Washington Laboratories, Ltd.

FCC & ISED CANADA CERTIFICATION TEST REPORT

for the

io360

FCC ID: P9R-10185585

IC ID: 324C-10185585

REPORT# 16237-01 REV 0

Prepared for:

Mine Safety Appliances Company

1000 Cranberry Woods Drive

Cranberry Township, PA 16066-5208

Prepared By:

Washington Laboratories, Ltd.

7560 Lindbergh Drive

Gaithersburg, Maryland 20879

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DECEMBER 11, 2019

WLL REPORT# 16237-01 REV 0

Prepared by:

Mike Violette, P.E.

CEO

Reviewed by:

Steven D. Koster

President

ABSTRACT

Revision History	Description of Change	Date
Rev 0	Initial Release	DECEMBER 11, 2019
Rev 1	Comments replied	JANUARY 30, 2020

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1 INTRODUCTION

1.1 COMPLIANCE STATEMENT

The io360 complies with the requirements of FCC 15.225 and RSS-210.

1.2 CONTRACT INFORMATION

Customer:	Mine Safety Appliances Company
Address	1000 Cranberry Woods Drive
	Cranberry Township, PA 16066-5208
Purchase Order Number:	4502594364
Quotation Number:	71566B

1.3 TEST DATES

Testing was performed on the following date(s): 14 September 2019

1.4 TEST AND SUPPORT PERSONNEL

Washington Laboratories, LTD	Mike Violette
Customer Representative	Richard Pingree

1.5 ABBREVIATIONS

A	**A**mpere
ac	**a**lternating **c**urrent
AM	Amplitude Modulation
Amps	Amperes
b/s	**b**its per **s**econd
BW	**B**and**W**idth
CE	**C**onducted **E**mission
cm	**C**enti**m**eter
CW	**C**ontinuous **W**ave
dB	**d**eci**B**el
dc	**d**irect **c**urrent
EMI	**E**lectro**m**agnetic **I**nterference
EUT	**E**quipment **U**nder **T**est
FM	**F**requency **M**odulation
G	**g**iga – prefix for 10^9 multiplier
Hz	**H**ertz
IF	**I**ntermediate **F**requency
k	**k**ilo – prefix for 10^3 multiplier
LISN	**L**ine **I**mpedance **S**tabilization **N**etwork
M	**M**ega – prefix for 10^6 multiplier
m	**M**eter
μ	**m**icro – prefix for 10^{-6} multiplier
NB	**N**arrow**b**and
QP	**Q**uasi-**P**eak
RE	**R**adiated **E**missions
RF	**R**adio **F**requency
rms	**r**oot-**m**ean-**s**quare
SN	**S**erial **N**umber
S/A	**S**pectrum **A**nalyzer
V	**V**olt

2 EQUIPMENT UNDER TEST

2.1 EUT IDENTIFICATION & DESCRIPTION

Table 1: Device Summary

Item	Gas Detector
Manufacturer:	Mine Safety Appliances Company
FCC ID:	P9R-10185585 Contains FCC ID: QOQBT121 and MCQ-XB900HP
ISED ID:	324C-10185585 Contains IC ID: 5123A-BGTBT121 and 1846A-XB900HP
Model:	io360
Serial Number of Unit Tested	NA
FCC Rule Parts:	15.225
ISED Rule Parts:	RSS-210
Frequency Range:	13.56 MHz
Maximum Output Power:	5mW
Modulation:	RFID
Occupied Bandwidth (99%):	99.57Hz for all modulations
FCC Emission Designator:	NA
ISED Emissions Designators:	99H6N0N for all modulations
Keying:	Automatic
Type of Information:	RFID
Number of Channels:	1
Power Output Level	Fixed
Highest TX Spurious Emission:	64.6 uV/m (-.17uA/m) @ 27.12 MHz @ 3m

Highest RX Spurious Emission:	175uV/m@5799 MHz
Antenna Connector	NA
Antenna Type	Trace Loop
Interface Cables:	None
Power Source & Voltage:	Battery. Rechargeable 10.8VDC

The Mine Safety Appliances Company io360 is gas detector that is used to monitor areas for noxious or toxic gasses. Use of 915 MHz radio to transmit data to a control center via hub gateway. A Bluetooth module is integrated into the device to provide for maintenance, setup and close-range monitoring of the device operation.

2.2 TEST CONFIGURATION

The io360 was configured to continuously transmit RFID energy and linking to a BT connection for gas data. A continuous 915 MHz signal was transmitting for co-location and spurious emissions measurements.

2.3 TEST LOCATION

All measurements herein were performed at Washington Laboratories, Ltd. test center in Gaithersburg, MD. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. The ISED Canada OATS numbers are 3035A-1 and 3035A-2 for Washington Laboratories, Ltd. Site 1 and Site 2, respectively. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ANAB under Testing Certificate AT-1448 as an independent FCC test laboratory.

2.4 MEASUREMENTS

2.4.1 References

ANSI C63.2 (Jan-2016) Specifications for Electromagnetic Noise and Field Strength Instrumentation

ANSI C63.4 (Jan 2014) American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

ANSI C63.10 (Jun 2013) American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

ANSI C63.26 (Dec 2015) American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services

2.5 MEASUREMENT UNCERTAINTY

All results reported herein relate only to the equipment tested. The basis for uncertainty calculation uses ANSI/NCSL Z540-2-1997 (R2002) with a type B evaluation of the standard uncertainty. Elements contributing to the standard uncertainty are combined using the method described in Equation 1 to arrive at the total standard uncertainty. The standard uncertainty is multiplied by the coverage factor to determine the expanded uncertainty which is generally accepted for use in commercial, industrial, and regulatory applications and when health and safety are concerned (see Equation 2). A coverage factor was selected to yield a 95% confidence in the uncertainty estimation.

Equation 1: Standard Uncertainty

$$u_c = \pm\sqrt{\frac{a^2}{div_a{}^2} + \frac{b^2}{div_b{}^2} + \frac{c^2}{div_c{}^2} + \ldots\ldots}$$

Where u_c = standard uncertainty

a, b, c,.. = individual uncertainty elements

$Div_{a, b, c}$ = the individual uncertainty element divisor based on the probability distribution

Divisor = 1.732 for rectangular distribution

Divisor = 2 for normal distribution

Divisor = 1.414 for trapezoid distribution

Equation 2: Expanded Uncertainty

$$U = ku_c$$

Where U = expanded uncertainty

k = coverage factor

$k \leq 2$ for 95% coverage (ANSI/NCSL Z540-2 Annex G)

u_c = standard uncertainty

The measurement uncertainty complies with the maximum allowed uncertainty from CISPR 16-4-2. Measurement uncertainty is not used to adjust the measurements to determine compliance. The expanded uncertainty values for the various scopes in the WLL accreditation are provided in Table 2 below.

Table 2: Expanded Uncertainty List

Scope	Standard(s)	Expanded Uncertainty
Conducted Emissions	CISPR11, CISPR22, , CISPR32, CISPR14, FCC Part 15	±2.63 dB
Radiated Emissions	CISPR11, CISPR22, , CISPR32, CISPR14, FCC Part 15	±4.55 dB

3 TEST EQUIPMENT

Table 3 shows a list of the test equipment used for measurements along with the calibration information.

Table 3: Test Equipment List

Test Name:	**Radiated Emissions**	**Test Date:**	**9/14/2019**
Asset #	Manufacturer/Model	Description	Cal. Due
00823	AGILENT	N9010A	8/21/2019
00276	ELECTRO-METRICS	BPA-1000	4/3/2020
00644	SUNOL SCIENCES CORPORATION	JB1 925-833-9936	1/16/2020
00066	HEWLETT PACKARD 8449B	Pre-amplifier	4/3/2020
A0001	ATTENUATOR SET 1	3 dB Attenuators	6/6/2020
00856	EMCO 6502	Loop Antenna	3/14/2020

4 TEST RESULTS

4.1 RADIATED EMISSIONS

4.1.1 Requirements

Compliance Standard: FCC Part 15.209, 15.225, RSS-210

4.2 §15.225 OPERATION WITHIN THE BAND 13.110-14.010 MHZ

(b) Within the bands 13.410-13.553 MHz and 13.567-13.710 MHz, the field strength of any emissions shall not exceed 334 microvolts/meter at 30 meters.

(c) Within the bands 13.110-13.410 MHz and 13.710-14.010 MHz the field strength of any emissions shall not exceed 106 microvolts/meter at 30 meters.

(d) The field strength of any emissions appearing outside of the 13.110-14.010 MHz band shall not exceed the general radiated emission limits in §15.209.

4.2.1 Test Procedure

The requirements of FCC Part 15 and RSS-210 call for the EUT to be placed on an 80 cm high 1 X 1.5 meters non-conductive motorized turntable for radiated testing on a 3-meter open field test site.

The RFID emissions were measured at a distance of 3 meters with a loop antenna.

The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. Bi-conical and log periodic broadband antennas were mounted on an antenna mast to determine the height of maximum emissions. The height of the antenna was varied between 1 and 4 meters. The output of the antenna was connected to the input of the spectrum analyzer and the emissions in the frequency range of 30 MHz to 1 GHz were measured. Both the horizontal and vertical field components were measured.

The output from the antenna was connected, via a preamplifier, to the input of the spectrum analyzer. The detector function was set to quasi-peak or peak, as appropriate. Above 1GHz average measurement are recorded. The measurement bandwidth of the spectrum analyzer system was set to at least 120 kHz, with all post-detector filtering no less than 10 times the measurement bandwidth. Frequencies above 1GHz were performed using a measurement bandwidth of 1MHz with a video bandwidth setting of 10 Hz for the average measurement.

4.2.2 Radiated Data Reduction and Reporting

To convert the raw spectrum analyzer radiated data into a form that can be compared with the FCC limits, it is necessary to account for various calibration factors that are supplied with the antennas and other measurement accessories. These factors are included into the antenna factor (AF) column of the table and in the cable factor (CF) column of the table. The AF (in dB/m) and the CF (in dB) is

algebraically added to the raw Spectrum Analyzer Voltage in dBµV to obtain the Radiated Electric Field in dBµV/m. This logarithm amplitude is converted to a linear amplitude, then compared to the FCC limit.

Example:
Spectrum Analyzer Voltage: VdBµV
Antenna Correction Factor: AFdB/m
Cable Correction Factor: CFdB
Pre-Amplifier Gain (if applicable): GdB
Electric Field: EdBµV/m = V dBµV + AFdB/m + CFdB - GdB
To convert to linear units of measure: EdBµV/m/20 Inv log

4.2.3 Test Data

The EUT complied with the Part 15.209 and Part 15.225 and RSS-210 Radiated Emissions requirements. Table 4 provides the test results for radiated emissions.

Table 4: Radiated Emission Test Data

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Comments
13.56	X	0.0	1.5	31.0	17.0	251.2	3340.0	-22.5	Peak
13.56	Y	0.0	1.5	35.6	17.0	426.6	3340.0	-17.9	Peak
13.56	Z	0.0	1.5	24.0	17.0	112.2	3340.0	-29.5	Peak
27.12	X	0.0	1.5	19.7	16.2	62.4	300.0	-13.6	NF
27.12	Y	0.0	1.5	20.0	16.2	64.6	300.0	-13.3	NF
27.12	Z	0.0	1.5	19.4	16.2	60.3	300.0	-13.9	NF
40.68	V	0.0	1.5	39.8	-11.2	26.8	100.0	-11.4	Peak
54.24	V	0.0	1.5	41.1	-17.8	14.6	100.0	-16.7	Peak
67.80	V	0.0	1.5	41.6	-16.9	17.2	100.0	-15.3	Peak
81.36	V	0.0	1.5	40.7	-17.3	14.8	100.0	-16.6	Peak
122.04	V	0.0	1.5	41.7	-10.5	36.4	150.0	-12.3	Peak
135.70	V	0.0	1.5	38.7	-10.9	24.5	150.0	-15.8	Peak
915.00	V	180.0	1.0	106.0	-0.1	196914	500.0	**51.9**	Carrier
2442.00	V	270.0	1.0	109.3	-7.1	129440	500.0	**48.3**	Carrier
3357.00	V	0.0	1.0	43.0	-2.8	101.8	500.0	-13.8	Peak
4272.00	V	0.0	1.0	42.5	-0.6	125.1	500.0	-12.0	Peak
5799.00	V	0.0	1.0	42.0	2.9	175.0	500.0	-9.1	Peak
40.68	H	0.0	1.5	39.9	-11.2	27.1	100.0	-11.3	Peak
54.24	H	0.0	1.5	42.1	-17.8	16.4	100.0	-15.7	Peak
67.80	H	0.0	1.5	41.1	-16.9	16.2	100.0	-15.8	Peak
81.36	H	0.0	1.5	41.0	-17.3	15.4	100.0	-16.3	Peak
122.04	H	0.0	1.5	42.1	-10.5	38.1	100.0	-8.4	Peak
135.60	H	0.0	1.5	39.9	-10.9	28.1	100.0	-11.0	Peak
915.00	H	0.0	1.5	106.7	-0.1	213440	1000.0	**46.6**	Carrier
2442.00	H	0.0	1.0	114.9	-7.1	246643	1000.0	**47.8**	Carrier
3357.00	H	0.0	1.0	42.0	-2.8	90.7	500.0	-14.8	NF
4272.00	H	0.0	1.0	42.8	-0.6	129.5	500.0	-11.7	NF
5799.00	H	0.0	1.0	42.6	2.9	187.5	500.0	-8.5	NF
9150.00	H	0.0	1.0	37.7	12.5	324.5	500.0	-3.8	NF

Magnetic field measurements per RSS-210)B.6

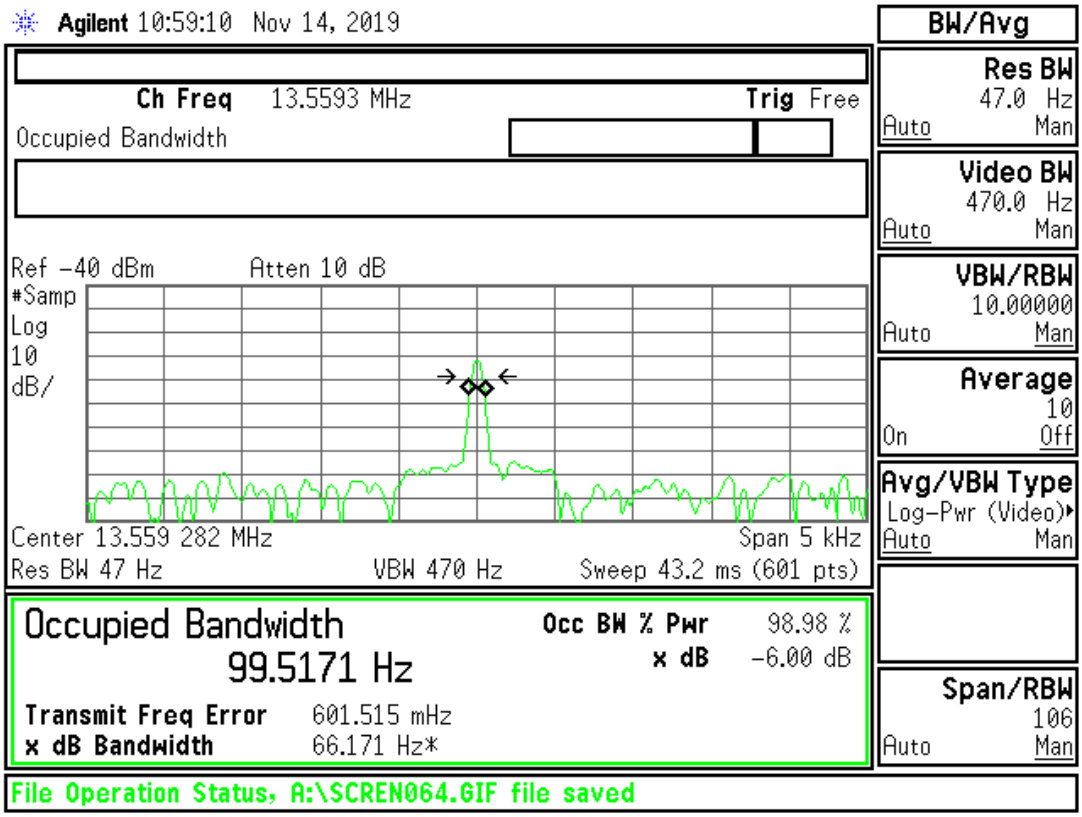
Freq		Az	Ant Ht	Spec An	Corr Factors	dBuV/m	dBuA/m	Limit dBuA/m	Margin
27.12	X	0	1.5	19.7	16.2	35.9	-15.6	-1.9	-13.7
27.12	Y	0	1.5	20	16.2	36.2	-15.3	-1.9	-13.4
27.12	Z	0	1.5	19.4	16.2	35.6	-15.9	-1.9	-14.0

Limits are expressed at 3m, converted from 30m limit by adding 20*log(30/3) = 20 dB.
Note that the margin is the difference, in dB, between the final field strength level and the field strength limit.

Emissions were scanned to 10X the highest transmit frequency.

4.3 OCCUPIED BANDWIDTH

The EUT was connected to the input of a spectrum analyzer and the occupied bandwidth measured. The test data are shown in the following figure.



4.4 FREQUENCY STABILITY

4.4.1 Requirements

Compliance Standard: FCC Part 15.209, 15.225.

(e) The frequency tolerance of the carrier signal shall be maintained within ±0.01% of the operating frequency over a temperature variation of −20 degrees to + 50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery. Due to manufacturers specifications, the unit was tested from -30 degrees to +55 degrees.

4.4.2 Test Procedure

The unit was placed into a temperature chamber and the temperature varied over the required temperature range per ANSI C63.

Test Name: Frequency Variation		Test Date: 11/14/2019	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
823	AGILENT EXA	SPECTRUM ANALYZER	04/20/2020
776	TENNEY BENCHMASTER	TEMP CHAMBER	06/01/2020

Table 5: Frequency Variation over Temperature

Job#:	16237
Company:	MSA
EUT:	io360
Standard/Test Level:	-30 to 55C
Test Frequency:	13.56
Nominal Test Voltage:	10.8
Test Engineer:	Mike Violette
Test Start Date:	11/14/19
Fail Date:	
Pass Date:	11/14/19
Limit: (10ppm)	0.010%

Calculated Test Voltages

12.42
9.18

Temperature Variations

Temperature (C)	Frequency (MHz)	Deviation (Hz)	Limit (+/- Hz)	Pass /Fail
22(ambient)	13.559300	0	1356	**NA**
-30	13.559470	170	1356	Pass
-20	13.559471	171	1356	Pass
-10	13.559470	170	1356	Pass
0	13.559380	80	1356	Pass
10	13.559380	80	1356	Pass
20	13.559380	80	1356	Pass
30	13.559280	-20	1356	Pass
40	13.559300	0	1356	Pass
50	13.559380	80	1356	Pass
55	13.559380	80	1356	Pass

The device was connected to a bench power supply and the DC voltage was varied from 85-115% of nominal. The results are provided in the following table.

Table 6: Frequency Variation Voltage

Voltage Variations

Voltage	Frequency (MHz)	Deviation (Hz)	Limit (+/-Hz)	Pass /Fail
Nominal Voltage	15.559300	0	330	**NA**
110% of Nominal Voltage	13.559300	0	330	Pass

12.42

9.18	85% of Nominal Voltage	13.559200	100	330	Pass