



H.B. Compliance Solutions

Intentional Radiator Test Report

For the

Ingecom.

Active Tag 2nd Generation

Tested under

The FCC Rules contained in Title 47 of the CFR, Part 15.249 for

RFID Operation

Prepared for:

Ingecom

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Reviewed By:

A handwritten signature in black ink, appearing to read 'Hoosamuddin Bandukwala'.

Hoosamuddin Bandukwala



Cert # ATL-0062-E

Engineering Statement: The measurements shown in this report were made in accordance with the procedure indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurement made, the equipment tested is capable of operation in accordance with the requirements of Part 15 of the FCC Rules under normal use and maintenance.

Report Status Sheet

Revision #	Report Date	Reason for Revision
Ø	October 18, 2013	Initial Issue
1	March 25, 2015	Re-test
2	May 14, 2015	TCB Comments
3	May 21, 2015	Changed ANSI reference

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EXECUTIVE SUMMARY

1. Testing Summary

These tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 15.249. All tests were conducted using measurement procedure from ANSI C63.4-2009, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the range of 9kHz to 40GHz as appropriate.

Test Name	Test Method/Standard	Result	Comments
Unintentional Radiated Emissions	15.109	Pass	
A/C Power Line Conducted Emissions	15.207(a)	N/A	Battery Powered Device
Occupied Bandwidth	15.215	Pass	
Radiated Fundamental Emissions	15.249(a)	Pass	
Radiated Spurious Emissions	15.249(a)(d)(e), 15.209(a), 15.205, 15.35(C)	Pass	

EQUIPMENT CONFIGURATION

1. Overview

H.B Compliance Solutions was contracted by Ingecom to perform testing on the Active Tag 2nd Generation under the purchase order number 1031.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Ingecom, Active Tag 2nd Generation.

The tests were based on FCC Part 15 Rules. The tests described in this document were formal tests as described with the objective of the testing was to evaluate compliance of the Equipment Under Test (EUT) to the requirements of the aforementioned specifications.

Ingecom should retain a copy of this document and it should be kept on file for at least five years after the manufacturing of the EUT has been permanently discontinued. The results obtained relate only to the item(s) tested.

Product Name:	Active Tag
Model(s) Tested:	2 nd Generation
FCC ID:	2ABCW-1243452
Supply Voltage Input:	Primary Power : 3 Vdc
Frequency Range:	2402MHz
No. of Channels:	Single
Type(s) of Modulation:	FSK
Range of Operation Power:	0.00002415W (Radiated)
Emission Designator:	N/A
Channel Spacing(s)	None
Test Item:	Pre-Production
Type of Equipment :	Fixed
Antenna Requirement (§15.203) :	Type of Antenna: Folded Dipole (PCB) Gain of Antenna: 3.0dBi
Environmental Test Conditions:	Temperature: 15-35°C Humidity: 30-60% Barometric Pressure: 860-1060 mbar
Modification to the EUT:	None
Evaluated By:	Staff at Emerson Network & H.B Compliance Solutions
Test Date(s):	03/23/15 till 03/25/15

2. Test Facility

All testing was performed at Artesyn Embedded Technologies. This facility is located at 2900 S. Diablo Way, Suite 190, Tempe, AZ 85282. All equipment used in making physical determination is accurate and bears recent traceability to the National Institute of Standards and Technology.

Test facility at Artesyn Embedded Technologies is an A2LA accredited test site. The A2LA certificate number is 2716.01. The scope of accreditation covers the FCC Method - 47 CFR Part 15, ICES-003, CISPR 22, AS/NZS 3548 and VCCI

Radiated Emissions measurements were performed in a semi-anechoic chamber (equivalent to an Open Area Test Site). In accordance with §2.948(a)(3), a complete site description is contained at Emerson Network Power.

3. Description of Test Sample

The Ingecom, Active Tag is a RFID smart Tag used for equipment tracking. The components are contained in a plastic enclosure.

4. Equipment Configuration

Ref. ID	Name / Description	Model Number	Serial Number
# 1	Active Tag	2 nd Generation	None

Table 1. Equipment Configuration

5. Support Equipment

All support equipment supplied is listed in the following Support Equipment List.

Ref ID	Name / Description	Manufacturer	Model #	Serial #
N/A	None	None	None	None

Table 2. Support Equipment

6. Ports and Cabling Information

Ref ID	Port name on the EUT	Cable Description	Qty.	Length (m)	Shielded? (Y/N)	Termination Box ID & Port ID
N/A	None	None	-	-	-	None

Table 3. Ports and Cabling Information

7. Method of Monitoring EUT Operation

A test receiver will be used to monitor the data transmission from the EUT.

8. Mode of Operation

The EUT will be configured to transmit at maximum power level. Tag with different firmware was provided for test purpose.

9. Modifications

9.1 Modifications to EUT

No modifications were made to the EUT

9.2 Modifications to Test Standard

No Modifications were made to the test standard.

10. Disposition of EUT

The test sample including all support equipment submitted to H.B Compliance Solutions for testing will be returned to Ingecom upon completion of testing & certification

Criteria for Un-Intentional Radiators

1. Radiated Emissions

Test Requirement(s):	§15.109	Test Engineer(s):	Frank Farrone
Test Results:	Pass	Test Date(s):	03/23/2015

Test Procedures:

The final radiated emissions test was performed using the parameters described above as worst case. That final test was conducted at a facility that meets the ANSI C63.4 NSA requirements. The frequency range noted in the data sheets was scanned/tested at that facility. Emissions were maximized as specified, by varying table azimuth, antenna height, and manipulating cables.

Using the mode of operation and configuration noted within this report, a final radiated emissions test was performed. The frequency range investigated (scanned), is also noted in this report. Radiated emissions measurements were made at the EUT azimuth and antenna height such that the maximum radiated emissions level will be detected. This requires the use of a turntable and an antenna positioner. The preferred method of a continuous azimuth search is utilized for frequency scans of the EUT field strength with both polarities of the measuring antenna. A calibrated, linearly polarized antenna was positioned at the specified distance from the periphery of the EUT.

Note: The specified distance is the horizontal separation between the closest periphery of the EUT and the center of the axis of the elements of the receiving antenna. However, if the receiving antenna is a log-periodic array, the specified distance shall be the distance between the closest periphery of the EUT and the front-to-back center of the array of elements.

Tests were made with the antenna positioned in both the horizontal and vertical polarization planes. The measurement was varied in height above the conducting ground plane to obtain the maximum signal strength. Though specified in the report, the measurement distance shall be 3 meters. At any measurement distance, the antenna height was varied from 1 meter to 4 meters. These height scans apply for both horizontal and vertical polarization, except that for vertical polarization the minimum height of the center of the antenna shall be increased so that the lowest point of the bottom of the antenna clears the ground surface by at least 25 cm.

Frequency Range (MHz)	Peak Data (kHz)	Quasi-Peak Data (kHz)	Average Data (kHz)
30 MHz to 1 GHz	120 kHz	120 kHz	N/A
1 GHz to 11 GHz	1MHz	N/A	1MHz
Measurements were made using the bandwidths and detectors specified. The video filter was at least as wide as the IF bandwidth of the measuring receiver.			

Table 4. Radiated Emissions – Measurement Bandwidth

Emissions Tests Calculations

In the case of indoor measurements, radiated emissions measurements are made by the manipulation of correction factors using Rohde and Schwarz ES-K1 software. This is done automatically by the software during the final measurement process.

In both cases, the level of the Field Strength of the interfering signal is calculated by adding the Antenna Factor, Cable Factor and by subtracting the Amplifier Gain from the measured reading. The basic equation is as follows:

$$FS = RA + AF + (CF - AG)$$

Where: FS = Field Strength

RA = Receiver (indicated) Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor

AG = Amplifier Gain

This laboratory uses an approach of combining the CF and AG using an end-to-end measurement of the entire cabling system, including the test cable, any in-line amplifiers, attenuators, or transient protection networks, all measured in-situ.

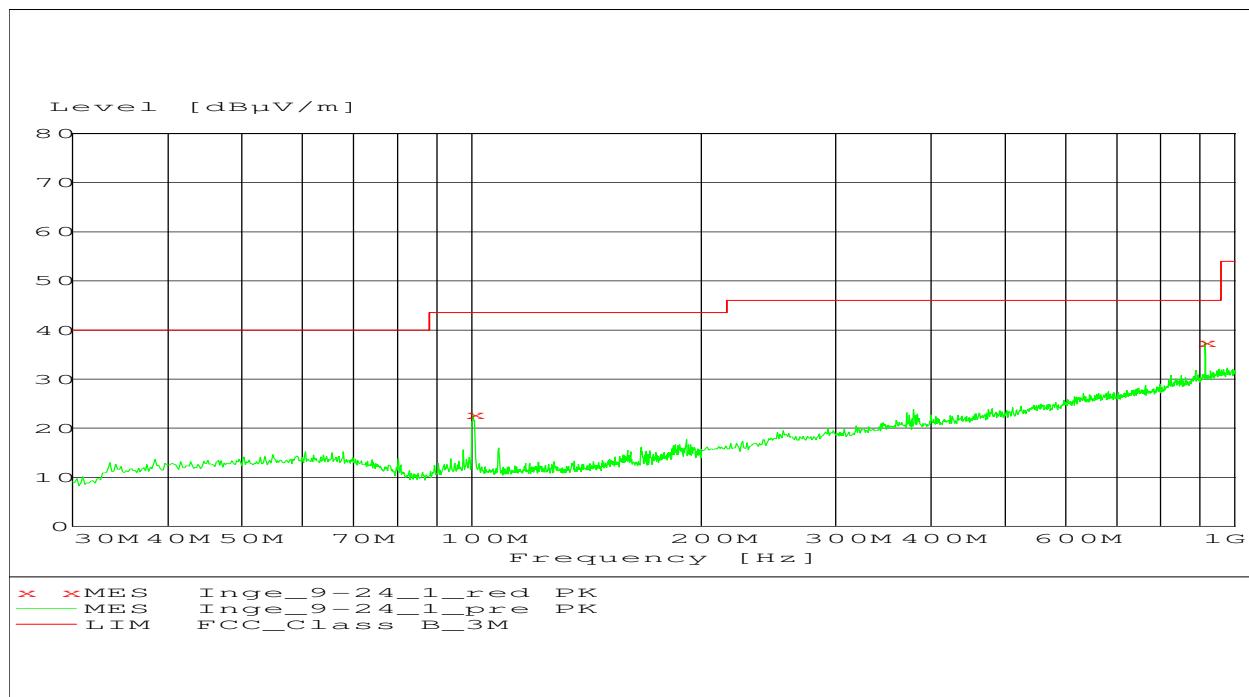
For a sample calculation, assume a receiver reading of 52.5 dBuV is obtained. With an antenna factor of 7.4 and a combined cable factor (CF + AG) of -27.9:

$$FS = 52.5 + 7.4 + (-27.9) = 32 \text{ dBuV/m}$$

$$FS = 32 \text{ dBuV/m}$$

If desired, this can be converted into its corresponding level in uV/m:

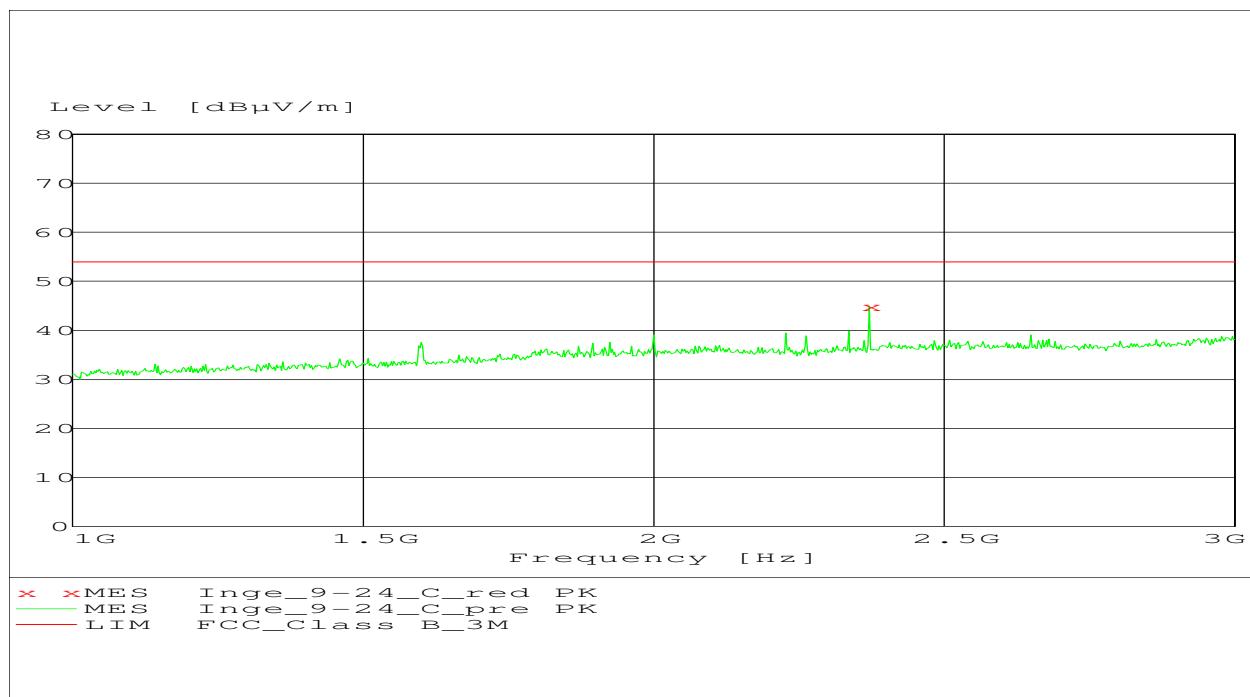
$$FS = 10^{((32 \text{ dBuV/m})/20)} = 39.8 \text{ uV/m}$$



Plot 1 – Radiated Emissions – 30MHz to 1GHz

Frequency (MHz)	Measured Level	Height(cm)	Azimuth (deg)	Polarization
100.4	22.68	100	135	Vertical
913.77	37.46	100	0	Vertical

Table 5. Final Measurement Results for Radiated Emissions



Plot 1 – Radiated Emissions – 1GHz to 3GHz (For Industry Canada RSS-GEN)

Criteria for Intentional Radiators

2. Conducted Emissions

Test Requirement(s):	§15.207	Test Engineer(s):	None
Test Results:	N/A	Test Date(s):	None

Test Procedures: The EUT was placed on a non-metallic table, 80cm above the ground plane inside a shielded enclosure. The EUT was powered through a $50\Omega/50\mu\text{H}$ LISN. The conducted emissions tests were performed using the mode of operation and configuration noted within this report. The frequency range investigated (scanned), is also noted in this report. Conducted power line measurements are made, unless otherwise specified, over the frequency range from 150 kHz to 30 MHz to determine the line-to-ground radio-noise voltage that is conducted from the EUT power-input terminals that are directly (or indirectly via separate transformer or power supplies) connected to a public power network. Equipment is tested with power cords that are the same as those cords normally used or that have electrical or shielding characteristics that are the same as those cords normally used. Typically those measurements are made using a LISN (Line Impedance Stabilization Network). All 50 Ohm measuring ports of the LISN are terminated by 50 Ohms, either by the 50 Ohm EMI receiver or a 50 Ohm resistive load.

Refer to the Emissions Tests Calculations section in the Radiated Emissions section for sample calculations. For the purposes of the conducted emissions test, the Antenna Factor (AF) is replaced by the LISN correction factor.

Frequency Range (MHz)	Peak Data (kHz)	Quasi-Peak Data (kHz)	Average Data (kHz)
0.150 - 30	9.0	9.0	9.0
Measurements were made using the bandwidths and detectors specified. No video filter was used.			

Table 6. Conducted Emissions – Measurement Bandwidth

Frequency Range (MHz)	15.107(b), Class A Limits (dBuV)		15.107(a), Class B Limits (dBuV)	
	Quasi-Peak	Average	Quasi Peak	Average
0.15 – 0.5	79	66	66 - 56	56 - 46
0.5 – 5.0	73	60	56	46
5.0 – 30	73	60	60	50

Note 1 – The lower limit shall apply at the transition frequencies.

Table 7. Conducted Emissions Limits – FCC Limits from Section 15.107(a)(b)

2. Occupied Bandwidth

Test Requirement(s):	15.215(c)	Test Engineer(s):	Hoosam B.
Test Results:	Pass	Test Date(s):	03/25/2015

Test Procedure: As required by 47 CFR 15.215(c): The bandwidth of the emission shall be determined at the points 20dB down from the modulated carrier.

Customer provided a test mode internal to the EUT to control the RF modulation. The EUT antenna was attached and the waveform was received by the test antenna which was connected to the spectrum analyzer. The measured highest peak power was set relative to zero dB reference. The RBW of the Spectrum Analyzer was set to 10kHz and VBW>RBW.

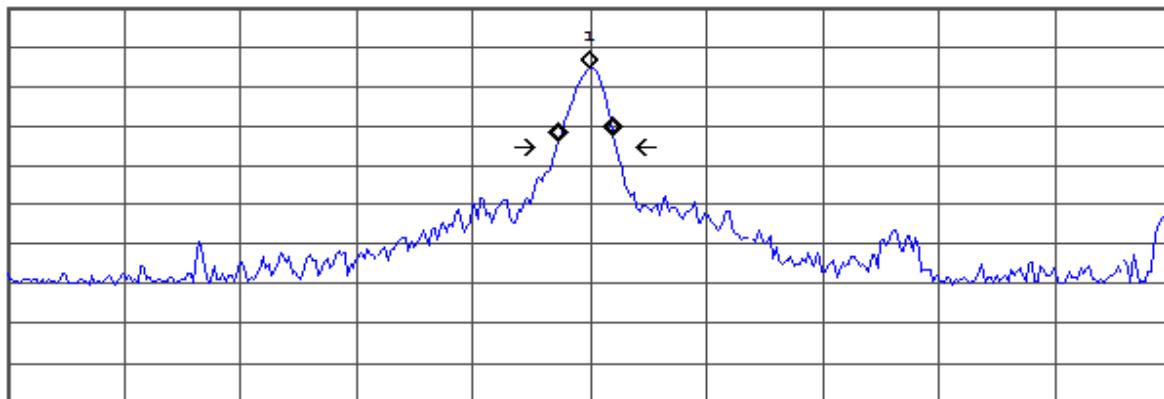
Frequency (MHz)	20dB Bandwidth (kHz)	99% Bandwidth (kHz)
2402	104.17	96.13

Table 8. Occupied Bandwidth Summary, Test Results

The following pages show measurements of Occupied Bandwidth plot:

Ref -18.73 dBm

#Atten 5 dB

 #Peak
 Log
 10
 dB/|


Center 2.402 GHz

#Res BW 30 kHz

VBW 100 kHz

Span 2 MHz

Sweep 5 ms (401 pts)

 Occupied Bandwidth
 96.1313 kHz

 Occ BW % Pwr 99.00 %
 x dB -20.00 dB

 Transmit Freq Error -7.311 kHz
 x dB Bandwidth 104.172 kHz

Plot 2 – 20dB BW FSK Modulation & 99% Occupied BW (For IC Only)

5. Radiated Fundamental Emissions

Test Requirement(s):	§15.249(a)	Test Engineer(s):	Jerry M.
Test Results:	Pass	Test Date(s):	03/25/2015

Test Procedures: As required by 47 CFR 15.249, Radiated emission measurements were made in accordance with the procedures of the ANSI C63.4 - 2009.

The EUT was placed on a wooden table inside a 3 meter semi-anechoic chamber. The EUT was set on continuous transmit.

The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height and polarization as well as EUT azimuth were varied in order to identify the maximum level of emissions from the EUT

Frequency Range	Detector Setting	Resolution Bandwidth	Video Bandwidth	Span
30MHz – 1000 MHz	Quasi Peak	120kHz	As Specified in §15.35(c)	Zero
1000 MHz – 5GHz	Peak	1MHz	1MHz	As necessary
1000 MHz – 5GHz	Average	1MHz	As Specified in §15.35(c)	As necessary

Table 12 - Analyzer Settings

The following table shows the highest levels of radiated emissions on both polarizations of horizontal and vertical

Frequency (MHz)	Peak Measurement @ 3m (dBuV/m)	Antenna Polarity (H/V)	Average Amplitude (dBuV/m)	FCC Average Limit (dBuV/m)	Margin (dB)	Comment
2402	90.83	V	N/A	94	-3.17	Fundamental

Table 13 – Fundamental Field Strength

Remark:

To get a maximum emission level from the EUT, the EUT was moved throughout the X-axis, Y-axis and Z-Axis. Worst case is X-axis.

6. Radiated Spurious Emissions

Test Requirement(s):	§15.249(a)(b)(e), 15.209(a), 15.205, 15.35	Test Engineer(s):	Jerry M.
Test Results:	Pass	Test Date(s):	03/25/2015

Test Procedures: As required by 47 CFR 15.231, Radiated emission measurements were made in accordance with the procedures of the ANSI C63.4 - 2009.

The EUT was placed on a wooden table inside a 3 meter semi-anechoic chamber. The EUT was set on continuous transmit.

The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height and polarization as well as EUT azimuth were varied in order to identify the maximum level of emissions from the EUT. The frequency range up to the 10th harmonic was investigated.

Frequency Range	Detector Setting	Resolution Bandwidth	Video Bandwidth	Span
30MHz – 1000 MHz	Quasi Peak	120kHz	As Specified in §15.35(c)	Zero
1000 MHz – 5GHz	Peak	1MHz	1MHz	As necessary
1000 MHz – 5GHz	Average	1MHz	As Specified in §15.35(c)	As necessary

Table 12 - Analyzer Settings

The following table shows the highest levels of radiated emissions on both polarizations of horizontal and vertical

Frequency (MHz)	Peak Measurement @ 3m (dBuV/m)	Antenna Polarity (H/V)	Average Amplitude (dBuV/m)	FCC Average Limit (dBuV/m)	FCC Peak Limit (dBuV/m)	Average Margin (dB)	Peak Margin (dB)	Comment
4804	48.17	V	N/A	54	74	-5.83	-25.83	Harmonic

Table 13 - Radiated Spurious Emission Data – 30MHz – 25GHz

Note: Emissions above 3rd harmonic were all below the noise floor of the analyzer

Remark:

To get a maximum emission level from the EUT, the EUT was moved throughout the X-axis, Y-axis and Z-Axis. Worst case is X-axis.

Test Equipment

Equipment	Manufacturer	Model	Serial #	Last Cal Date	Cal Due Date
Power Supply	H.P	E3610A	KR83021468	NCR	None
Spectrum Analyzer	Agilent	E4402B	USA1192757	Jan/27/15	Jan/27/16
DMM	Fluke	77 III	72550270	Sep/26/13	Sep/26/15
Combiner/Splitter	Mini-Circuits	ZFSC-2-2	None	NCR	None
High Pass Filter	Mini-Circuits	VHF-3100+	15542	Verified	
Temperature Meter	Control Company	6066N53	140536623	Aug/08/14	Aug/08/16
Attenuator 10dB	Huber+Suhner	6810.17.A	747300	Verified	
EMI Receiver	R&S	ESCS-30	828985/007	Sep/03/14	Sep/03/15
Signal Generator	R&S	SMY02	1062.5502.12	NCR	None
Horn Antenna	Com Power	AHA-118	711150	Feb/10/15	Feb/10/16
Bilog Antenna	Chase	CBL6140	1040	Nov/09/4	Nov/09/15

Table 14 – Test Equipment List

***Statement of Traceability:** Test equipment is maintained and calibrated on a regular basis. All calibrations have been performed by a 17025 accredited test facility, traceable to National Institute of Standards and Technology (NIST)

END OF TEST REPORT