EMI – TEST REPORT

- FCC Part 90.217 -

DAkkS Deutsche Akkreditierungsstelle D-PL-12030-01-01

Test Report No. :	**T35704-00-00KJ**	12 October 2012 Date of issue

Type / Model Name : LOG Repeater 3-M

Product Description : Repeater for extending the operating distance of the LOG N-3M

Applicant : Seba Dynatronic Mess- und Ortungstechnik GmbH

Address : Dr.-Herbert-Iann-Str. 6
96148 BAUNACH, GERMANY

Manufacturer : Seba Dynatronic Mess- und Ortungstechnik GmbH

Address : Dr.-Herbert-Iann-Str. 6
96148 BAUNACH, GERMANY

Licence holder : Seba Dynatronic Mess- und Ortungstechnik GmbH

Address : Dr.-Herbert-Iann-Str. 6
96148 BAUNACH, GERMANY

Test Result according to the standards listed in clause 1 test standards:	**POSITIVE**

Contents

1 TEST STANDARDS

The tests were performed according to following standards:

FCC 47 CFR Part 2: 2011	Frequency allocations and radio treaty matters; General rules and regulations
FCC 47 CFR Part 15: 2011	Radio frequency devices
FCC 47 CFR Part 90: 2011	Private land mobile radio services
ANSI/TIA-603-C: 2004	Land Mobile FM or PM-Communications Equipment - Measurement and Performance Standards
ANSI C63.4: 2003	Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
KDB 412172 D01: 2010	Determining ERP and EIRP

1.1 Test result summary

Wireless repeater using digital modulation:

Operating in the frequency band from 902 MHz to 928 MHz:

Description	FCC Rule Part	Test Procedure	Result
AC power line conducted emissions	15.107(a)	ANSI C63.4:2003	not applicable
Maximum output power	90.217	ANSI/TIA-603-C-2004	passed
Spurious emissions radiated	90.217(a)	ANSI/TIA-603-C-2004	passed
Modulation characteristics	90.217(a)	ANSI/TIA-603-C-2004	passed
Occupied bandwith	General	ANSI/TIA-603-C-2004	passed
Frequency stability	90.213(a)(b)	ANSI/TIA-603-C-2004	passed
Receiver spurious emissions	15.109	ANSI C63.4:2003	passed

2 General remarks

Items	Description
Power supply	3.6 V DC powered (lithium battery)
Type of modulation	FSK
Operating frequency	913.02 MHz
Frequency band	902 MHz to 928 MHz
Data rate	9.6 kBd
Channel spacing	-
Number of channels	1
Antenna type	Internal circular F-antenna
Antenna connector	Integral
Antenna gain	2.1 dBi
Lowest internal frequency	32.768 kHz
Highest internal frequency	26.0 MHz

2.1 Final assessment

The equipment under test **fulfills** the EMI requirements cited in clause 1 test standards.

Date of receipt of test sample : acc. to storage records

Testing commenced on : 30. November 2011

Testing concluded on : 14. June 2012

Checked by:

Klaus Gegenfurtner
I confirm the correctness and Integrity of this documents
2012.10.12 08:50:41 +02'00'

Klaus Gegenfurtner
Dipl. Ing.(FH)
Manager: Radio Group

Tested by:

Josef Knab
I'm the autor of this document
2012.10.12 08:49:51 +02'00'

Josef Knab
Radio Senior Expert

3 EQUIPMENT UNDER TEST

3.1 Power supply system utilised

Power supply voltage : 3.6 V DC (lithium battery)
V_{nom}= 3.6 V
V_{min}= 3.0 V
V_{max}= 3.7 V

Max. current: TX mode 35 mA
RX mode 20 mA

3.2 Short description of the equipment under test (EUT)

The EUT is a wireless repeater for water leak detection system.

Number of tested samples: 1
Serial number: 0821000448

EUT operation mode:

The equipment under test was operated during the measurement under the following conditions:

- cont. TX at 913.02 MHz (unmodulated)

- cont. TX at 913.02 MHz (modulated)

- cont. RX mode

EUT configuration:

(The CDF filled by the applicant can be viewed at the test laboratory.)

The following peripheral devices and interface cables were connected during the measurements:

- _____ Model : _____
- _____ Model : _____
- _____ Model : _____

4 TEST ENVIRONMENT

4.1 Address of the test laboratory

mikes-testingpartners gmbh
Ohmstrasse 2-4
94342 STRASSKIRCHEN
GERMANY

4.2 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature:	15-35 °C
Humidity:	30-60 %
Atmospheric pressure:	86-106 kPa

4.3 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report acc. to CISPR 16-4-2 „Uncertainties, statistics and limit modelling – Uncertainty in EMC measurements“ and is documented in the quality system acc. to DIN EN ISO/IEC 17025. For all measurements shown in this report, the measurement uncertainty of the test laboratory, mikes-testingpartners gmbh, is below the measurement uncertainty as defined by CISPR. Therefore, no special measures must be taken into consideration with regard to the limits according to CISPR. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

4.4 Measurement protocol for FCC

4.4.1 General information

4.4.1.1 Test methodology

Conducted and radiated disturbance testing is performed according to the procedures set out by ANSI/TIA 603-C as shown under section 1 of this report.

4.4.1.2 Justification

The equipment under test (EUT) is configured in a typical user arrangement in accordance with the manufacturer's instructions. A cable is connected to each available port and either terminated with a peripheral using the appropriate impedance characteristic or left without termination. Where appropriate, cables are manually manipulated with respect to each other thus obtaining maximum disturbances from the unit.

4.4.2 Details of test procedures

4.4.2.1 Conducted emission

Description of measurement:
The final level in dBµV level is compared directly to the FCC limit or to the CISPR limit.
To convert between dBµV and µV, the following conversions apply:

dBµV = 20*log(µV)
µV = 10^(dBµV/20)

Conducted emission on the 50 Hz and/or 60 Hz power interface of the EUT are measured in the frequency range of 150 kHz to 30 MHz. The measurements are performed using a receiver, which has CISPR characteristic bandwidth and quasi-peak detection and a Line Impedance Stabilization Network (LISN) with 50 Ω / 50 µH (CISPR 16) characteristics. Table top equipment is placed on a non-conducting table 80 centimetres above the floor and is positioned 40 centimetres from the vertical ground plane (wall) of the screen room. If the minimum limit margin of a peak mode measurement appears to be less than 20 dB, the emissions are re-measured using a tuned receiver with quasi-peak and average detection and recorded on the data sheets.

4.4.2.2 Radiated emission (electrical field 30 MHz - 1 GHz)

Description of measurement:
Spurious emission from the EUT is measured in the frequency range of 30 MHz to 1000 MHz using a tuned receiver and appropriate broadband linearly polarised antennas. Measurements between 30 MHz and 1000 MHz are made with 120 kHz/6 dB bandwidth and quasi-peak detection. Table top equipment is placed on a 1.0 X 1.5 m non-conducting table 80 centimetres above the ground plane. Floor standing equipment is placed directly on the turntable/ground plane. The interface cables that are closer than 40 centimetres to the ground plane are bundled in the centre in a serpentine fashion so that they are at least 40 centimetres from the ground plane. Cables to simulators/testers (if used in this test) are routed through the centre of the table and to a screened room located outside the test area. The antenna is positioned 3, 10 or 30 metres horizontally from the EUT and is repeated vertically. To locate maximum emissions from the test sample the antenna is varied in height from 1 to 4 metres and the EUT is rotated 360 degrees.
The final level in dBµV/m is calculated by taking the reading from the EMI receiver (Level dBµV) and adding the correction factors and cable loss factor (dB). The FCC or CISPR limit is subtracted from this result in order to provide the limit margin listed in the measurement protocol.

The resolution bandwidth setting:
30 MHz – 1000 MHz: RBW: 120 kHz

4.4.2.3 Radiated emission (electrical field 1 GHz - 40 GHz)

Description of measurement:

Radiated emissions from the EUT are measured in the frequency range 1 GHz up to 12.75 GHz, using a spectrum analyser and appropriate linearly polarized antennas. Table top equipment is placed on a 1.0 X 1.5 metre non-conducting table 80 centimetres above the ground plane. Floor standing equipment is placed directly on the turntable/ground plane. The interface cables that are closer than 40 centimetres to the ground plane are bundled in the centre in a serpentine fashion so they are at least 40 centimetres from the ground plane. Cables to simulators/testers (if used in this test) are routed through the centre of the table and to a screened room located outside the test area. Measurements are made in both the horizontal and vertical polarization planes in a fully anechoic room using a spectrum analyser set to max peak detector function and a resolution 1 MHz and video bandwidth 3 MHz for peak and 10 Hz for average measurement. The conditions determined as worst case will then be used for the final measurements. When the EUT is larger than the beam width of the measuring antenna it will be moved over the surface for the four sides of the equipment. Where appropriate, the test distance may be reduced in order to detect emissions under better uncertainty and are calculated at the specified test distance.

5 TEST CONDITIONS AND RESULTS

5.1 Conducted emissions

For test instruments and accessories used see section 6 Part **A 4**.

5.1.1 Description of the test location

Test location: None

Remarks: Not applicable. The EUT is battery powered.

5.2 Maximum output power radiated

For test instruments and accessories used see section 6 Part **CPR 2**.

5.2.1 Description of the test location

Test location: OATS 1

Test distance: 10 m

5.2.2 Photo documentation of the test set-up

5.2.3 Applicable standard

According to FCC Part 90.217:
Except as noted herein, transmitters used at stations licensed below 800 MHz on any frequency listed in subparts B and C of this part or licensed on a business category channel above 800 MHz which have an output power not exceeding 120 mW are exempt from the technical requirements set out in this subpart, but must instead comply with the following:
(a) For equipment designed to operate with a 25 kHz channel bandwidth, the sum of the bandwidth occupied by the emitted signal plus the bandwidth required for frequency stability shall be adjusted so that any emission appearing on a frequency 40 kHz or more removed from the assigned frequency is attenuated at least 30 dB below the unmodulated carrier.

5.2.4 Description of Measurement

The radiated power of the fundamental emission from the EUT is measured in a test setup following the procedures set out in ANSI/TIA-603-C Section 2.2.17.
The resolution bandwidth during the measurement is as follows:
30 MHz – 1000 MHz: RBW: 120 kHz

5.2.5 Test result

Frequency (MHz)	Level PK (dBµV)	Bandwidth (kHz)	Correct. factor (dB)	Corrected power ERP (dBm)	Power limit (dBm)	Delta (dB)
913.02	68.6	120	-61.1	7.5	20.8	13.3

Note: Correction factor means the site correction factor contains cable loss, antenna gain, free space attenuation.

Power limit according to FCC Part 90.217:

Frequency	Radiated power limit	
(MHz)	(dBm)	(mW)
>800	20.8	120

The requirements are **FULFILLED.**

Remarks: _____

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5.3 Spurious emissions radiated (electric field)

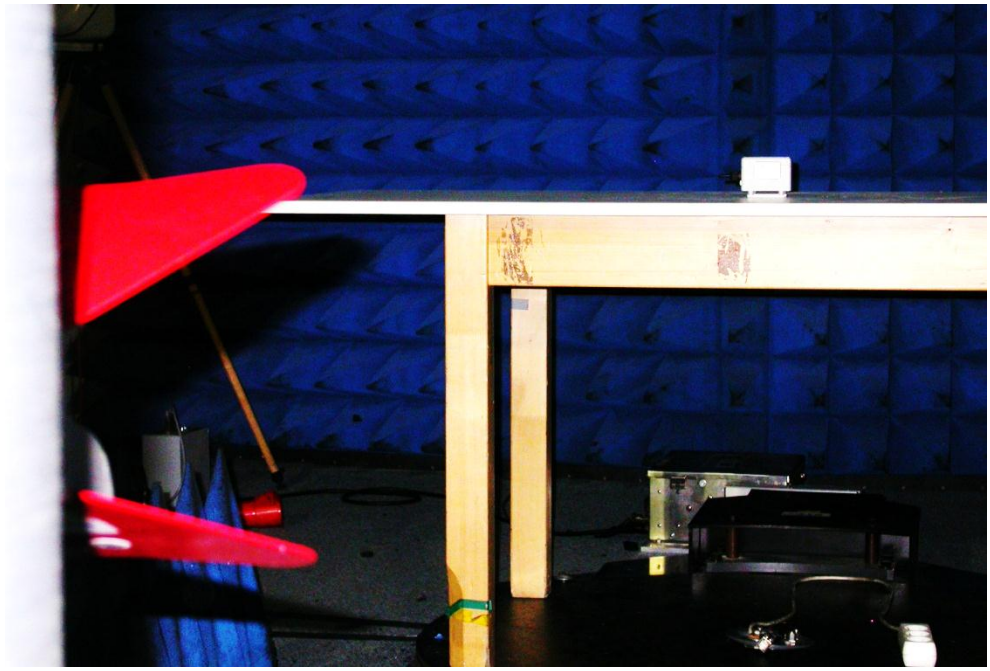
For test instruments and accessories used see section 6 Part **SER 2, SER 3**.

5.3.1 Description of the test location

Test location: OATS 1
Test distance: 10 m

Test location: Anechoic chamber 2
Test distance: 3 m

5.3.2 Photo documentation of the test set-up



5.3.3 Applicable standard

According to FCC Part 90.217(a):
(a) For equipment designed to operate with a 25 kHz channel bandwidth, the sum of the bandwidth occupied by the emitted signal plus the bandwidth required for frequency stability shall be adjusted so that any emission appearing on a frequency 40 kHz or more removed from the assigned frequency is attenuated at least 30 dB below the unmodulated carrier.

5.3.4 Description of Measurement

The radiated power of the spurious emission from the EUT is measured in a test setup following the procedures set out in ANSI/TIA-603-C Section 2.2.12.

Instrument settings:
30 MHz – 1000 MHz: RBW: 120 kHz
1000 MHz – 10000 MHz RBW: 1 MHz

5.3.5 Test result

f < 1 GHz:

Frequency (MHz)	Level QP (dBµV)	Bandwidth (kHz)	Correct. factor (dB)	Corrected power (dBm)	Power limit (dBm)	Delta (dB)
30 – 1000	-	-	-	-	-21.6	> 10

f > 1 GHz:

Frequency (MHz)	Level PK dBm	Bandwidth (kHz)	Correct. factor (dB)	Corrected power ERP (dBm)	Power limit (dBm)	Delta (dB)
1826.13	-24.6	1000	-10.1	-34.7	-21.6	13.1
2739.25	-52.1	1000	-8.0	-60.1	-21.6	38.5
3652.38	-53.9	1000	-4.6	-58.5	-21.6	36.9
4564.75	-58.1	1000	7.2	-50.9	-21.6	29.3
5478.25	-51.0	1000	8.2	-42.8	-21.6	21.2
6390.63	-49.4	1000	10.6	-38.8	-21.6	17.2
7304.13	-54.3	1000	11.3	-43.0	-21.6	21.4
8217.63	-66.3	1000	15.0	-51.3	-21.6	29.7
9130.00	-58.4	1000	15.6	-42.8	-21.6	21.2
10043.50	-62.6	1000	15.1	-47.5	-21.6	25.9
10957.00	-62.6	1000	15.7	-46.9	-21.6	25.3
11870.50	-68.0	1000	16.9	-51.1	-21.6	29.5

Spurious emission limit according to FCC Part 90.217:

Spurious emission limit (dBm)	
30 dB down	-21.6

The requirements are **FULFILLED.**

Remarks: _____

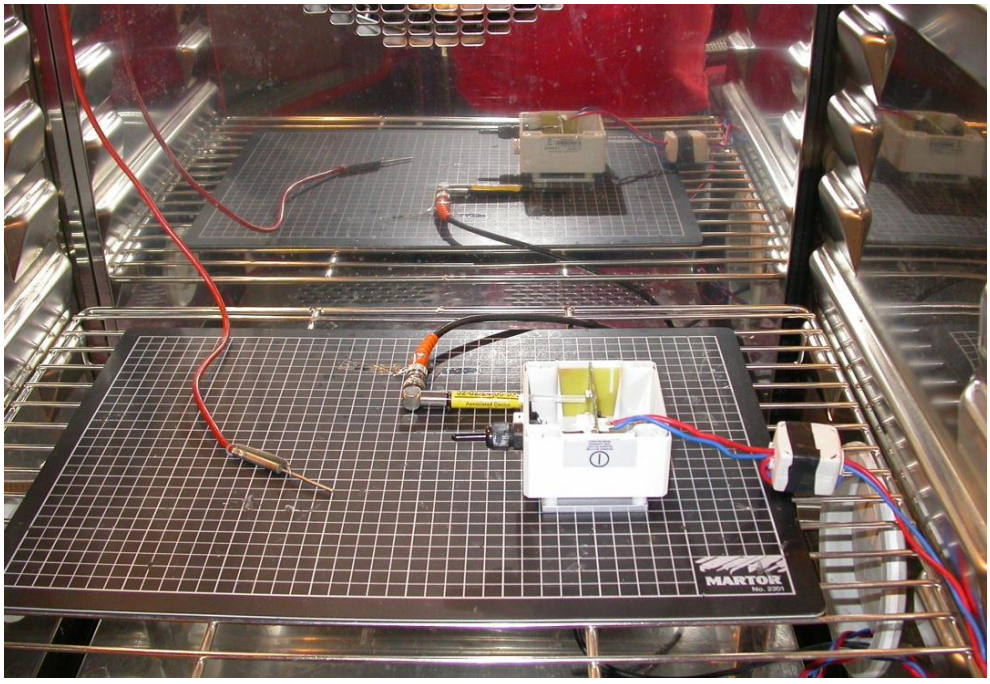
5.4 Modulation characteristics

For test instruments and accessories used see section 6 Part **MB**.

5.4.1 Description of the test location

Test location: METROLOGY

5.4.2 Photo documentation of the test set-up



5.4.3 Applicable standard

According to FCC Part 90.217(a):
(a) For equipment designed to operate with a 25 kHz channel bandwidth, the sum of the bandwidth occupied by the emitted signal plus the bandwidth required for frequency stability shall be adjusted so that any emission appearing on a frequency 40 kHz or more removed from the assigned frequency is attenuated at least 30 dB below the unmodulated carrier.

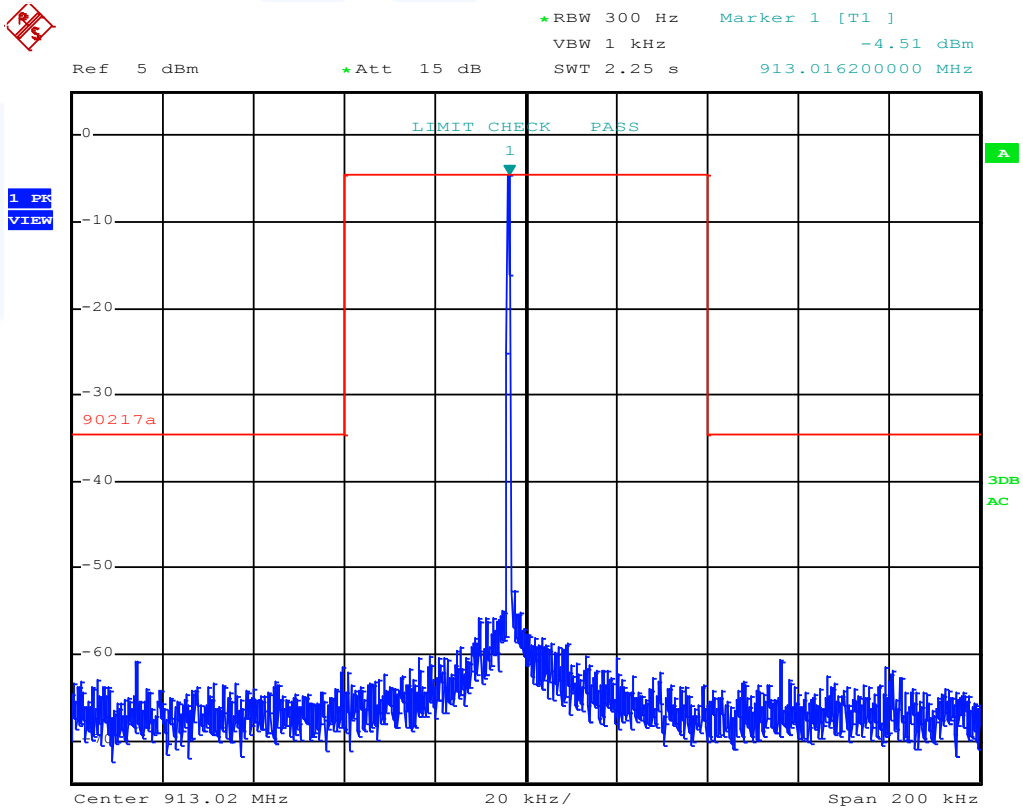
5.4.4 Description of Measurement

The measurement was performed radiated with intentional modulation on and off. The emission mask defined for 25 kHz channel bandwidth devices is shown on each plot. The 0 dB reference for the mask is the measured output power of the unmodulated carrier at that frequency.

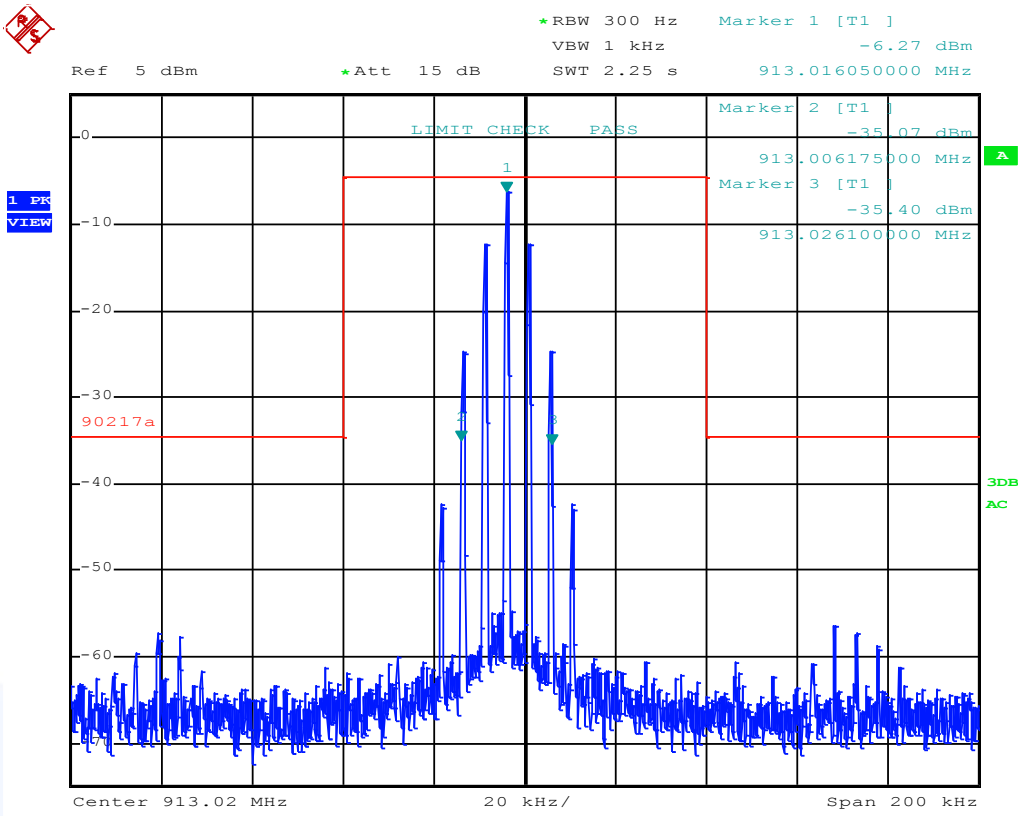
Spectrum analyser settings:
RBW: 300 Hz, VBW: 1 kHz, Detector: PK sampling detector, Sweep time: auto

5.4.5 Test result

Cont. TX without modulation



Cont. TX with modulation



Peak power limit according to FCC Part 90.217(a):

Limit	Lower envelope point minimum frequency	Upper envelope point maximum frequency
30 dB down	912.98 MHz ($f_{e,\ lower}$ - 40 kHz)	913.06 MHz ($f_{e,\ upper}$ + 40 kHz)

The requirements are **FULFILLED.**

Remarks: _____

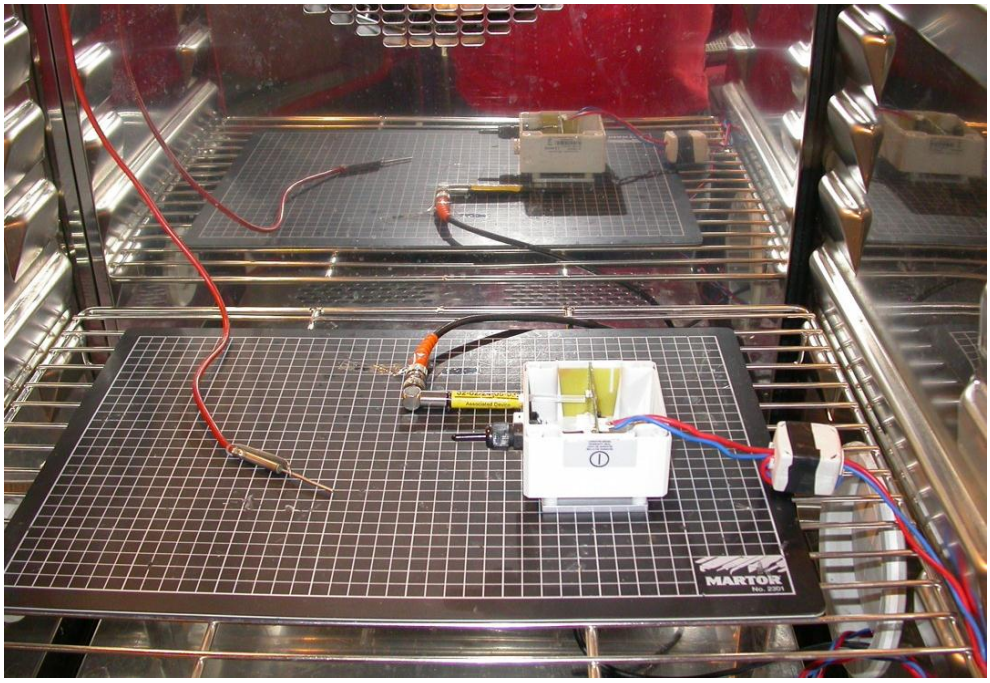
5.5 Occupied bandwidth

For test instruments and accessories used see section 6 Part **MB**.

5.5.1 Description of the test location

Test location: METROLOGY

5.5.2 Photo documentation of the test set-up



5.5.3 Applicable standard

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 per cent of the total mean power radiated by a given emission shall be measured under the following conditions as applicable:
Transmitters in which the modulating baseband comprises not more than three independent channels—when modulated by the full complement of signals for which the transmitter is rated. The level of modulation for each channel should be set to that prescribed in rule parts applicable to the services for which the transmitter is intended. If specific modulation levels are not set forth in the rules, the tests should provide the manufacturer's maximum rated condition.

5.5.4 Description of Measurement

The bandwidth was measured radiated with the function “bandwidth measurement” of the spectrum analyser.

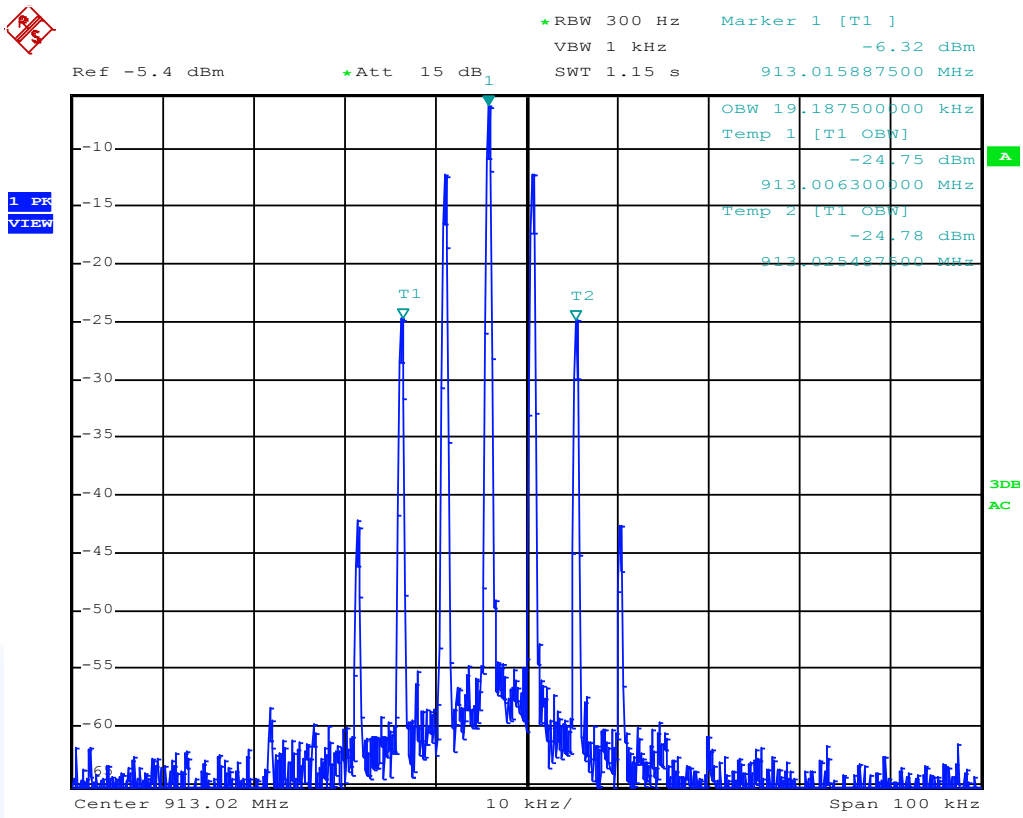
Spectrum analyser settings:
RBW: 300 Hz, VBW: 1 kHz, Detector: PK sampling detector, Sweep time: auto

5.5.5 Test result

Channel number	Fundamental frequency (MHz)	99 % Bandwidth (kHz)
1	913.02	19.19

5.5.6 Test protocol

99% Bandwidth measurement plots



The requirements are **FULFILLED.**

Remarks: _____

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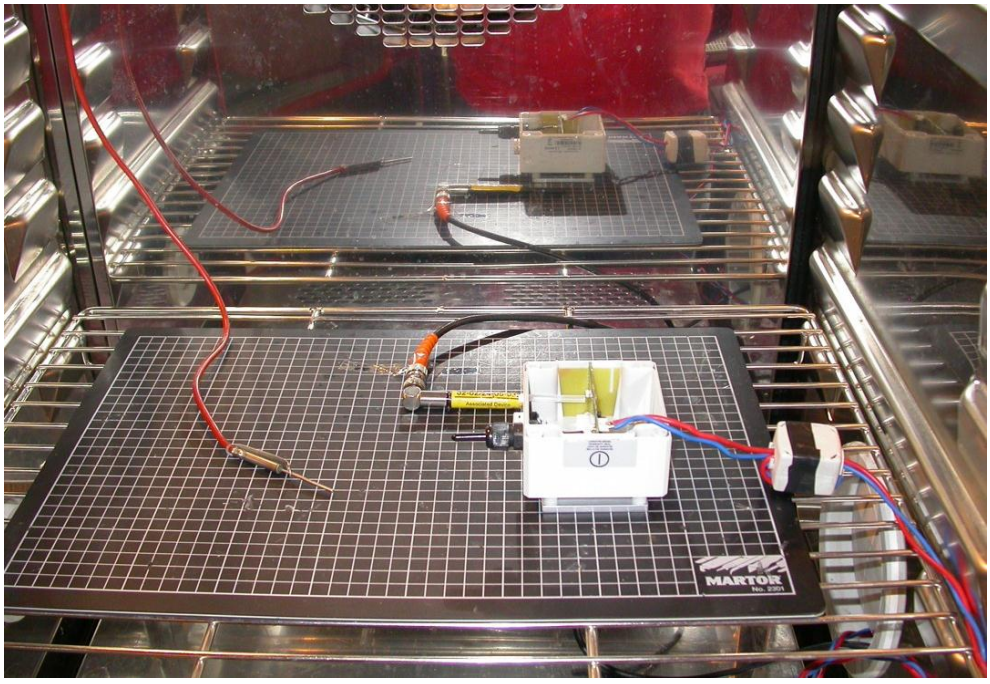
5.6 Frequency stability

For test instruments and accessories used see section 6 Part **MB**.

5.6.1 Description of the test location

Test location: METROLOGY

5.6.2 Photo documentation of the test setup



5.6.3 Applicable standard

According to FCC Part 90.217(a):
(a) For equipment designed to operate with a 25 kHz channel bandwidth, the sum of the bandwidth occupied by the emitted signal plus the bandwidth required for frequency stability shall be adjusted so that any emission appearing on a frequency 40 kHz or more removed from the assigned frequency is attenuated at least 30 dB below the unmodulated carrier.

5.6.4 Description of Measurement

This test has been performed over variations in temperature and voltage. The temperature stability was measured with the EUT in a climatic chamber and was powered DC voltage supplied externally. The frequency stability of the transmitter was examined at the voltage extremes and for the temperature range of -30°C to +50°C. The carrier frequency was measured with a spectrum analyser.

5.6.5 Test result

Test conditions		Test result	
		Frequency reading (MHz)	Frequency error (kHz)
T (50°C)	V_{min}	913.014259	-5.74
	V_{nom}	913.014315	-5.68
	V_{max}	913.014227	-5.77
T (40°C)	V_{min}	913.015613	-4.39
	V_{nom}	913.015509	-4.49
	V_{max}	913.015430	-4.57
T (30°C)	V_{min}	913.017544	-2.46
	V_{nom}	913.017453	-2.55
	V_{max}	913.017365	-2.64
T_{nom} (20°C)	V_{min}	913.019913	-0.09
	V_{nom}	913.019801	-0.20
	V_{max}	913.019703	-0.30
T (10°C)	V_{min}	913.022005	2.01
	V_{nom}	913.022016	2.02
	V_{max}	913.021921	1.92
T (0°C)	V_{min}	913.023613	3.61
	V_{nom}	913.023536	3.54
	V_{max}	913.023448	3.45
T (-10°C)	V_{min}	913.023819	3.82
	V_{nom}	913.023870	3.87
	V_{max}	913.023891	3.89
T (-20°C)	V_{min}	913.022351	2.35
	V_{nom}	913.022475	2.48
	V_{max}	913.022606	2.61
T (-30°C)	V_{min}	913.018752	-1.25
	V_{nom}	913.019056	-0.94
	V_{max}	913.019113	-0.89
Measurement uncertainty		± 3 dB	

Measured frequency 30 dB down nearest at the lower frequency (see page 16):

$$f_L + FE_{min} = 913.0062 \text{ MHz} + -5.8 \text{ kHz} = \mathbf{913.0004 \text{ MHz}}$$

Measured frequency 30 dB down nearest at the higher frequency (see page 16):

$$f_H + FE_{max} = 913.0261 \text{ MHz} + 3.9 \text{ kHz} = \mathbf{913.0300 \text{ MHz}}$$

Bandwidth limit according to FCC Part 90.217(a):

Limit	Lower envelope point minimum frequency	Upper envelope point maximum frequency
30 dB down	912.98 MHz ($f_{e, lower}$ - 40 kHz)	913.06 MHz ($f_{e, upper}$ + 40 kHz)

The requirements are **FULFILLED.**

Remarks: _____

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5.8 Receiver spurious emissions, radiated

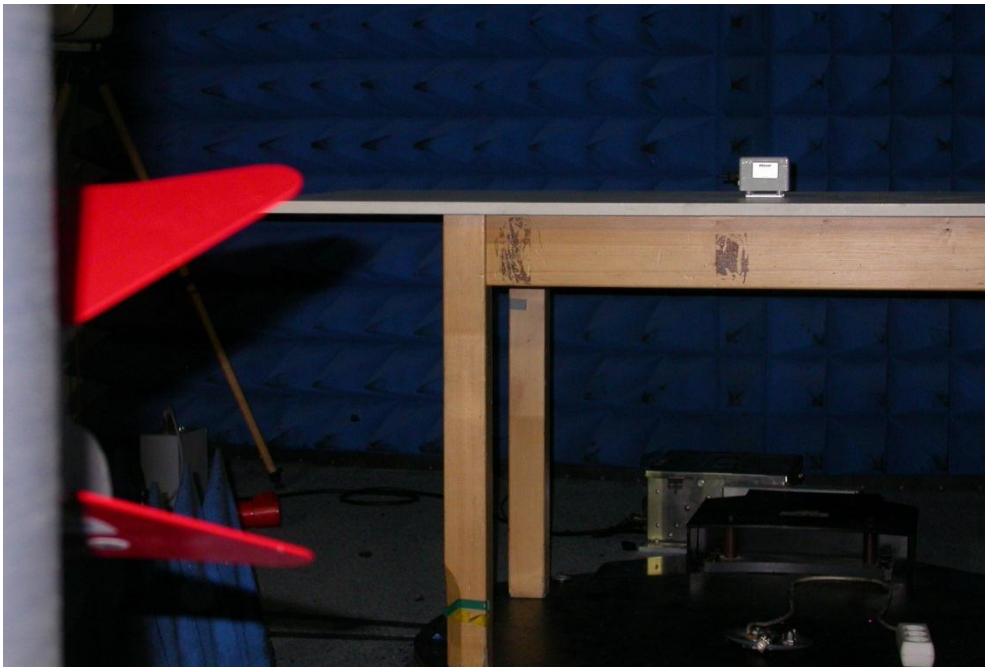
For test instruments and accessories used see section 6 Part **SER 2 and SER 3**.

5.8.1 Description of the test location

Test location: OATS 1
Test location: Anechoic chamber 2

Test distance: 3 m

5.8.2 Photo documentation of the test set-up



5.8.3 Applicable standard

According to ANSI/TIA-603-C Section 3.1.1 and FCC Part 15B, Section 15.109 (a) and:
Except for Class A digital devices, the field strength of radiated emission from unintentional radiators at a distance of 3 m shall not exceed the given limit.

5.8.4 Description of Measurement

The radiated power of the spurious emission from the EUT is measured in a test setup following the procedures set out in ANSI C63.4. If the emission level of the EUT in peak mode complies with the average limit is 20 dB lower, then testing will be stopped and peak values of the EUT will be reported, otherwise the emission will be measured in average mode again and reported.

Instrument settings:
30 MHz – 1000 MHz: RBW: 120 kHz
1000 MHz – 5000 MHz RBW: 1 MHz

5.8.5 Test result

f < 1 GHz:

Frequency (MHz)	L: QP (dBµV)	L: AV (dBµV)	Bandwidth (kHz)	Correct. (dB)	L: QP (dBµV/m)	L: AV (dBµV/m)	Limit (dBµV/m)	Delta (dB)
30 – 1000	-	-	-	-	-	-	40	> 10

f > 1 GHz:

Frequency (MHz)	L: PK (dBµV)	L: AV (dBµV)	Bandwidth (kHz)	Correct. (dB)	L: PK (dBµV/m)	L: AV (dBµV/m)	Limit AV (dBµV/m)	Delta (dB)
1000 – 5000	-	-	-	-	-	-	54	> 10

Limit according to FCC Part 15B, Section 15.109(a):

Frequency (MHz)	Limit (µV/m)	Limit (dBµV/m)
30 - 88	100	40
88 - 216	150	43.5
216 - 960	200	46
Above 960	500	54

The requirements are **FULFILLED.**

Remarks: The measurement was performed according to FCC Part 15A, Section 15.33(b), up to the 5 MHz.

6 USED TEST EQUIPMENT AND ACCESSORIES

All test instruments used are calibrated and verified regularly. The calibration history is available on request.

Test ID	Model Type	Equipment No.	Next Calib.	Last Calib.	Next Verif.	Last Verif.
CPR 2	ESVS 30	02-02/03-05-006	26/06/2013	26/06/2012		
	VULB 9168	02-02/24-05-005	16/03/2013	16/03/2012	16/09/2012	16/03/2012
	S10162-B	02-02/50-05-031				
	NW-2000-NB	02-02/50-05-113				
	KK-EF393/U-16N-21N_20m	02-02/50-12-018				
MB	RF Antenna	02-02/24-05-032				
	MetraHIT World	02-02/32-10-001	25/08/2012	25/08/2011		
	WK-180/40	02-02/45-08-001	31/07/2012	31/072011		
	6543A	02-02/50-05-157				
	VLP-1405 PRO	02-02/50-10-014				
SER 2	ESVS 30	02-02/03-05-006	26/06/2013	26/06/2012		
	VULB 9168	02-02/24-05-005	16/03/2013	16/03/2012	16/09/2012	16/03/2012
	S10162-B	02-02/50-05-031				
	NW-2000-NB	02-02/50-05-113				
	KK-EF393/U-16N-21N_20m	02-02/50-12-018				
SER 3	FSP 30	02-02/11-05-001	05/10/2012	05/10/2011		
	AFS4-01000400-10-10P-4	02-02/17-05-003				
	AMF-4F-04001200-15-10P	02-02/17-05-004				
	AFS5-12001800-18-10P-6	02-02/17-06-002				
	3117	02-02/24-05-009	16/02/2013	16/02/2012		
	WHJS 1000-10EE	02-02/50-05-070				
	Sucoflex N-1600-SMA	02-02/50-05-073				
	Sucoflex N-2000-SMA	02-02/50-05-075				

7 Photo documentation

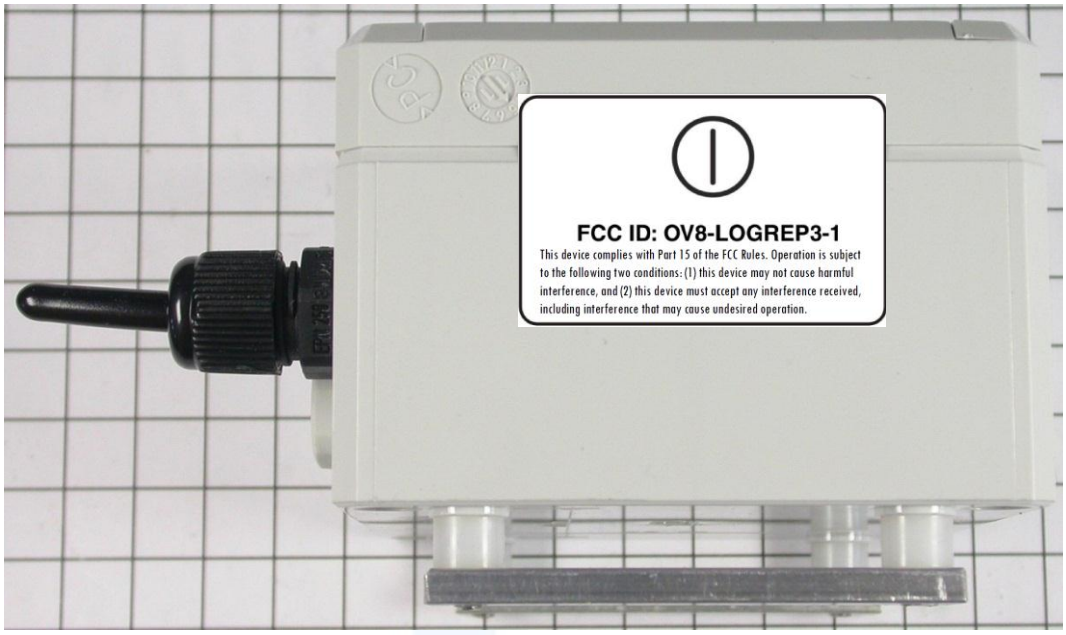
7.1 External photos of the EUT

Left side view / label placement
(Label for European market)

Label view
(Label for European market)

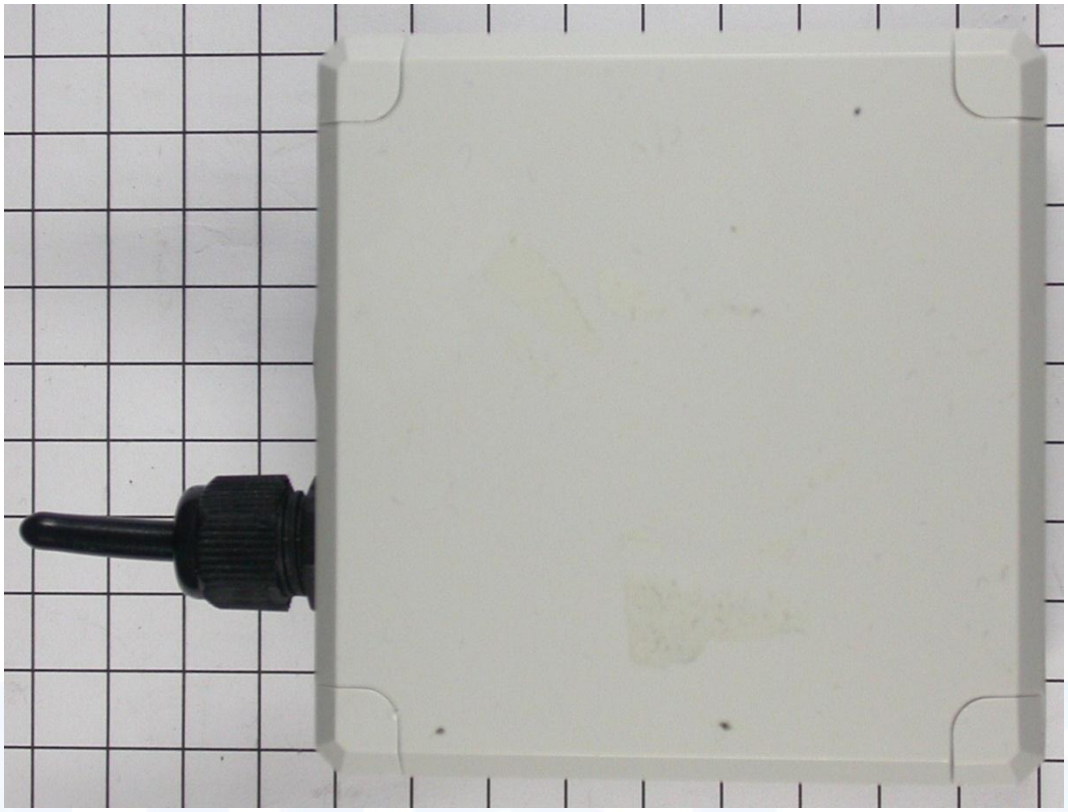
FCC: OV8-LOGREP3-1

Right side view / FCC lable placement
(on/off magnetic switch)

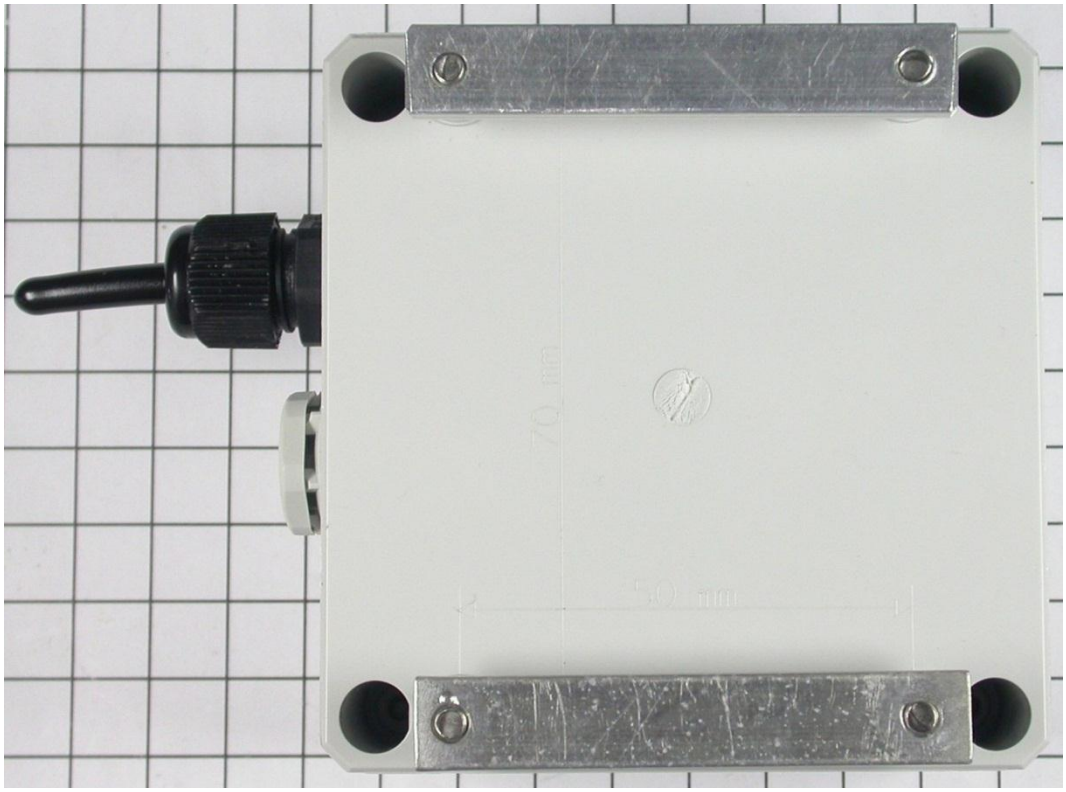


Front view

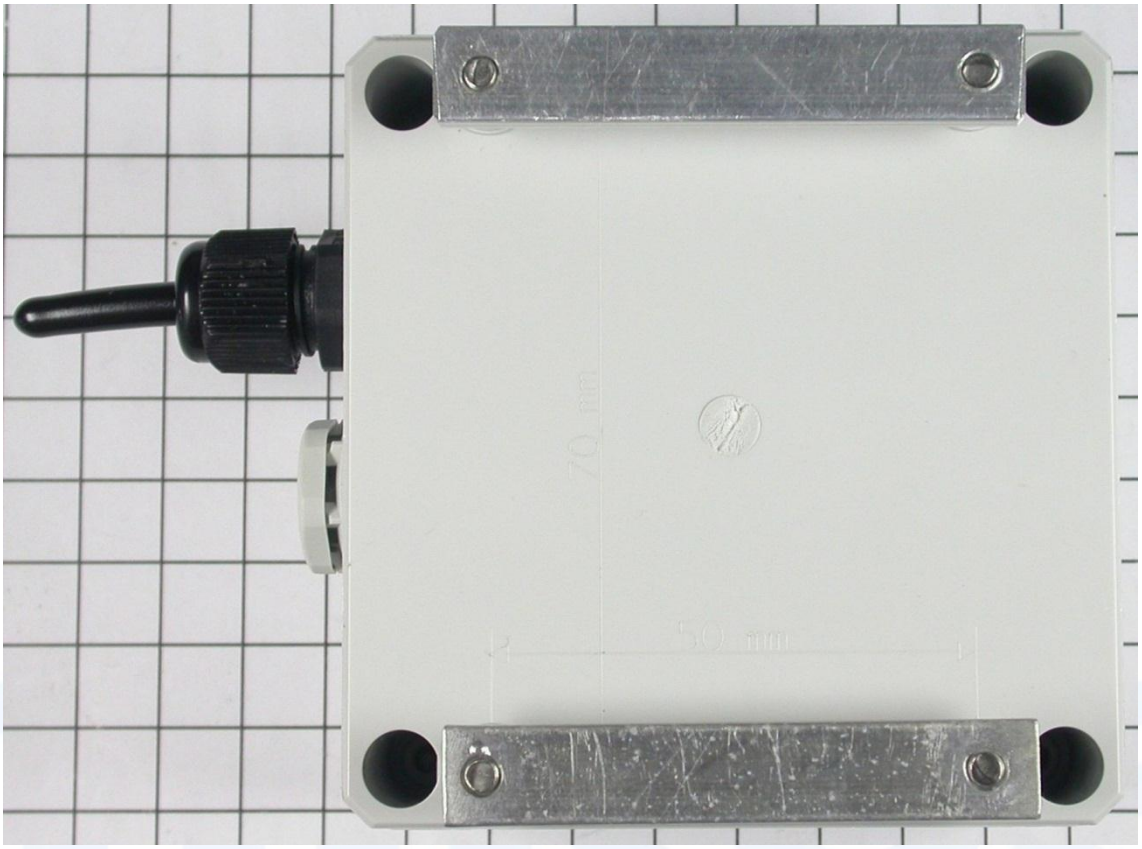
Top view



Bottom view

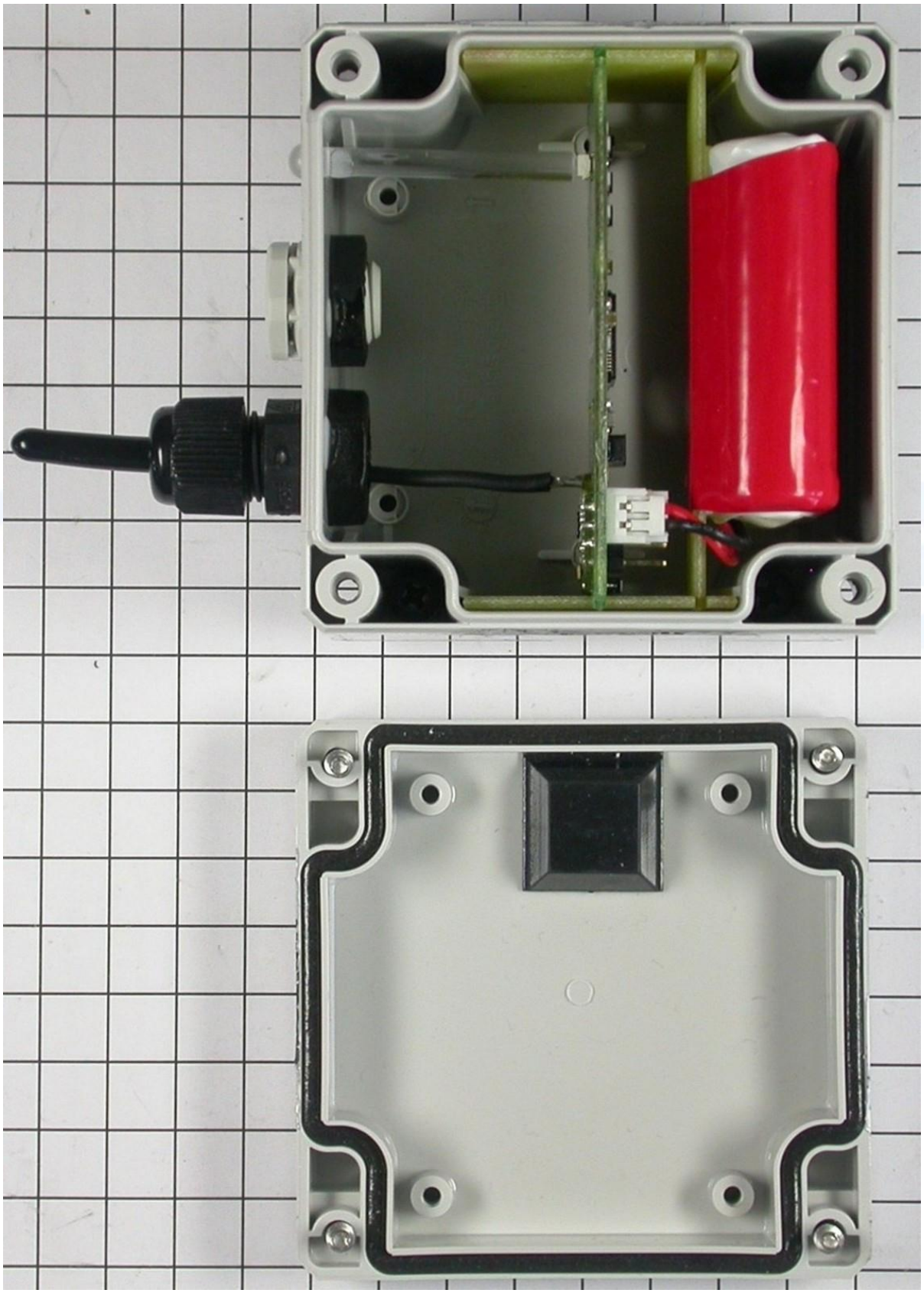


Bottom view

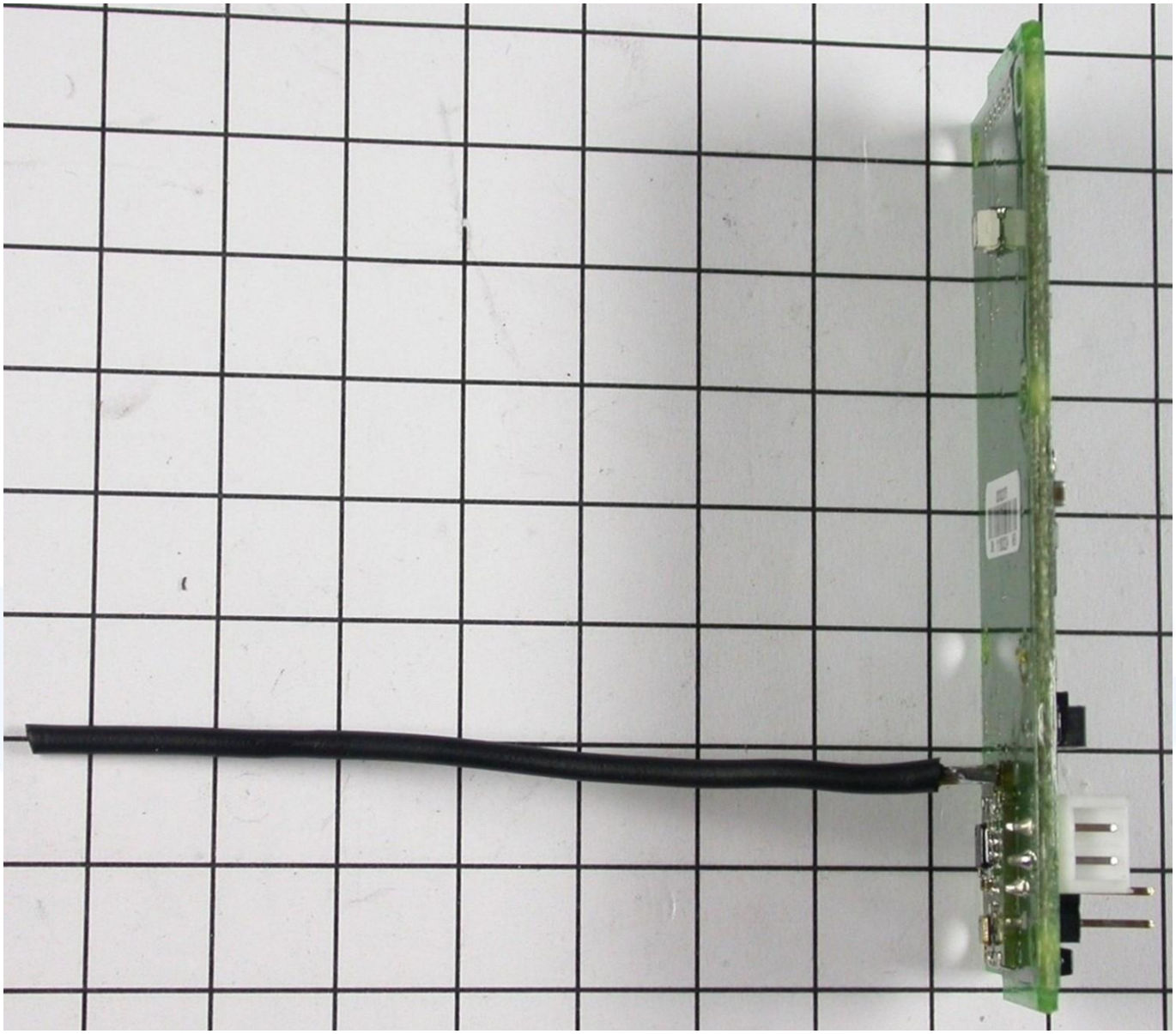


7.2 Internal photos of the EUT

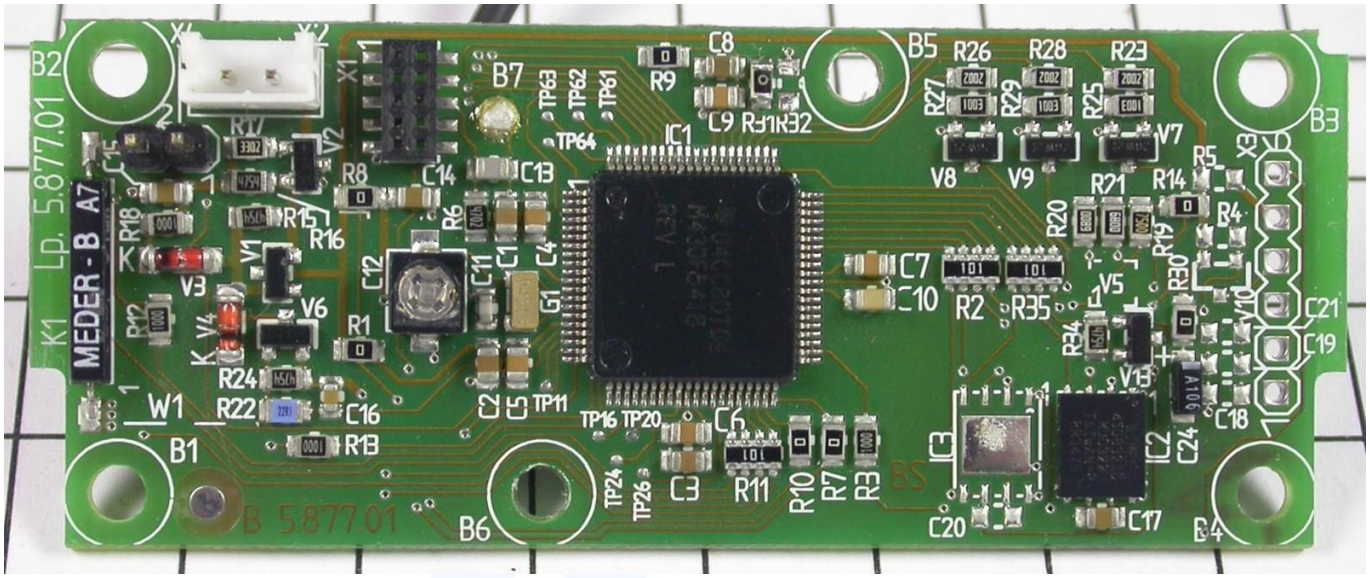
Open casing



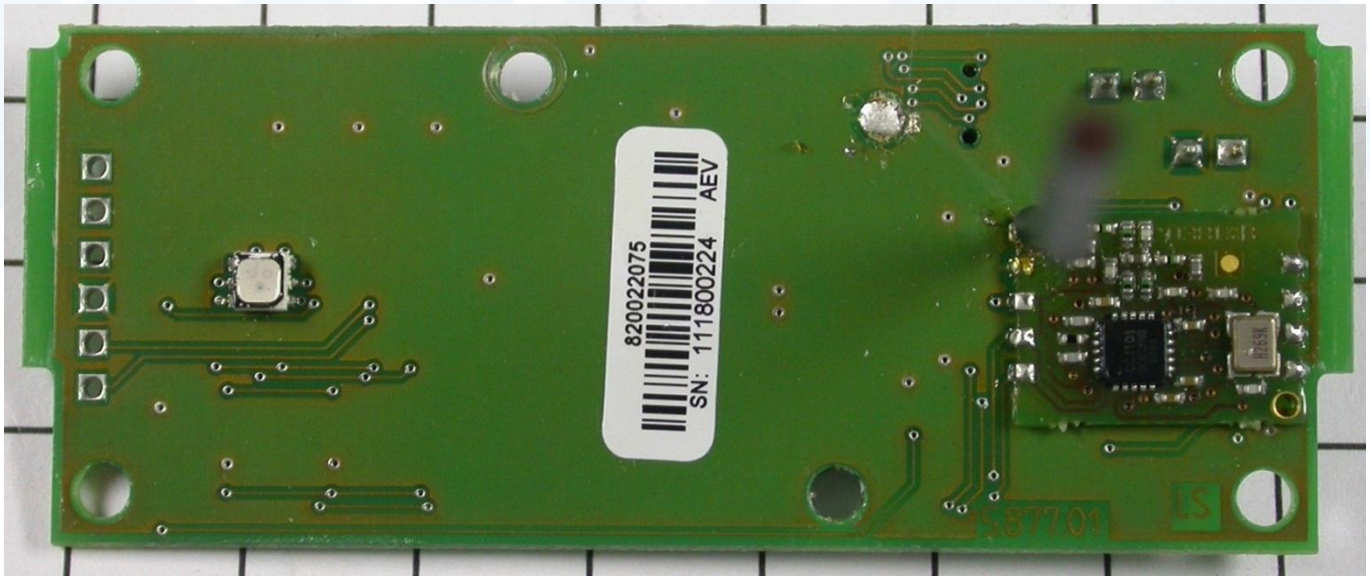
Antenna / PCB side view



PCB top view



PCB bottom view



RF module top view (zoom)