Measurement of RF Interference from an Ventis Pro 5 Gas Monitor

For	Industrial Scientific Corporation 1 Life Way Pittsburgh, PA 150205
P.O. Number	400292070
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Test Personnel	Javier Cardenas
Specification	FCC "Code of Federal Regulations" Title 47, Part 24, Subpart E ISED RSS-GEN ISED RSS-133

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REVISION HISTORY

Revision	Date	Description
—	06 July 2020	Initial release
A	13 July 2020 By Javier Cardenas	-Throughout the report, “Rev A” was added to the report number in the header. -On the cover page, the address was updated.
B	31 July 2020 By Javier Cardenas	-Throughout the report, “Rev B” was added to the report number in the header. -In section 2 and 4.2, referenced C63.5: 2017
C	17 August 2020 By Javier Cardenas	-Throughout the report, “Rev C” was added to the report number in the header. -Throughout the report, the declared antenna gain was updated to reflect the measurements in report etr2003878-01.

Measurement of RF Emissions from a Gas Monitor, Part No. Ventis Pro 5 Transceiver

1. INTRODUCTION

1.1 Scope of Tests

This document represents the results of the series of radio interference measurements performed on an Industrial Scientific Corporation Gas Monitor, Part No. Ventis Pro 5, Serial No. ATT5, (hereinafter referred to as the EUT). The transceiver was designed to communicate over LTE Band 2 using an IFA antenna. The EUT was manufactured and submitted for testing by Industrial Scientific Corporation located in Pittsburgh, PA.

The EUT has an integrated LTE cell module, FCC ID XPY2AGQN4NNN, IC: 8595A-2AGQN4NNN. The original testing was documented in the TUV test report, report no. SD72128174-0517B.

1.2 Purpose

The test series was performed to determine if the EUT meets the Class 2 Permissive Change requirements of the FCC.

The test series was also performed to determine if the EUT meets the Class 4 Permissive Change requirements of Innovation, Science and Economic Development Canada.

Testing was performed in accordance with ANSI C63.26-2015.

1.3 Deviations, Additions and Exclusions

There were no deviations, additions to, or exclusions from the test specification during this test series

1.4 EMC Laboratory Identification

This series of tests was performed by Elite Electronic Engineering Incorporated of Downers Grove, Illinois. The laboratory is accredited by the American Association for Laboratory Accreditation (A2LA), A2LA Lab Code: 1786-01.

1.5 Laboratory Conditions

The temperature at the time of the test was 21°C and the relative humidity was 24%.

2. APPLICABLE DOCUMENTS

The following documents of the exact issue designated form part of this document to the extent specified herein:

- Federal Communications Commission "Code of Federal Regulations", Title 47, Part 24, Subparts E
- ANSI C63.26 2015, " American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services”
- ANSI C63.5 2017, “American National Standard for Electromagnetic Compatibility— Radiated Emission Measurements in Electromagnetic Interference (EMI) Control—Calibration and Qualification of Antennas (9 kHz to 40 GHz)”
- Industry Canada RSS-133, Issue 6, January 2018, “2 GHz Personal Communications Services”
- Industry Canada RSS-GEN, Issue 5, March 2019, “General Requirements for Compliance of Radio Apparatus”
- Industry Canada RSP-100, Issue 12, 2019, “Certification of Radio Apparatus and Broadcasting Equipment”

3. EUT SETUP AND OPERATION

3.1 General Description

The EUT is a Gas Monitor, Part No. Ventis Pro 5. A block diagram of the EUT setup is shown as Figure 1.

3.1.1 Power Input

The EUT was powdered by internal batteries.

3.1.2 Peripheral Equipment

No peripheral equipment was submitted with the EUT:

3.1.3 Interconnect Cables

No interconnect cables were submitted with the EUT:

3.1.4 Grounding

The EUT was ungrounded during the tests.

3.2 Operational Mode

3.2.1 Transmitting

The EUT was energized. The unit was attached to a call box simulator in one of the following modes:

- Band 2, UL Ch 18650, 10MHz Channel Bandwidth
- Band 2, UL Ch 18650, 10MHz Channel Bandwidth
- Band 2, UL Ch 18650, 10MHz Channel Bandwidth

3.2.1 Multi-Tx

The EUT was energized. The EUT's onboard NFC, LENS, Bluetooth and Cell radios were activated and set to transmit continuously:

- NFC – 13.56MHz
- LENS – 2405MHz
- Bluetooth – 2402MHz
- Cell – LTE B2 Ch 19150

3.3 EUT Modifications

No modifications were required for compliance.

4. TEST FACILITY AND TEST INSTRUMENTATION

4.1 Shielded Enclosure

All tests were performed in a 32ft. x 20ft. x 18ft. hybrid ferrite-tile/anechoic absorber lined test chamber. With the exception of the floor, the reflective surfaces of the shielded chamber are lined with ferrite tiles on the walls and ceiling. Anechoic absorber material is installed over the ferrite tile. The floor of the chamber is used as the ground plane. The chamber complies with ANSI C63.4-2014 for site attenuation.

4.2 Test Instrumentation

The test instrumentation and auxiliary equipment used during the tests are listed in Table 9-1.

Conducted and radiated emission tests were performed with an EMI receiver utilizing the bandwidths and detectors specified by the FCC.

The receive antennas were calibrated per and meet the requirements of C63.5.

4.3 Calibration Traceability

Test equipment is maintained and calibrated on a regular basis. All calibrations are traceable to the International System Units (SI) through the National Institute of Standards and Technology (NIST).

4.4 Measurement Uncertainty

All measurements are an estimate of their true value. The measurement uncertainty characterizes, with a specified confidence level, the spread of values which may be possible for a given measurement system.

Values of Expanded Measurement Uncertainty (95% Confidence) are presented below:

Measurement Type	Expanded Measurement Uncertainty
Conducted disturbance (mains port) (150 kHz – 30 MHz)	2.7
Radiated disturbance (electric field strength on an open area test site or alternative test site) (30 MHz – 1000 MHz)	4.3
Radiated disturbance (electric field strength on an open area test site or alternative test site) (1 GHz – 6 GHz)	3.1
Radiated disturbance (electric field strength on an open area test site or alternative test site) (6 GHz – 18 GHz)	3.2

5. TEST PROCEDURES

5.1 Peak Output Power

5.1.1 Requirements

Per FCC 24.232(c), Mobile and portable stations are limited to 2 watts EIRP and the equipment must employ a means for limiting power to the minimum necessary for successful communications.

5.1.2 Procedures

The EUT was configured to transmit at maximum power in the LTE Band 2. The EUT was set to transmit at a low, middle and high channel. The power was recorded using a power meter through an attenuator of known impedance. The EIRP was calculated as follows:

$$\text{EIRP} = \text{Conducted Output power Level} + \text{Antenna Gain}$$

5.1.3 Results

The results are presented on page 14. The maximum conducted output power was 133.4mW (21.25dBm). The maximum EIRP from the transmitter was 35.9mW (15.55 dBm) which is below the 2 Watt limit.

5.2 Radiated Spurious Emissions Measurements

5.2.1 Requirements

Per section 24.238(a), the power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log (P) dB.

$$\text{Minimum Attenuation} = 43 + 10\log 0.2\text{W}^{*}$$

* The maximum rated power of the EUT is 200mW (23dBm)

The emissions shall be attenuated by a minimum of 36dB.

5.2.2 Procedures

Radiated measurements were performed in a 32ft. x 20ft. x 14ft. high shielded enclosure. The shielded enclosure prevents emissions from other sources, such as radio and TV stations from interfering with the measurements. All powerlines and signal lines entering the enclosure pass through filters on the enclosure wall. The powerline filters prevent extraneous signals from entering the enclosure on these leads.

Preliminary radiated emissions tests were performed to determine the emission characteristics of the EUT. For the preliminary test, a broadband measuring antenna was positioned at a 3 meter distance from the EUT.

The final open field emission tests were then manually performed with the following steps:

a) The EUT was configured in the Transmitting mode.

b) The emission levels were measured with a spectrum analyzer.

c) The EIRP of all of the emissions was measured using the substitution method.

d) To ensure that maximum or worst case emission levels of the emissions were measured, the following steps were taken:

   i) The EUT was rotated so that all of its sides were exposed to the receiving antenna.

   ii) Since the measuring antenna is linearly polarized, both horizontal and vertical field components were measured.

   iii) The measuring antenna was raised and lowered for each antenna polarization to maximize the readings.

   iv) In instances where it was necessary to use a shortened cable between the measuring antenna and the spectrum analyzer, the measuring antenna was not raised or lowered to ensure maximized readings, instead the EUT was rotated through all axes to ensure the maximum readings were recorded for the EUT.

e) Steps (a) through (c) were repeated with the EUT in the Multi-Tx mode in order to investigate any intermodulation products that may be produced due to the collocated RF radios.

5.2.3 Results

Final radiated emissions data are presented on data pages 14 through 16. As can be seen from the data, all emissions measured from the EUT were within the specification limits. Photographs of the test configuration which yielded the highest or worst case, radiated emission levels are shown in Figures 2 and Figure 3.

6. CONCLUSIONS

It was determined that the Industrial Scientific Corporation Gas Monitor, Part No. Ventis Pro 5, Serial No. ATT5 did fully meet the Class 2 permissive change requirements of the FCC, when tested per the FCC "Code of Federal Regulations" Title 47, Part 24, Subpart E and ANSI C63.4-2014. The emissions data recorded do not exceed the values originally measured and documented for the original grant.

It was also determined that the Industrial Scientific Corporation Gas Monitor, Part No. Ventis Pro 5, Serial No. ATT5 did fully meet the Class 4 permissive change requirements of the Innovation, Science and Economic Development Canada, when tested per RSS-GEN, RSS-133 and ANSI C63.4-2014.

7. CERTIFICATION

Elite Electronic Engineering Incorporated certifies that the information contained in this report was obtained under conditions which meet or exceed those specified in the test specifications.

The data presented in this test report pertains to the EUT at the test date. Any electrical or mechanical modification made to the EUT subsequent to the specified test date will serve to invalidate the data and void this certification.

8. ENDORSEMENT DISCLAIMER

This report must not be used to claim product certification, approval, or endorsement by A2LA, NIST or any agency of the Federal Government.

9. EQUIPMENT LIST

Table 9-1 Equipment List

Eq ID	Equipment Description	Manufacturer	Model No.	Serial No.	Frequency Range	Cal Date	Due Date
APW1	PREAMPLIFIER	PLANAR ELECTRONICS	PE2-30-20G20R6G-3R0-10-12-SFF	PL162015/1446	20GHZ-26.5GHZ	10/2/2019	10/2/2020
APW11	PREAMPLIFIER	PMI	PE2-35-120-5R0-10-12-SFF	PL11685/1241	1GHZ-20GHZ	4/2/2020	4/2/2021
CDX8	COMPUTER	ELITE	WORKSTATION			N/A	
CDY0	WORKSTATION	ELITE	WORKSTATION		WINDOWS 7	N/A	
GRE2	SIGNAL GENERATOR	AGILENT	E4438C	MY42081749	250KHZ-6GHZ	3/20/2020	3/20/2021
MPC2	DUAL POWER METER	HEWLETT PACKARD	EPM-442A	US37480150	0.1MHZ-50GHZ	8/19/2019	8/19/2020
MPI5	POWER SENSOR	KEYSIGHT	E9304A	MY56200006	9KHZ-6GHZ	4/9/2020	4/9/2022
NHG1	STANDARD GAIN HORN ANTENNA	NARDA	638	---	18-26.5GHZ	NOTE 1	
NLS0	24" ACTIVE LOOP ANTENNA	EMCO	6502	89979	10KHZ-30MHZ	8/22/2018	8/22/2020
NTA3	BILOG ANTENNA	TESEQ	6112D	32853	25-1000MHz	10/10/2019	10/10/2020
NTA4	BILOG ANTENNA	TESEQ	6112D	46660	20-2000GHZ	9/23/2019	9/23/2020
NWQ0	DOUBLE RIDGED WAVEGUIDE ANTENNA	ETS LINDGREN	3117	66657	1GHZ-18GHZ	5/13/2020	5/13/2022
NWQ2	DOUBLE RIDGED WAVEGUIDE ANTENNA	ETS LINDGREN	3117	66659	1GHZ-18GHZ	4/7/2020	4/7/2022
RBF2	WIDEBAND RADIO COMM. TESTER	ROHDE & SCHWARZ	CMW500	121396	---	2/21/2020	2/11/2024
RBG2	EMI ANALYZER	ROHDE & SCHWARZ	ESW44	101591	2HZ-44GHZ	3/23/2020	3/23/2021
RBG3	EMI ANALYZER	ROHDE & SCHWARZ	ESW44	101592	2HZ-44GHZ	4/24/2020	4/24/2021
T2D5	20DB, 25W ATTENUATOR	WEINSCHEL	46-20-43	AY9244	DC-18GHZ	1/9/2020	1/9/2022
VBV2	CISPR EN FCC ICES RE.EXE	ELITE	CISPR EN FCC ICES RE.EXE	---	---	N/A	
WKA1	SOFTWARE, UNIVERSAL RCV EMI	ELITE	UNIV_RCV_EMI	1	---	I/O	

N/A: Not Applicable I/O: Initial Only CNR: Calibration Not Required

NOTE 1: For the purpose of this test, the equipment was calibrated over the specified frequency range, pulse rate, or modulation prior to the test or monitored by a calibrated instrument.

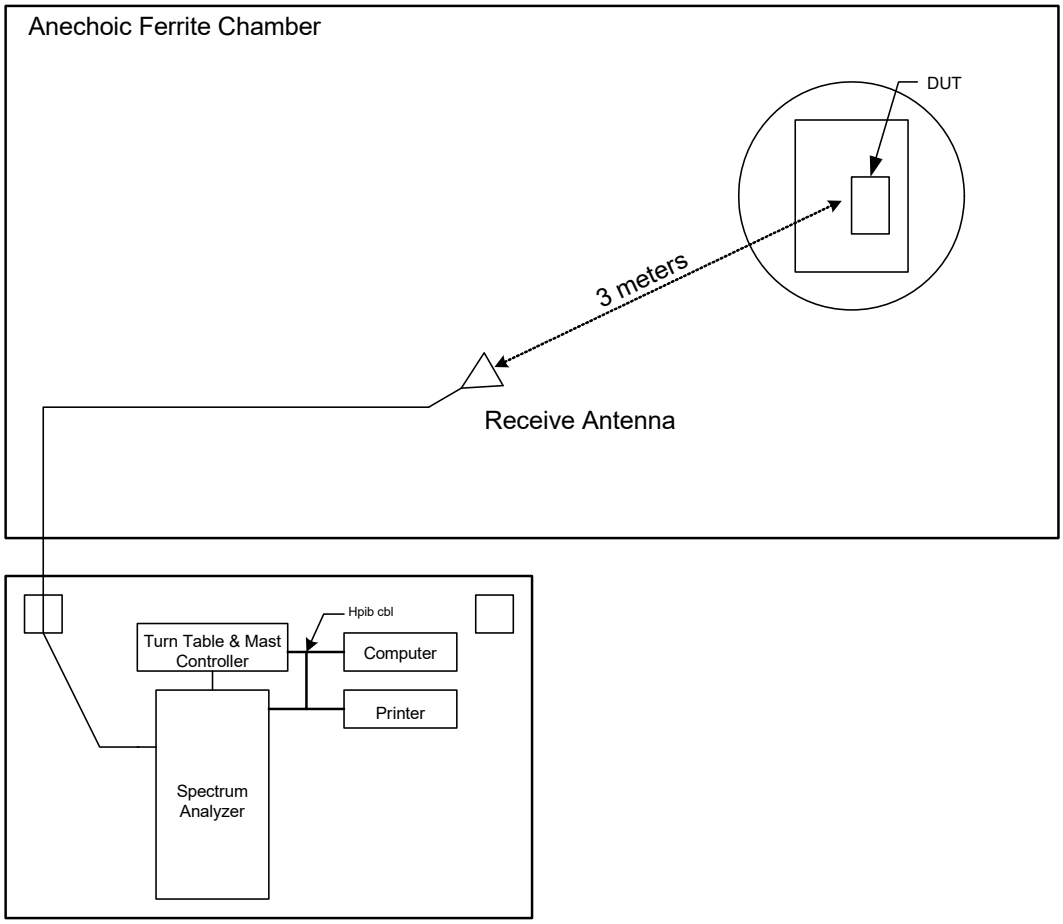

FIGURE 1 BLOCKDIAGRAM OF TEST SETUP

Test Details	
Manufacturer	Industrial Scientific Corporation
Model	Ventis Pro 5
S/N	ATT5
Mode	Transmitting
Notes	None

Channel No.	Frequency (MHz)	Conducted Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)
18650	1850.5	20.84	2.2	23.04
18900	1880	21.02	1.9	22.92
19150	1909.5	21.25	1.2	22.45

Test Details	
Manufacturer	Industrial Scientific Corporation
Model	Ventis Pro 5
S/N	ATT5
Mode	Transmitting
Carrier Frequency	LTE Band 2, Channel 18650: 10MHz
Notes	None

Freq. MHz	Ant Pol	Meter Reading (dBuV)	Ambient	Matched Sig. Gen. Reading (dBm)	Equivalent Antenna Gain (dB)	Cable Loss (dB)	EIRP (dBm)	Attenuation Below Output Power (dB)	Minimum Attenuation (dB)
2967.70	H	28.3		-36.7	4.6	2.9	-35.1	58.1	36.0
2967.70	V	29.8		-35.2	4.6	2.9	-33.6	56.6	36.0
3701.00	H	26.1		-40.3	6.2	3.3	-37.4	60.4	36.0
3701.00	V	27.3		-39.1	6.2	3.3	-36.1	59.1	36.0
5551.50	H	24.5	*	-35.4	8.0	4.0	-31.4	54.4	36.0
5551.50	V	24.4	*	-35.6	8.0	4.0	-31.6	54.6	36.0
7402.00	H	27.8		-30.6	9.8	4.7	-25.5	48.5	36.0
7402.00	V	31.3		-27.1	9.8	4.7	-22.0	45.0	36.0
9252.50	H	26.8	*	-30.4	11.1	5.0	-24.4	47.4	36.0
9252.50	V	27.1	*	-30.1	11.1	5.0	-24.1	47.1	36.0
11103.00	H	26.5	*	-26.4	10.8	5.8	-21.4	44.4	36.0
11103.00	V	26.9	*	-26.0	10.8	5.8	-21.0	44.0	36.0

EIRP (dBm) = Matched Sig Gen Reading (dBm) + Equivalent Antenna Gain – Cable Loss

Test Details	
Manufacturer	Industrial Scientific Corporation
Model	Ventis Pro 5
S/N	ATT5
Mode	Transmitting
Carrier Frequency	LTE Band 2, Channel 18900: 10MHz
Notes	None

Freq. MHz	Ant Pol	Meter Reading (dBuV)	Ambient	Matched Sig. Gen. Reading (dBm)	Equivalent Antenna Gain (dB)	Cable Loss (dB)	ERP (dBm)	Attenuation Below Output Power (dB)	Minimum Attenuation (dB)
2941.00	H	28.2		-38.4	4.6	3.8	-37.6	60.6	36.0
2941.00	V	28.3		-38.3	4.6	3.8	-37.5	60.5	36.0
3760.00	H	24.3		-42.2	6.3	4.3	-40.2	63.2	36.0
3760.00	V	24.2		-42.0	6.3	4.3	-40.0	63.0	36.0
5640.00	H	25.2		-39.6	8.1	5.3	-36.8	59.8	36.0
5640.00	V	25.3		-39.4	8.1	5.3	-36.5	59.5	36.0
7520.00	H	26.7		-31.4	10.0	6.3	-27.8	50.8	36.0
7520.00	V	27.7		-30.5	10.0	6.3	-26.8	49.8	36.0
9400.00	H	26.4	*	-30.4	11.1	6.7	-26.0	49.0	36.0
9400.00	V	26.6	*	-30.2	11.1	6.7	-25.7	48.7	36.0
11280.00	H	26.7	*	-26.3	11.0	7.7	-22.9	46.0	36.0
11280.00	V	26.8	*	-26.1	11.0	7.7	-22.8	45.8	36.0

EIRP (dBm) = Matched Sig Gen Reading (dBm) + Equivalent Antenna Gain – Cable Loss

Test Details	
Manufacturer	Industrial Scientific Corporation
Model	Ventis Pro 5
S/N	ATT5
Mode	Transmitting
Carrier Frequency	LTE Band 2, Channel 19150: 10MHz
Notes	None

Freq. MHz	Ant Pol	Meter Reading (dBuV)	Ambient	Matched Sig. Gen. Reading (dBm)	Equivalent Antenna Gain (dB)	Cable Loss (dB)	ERP (dBm)	Attenuation Below Output Power (dB)	Minimum Attenuation (dB)
2910.50	H	29.5		-38.7	3.7	3.8	-38.8	61.9	36.0
2910.50	V	30.3		-37.6	3.7	3.8	-37.7	60.8	36.0
3819.00	H	26.9		-41.0	5.5	4.4	-39.9	62.9	36.0
3819.00	V	28.0		-40.3	5.5	4.4	-39.2	62.2	36.0
5728.50	H	25.9		-39.9	5.6	5.3	-39.5	62.5	36.0
5728.50	V	28.3		-37.0	5.6	5.3	-36.7	59.7	36.0
7638.00	H	27.2		-31.0	7.4	6.3	-29.9	52.9	36.0
7638.00	V	28.0		-30.2	7.4	6.3	-29.1	52.1	36.0
9547.50	H	27.1	*	-29.7	8.6	6.8	-28.0	51.0	36.0
9547.50	V	27.7	*	-29.2	8.6	6.8	-27.4	50.4	36.0
11457.00	H	28.2	*	-24.4	8.6	7.7	-23.5	46.5	36.0
11457.00	V	28.4	*	-24.1	8.6	7.7	-23.3	46.3	36.0

EIRP (dBm) = Matched Sig Gen Reading (dBm) + Equivalent Antenna Gain – Cable Loss

Test Details	
Manufacturer	Industrial Scientific Corporation
Model	Ventis Pro 5
S/N	ATT5
Mode	Multi-Tx
Notes	None

Freq. MHz	Ant Pol	Meter Reading (dBuV)	Ambient	Matched Sig. Gen. Reading (dBm)	Equivalent Antenna Gain (dB)	Cable Loss (dB)	ERP (dBm)	Attenuation Below Output Power (dB)	Minimum Attenuation (dB)
1417.00*	H	22.5	*	-46.2	1.5	2.6	-47.3	70.3	36.0
1417.00*	V	23.7	*	-45.0	1.5	2.6	-46.1	69.1	36.0

*The frequency 1417MHz corresponds to the intermixing of the LTE Uplink frequency and the Bluetooth channel frequency. The spurious emission frequency is calculated as follows:

$(2 \times 1909.5\text{MHz}) - 2402\text{MHz} = 1417\text{MHz}$