



FCC LISTED,
REGISTRATION NUMBER:
720267

Informe de ensayo nº:
Test report No:

IC LISTED REGISTRATION
NUMBER IC 4621A-1

NIE: 45407RRF.001

Test report

USA FCC Part 15.231, 15.209

CANADA RSS-210, RSS-Gen

Radio Frequency Devices. Periodic operation in the band 40.66-40.70 MHz and above 70 MHz.

Licence-Exempt Radio Apparatus (All Frequency Bands): Category I Equipment.
General Requirements and Information for the Certification of Radio Apparatus.

Identificación del objeto ensayado.....: Identification of item tested	TIRE PRESSURE MONITORING SYSTEM
Marca Trademark	Continental
Modelo y/o referencia tipo Model and /or type reference	TIS-03
Other identification of the product	Commercial name: TIS-03 FCC ID: KR5TIS-03 IC: 7812D-TIS03
Final HW version	V1
Final SW version	V1
Características Features	---
Fabricante Manufacturer	Continental Automotive GmbH Siemensstraße,12 D-93055 Regensburg Germany
Método de ensayo solicitado, norma.....: Test method requested, standard	USA FCC Part 15.231 10-1-14 Edition: Periodic operation in the band 40.66-40.70 MHz and above 70 MHz. USA FCC Part 15.209 10-1-14 Edition: Radiated emission limits; general requirements. CANADA RSS-210 Issue 8 (December 2010). CANADA RSS-Gen Issue 4 (November 2014). ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices.
Resultado.....: Summary	IN COMPLIANCE
Aprobado por (nombre / cargo y firma) Approved by (name / position & signature)	A. Llamas / RF Lab. Manager
Fecha de realización Date of issue	2015-08-07

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Competences and guarantees

AT4 wireless 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.

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 conjunction 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.

IMPORTANT: No parts of this report may be reproduced or quoted out of context, in any form or by any means, except in full, without the previous written permission of AT4 wireless.

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
45074B/009	Tire pressure monitoring unit with integral antenna	TIS-03	---	2015-07-07

1. Sample M/01 has undergone following test(s) in appendix A:
Subclause (e). Radiated emissions for transmitter.

Sample M/02 is composed of the following elements:

Control N°	Description	Model	Serial N°	Date of reception
45074B/14	Tire pressure monitoring unit with antenna connector	TIS-03	---	2015-08-03
45074B/15	Tire pressure monitoring unit with antenna connector	TIS-03	---	2015-08-03

- Sample M/02 has undergone following test(s) in appendix A:
Subclause (c). 20 dB Emission Bandwidth and Occupied Bandwidth.

Sample M/03 is composed of the following elements:

Control N°	Description	Model	Serial N°	Date of reception
45074B/011	Tire pressure monitoring unit with integral antenna	TIS-03	---	2015-08-03

- Sample M/03 has undergone following test(s) in appendix A:
Subclause (e). Transmitter deactivation (Periodic transmission).

Test sample description

The tire pressure monitoring system consists of the following units:

- Tire guard (TG) wheel unit type TIS-03 which includes an integrated pressure, temperature and acceleration sensor and a RF transmitter.
- LF receiver unit which includes a LF receiver (not described in this document)

The TG monitors a vehicle's tire pressure while driving or stationary. An electronic unit (wheel unit) inside each tire, mounted to the valve stem, periodically measures the actual tire pressure. By means of RF communication, this pressure information is transmitted to the RF transmitter.

Identification of the client

Continental Automotive GmbH
Siemensstraße,12
D-93055 Regensburg Germany

Testing period

The performed test started on 2015-07-17 and finished on 2015-08-05.

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 °C Max. = 35 °C
Relative humidity	Min. = 20 % Max. = 75 %
Shielding effectiveness	> 100 dB
Electric insulation	> 10 kΩ
Reference resistance to earth	< 0,5 Ω

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

Temperature	Min. = 15 °C Max. = 35 °C
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	< 0,5 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 °C Max. = 35 °C
Relative humidity	Min. = 20 % Max. = 35 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar
Shielding effectiveness	> 100 dB
Electric insulation	> 10 kΩ
Reference resistance to earth	< 0,5 Ω

Remarks and comments

1: Used instrumentation:

Conducted Measurements

		Last Cal. date	Cal. due date
1.	Spectrum Analyzer Agilent E4440A	2014/05	2016/05
2.	Spectrum Analyzer R&S FSQ8	2014/05	2016/05
3.	DC power supply R&S NGPE 40/40	2014/11	2017/11

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	2013/08	2015/08
6.	Spectrum analyser Rohde & Schwarz FSW50	2013/10	2015/10
7.	RF pre-amplifier 10 MHz-6 GHz SCHWARZBECK BBV9743	2015/03	2016/03
8.	RF pre-amplifier 1-18 GHz BONN ELEKTRONIK BLMA 0118-3A	2015/05	2016/05

Testing verdicts

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

FCC PART 15 PARAGRAPH / RSS-210		VERDICT			
		NA	P	F	NM
Section 15.231 Subclause (e) / RSS-210 A1.1.5.	Transmitter deactivation		P		
Section 15.231 Subclause (c) / RSS-210 A1.1.3.	Bandwidth		P		
Section 15.231 Subclause (e) / 15.209 / RSS-210 A1.1.5.	Field strength and Emission limitations radiated (Transmitter)		P		

Appendix A – Test result

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TEST CONDITIONS

Power supply (V):

$$V_{\text{nominal}} = 3.0 \text{ Vdc}$$

Type of power supply = Battery

Type of antenna = Integral antenna

TEST FREQUENCIES:

The equipment transmits at the nominal frequency of 433.92 MHz.

The equipment uses a short ASK modulated signal for wake-up purposes and a FSK modulated signal for data transmission.

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 one meter above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° 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.

Section 15.231 Subclause (e) / RSS-210 A1.1.5. Transmitter deactivation.

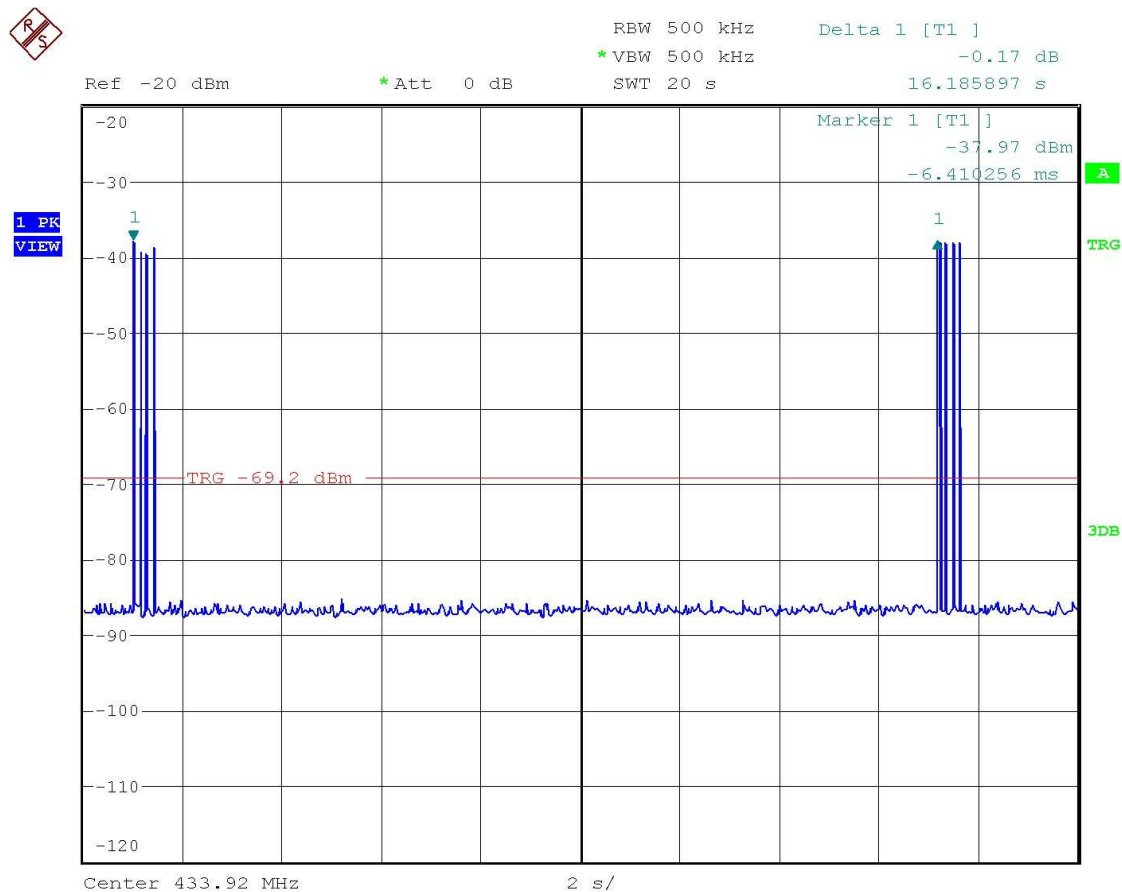
SPECIFICATION

Devices operated under the provisions of this paragraph shall be provided with a means for automatically limiting operation so that the duration of each transmission shall not be greater than one second and the silent period between transmissions shall be at least 30 times the duration of the transmission but in no case less than 10 seconds.

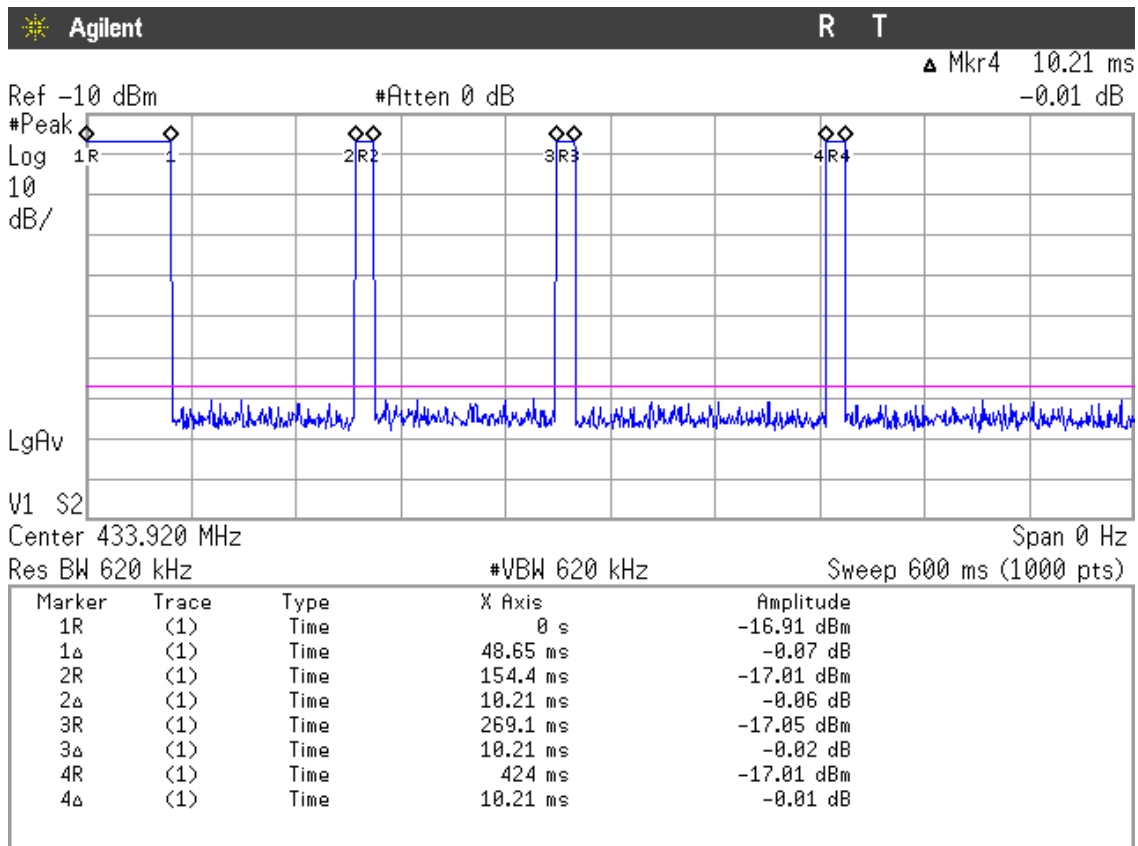
RESULTS

In normal operation the equipment transmits a pulse train of 4 pulses periodically (see next plots).

1. Pulse train period = 16.18 s.



2. Pulse duration = 11.43 ms.



The equipment transmits 1 pulse of 48.65 ms and 3 pulses of 10.21 ms every 16.18 seconds (see plots above) so the total transmission duration is $48.65 \text{ ms} + 3 \times 10.21 \text{ ms} = 79.28 \text{ ms}$. 30 times the duration of the transmission is 2.38 seconds.

The silent period between transmissions is 16.18 seconds.

Verdict: Pass

Section 15.231 Subclause (c) / RSS-210 A1.1.3. Bandwidth

SPECIFICATION

FCC 15.231: The bandwidth of the emission shall be no wider than 0.25 % of the centre frequency for devices operating above 70 MHz and below 900 MHz. Bandwidth is determined at the points 20 dB down from the modulated carrier.

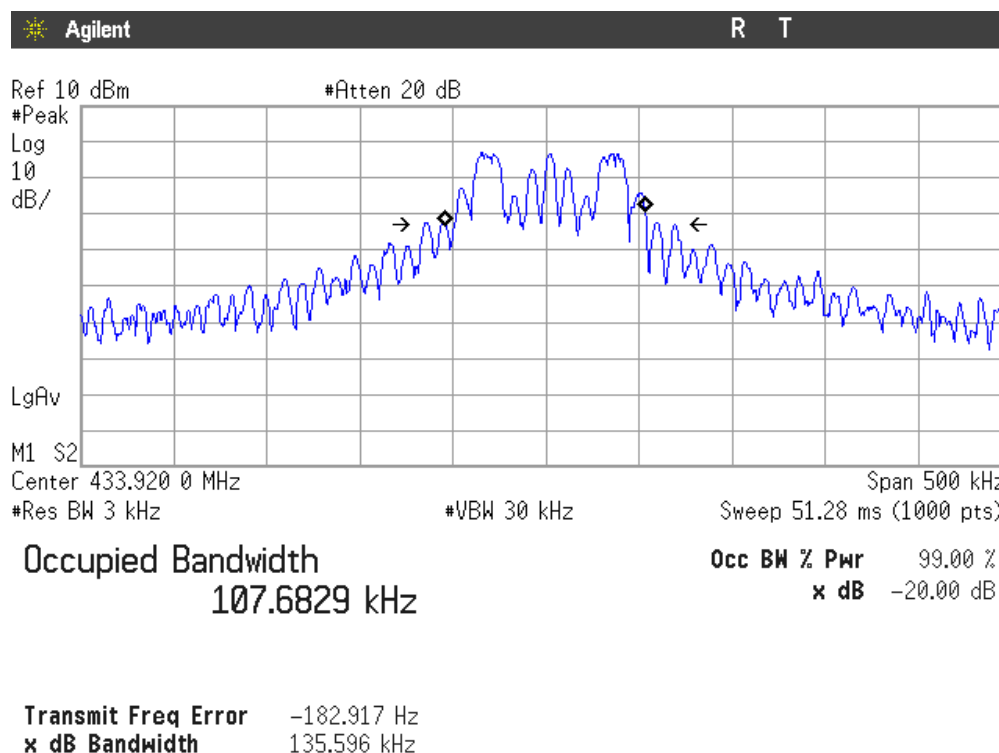
RESULTS (see next plot)

Nominal centre frequency = 433.92 MHz

Limit of spectrum bandwidth = 0.25 % of 433.92 MHz = 1084.80 kHz

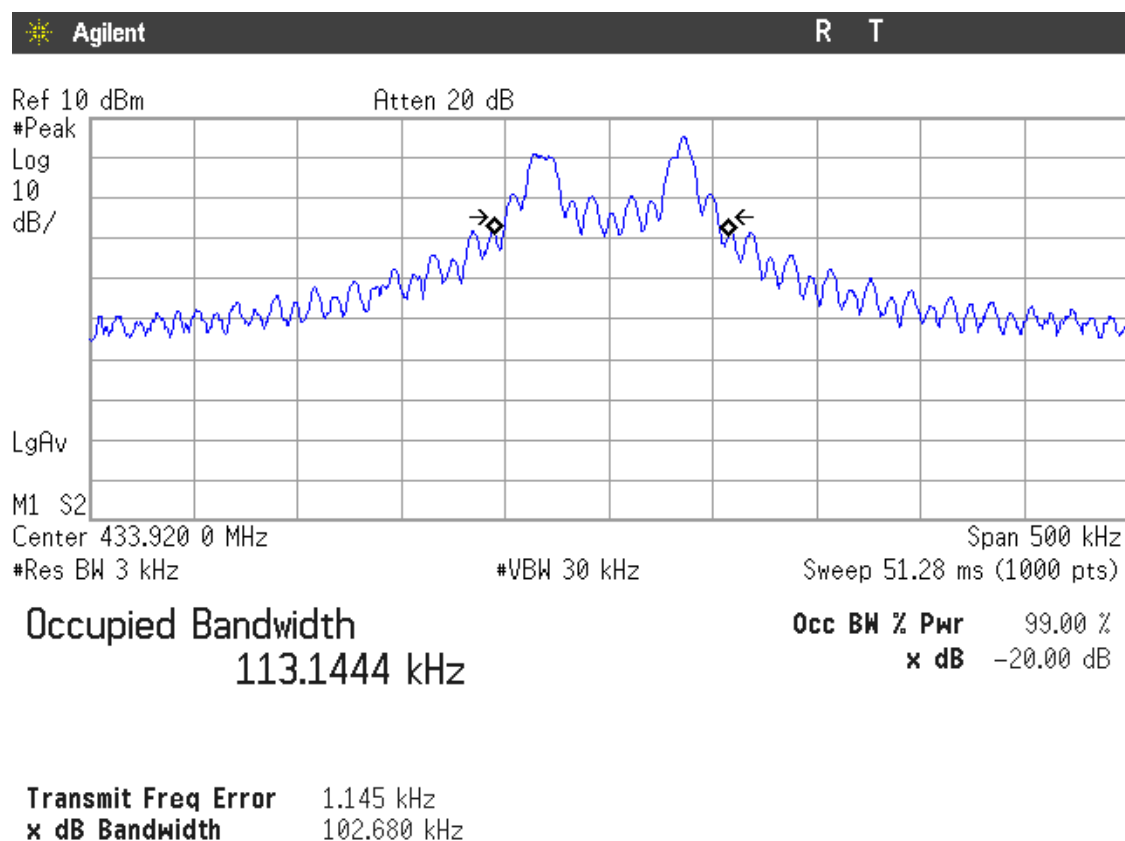
ASK modulation:

Measured 20 dB Bandwidth (kHz)	135.596
Measurement uncertainty (kHz)	<±1.65



FSK modulation:

Measured 20 dB Bandwidth (kHz)	102.680
Measurement uncertainty (kHz)	<±1.65



Verdict: PASS

Occupied Bandwidth

SPECIFICATION

RSS-210. A.1.1.3.: the 99% bandwidth shall be no wider than 0.25% of the centre frequency for devices operating between 70 MHz and 900 MHz.

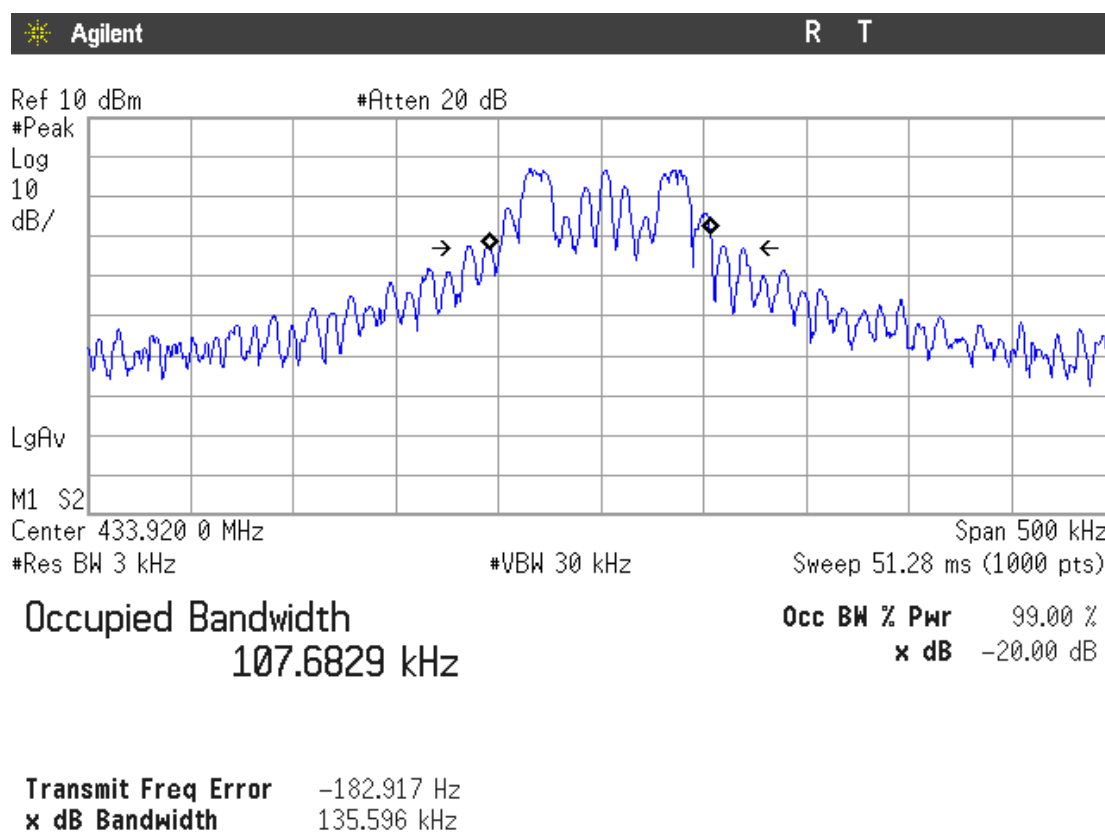
RESULTS (see next plot).

Nominal centre frequency = 433.92 MHz

Limit of spectrum bandwidth = 0.25 % of 433.92 MHz = 1084.80 kHz

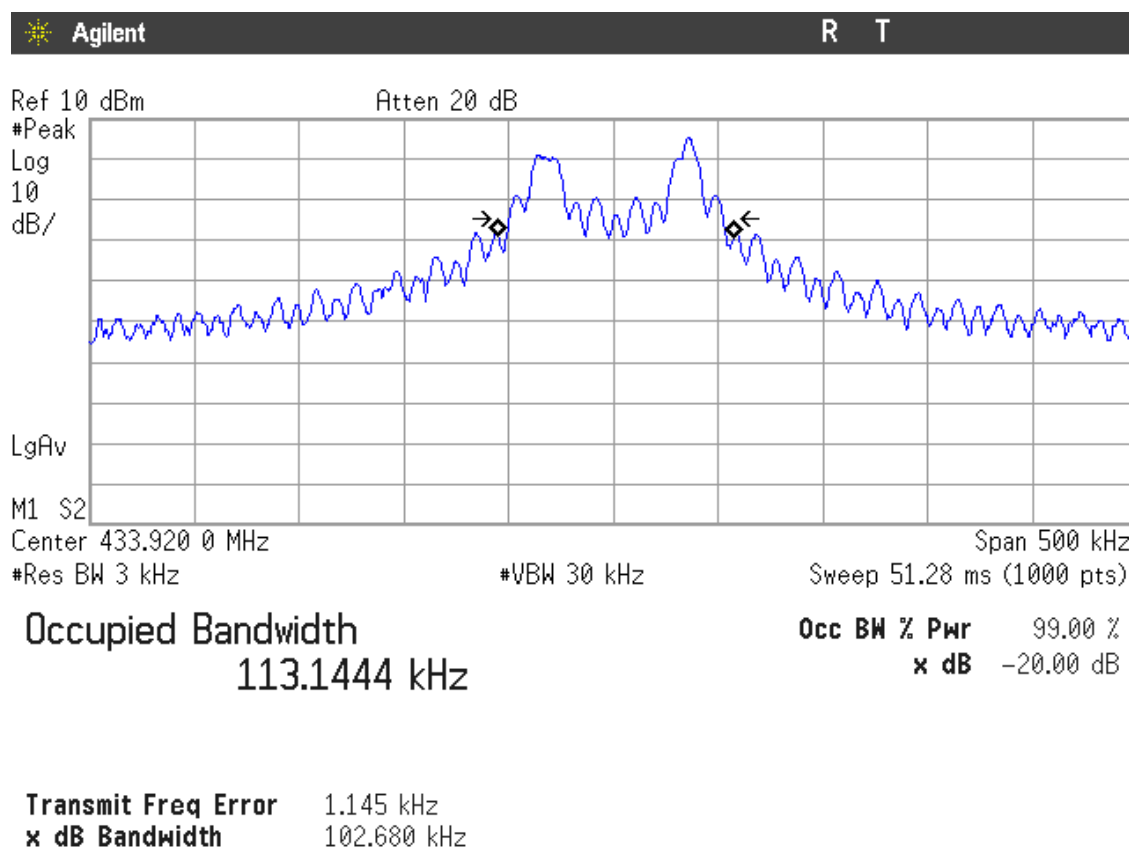
ASK modulation:

99% bandwidth (kHz)	107.6829
Measurement uncertainty (kHz)	<±1.65



FSK modulation:

99% bandwidth (kHz)	113.1444
Measurement uncertainty (kHz)	<±1.65



Verdict: PASS

Section 15.231 Subclause (e)/15.209 / RSS-210 A1.1.5. Field strength and Emission limitations radiated (Transmitter)

SPECIFICATION

Intentional radiators may operate at a periodic rate exceeding that specified in paragraph (a) of this section and may be employed for any type of operation, including operation prohibited in paragraph (a) of this section, provided the intentional radiator complies with the provisions of paragraphs (b) through (d) of this section, except the field strength table in paragraph (b) of this section is replaced by the following:

Fundamental frequency (MHz)	Field strength of fundamental ($\mu\text{V/m}$)	Field strength of spurious emissions ($\mu\text{V/m}$)
40.66 – 40.70	1,000	100
70 – 130	500	50
130 - 174	500 to 1,500 **	50 to 150 **
174 - 260	1,500	150
260 - 470	1,500 to 5,000 **	150 to 500 **
Above 470	5,000	500

**: Linear Interpolations. The maximum permitted unwanted emission level is 20dB below the maximum permitted fundamental level.

Spurious emissions shall be attenuated to the limits shown in the above table or to the general limits shown in Section 15.209/RSS-Gen, whichever limit permits a higher field strength.

For average radiated emission measurements above 1000 MHz, there is also a limit corresponding to 20 dB above the indicated values in the table is specified when measuring with peak detector function.

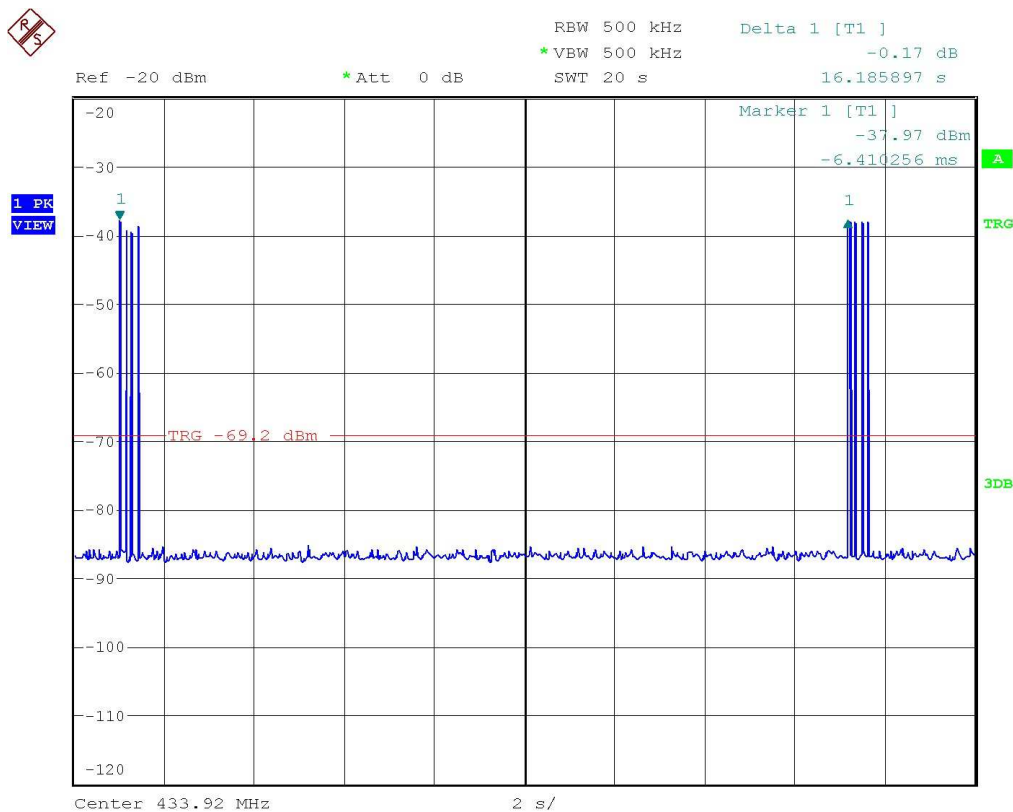
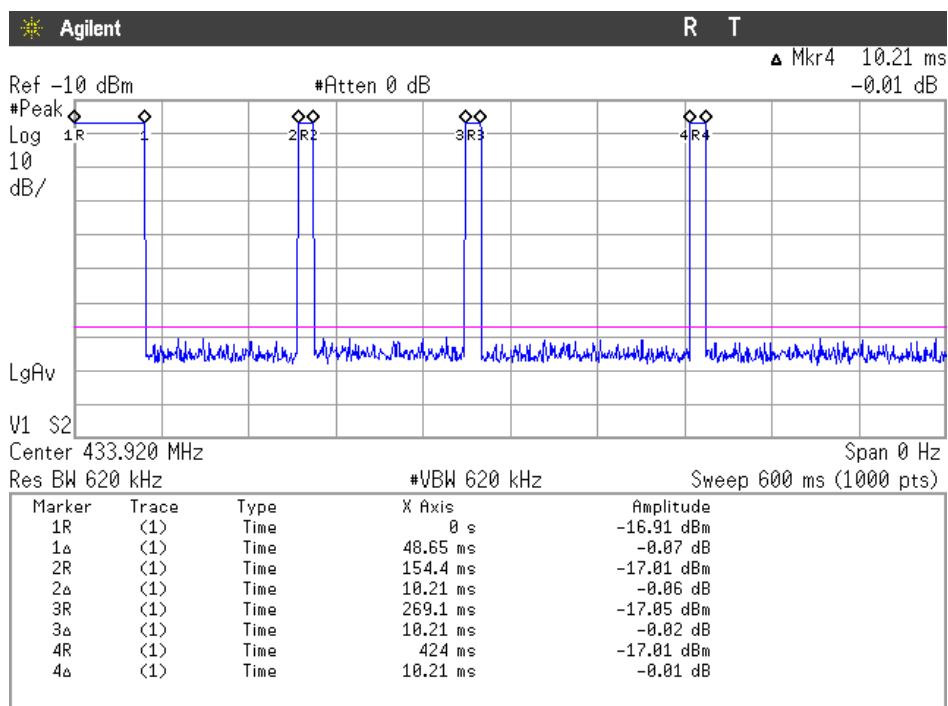
RESULTS:

The field strength is calculated by adding correction factor to the measured level from the spectrum analyser. This correction factor includes antenna factor, cable loss and pre-amplifiers gain.

The EUT is set in continuous unmodulated transmission for peak level measurement.

The normal operation transmission is pulsed so the average values of transmitter fundamental and spurious emissions are calculated from the measured peak values using the duty cycle correction factor δ as indicated in standard ANSI C63.10-2013.

Computation of duty-cycle correction factor.



Pulse train period: 16.18 s
 Number of pulses within 100 ms: 1
 Pulse duration: 48.65 ms

Duty-cycle correction factor calculation.

Sub-pulse	Duration (ms)	Number of pulses	Sub-pulse "On Time" (ms)
1	48.65	1	48.65
		TOTAL ON TIME:	48.65

Duty cycle correction factor $\delta = 48.65 / 100 = 0.4865$

$\delta = 20 \log (0.4865) = -6.26 \text{ dB}$

Frequency range 30 MHz-1000 MHz (see next plots)

Frequency (MHz)	Polarization	Detector	Emission Level	Limits 15.231 (e) / 15.209
433.92 (Fundamental)	V	Peak	6,823.39 (μ V/m) / 76.68 (dB μ V/m)	43,992.5 (μ V/m) / --- 92.87 (dB μ V/m) / ---
867.789	V	Peak	25.97 (μ V/m) / 28.29 (dB μ V/m)	4,399.25 / 2,000 (μ V/m) 72.87 / 66 (dB μ V/m)

Calculation for average level

Spurious frequency (MHz)	Emission Level (dB μ V/m) Peak	Duty-cycle correction factor δ (dB)	Corrected Emission Level (dB μ V/m) Average	Limits 15.231 (e) / 15.209
433.92 (Fundamental)	76.68	-6.26	70.42	4,399.25 (μ V/m) (72.87 dB μ V/m) / ---
867.789	28.29	-6.26	22.03	439.925 / 200 (μ V/m) 52.87 / 46 (dB μ V/m)

Measurement uncertainty (dB): ± 3.8 dB.

Verdict: PASS

Frequency range 1 GHz-5 GHz (see next plots)

Highest spurious levels.

Frequency (GHz)	Polarization	Detector	Emission Level (dBμV/m)	Limits (dBμV/m) 15.231 (e) / 15.209
1.73540	V	Peak	34.53	72.87 / 74
2.60327	V	Peak	38.30	72.87 / 74
3.47870	V	Peak	37.63	72.87 / 74

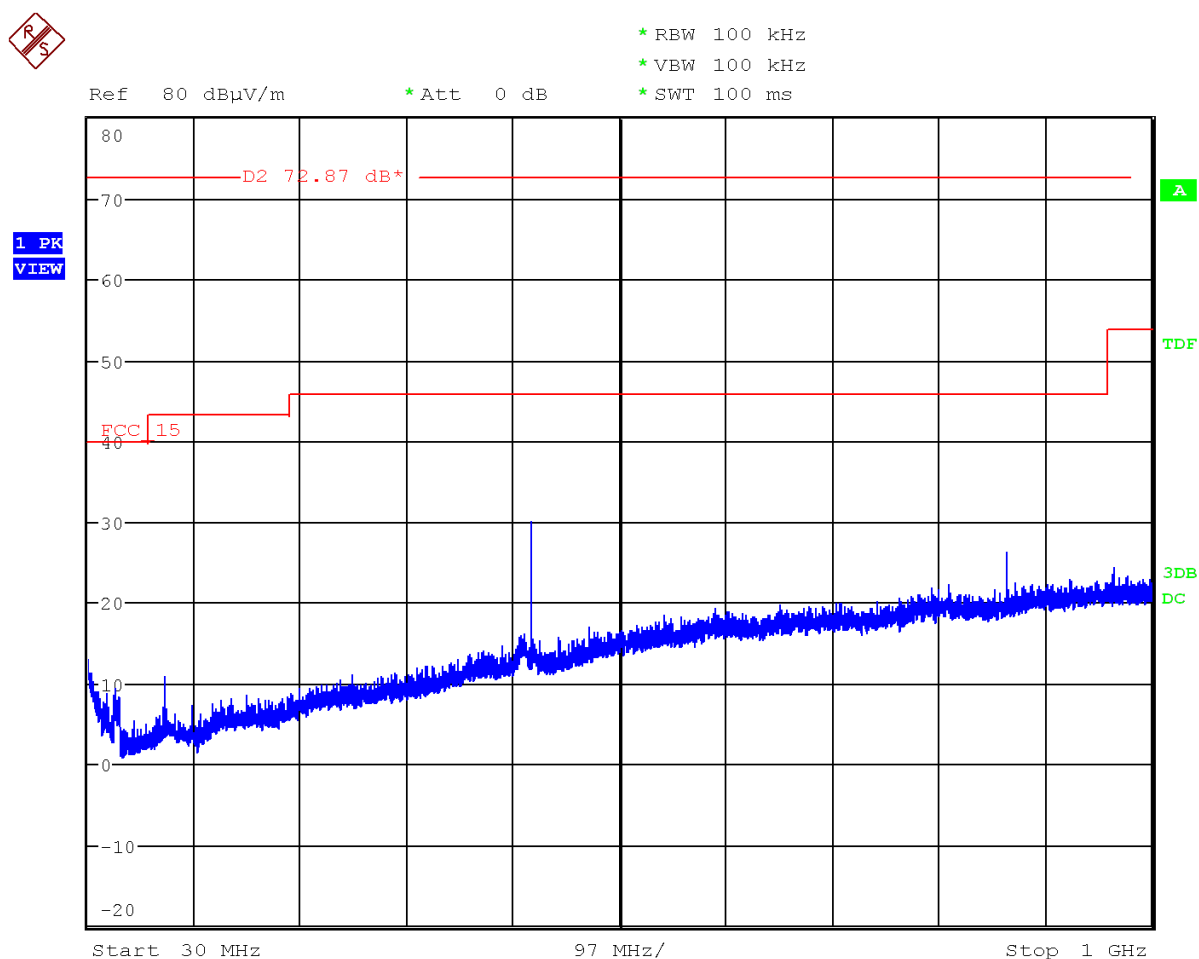
Calculation for average level

Spurious frequency (MHz)	Emission Level (dBμV/m) Peak	Duty-cycle correction factor δ (dB)	Corrected Emission Level (dBμV/m) Average	Limits (dBμV/m) 15.231 (b) / 15.209
1.73540	34.53	-6.26	28.27	52.87 / 54
2.60327	38.30	-6.26	32.04	52.87 / 54
3.47870	37.63	-6.26	31.37	52.87 / 54

Measurement uncertainty (dB): ± 4.0 dB.

Verdict: PASS.

FREQUENCY RANGE 30 MHz-1000 MHz



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

FREQUENCY RANGE 1 GHz to 5 GHz

