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 27, Subpart C ISED RSS-GEN ISED RSS-130 ISED RSS-139

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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. – Throughout the report: S/N “ATT 5” was added.
B	23 July 2020 By Rick King	– Throughout the report: “Rev B” was changed throughout the report. – Throughout the report: all references to Band 13 were removed. – Throughout the report: Removed all references to VzW 6.
C	31 July 2020 By Javier Cardenas	-Throughout the report, “Rev C” was added to the report number in the header. -In section 2 and 4.2, referenced C63.5: 2017
D	17 August 2020 By Javier Cardenas	-Throughout the report, “Rev D” was added to the report number in the header. -Throughout the report, the antenna gain reported 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. ATT 5, (hereinafter referred to as the EUT). The transceiver was designed to communicate over LTE Band 4 and 12 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 21C 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 27, Subparts C
- 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-130, Issue 2, February 2019, “Equipment Operating in the Frequency Bands 617-652 MHz, 663-698 MHz, 698-756 MHz and 777-787 MHz”
- Industry Canada RSS-139, Issue 3, July 2015, “Advanced Wireless Services (AWS) Equipment Operating in the Bands 1710-1780 MHz and 2110-2180 MHz”
- 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 4, UL Ch 20000, 10MHz Channel Bandwidth
- Band 4, UL Ch 20175, 10MHz Channel Bandwidth
- Band 4, UL Ch 20350, 10MHz Channel Bandwidth

- Band 12, UL Ch 23060, 10MHz Channel Bandwidth
- Band 12, UL Ch 23095, 10MHz Channel Bandwidth
- Band 12, UL Ch 23130, 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. The EUT was set in the following combinations:

- NFC – 13.56MHz
- LENS – 2405MHz
- Bluetooth – 2402MHz
- Cell – LTE B4 Ch 23060

- NFC – 13.56MHz
- LENS – 2405MHz
- Bluetooth – 2402MHz
- Cell – LTE B12 Ch 23130

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. All equipment was calibrated per the instruction manuals supplied by the manufacturer.

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 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 27.50(c) (10), Portable stations (hand-held devices) in the 600 MHz uplink band and the 698-746 MHz band, and fixed and mobile stations in the 600 MHz uplink band are limited to 3 watts ERP.

Per FCC 24.50(d)(4), Fixed, mobile, and portable (hand-held) stations operating in the 1710-1755 MHz band and mobile and portable stations operating in the 1695-1710 MHz and 1755-1780 MHz bands are limited to 1 watt EIRP.

5.1.2 Procedures

The EUT was configured to transmit at maximum power in the LTE Band 4 and Band 12. The EUT was set to transmit at a low, middle and high channel. The power was recorded using a power meter though 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 pages 13 through 13.

5.2 Radiated Spurious Emissions Measurements

5.2.1 Requirements

Per section 27.53 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.

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

* 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 and 19. As can be seen from the data, all emissions measured from the EUT were within the specification limits. No intermodulation spurious emissions were found S/N ATT 5 Photographs of the test configuration which yielded the highest or worst case, radiated emission levels are shown in Figure 2 and Figure 3.

6. CONCLUSIONS

It was determined that the Industrial Scientific Corporation Gas Monitor, Part No. Ventis Pro 5, Serial No. ATT 5, did fully meet the class 2 permissive change requirements of the FCC, when tested per the FCC "Code of Federal Regulations" Title 47, Part 27, Subpart C 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. ATT 5 did fully meet the class 4 permissive change requirements of the Innovation, Science and Economic Development Canada, when tested per RSS-GEN, RSS-130, RSS-139 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.

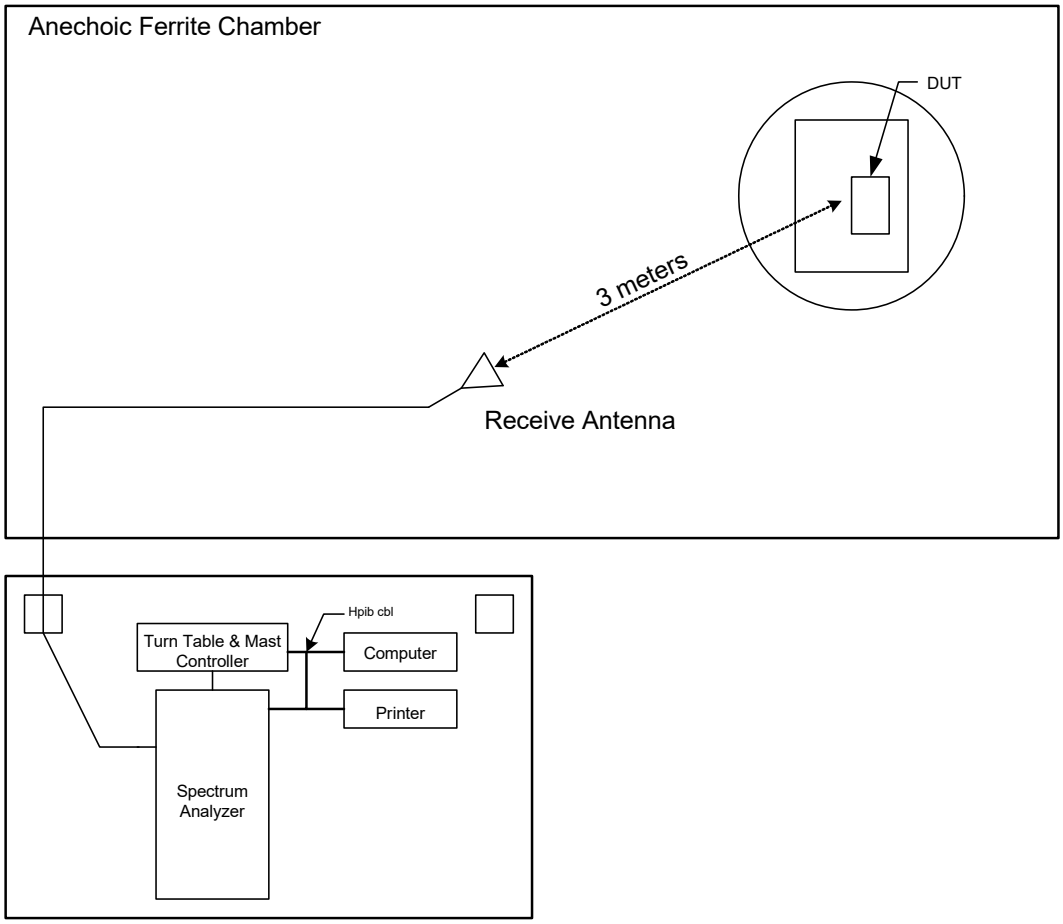

FIGURE 1 BLOCKDIAGRAM OF TEST SETUP

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

LTE Band 4

Channel No.	Frequency (MHz)	Conducted Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)
20000	1711	20.98	0.2	21.08
20175	1728.5	20.60		20.80
20350	1754.5	20.76		20.96

LTE Band 12

Channel No.	Frequency (MHz)	Conducted Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)
23060	699	21.92	-3.0	18.92
23095	707.5	21.87		18.87
23130	715.5	21.76		18.76

Band of Operation	Maximum Conducted Power (dBm)	EIRP (dBm)	EIRP Limit (dBm)	Pass/Fail
LTE B4	20.98	21.08	30	Pass
LTE B12	21.92	18.92	34.78	Pass

Test Details	
Manufacturer	Industrial Scientific Corporation
Model	Ventis Pro 5
S/N	ATT 5
Mode	Transmitting
Carrier Frequency	LTE Band 4, Channel 20000: 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)
3422.00	H	26.7	*	-39.0	4.5	3.2	-37.7	60.7	36.0
3422.00	V	26.2	*	-39.6	4.5	3.2	-38.2	61.2	36.0
5133.00	H	27.7	*	-33.2	5.4	3.8	-31.6	54.6	36.0
5133.00	V	27.6	*	-33.3	5.4	3.8	-31.7	54.7	36.0
6844.00	H	28.1	*	-29.6	6.1	4.5	-28.0	51.0	36.0
6844.00	V	28.0	*	-29.8	6.1	4.5	-28.1	51.2	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	ATT 5
Mode	Transmitting
Carrier Frequency	LTE Band 4, Channel 20175: 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)
3457.00	H	26.3	*	-39.2	4.8	3.2	-37.6	60.6	36.0
3457.00	V	27.1	*	-38.5	4.8	3.2	-36.9	59.9	36.0
5185.50	H	27.2	*	-33.3	5.4	3.8	-31.8	54.8	36.0
5185.50	V	26.9	*	-33.7	5.4	3.8	-32.2	55.2	36.0
6914.00	H	27.9	*	-29.9	6.5	4.5	-27.9	50.9	36.0
6914.00	V	27.6	*	-30.2	6.5	4.5	-28.3	51.3	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	ATT 5
Mode	Transmitting
Carrier Frequency	LTE Band 4, Channel 20350: 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)
3509.00	H	26.1		-41.3	4.9	3.2	-39.6	62.6	36.0
3509.00	V	28.2		-39.0	4.9	3.2	-37.3	60.3	36.0
5263.50	H	27.2	*	-33.3	5.7	3.8	-31.4	54.4	36.0
5263.50	V	27.5	*	-33.0	5.7	3.8	-31.2	54.2	36.0
7018.00	H	28.1	*	-29.8	6.6	4.6	-27.8	50.8	36.0
7018.00	V	28.0	*	-29.9	6.6	4.6	-27.8	50.8	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	ATT 5
Mode	Transmitting
Carrier Frequency	LTE Band 12, Channel 23060: 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)
1398.00	H	26.1	*	-42.3	1.2	2.0	-43.1	66.1	36.0
1398.00	V	26.2	*	-42.2	1.2	2.0	-43.0	66.0	36.0
2097.00	H	25.2	*	-40.0	1.8	2.4	-40.6	63.6	36.0
2097.00	V	25.1	*	-40.1	1.8	2.4	-40.7	63.7	36.0
2796.00	H	25.9	*	-40.6	4.2	2.8	-39.3	62.3	36.0
2796.00	V	25.6	*	-40.8	4.2	2.8	-39.5	62.5	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	ATT 5
Mode	Transmitting
Carrier Frequency	LTE Band 12, Channel 23095: 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)
1415.00	H	26.3		-44.5	1.5	2.0	-45.0	68.0	36.0
1415.00	V	28.5		-42.6	1.5	2.0	-43.1	66.1	36.0
2122.50	H	25.5	*	-39.8	2.1	2.4	-40.1	63.1	36.0
2122.50	V	26.0	*	-39.3	2.1	2.4	-39.6	62.7	36.0
2830.00	H	25.9	*	-40.4	4.2	2.9	-39.0	62.0	36.0
2830.00	V	26.0	*	-40.3	4.2	2.9	-38.9	61.9	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	ATT 5
Mode	Transmitting
Carrier Frequency	LTE Band 12, Channel 23130: 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)
1431.00	H	26.8		-43.6	1.7	2.0	-43.9	66.9	36.0
1431.00	V	28.8		-41.3	1.7	2.0	-41.6	64.6	36.0
2146.50	H	25.1	*	-40.2	2.3	2.4	-40.4	63.4	36.0
2146.50	V	25.4	*	-39.9	2.3	2.4	-40.1	63.1	36.0
2862.00	H	26.6	*	-39.4	4.1	2.9	-38.2	61.2	36.0
2862.00	V	27.1	*	-39.0	4.1	2.9	-37.7	60.7	36.0

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