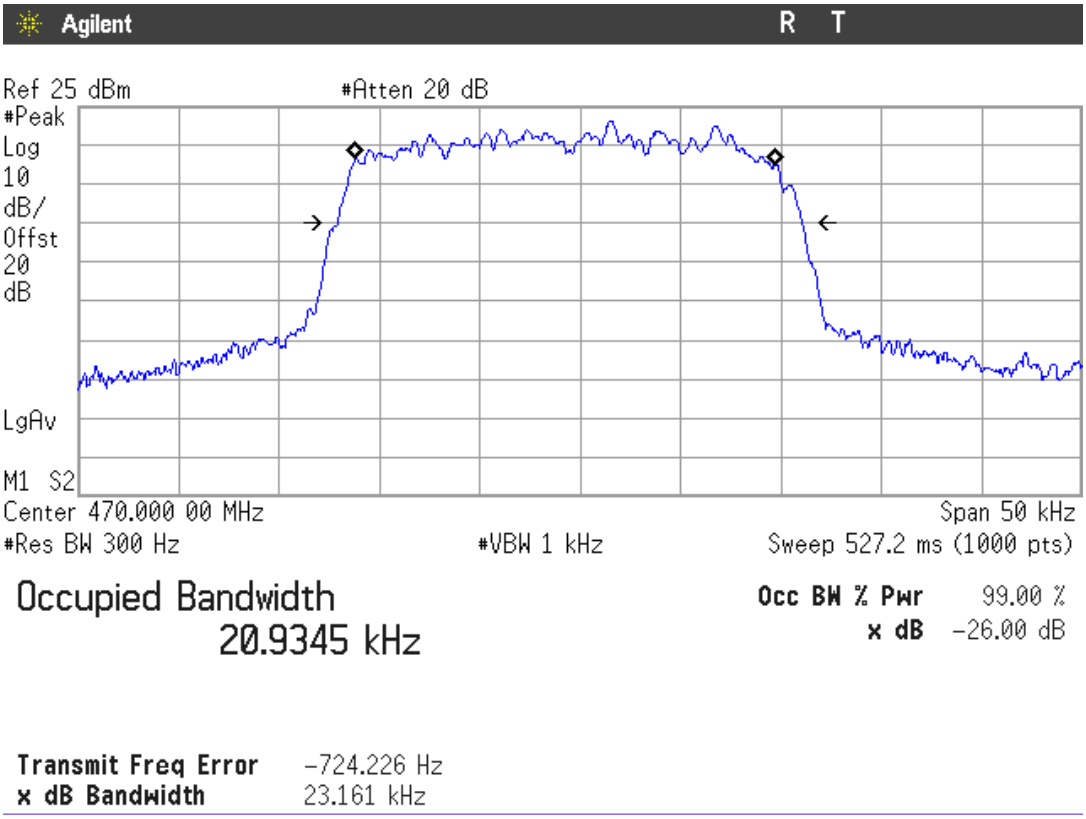
Lowest Channel



Middle Channel



Highest Channel



RF Output Power (conducted)

SPECIFICATION

FCC §2.1046, §90.205(h)

RSS-Gen 6.12, RSS-119 4.1 and 5.4.

The output power shall be within ±1.0 dB of the manufacturer's rated power listed in the equipment specifications. Additionally the power shall not exceed the limits in the following table:

Frequency Band (MHz)	Transmitter Output Power (W)	
	Base/Fixed Equipment	Mobile Equipment
406.1-430 and 450-470	110	60

METHOD

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.

RESULTS

RF declared rated Average Power: 28.75 dBm (0.75 W) for 22 kHz bandwidth.

TETRA. 22 kHz Bandwidth	Frequency (MHz)	Maximum average power (dBm)	Maximum deviation (dB)
IC 407-430 MHz band	407	28.77	0.02
	418.5	28.65	-0.10
	430	28.80	0.05
IC 450-470 MHz band	450	28.63	-0.12
	460	28.71	-0.04
	470	28.79	0.04
Measurement uncertainty (dB)		<±0.33	

TETRA. 22 kHz Bandwidth	Frequency (MHz)	Maximum average power (dBm)	Maximum peak power (dBm)
FCC 450-470 MHz band	450	28.63	31.60
	460	28.71	31.70
	470	28.79	31.78
Measurement uncertainty (dB)		<±0.33	

Verdict: PASS

Emission Mask

SPECIFICATION

RSS-119 §5.5. and 5.8.10.

Frequency Band (MHz)	Related SRSP for Channelling Plan and e.r.p.	Channel Spacing (kHz)	Authorized Bandwidth (kHz)	Spectrum Masks for equipment with Audio Filter	Spectrum Masks for equipment Without Audio Filter
406.1-430 and 450-470	SRSP-501	25	22	Y	Y

Table 17 - Emission Mask Y

Displacement Frequency, fd (kHz)	Minimum Attenuation (dB)	Resolution Bandwidth (Hz)
12.375 < fd ≤ 13.975	whichever is the lesser attenuation: 30 + 16.67(fd–12.375) or 55 + 10 log10(p)	Specified in Section 4.2.2
fd > 13.975	whichever is the lesser attenuation: 57 or 55 + 10 log10(p)	Specified in Section 4.2.2

METHOD

The emission masks were measured at the RF output terminals of the EUT using an attenuator and a spectrum analyser with a built-in spectrum mask measurement function. Reference to the unmodulated carrier power refers to the total output power contained in the occupied bandwidth when the transmitter is modulated with signals representative of those encountered in a real system operation.

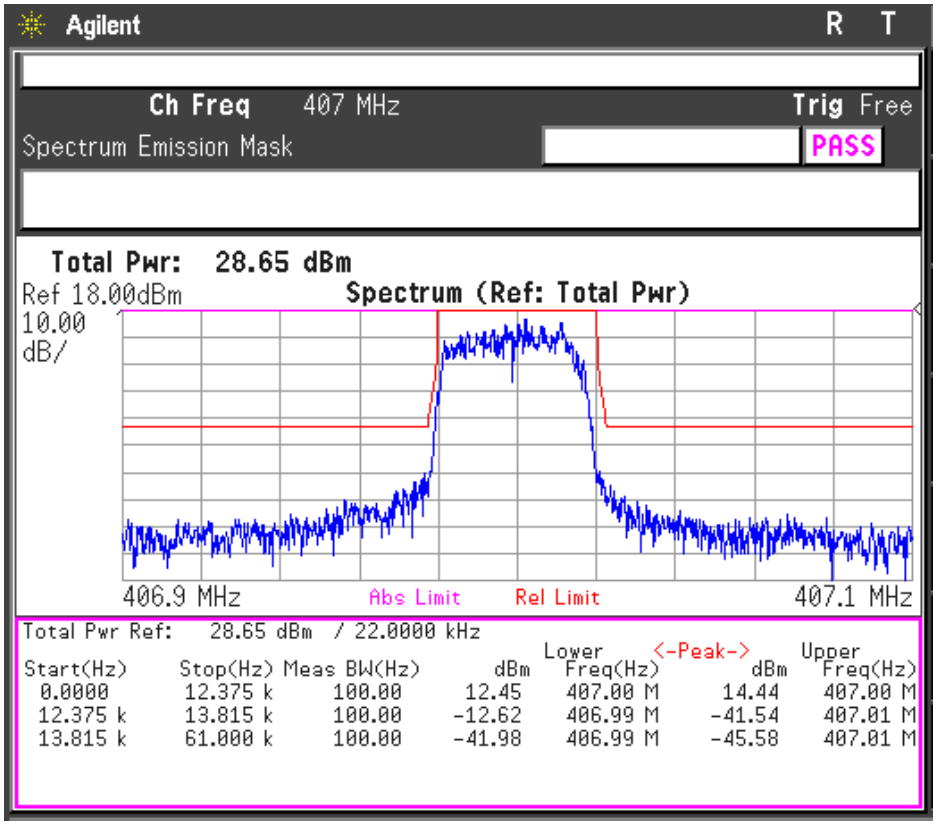
RESULTS (see next plots)

Measurement uncertainty (dB)	<±2.03

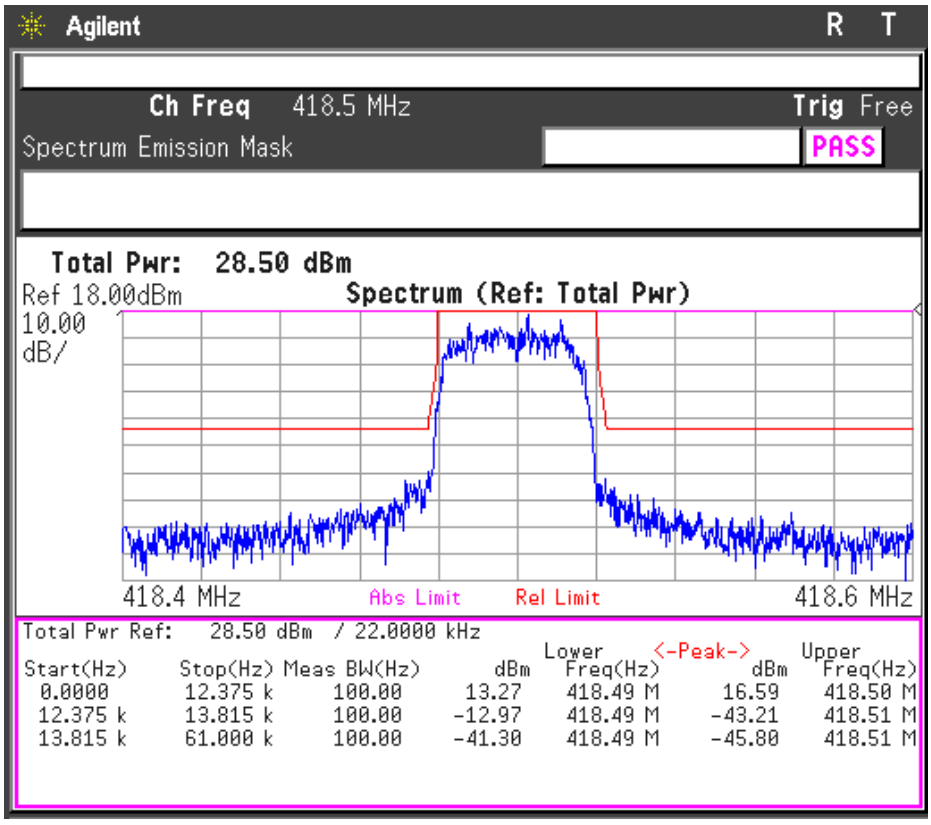
Verdict: PASS

Emission Mask Y. IC: 407-430 MHz. TETRA 22 kHz Bandwidth.

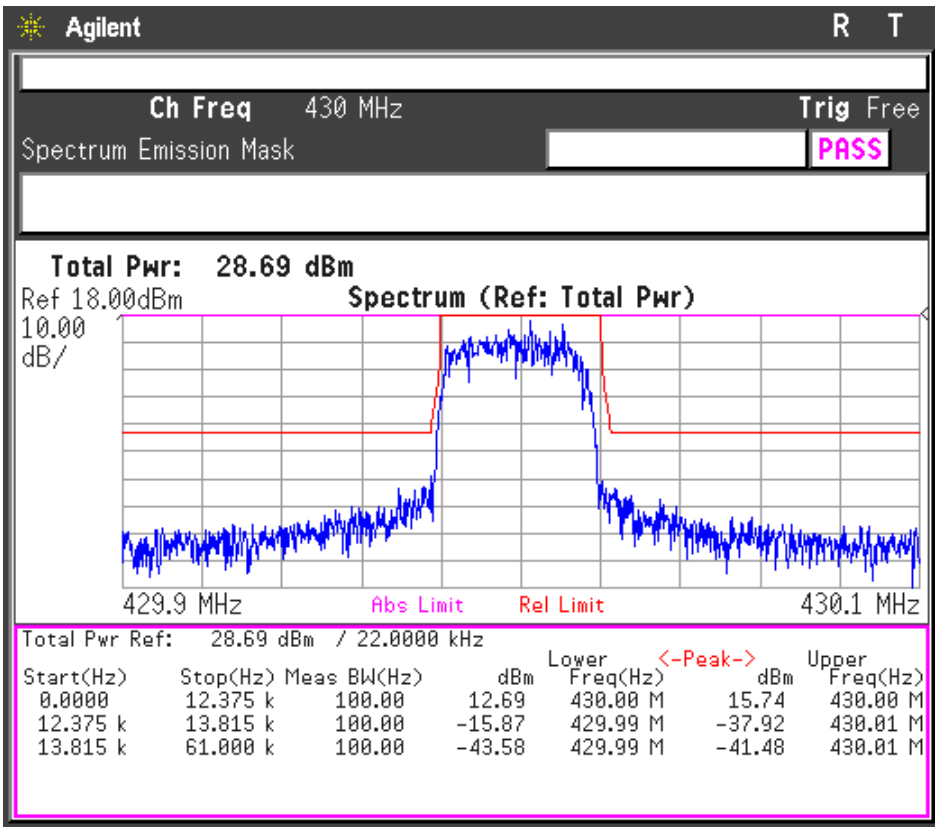
Lowest Channel



Middle Channel

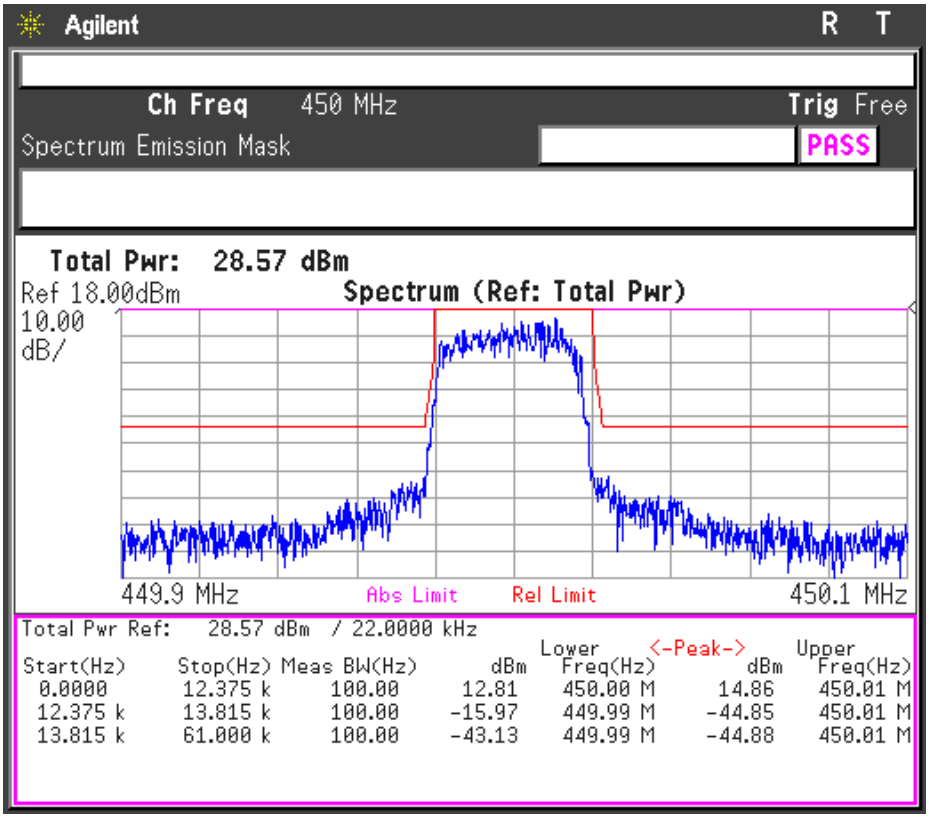


Highest Channel

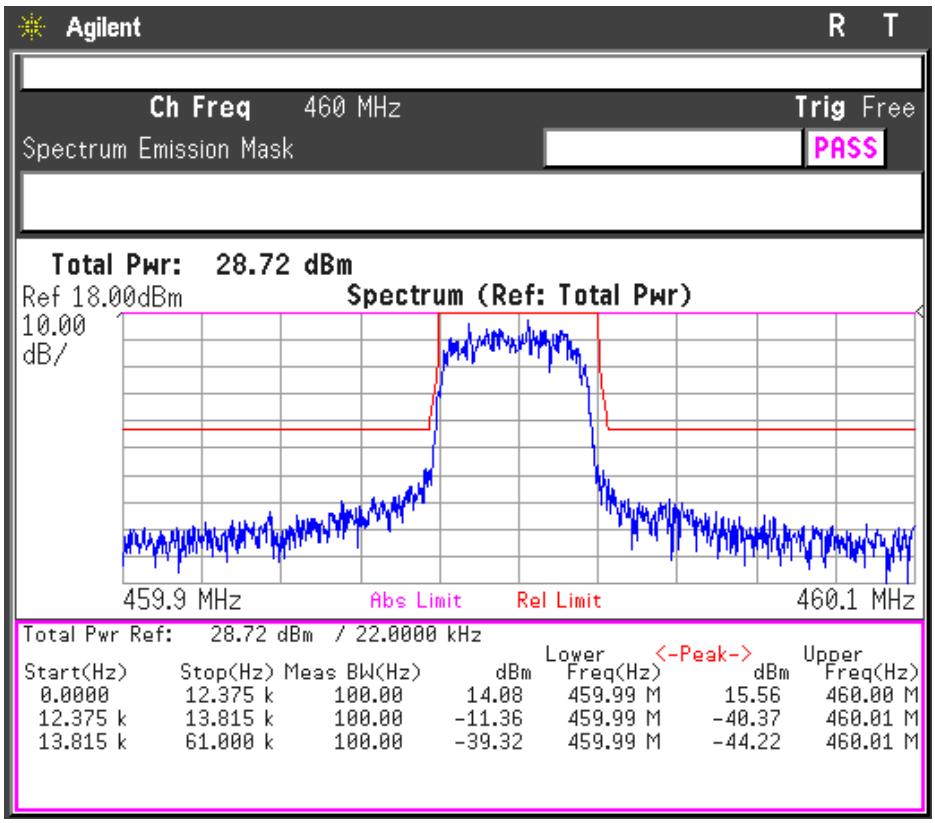


IC: 450-470 MHz. TETRA 22 kHz Bandwidth.

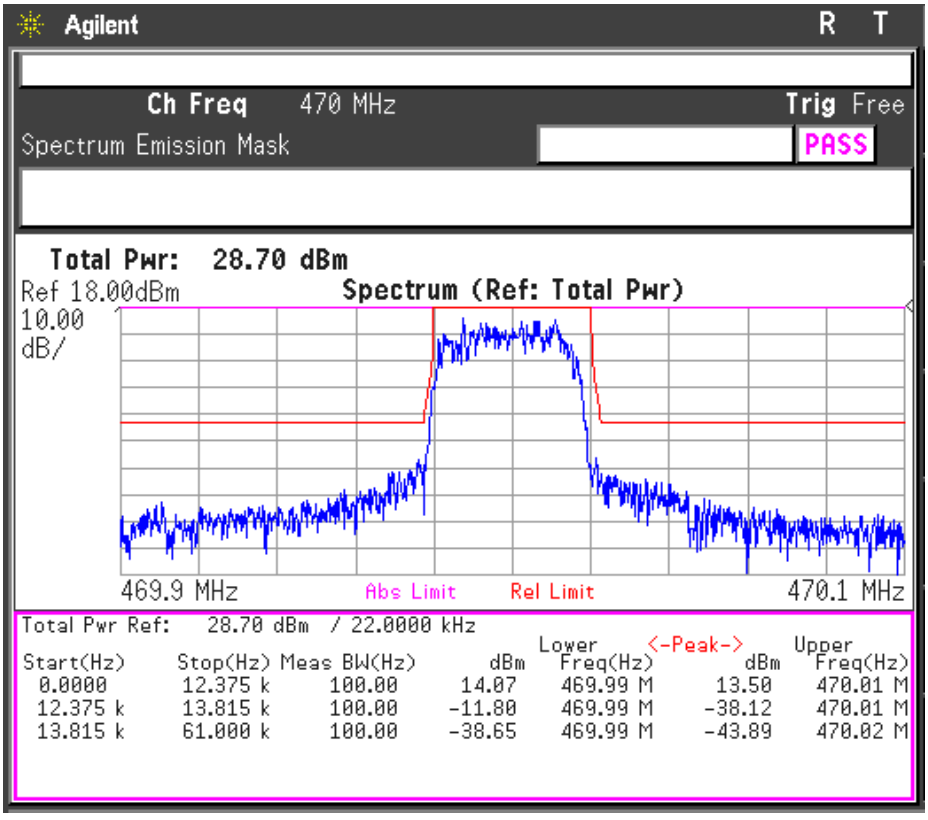
Lowest Channel



Middle Channel



Highest Channel



Adjacent channel power

SPECIFICATION

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)(1) 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

(2) In any case, no requirement in excess of -36 dBm shall apply.

(d) On any frequency removed from the assigned frequency by more than 75 kHz, the attenuation of any emission must be at least 43 + 10 log (Pwatts) dB.

METHOD

The Adjacent Channel Power measurements were made at the RF output terminals of the EUT using an attenuator and a spectrum analyser with a built-in adjacent channel power (ACP) measurement function.

RESULTS. See next plots.

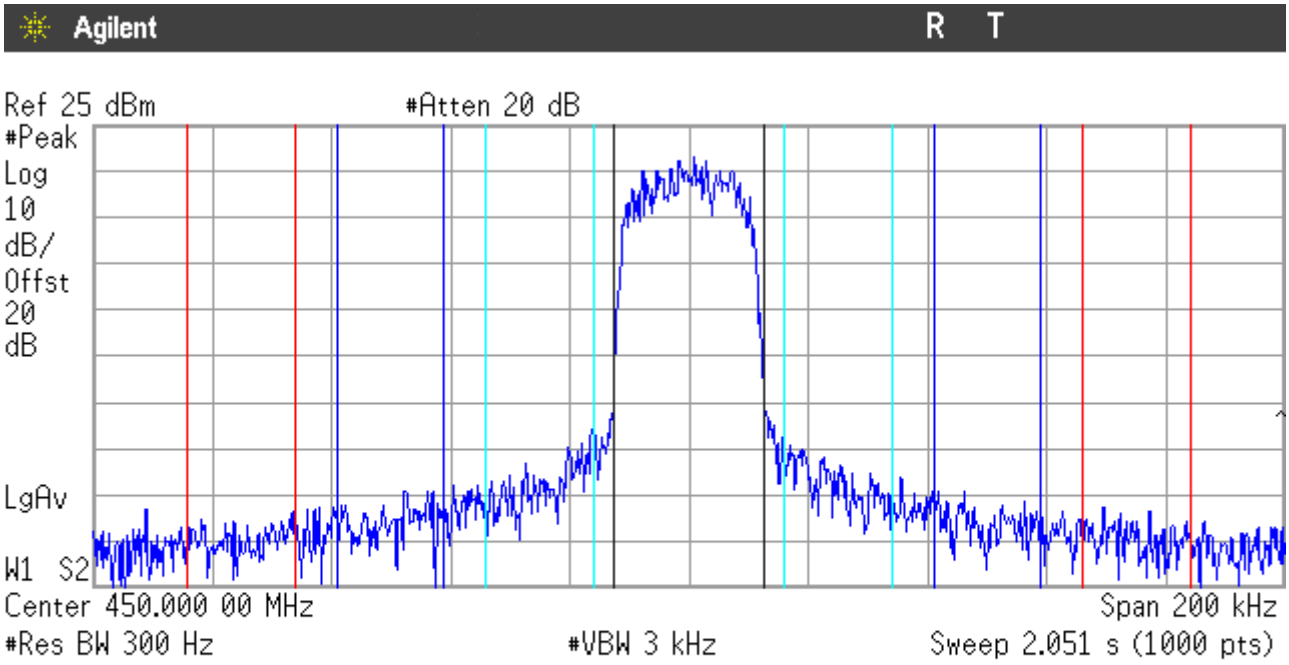
Declared maximum output power: 29 dBm (0.79 W).

Measurement uncertainty (dB)	<±2.03

Verdict: PASS

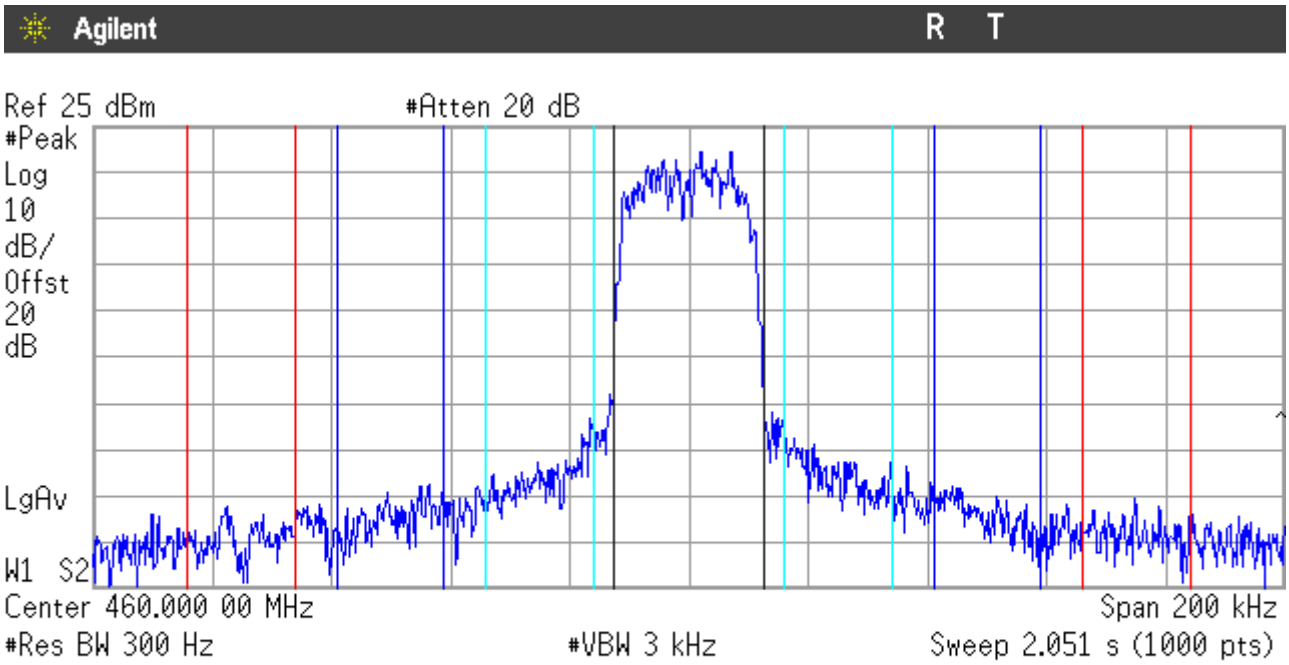
TETRA, 22 kHz. FCC 450-470 MHz band.

Lowest Channel



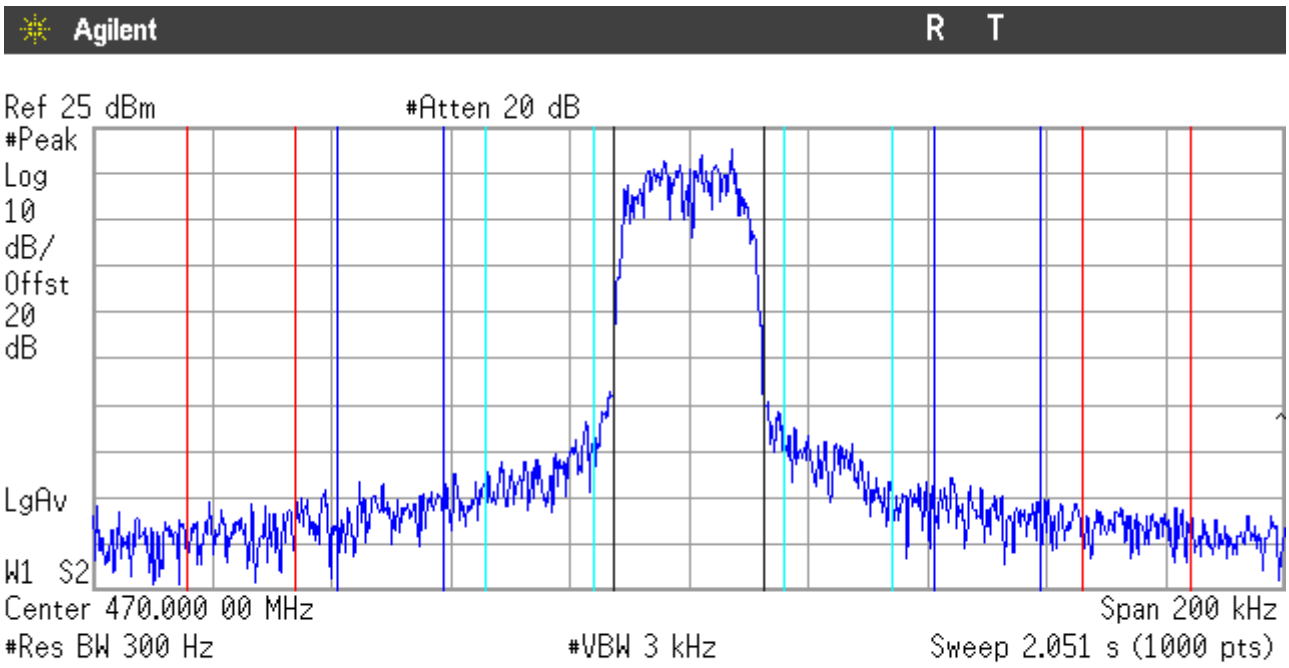
RMS Results	Freq Offset	Ref BW	dBc	Lower dBm	dBc	Upper dBm
Carrier Power	25.00 kHz	18.00 kHz	-63.40	-32.64	-63.80	-33.04
30.76 dBm /	50.00 kHz	18.00 kHz	-72.83	-42.07	-73.22	-42.45
25.0000 kHz	75.00 kHz	18.00 kHz	-77.07	-46.31	-76.69	-45.93

Middle Channel



RMS Results	Freq Offset	Ref BW	dBc	Lower dBm	dBc	Upper dBm
Carrier Power	25.00 kHz	18.00 kHz	-62.78	-30.86	-63.08	-31.16
31.92 dBm /	50.00 kHz	18.00 kHz	-72.96	-41.03	-72.25	-40.33
25.0000 kHz	75.00 kHz	18.00 kHz	-77.56	-45.64	-76.88	-44.96

Highest Channel



RMS Results

	Freq Offset	Ref BW	dBc	Lower dBm	dBc	Upper dBm
Carrier Power	25.00 kHz	18.00 kHz	-62.06	-30.11	-60.97	-29.02
31.95 dBm /	50.00 kHz	18.00 kHz	-71.57	-39.63	-71.33	-39.38
25.0000 kHz	75.00 kHz	18.00 kHz	-75.66	-43.71	-75.10	-43.15

Frequency Stability

SPECIFICATION

FCC §2.1055, §90.213:

(a) Unless noted elsewhere, transmitters used in the services governed by this part must have a minimum frequency stability as specified in the following table.

Frequency range (MHz)	Mobile stations	
	Over 2 watts output power	2 watts or less output power
421-512	[8]5 ppm	[8]5 ppm

Note 8: In the 421-512 MHz band, mobile stations designed to operate with a 12.5 kHz channel bandwidth must have a frequency stability of 2.5 ppm. Mobile stations designed to operate with a 6.25 kHz channel bandwidth must have a frequency stability of 1.0 ppm.

RSS-Gen 6.11, RSS-119 §5.3.

The carrier frequency shall not depart from the reference frequency in excess of the values given in the following table:

Frequency Band (MHz)	Channel Bandwidth (kHz)	Frequency Stability (ppm)	
		Mobile stations	
		Output power > 2 watts	Output power ≤ 2 watts
406.1-430 and 450-470 (Note 6)	25 (Note 2)	1	1
	25	5	5

Note 2: This provision is for digital equipment with a channel spacing of 25 kHz and an occupied bandwidth greater than 20 kHz. The mobile station's frequency stability values given in Table 1 are for mobile, portable and control transmitters using automatic frequency control (AFC) to lock onto the base station signal. When the mobile, portable and control transmitters are operating without using AFC to lock onto the base station signal, the frequency stability limit shall be better than 1 kHz and the equipment's unwanted emissions measured with maximum frequency shift shall still comply with emission mask Y (Section 5.8.10) at nominal carrier frequency.

Note 6: Control stations may operate with the frequency tolerance specified for associated mobile frequencies.

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: A hand-held device that is only capable of operating using internal batteries shall be tested at the battery`s nominal voltage, and again at the battery's operating end-point voltage, which must be specified by the equipment manufacturer.

The EUT is connected to the Tetra Radio test set IFR MI2968-M3 and locked to a TETRA T1 signal provided by the Tetra Radio test set. The frequency error is measured with the built-in frequency meter of the Tetra Radio test set.

RESULTS

Channel bandwidth: 25 kHz.

Occupied bandwidth > 20 kHz.

Output power < 1 W.

TETRA 22 kHz. IC 407-430 MHz band. Middle Channel: 418.5 MHz.

Voltage (Vdc)	**Temperature (ºC)**	**Frequency Error (Hz)**	**Frequency Error (ppm)**
Frequency stability with Temperature			
7.60	+50	-267.8	-0.63990
	+40	-289.3	-0.69128
	+30	-304.2	-0.72688
	+20	-298.0	-0.71207
	+10	-271.9	-0.64970
	0	-295.6	-0.70633
	-10	-148.3	-0.35436
	-20	-354.1	-0.84612
	-30	-404.5	-0.96655
Frequency stability with Supply Voltage			
6.60	20	-286.3	-0.68411
8.65	20	-232.7	-0.55603

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

TETRA 22 kHz. IC 450-470 MHz band. Middle Channel: 460 MHz.

Voltage (Vdc)	Temperature (ºC)	Frequency Error (Hz)	Frequency Error (ppm)
Frequency stability with Temperature			
7.60	+50	-288.9	-0.62804
	+40	-301.3	-0.65500
	+30	-243.0	-0.52826
	+20	-210.5	-0.45761
	+10	-147.8	-0.32130
	0	-230.5	-0.50109
	-10	-187.8	-0.40826
	-20	-373.7	-0.81239
	-30	-411.6	-0.89478
Frequency stability with Supply Voltage			
6.60	20	-216.6	-0.47087
8.65	20	-174.7	-0.37978

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

TETRA 22 kHz. FCC 450-470 MHz band. Middle Channel: 460 MHz.

Voltage (Vdc)	Temperature (ºC)	Frequency Error (Hz)	Frequency Error (ppm)
Frequency stability with Temperature			
7.60	+50	-288.9	-0.62804
	+40	-301.3	-0.65500
	+30	-243.0	-0.52826
	+20	-210.5	-0.45761
	+10	-147.8	-0.32130
	0	-230.5	-0.50109
	-10	-187.8	-0.40826
	-20	-373.7	-0.81239
	-30	-411.6	-0.89478
Frequency stability with Supply Voltage			
6.60	20	-216.6	-0.47087
8.65	20	-174.7	-0.37978

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

Verdict: PASS

Spurious emissions at antenna terminals

SPECIFICATION

FCC §2.1051, §90.221 (see Adjacent channel power tests).

(d) On any frequency removed from the assigned frequency by more than 75 kHz, the attenuation of any emission must be at least 43 + 10 log (P_{watts}) dB.

RSS-119 §5.5. and 5.8.10 (see Emission Mask test).

Table 17 - Emission Mask Y

Displacement Frequency, fd (kHz)	Minimum Attenuation (dB)	Resolution Bandwidth (Hz)
12.375 < fd ≤ 13.975	whichever is the lesser attenuation: 30 + 16.67(fd–12.375) or 55 + 10 log10(p)	Specified in Section 4.2.2
fd > 13.975	whichever is the lesser attenuation: 57 or 55 + 10 log10(p)	Specified in Section 4.2.2

METHOD

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 10 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.

RESULTS (see plots in next pages)

TETRA 22 kHz bandwidth. IC 407-430 MHz bands.

1. CHANNEL: LOWEST

No spurious signals were found in all the range.

2. CHANNEL: MIDDLE

No spurious signals were found in all the range.

3. CHANNEL: HIGHEST

No spurious signals were found in all the range.

TETRA 22 kHz bandwidth. FCC 450-470 MHz and IC 450-470 MHz bands.

1. CHANNEL: LOWEST

No spurious signals were found in all the range.

2. CHANNEL: MIDDLE

No spurious signals were found in all the range.

3. CHANNEL: HIGHEST

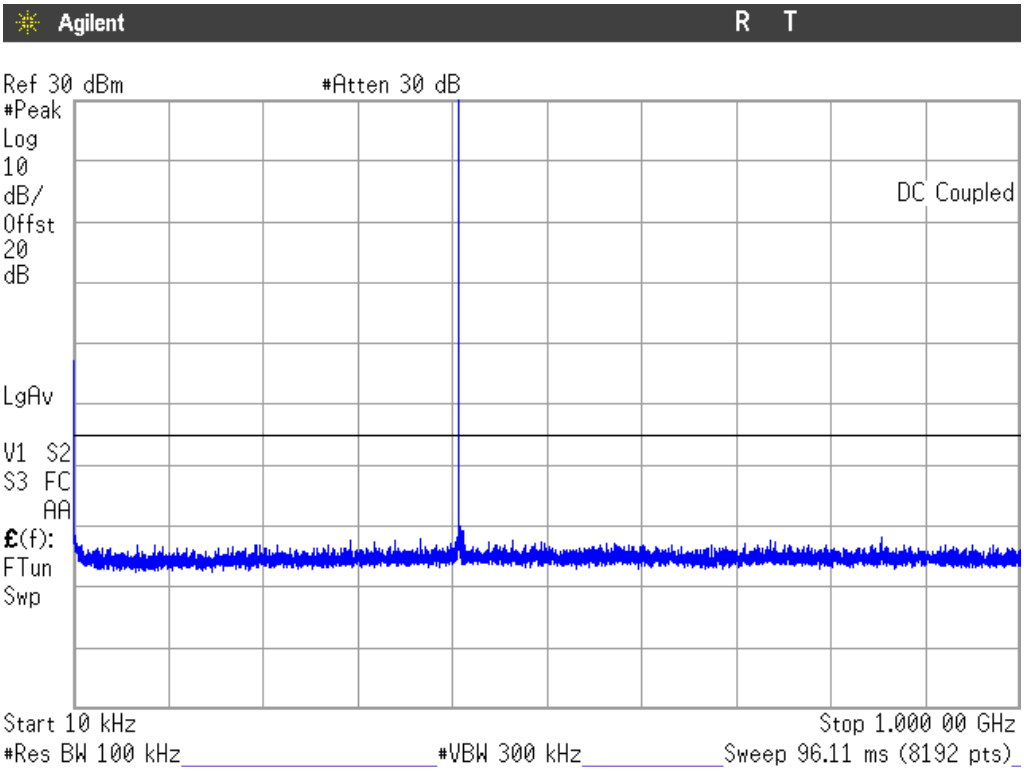
No spurious signals were found in all the range.

Verdict: PASS

Frequency range 10 kHz to 1000 MHz.

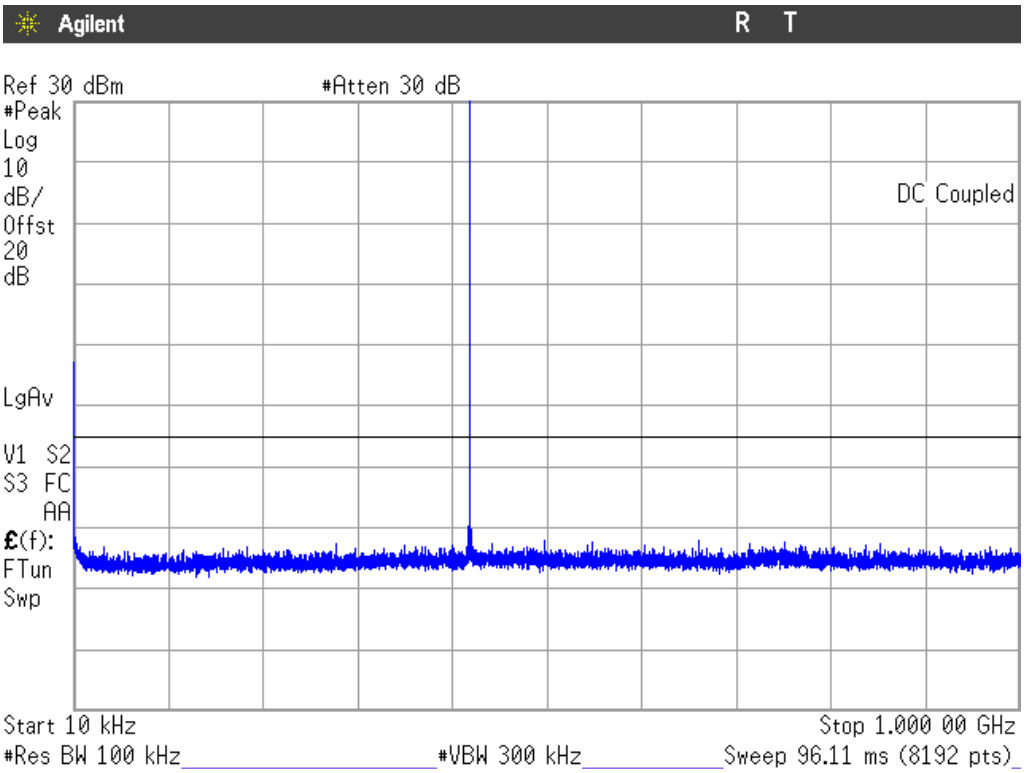
TETRA 22 kHz bandwidth. IC 407-430 MHz bands.

1. CHANNEL: LOWEST. 407 MHz.



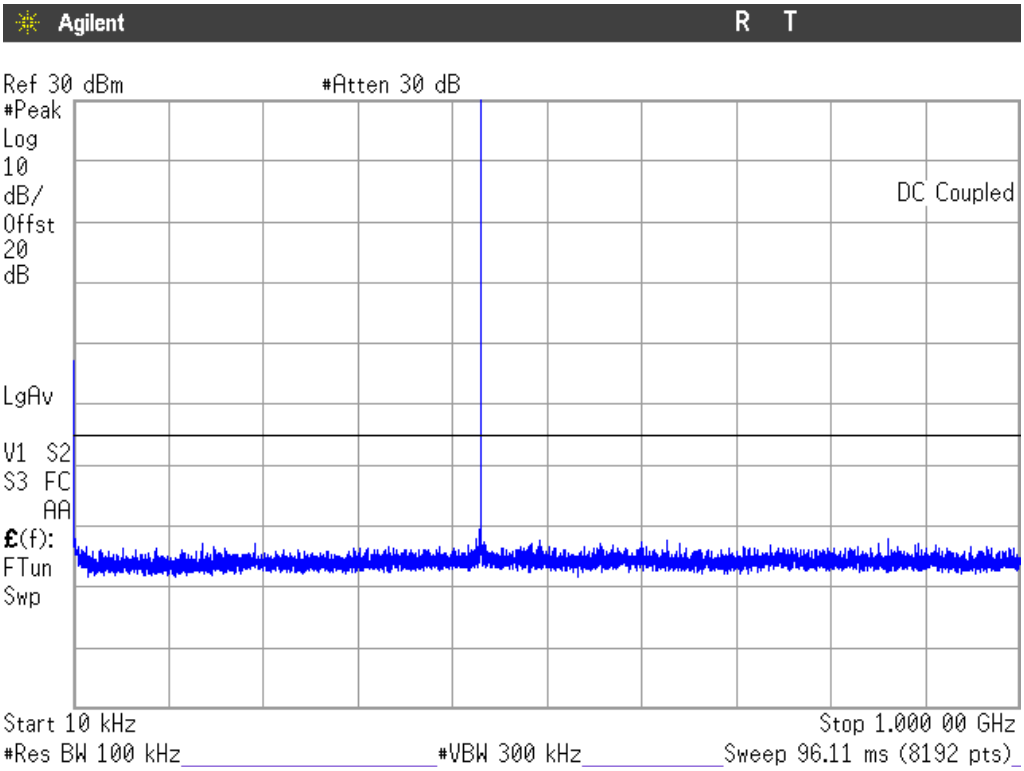
Note: The peak above the limit is the carrier frequency.

2. CHANNEL: MIDDLE. 418.5 MHz.



Note: The peak above the limit is the carrier frequency.

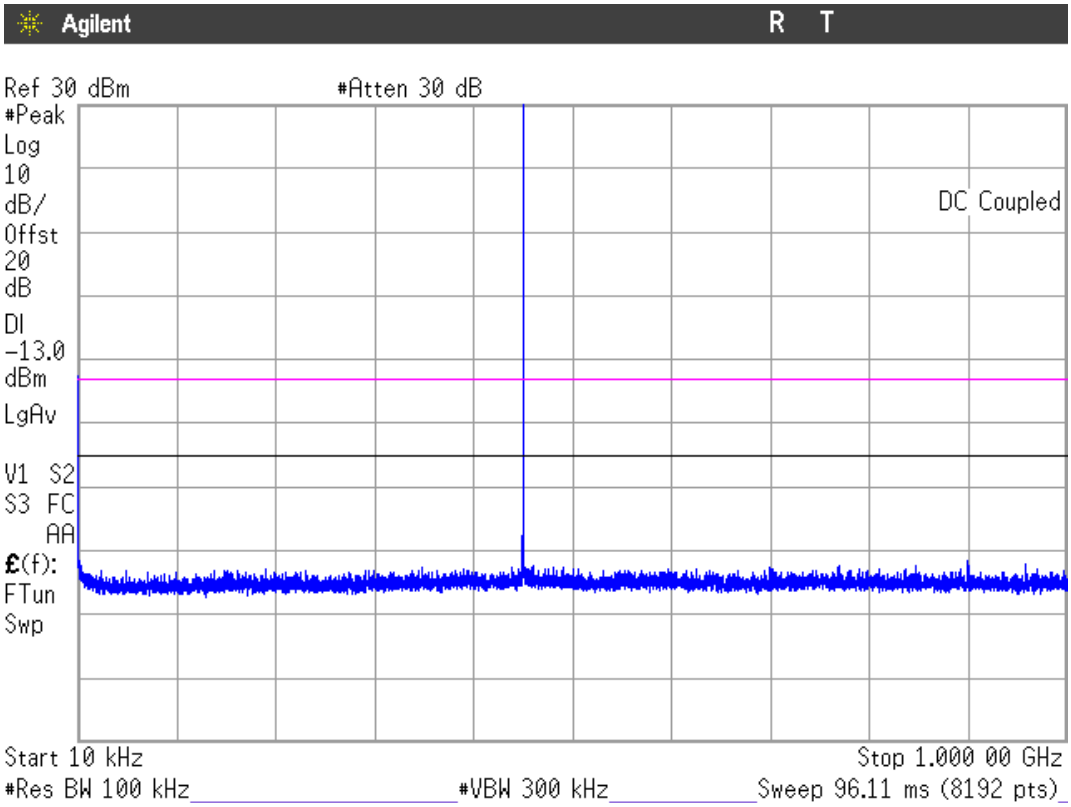
3. CHANNEL: HIGHEST. 430 MHz.



Note: The peak above the limit is the carrier frequency.

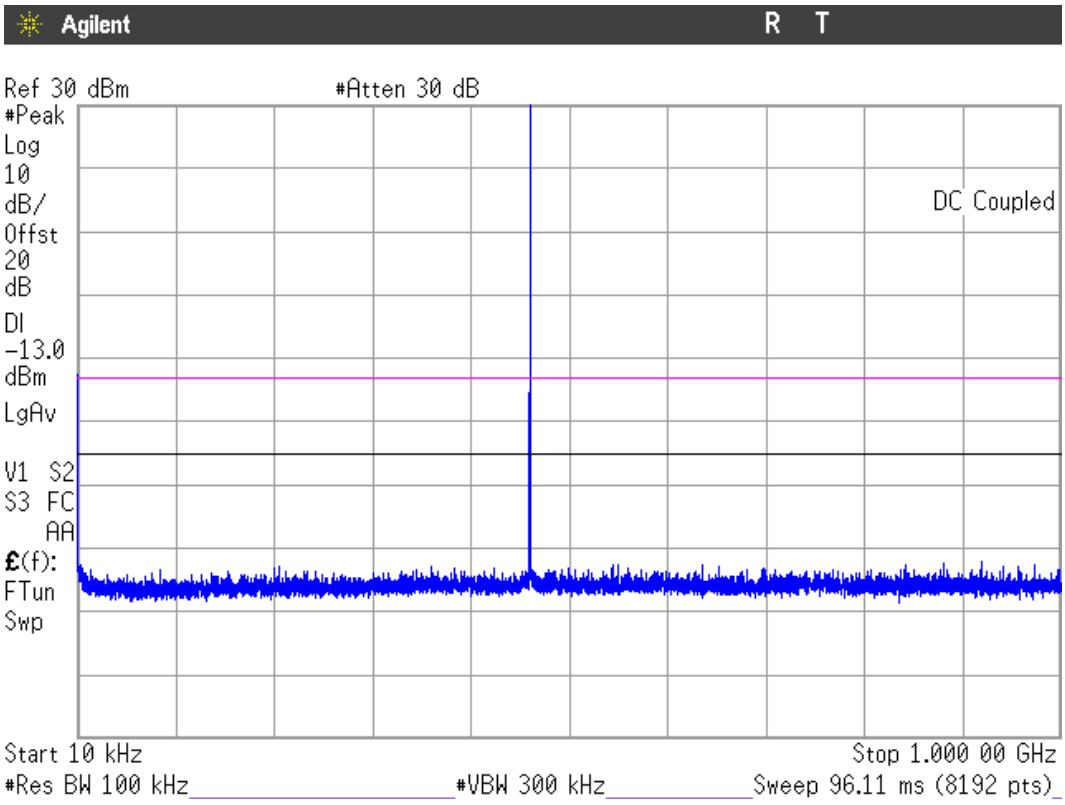
TETRA 22 kHz bandwidth. FCC 450-470 MHz and IC 450-470 MHz bands.

1. CHANNEL: LOWEST. 450 MHz.



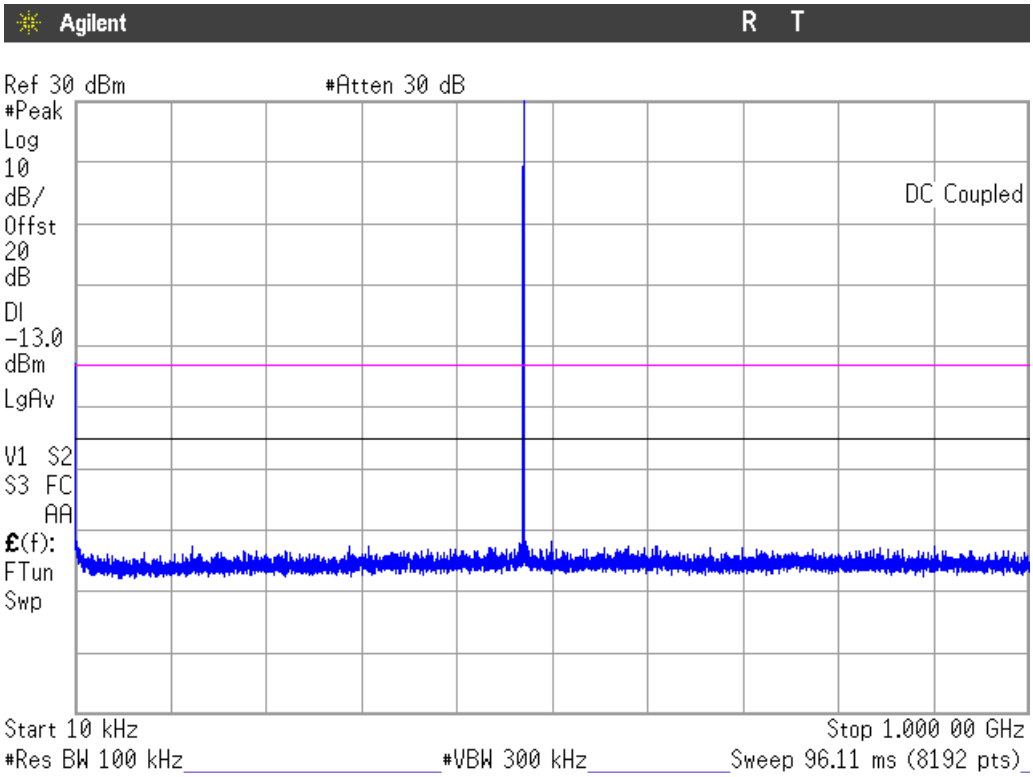
Note: The peak above the limit is the carrier frequency.

2. CHANNEL: MIDDLE. 460 MHz.



Note: The peak above the limit is the carrier frequency.

3. CHANNEL: HIGHEST. 470 MHz.

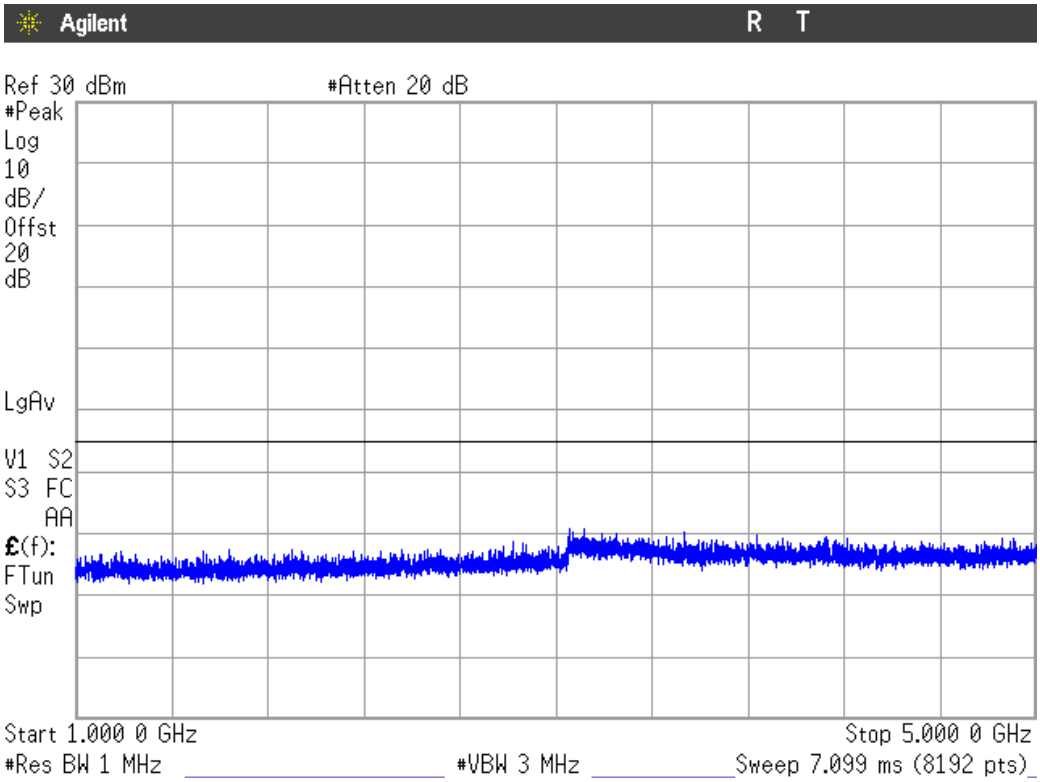


Note: The peak above the limit is the carrier frequency.

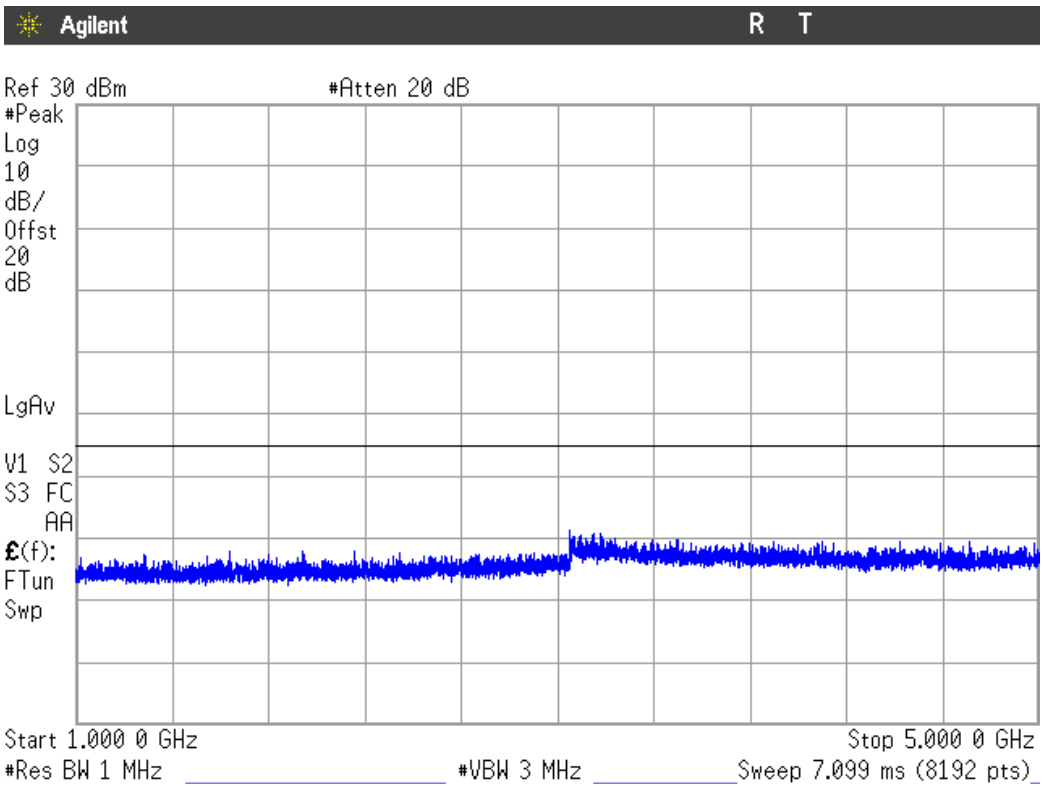
Frequency range 1 GHz to 5 GHz.

TETRA 22 kHz bandwidth. IC 407-430 MHz bands.

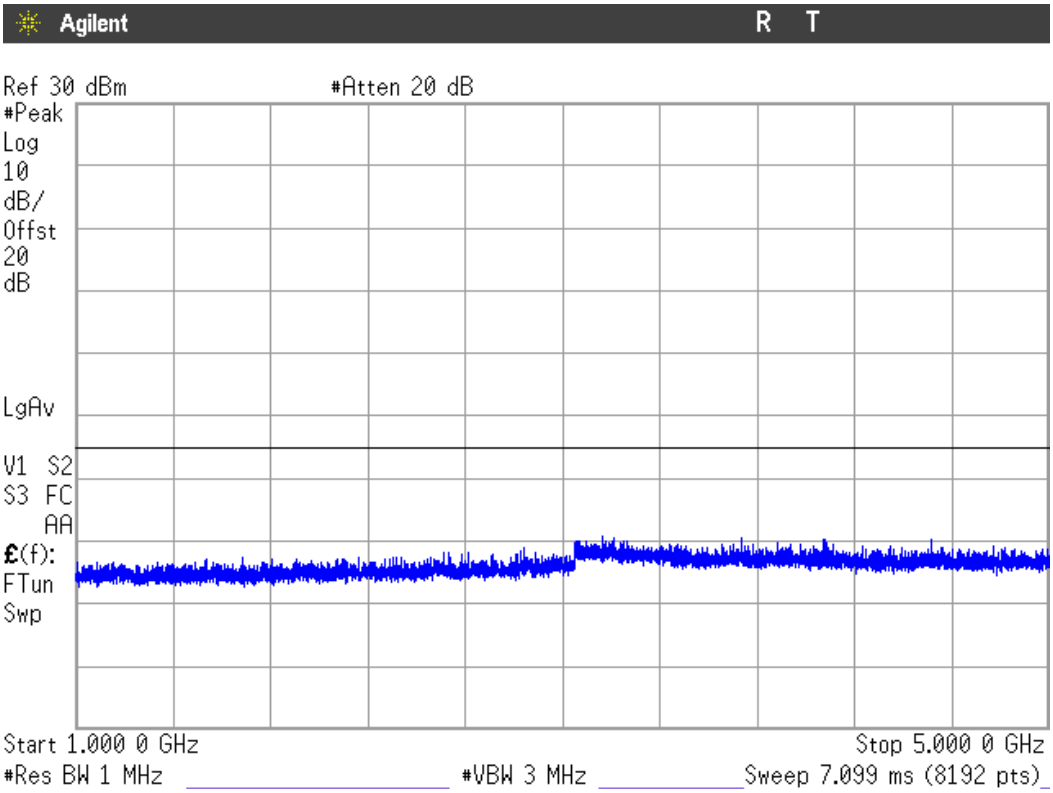
1. CHANNEL: LOWEST. 407 MHz.



2. CHANNEL: MIDDLE. 418.5 MHz.

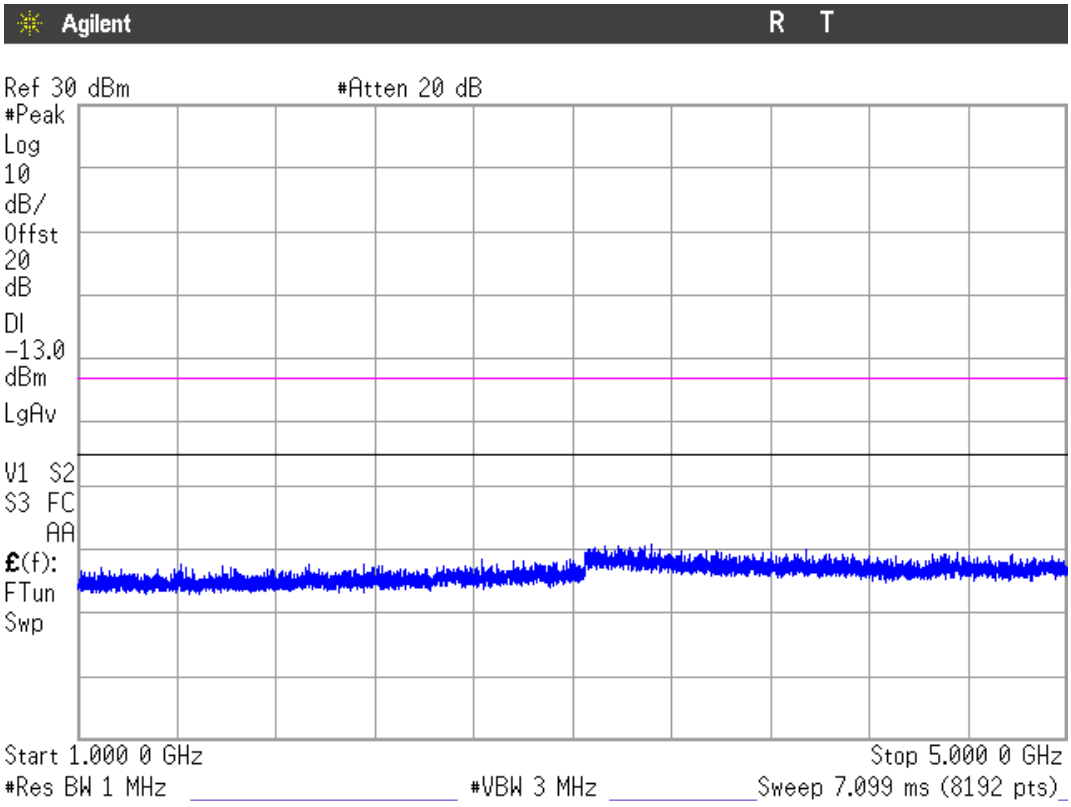


3. CHANNEL: HIGHEST. 430 MHz.

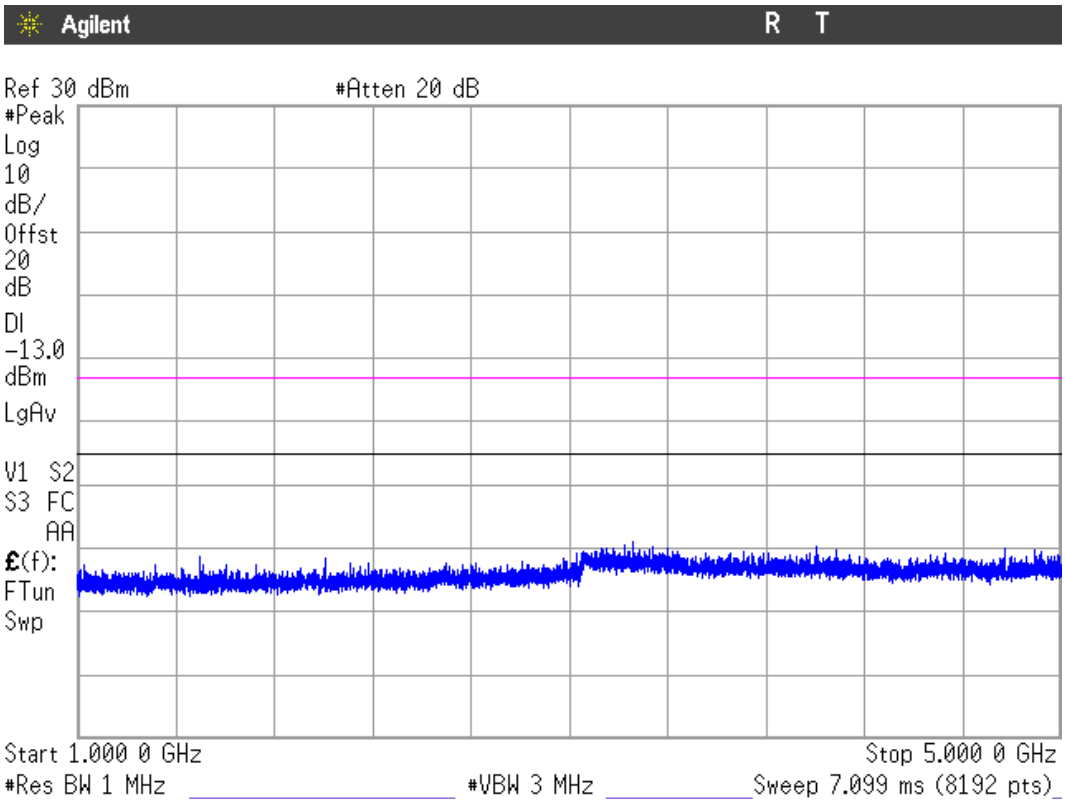


TETRA 22 kHz bandwidth. FCC 450-470 MHz and IC 450-470 MHz bands.

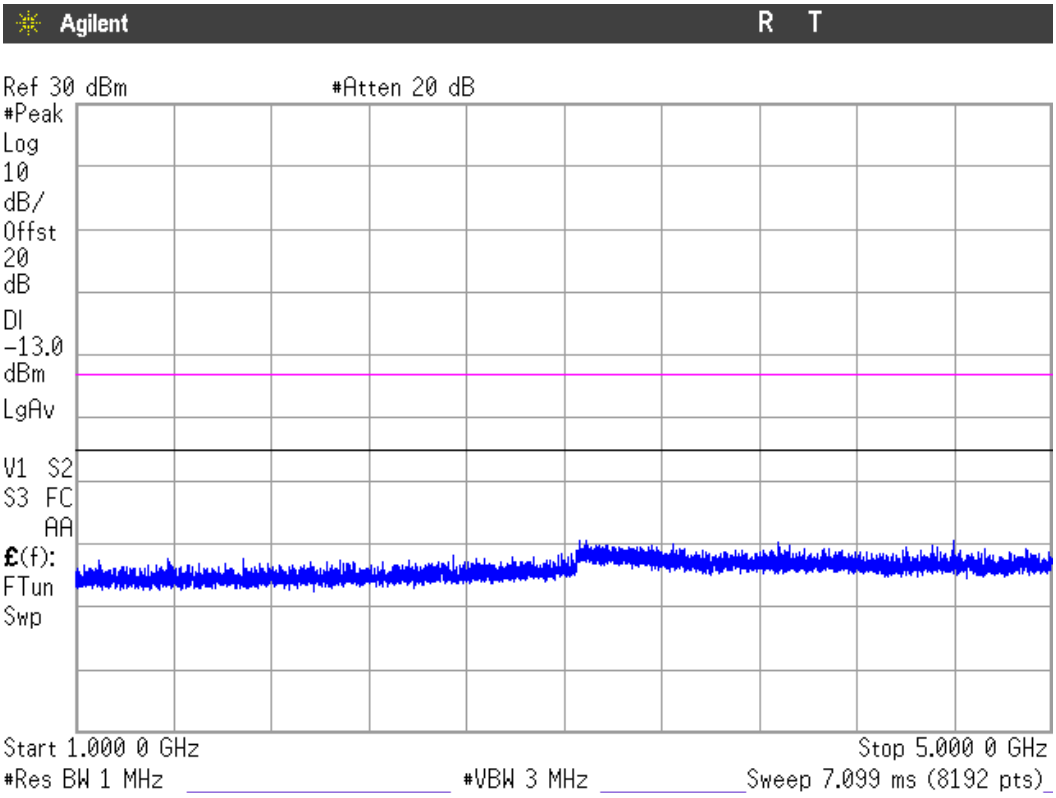
1. CHANNEL: LOWEST. 450 MHz.



2. CHANNEL: MIDDLE. 460 MHz.



3. CHANNEL: HIGHEST. 470 MHz.



Radiated emissions

SPECIFICATION

FCC §2.1051, §90.221.

(d) On any frequency removed from the assigned frequency by more than 75 kHz, the attenuation of any emission must be at least 43 + 10 log (P_{watts}) dB.

RSS-119 §5.5. and 5.8.10.

Table 17 - Emission Mask Y

Displacement Frequency, fd (kHz)	Minimum Attenuation (dB)	Resolution Bandwidth (Hz)
12.375 < fd ≤ 13.975	whichever is the lesser attenuation: 30 + 16.67(fd–12.375) or 55 + 10 log10(p)	Specified in Section 4.2.2
fd > 13.975	whichever is the lesser attenuation: 57 or 55 + 10 log10(p)	Specified in Section 4.2.2

METHOD

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 1 meter high non-conductive stand at a 3 meter distance from the measuring antenna for measurements below 1 GHz and at 1 m distance for measurements above 1 GHz.
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.

RESULTS

TETRA 22 kHz bandwidth. IC 407-430 MHz bands.

1. CHANNEL: LOWEST. 407 MHz.

Frequency range 30 MHz-1000 MHz.
No spurious signals were found at less than 20 dB respect to the limit.

Frequency range 1 GHz-5 GHz.
No spurious signals were found at less than 20 dB respect to the limit.

2. CHANNEL: MIDDLE. 418.5 MHz.

Frequency range 30 MHz-1000 MHz.
No spurious signals were found at less than 20 dB respect to the limit.

Frequency range 1 GHz-5 GHz.
No spurious signals were found at less than 20 dB respect to the limit.

3. CHANNEL: HIGHEST. 430 MHz.

Frequency range 30 MHz-1000 MHz.

Substitution method data

Frequency (MHz)	Instrument reading (dBm)	Polarization	(1) Generator output (dBm)	(2) Cable loss (dB)	(3) Substitution antenna gain Gi (respect to isotropic radiator) (dB)	E.I.R.P. (dBm) = (1) – (2) + (3)
859.9966	-51.35	Vertical	-45.59	4.37	8.03	-41.93

Measurement uncertainty (dB)	<±3.88

Frequency range 1 GHz-5 GHz.
No spurious signals were found at less than 20 dB respect to the limit.

TETRA 22 kHz bandwidth. FCC 450-470 MHz and IC 450-470 MHz bands.

1. CHANNEL: LOWEST. 450 MHz.

Frequency range 30 MHz-1000 MHz.

Substitution method data

Frequency (MHz)	Instrument reading (dBm)	Polarization	(1) Generator output (dBm)	(2) Cable loss (dB)	(3) Substitution antenna gain Gi (respect to isotropic radiator) (dB)	E.I.R.P. (dBm) = (1) – (2) + (3)
900.0253	-53.03	Horizontal	-44.69	4.51	7.13	-42.07

Measurement uncertainty (dB)	<±3.88

Frequency range 1 GHz-5 GHz.
No spurious signals were found at less than 20 dB respect to the limit.

2. CHANNEL: MIDDLE. 460 MHz.

Frequency range 30 MHz-1000 MHz.

Substitution method data

Frequency (MHz)	Instrument reading (dBm)	Polarization	(1) Generator output (dBm)	(2) Cable loss (dB)	(3) Substitution antenna gain Gi (respect to isotropic radiator) (dB)	E.I.R.P. (dBm) = (1) – (2) + (3)
920.0396	-53.51	Horizontal	-45.17	4.51	7.13	-42.55

Measurement uncertainty (dB)	<±3.88

Frequency range 1 GHz-5 GHz.
No spurious signals were found at less than 20 dB respect to the limit.

3. CHANNEL: HIGHEST. 470 MHz.

Frequency range 30 MHz-1000 MHz.

Substitution method data

Frequency (MHz)	Instrument reading (dBm)	Polarization	(1) Generator output (dBm)	(2) Cable loss (dB)	(3) Substitution antenna gain Gi (respect to isotropic radiator) (dB)	E.I.R.P. (dBm) = (1) – (2) + (3)
940.0216	-50.67	Vertical	-41.72	4.65	7.20	-39.17

Measurement uncertainty (dB)	<±3.88

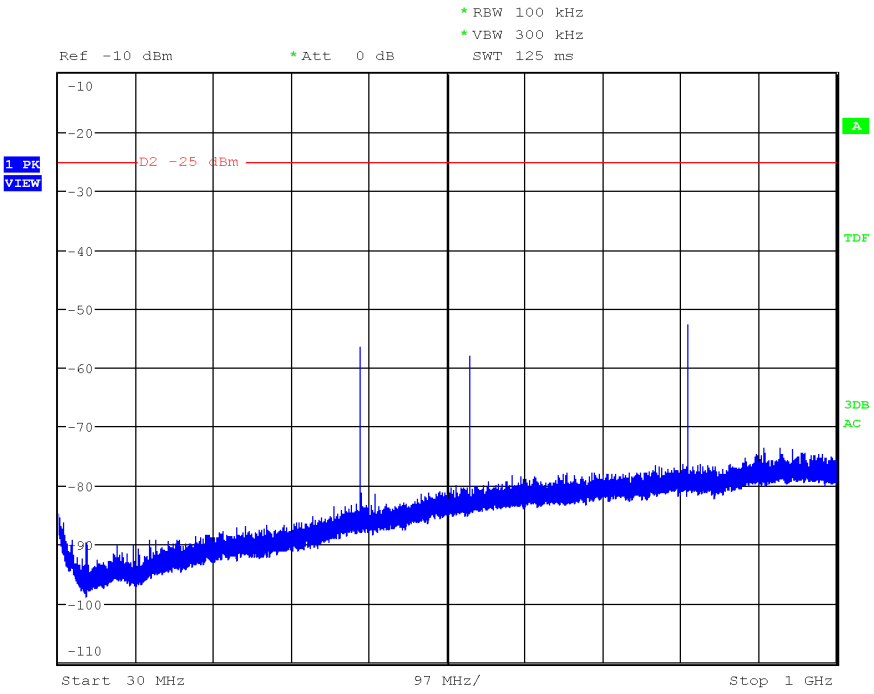
Frequency range 1 GHz-5 GHz.
No spurious signals were found at less than 20 dB respect to the limit.

Verdict: PASS

FREQUENCY RANGE 30 MHz-1000 MHz.

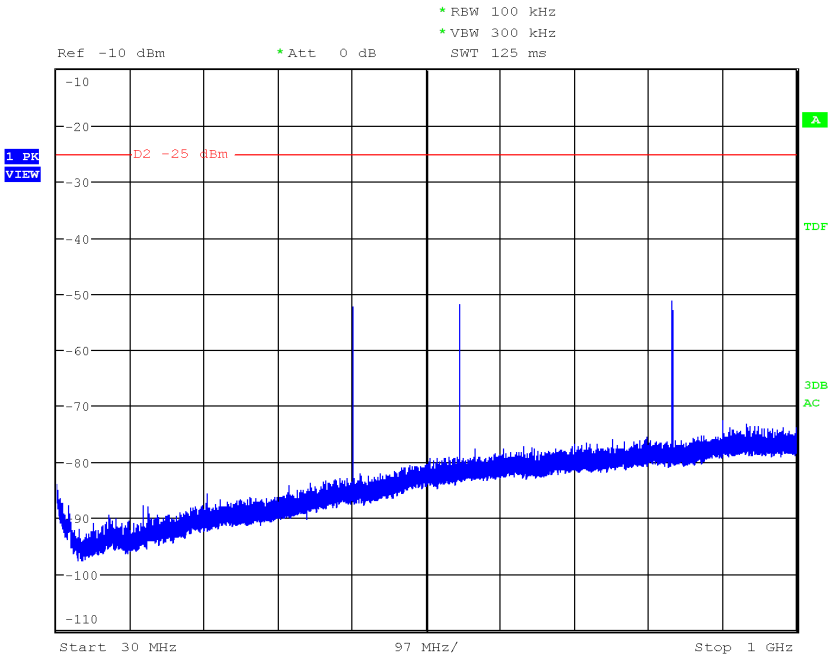
TETRA 22 kHz bandwidth. IC 407-430 MHz bands.

CHANNEL: LOWEST. 407 MHz.



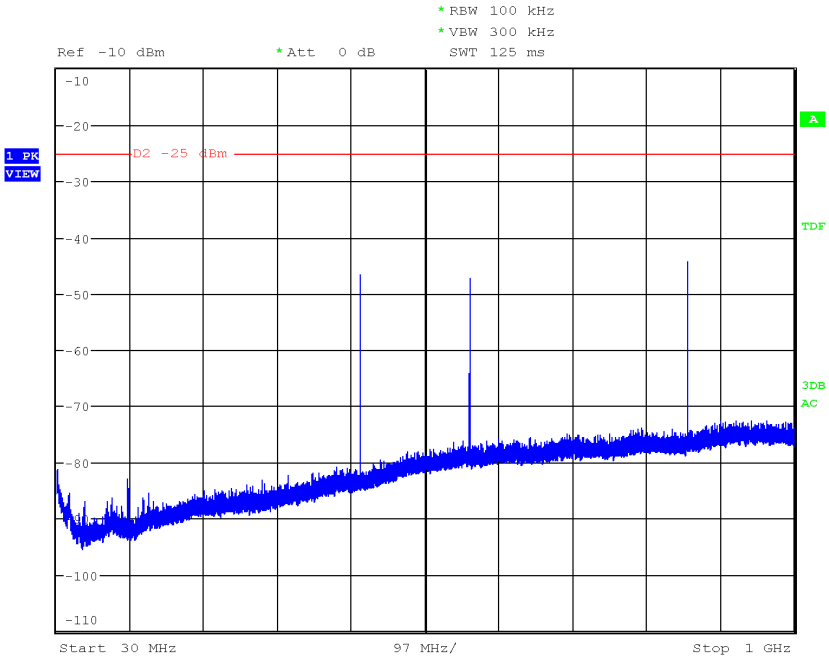
Note: The carrier frequency was attenuated using a notch filter.

CHANNEL: MIDDLE. 418.5 MHz.



Note: The carrier frequency was attenuated using a notch filter.

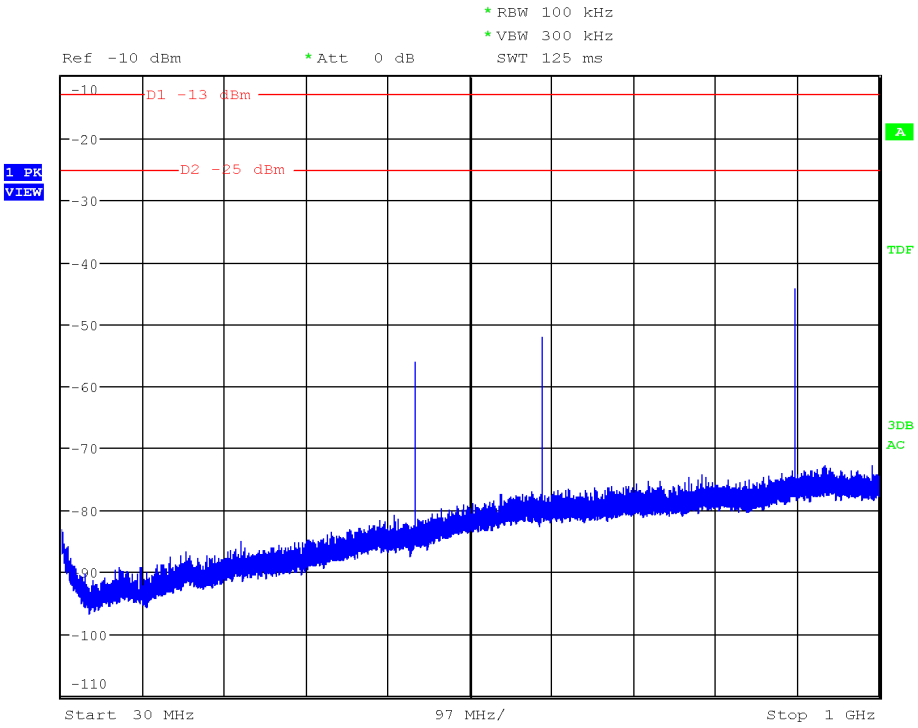
CHANNEL: HIGHEST. 430 MHz.



Note: The carrier frequency was attenuated using a notch filter.

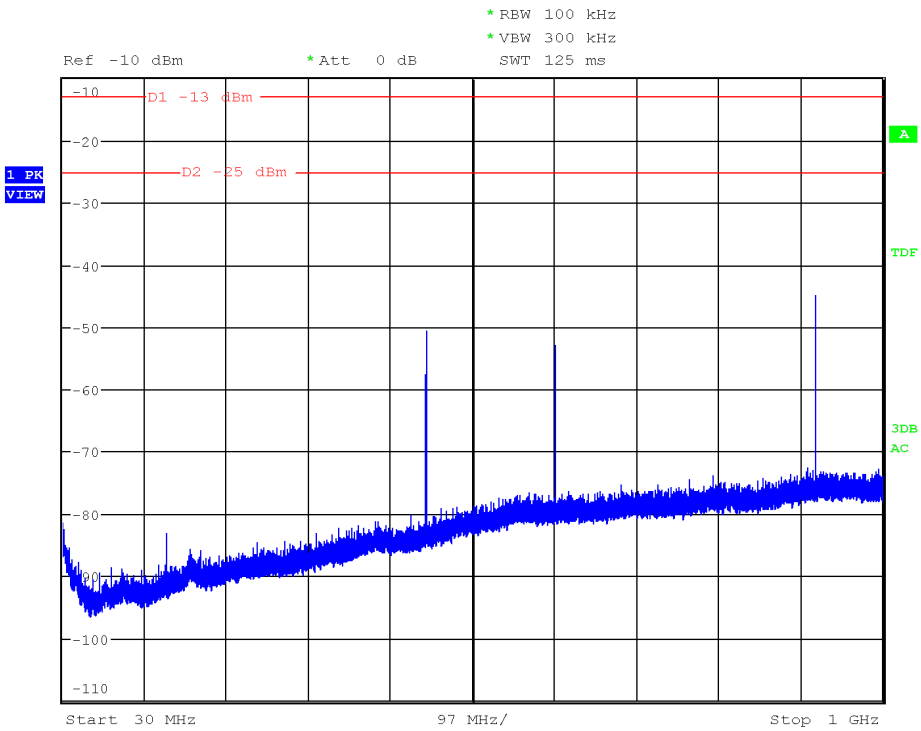
TETRA 22 kHz bandwidth. FCC 450-470 MHz and IC 450-470 MHz bands.

CHANNEL: LOWEST. 450 MHz.



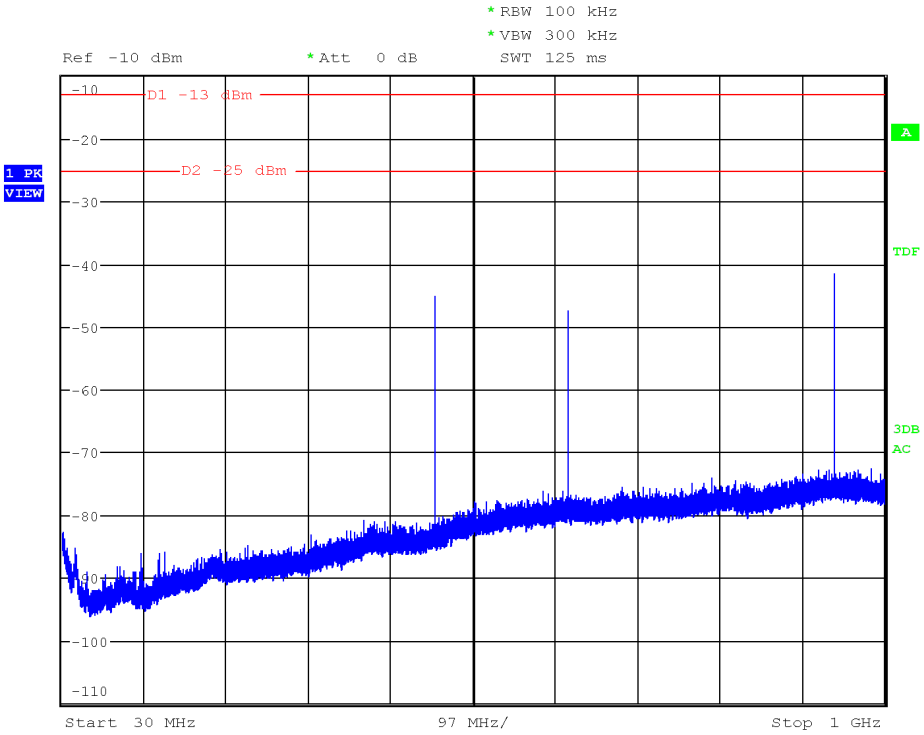
Note: The carrier frequency was attenuated using a notch filter.

CHANNEL: MIDDLE. 460 MHz..



Note: The carrier frequency was attenuated using a notch filter.

CHANNEL: HIGHEST. 470 MHz.

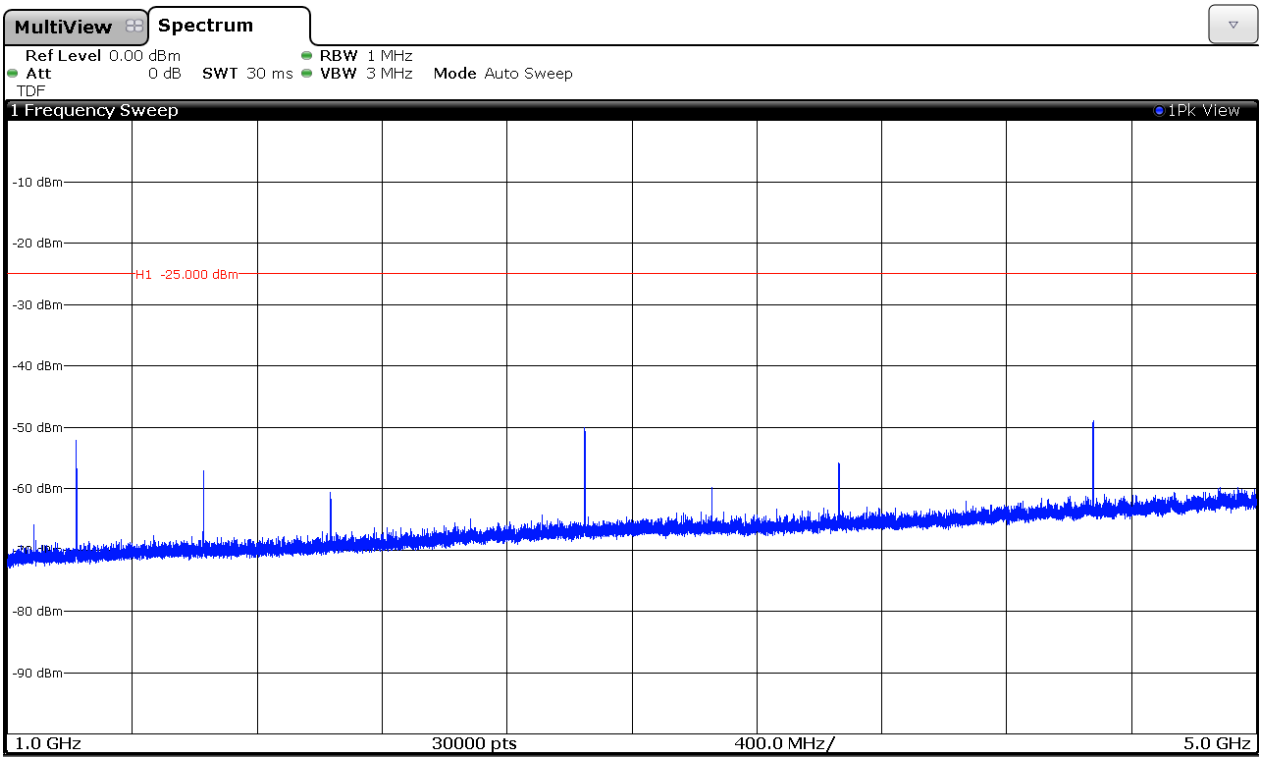


Note: The carrier frequency was attenuated using a notch filter.

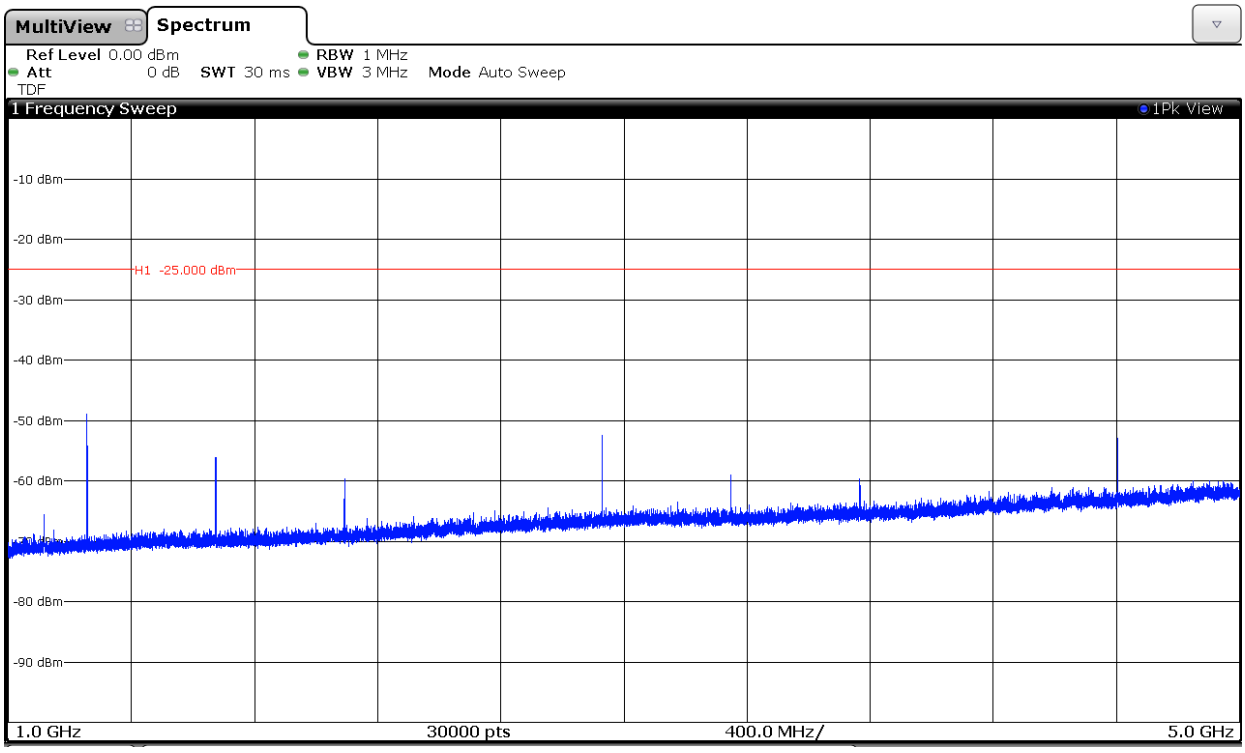
FREQUENCY RANGE 1 GHz to 5 GHz.

TETRA 22 kHz bandwidth. IC 407-430 MHz bands.

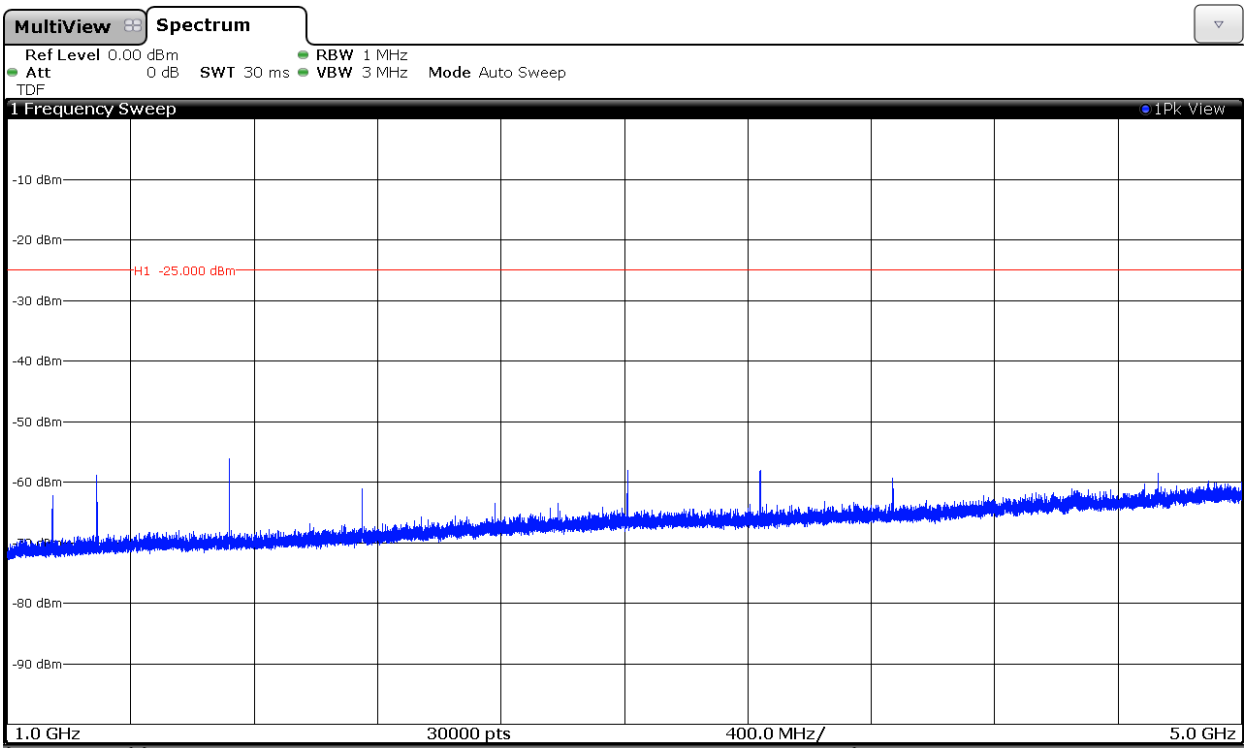
CHANNEL: LOWEST. 407 MHz.



CHANNEL: MIDDLE. 418.5 MHz

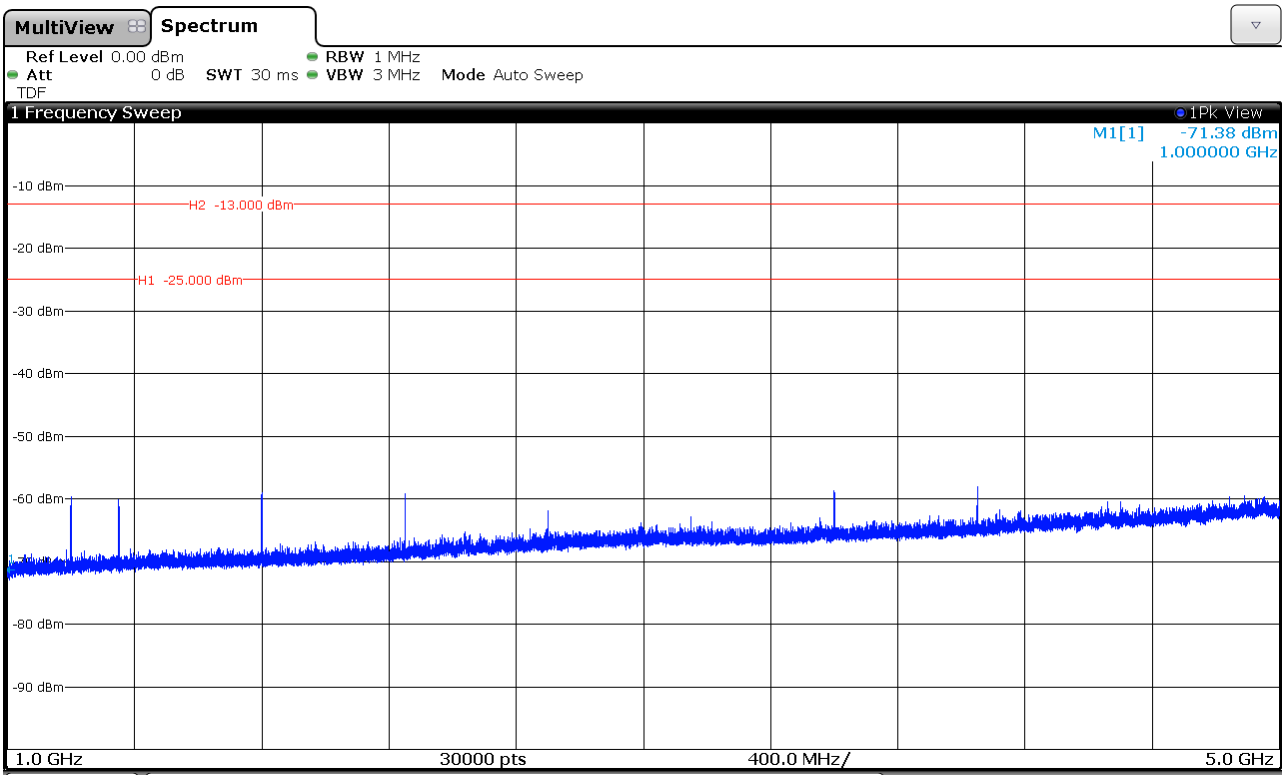


CHANNEL: HIGHEST. 430 MHz

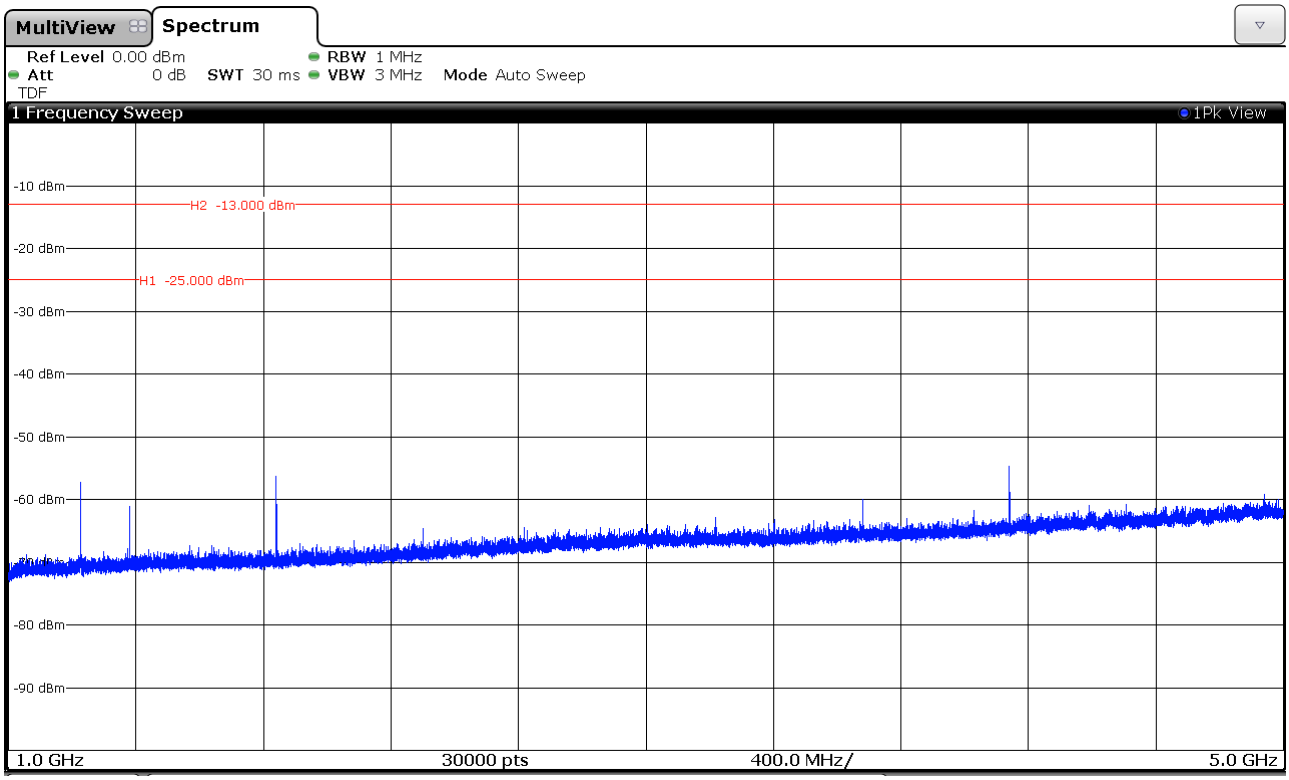


TETRA 22 kHz bandwidth. FCC 450-470 MHz and IC 450-470 MHz bands.

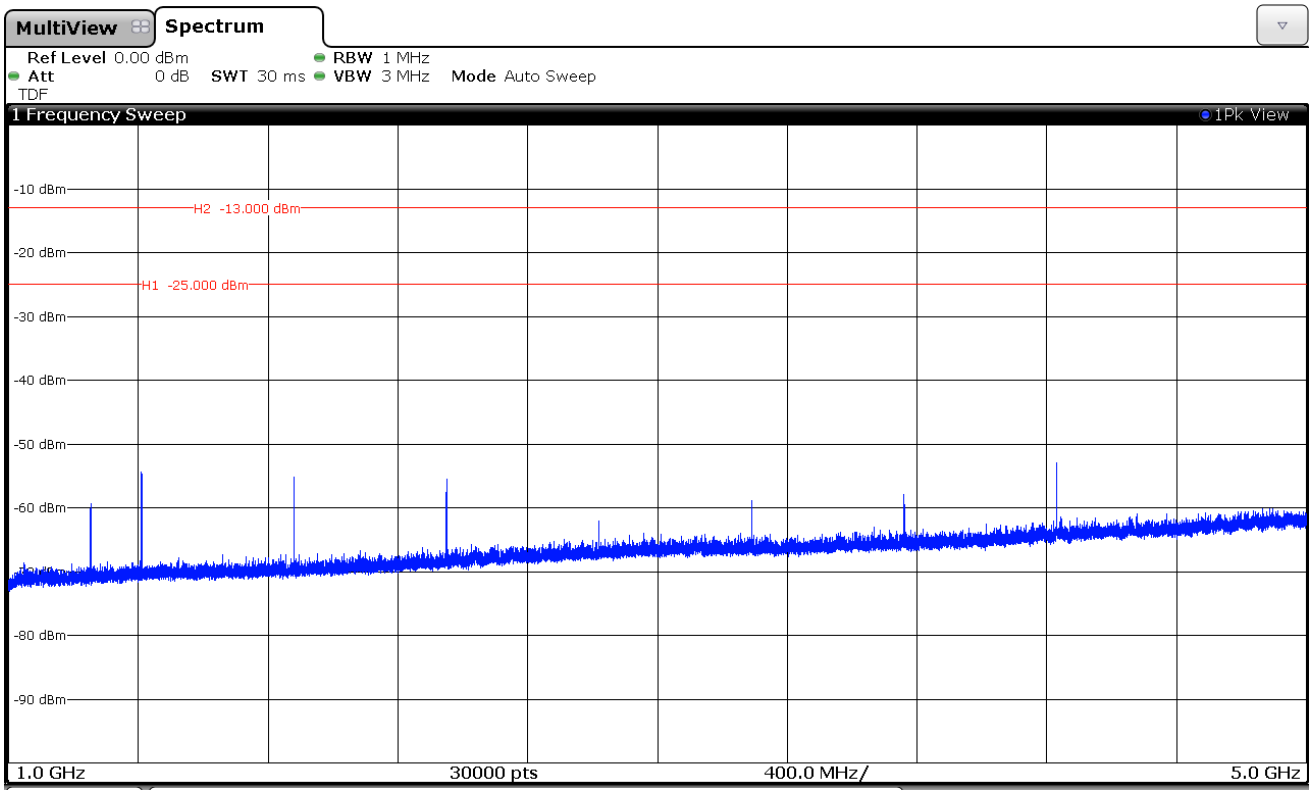
CHANNEL: LOWEST. 450 MHz.



CHANNEL: MIDDLE. 460 MHz.



CHANNEL: HIGHEST. 470 MHz.



Transient Frequency Behaviour

SPECIFICATION

FCC §90.214

Transmitters designed to operate in the 150-174 MHz and 421-512 MHz frequency bands must maintain transient frequencies within the maximum frequency difference limits during the time intervals indicated:

Time intervals[1 2]	Maximum frequency difference[3]	All equipment	
		150 to 174 MHz	421 to 512 MHz
Transient Frequency Behavior for Equipment Designed to Operate on 25 kHz Channels			
t_1[4]	±25.0 kHz	5.0 ms	10.0 ms
t_2	±12.5 kHz	20.0 ms	25.0 ms
t_3[4]	±25.0 kHz	5.0 ms	10.0 ms

1. t_{on} is the instant when a 1 kHz test signal is completely suppressed, including any capture time due to phasing.

t_1 is the time period immediately following t_{on}.

t_2 is the time period immediately following t_1.

t_3 is the time period from the instant when the transmitter is turned off until t_{off}.

t_{off} is the instant when the 1 kHz test signal starts to rise.

2. During the time from the end of t_2 to the beginning of t_3, the frequency difference must not exceed the limits specified in §90.213.

3. Difference between the actual transmitter frequency and the assigned transmitter frequency.

4. If the transmitter carrier output power rating is 6 watts or less, the frequency difference during this time period may exceed the maximum frequency difference for this time period.

RSS-119 §5.9.

When a transmitter is turned on, the radio frequency may take some time to stabilize. During this initial period, the frequency error or frequency difference (i.e., between the instantaneous and the steady state frequencies) shall not exceed the limits specified in Table 18.

Table 18 – Transient Frequency Behaviour

Channel Bandwidth (kHz)	**Time intervals (Notes 1, 2)**	**Maximum Frequency Difference (kHz)**	**Transient Duration Limit (ms)**	
			138 to 174 MHz	**406.1 to 512 MHz**
25	t_1	±25.0 kHz	5.0	10.0
	t_2	±12.5 kHz	20.0	25.0
	t_3	±25.0 kHz	5.0	10.0

Notes:

1. t_{on}: the instant when a 1 kHz test signal is completely suppressed, including any capture time due to phasing.

t_1 is the time period immediately following t_{on}.

t_2 is the time period immediately following t_1.

t_3 is the time period from the instant when the transmitter is turned off until t_{off}.

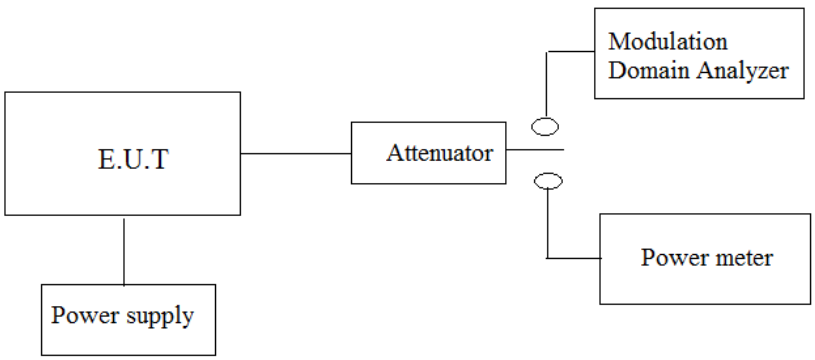
t_{off} is the instant when the 1 kHz test signal starts to rise.

2. If the transmitter carrier output power rating is 6 watts or less, the frequency difference during the time periods t_1 and t_3 may exceed the maximum frequency difference for theses time periods.

<u>METHOD</u>

The test was performed using a Modulation Domain Analyzer.

An attenuator and a calibrated wideband power sensor were used to measure the reference power level.



RESULTS (see next plots).

TETRA 22 kHz bandwidth. IC 407-430 MHz bands.

CHANNEL: MIDDLE. 418.50225 MHz.

Time intervals	Maximum Frequency Difference (kHz)
t_1	11.23522 kHz
t_2	0.05713 kHz
t_3	0.81303 kHz
Measurement uncertainty (kHz)	< ± 0.12

TETRA 22 kHz bandwidth. FCC 450-470 MHz and IC 450-470 MHz bands.

CHANNEL: MIDDLE. 460.00225 MHz.

Time intervals	Maximum Frequency Difference (kHz)
t_1	5.10759 kHz
t_2	0.09286 kHz
t_3	0.36963 kHz
Measurement uncertainty (kHz)	< ± 0.12

Verdict: PASS

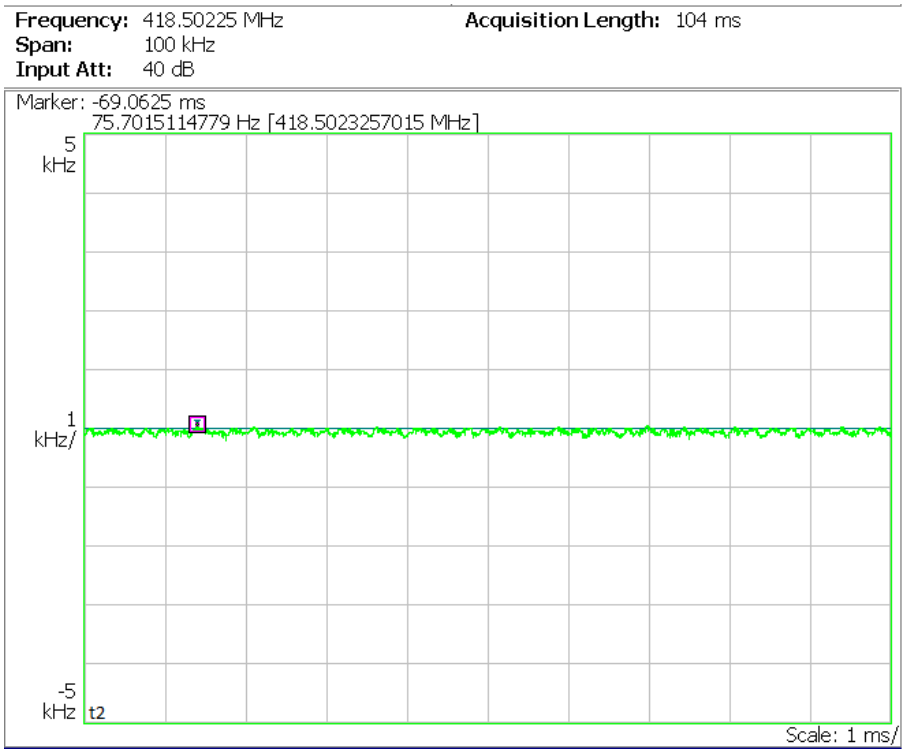
TETRA 22 kHz bandwidth. IC 407-430 MHz bands.

CHANNEL: MIDDLE. 418.50225 MHz.

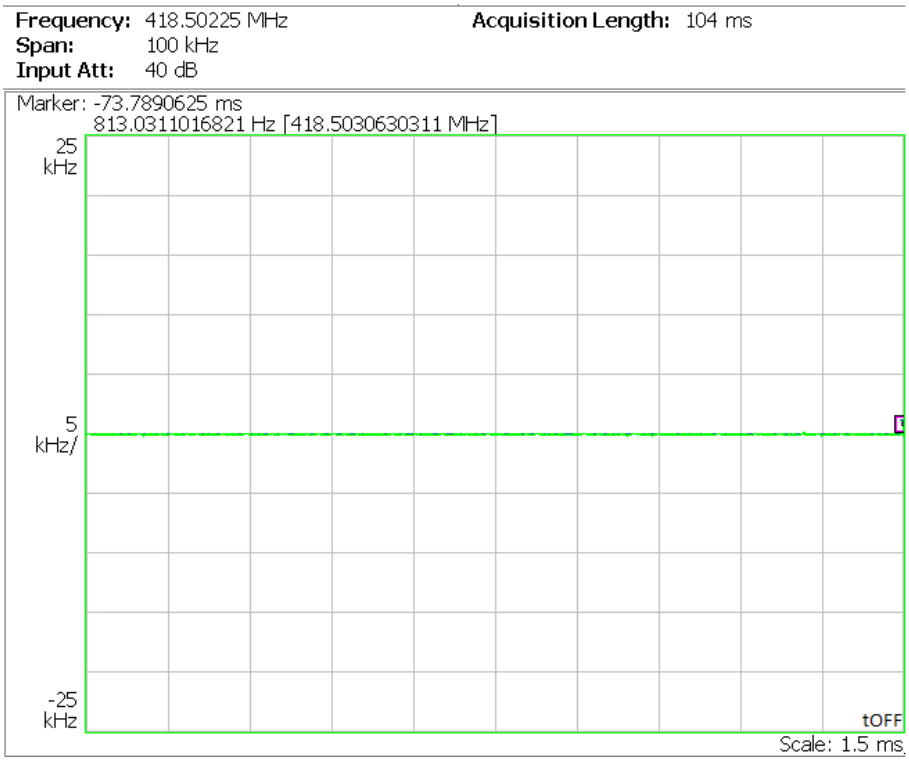
Transient Frequency Behaviour t_{on} to t_1.

Transient Frequency Behaviour t_1 to t_2.

Transient Frequency Behaviour following t_2.



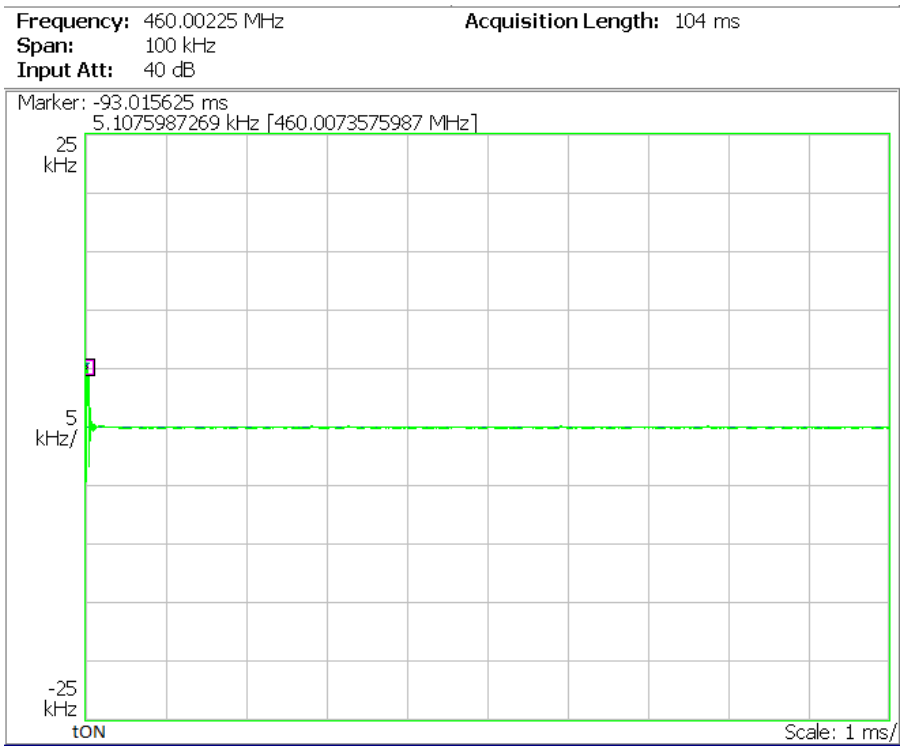
Transient Frequency Behaviour t_3 to $t_{off.}$



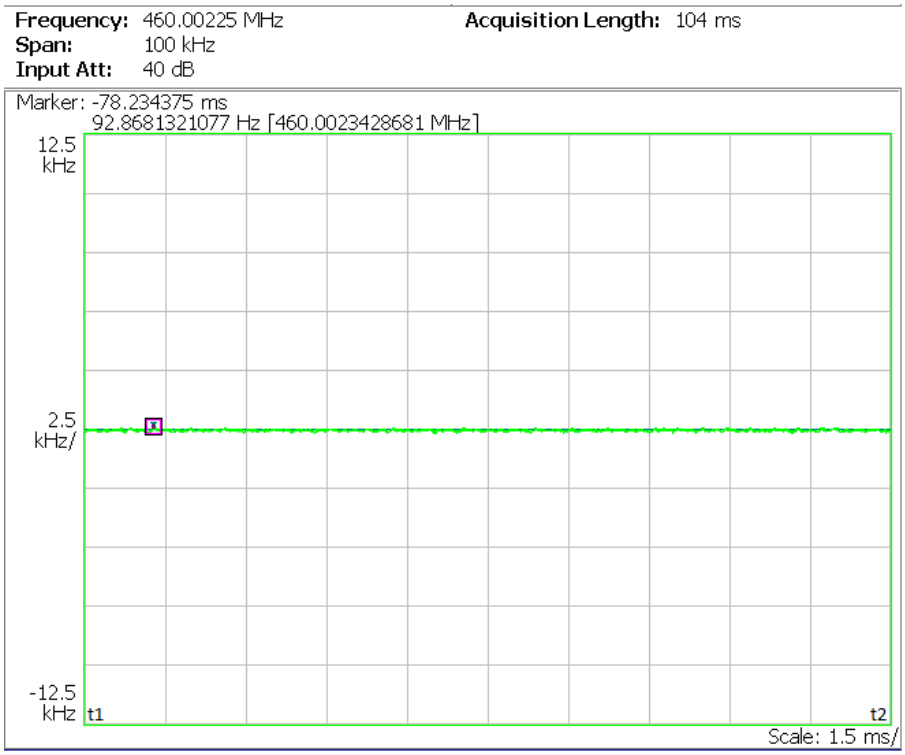
TETRA 22 kHz bandwidth. FCC 450-470 MHz and IC 450-470 MHz bands.

CHANNEL: MIDDLE. 460.00225 MHz.

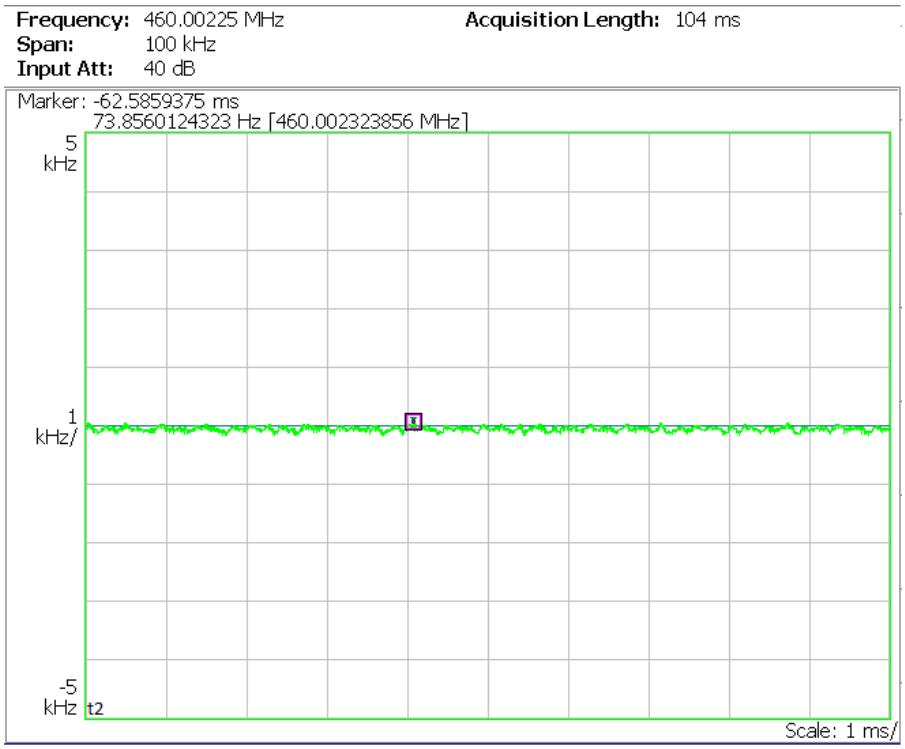
Transient Frequency Behaviour t_{on} to t_1.



Transient Frequency Behaviour t_1 to t_2.



Transient Frequency Behaviour following t_2.



Transient Frequency Behaviour t_3 to t_{off}.