Report on the Exposure Calculation for DetNet South Africa (Pty) of the Free standing blast controller, Model: DigiShot Plus In accordance with FCC 47 Part 1 and ISED RSS-102

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RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Project Management	Natalie Bennett	03 April 2019	
Authorised Signatory	Matthew Russell	03 April 2019	

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD document control rules.

ENGINEERING STATEMENT
The calculations shown in this report were made in accordance with the procedures described in FCC 47 Part 1 and ISED RSS-102.

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Calculation	Pete Dorey	03 April 2019	

EXECUTIVE SUMMARY
The calculation of exposure for this product was found to be compliant at 20 cm with FCC 47 Part 1 and ISED RSS-102.

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Contents

1 Report Summary

1.1 Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

Issue	Description of Change	Date of Issue
1	First Issue	21 November 2018
2	To amend the model number	03 April 2019

1.2 Introduction

Objective	To perform electromagnetic field exposure assessment to determine the equipment under test's (EUT's) compliance with the applied specifications.
Applicant	DetNet South Africa (Pty)
Manufacturer	DetNet South Africa (Pty)
Model Number(s)	DigiShot Plus
Hardware Version(s)	Hardware rev. 11 PCB rev. 3
Software Version(s)	SVN 34340
Specification/Issue/Date	• FCC: CFR 47 Pt1.1310:2017 • ISED Canada: Health Canada Safety Code 6:2015
Order Number Date	4500351687 14/9/2018
Related Document(s)	• OET65:97 Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields • IEEE C95.3:2002 IEEE Recommended Practice for Measurements and Computations of Radio Frequency Electromagnetic Fields With Respect to Human Exposure to Such Fields, 100 kHz–300 GHz • RSS-102 Issue 5 Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)

1.3 Brief Summary of Results

The wireless device described within this report was compliant with the restrictions related to human exposure to electromagnetic fields for both general public and worker/occupational exposures.

The calculations shown in this report were made in accordance with the procedures specified in the applied test specification(s).

1.3.1 DigiShot Plus

Regional Requirement	Calculated RF exposure level at compliance boundary of 0.2 m							
	S Power Density (W/m^2)		E Field (V/m)		H Field (A/m)		B Field (µT)	
	Result	Limit	Result	Limit	Result	Limit	Result	Limit
FCC	0.13	30.07	6.90	N/A	0.0183	N/A	0.0230	N/A
CANADA	0.13	19.39	6.90	85.49	0.0183	0.2268	0.0230	N/A

Table 1 – Worker/Occupational Exposure Results

The calculations show that the EUT complies with the worker/occupational exposure levels described in in the listed specifications in Annex A at the point of investigation, 0.2 m.

Regional Requirement	Calculated RF exposure level at compliance boundary of 0.2 m							
	S Power Density (W/m^2)		E Field (V/m)		H Field (A/m)		B Field (µT)	
	Result	Limit	Result	Limit	Result	Limit	Result	Limit
FCC	0.13	6.01	6.90	N/A	0.0183	N/A	0.0230	N/A
CANADA	0.13	2.74	6.90	32.14	0.0183	0.0853	0.0230	N/A

Table 2 – General Public Exposure Results

The calculations show that the EUT complies with the general public exposure levels described in in the listed specifications in Annex A at the point of investigation, 0.2 m.

1.4 Product Information

1.4.1 Technical Description

The DigiShot Plus is a free standing electronic detonator blast controller.

1.4.2 Transmitter Description

The following radio access technologies and frequency bands are supported by the equipment under test.

Radio Access Technology	Antenna Port	Frequency Band	Minimum Frequency	Output Power	Duty Cycle
		MHz	MHz	dBm	%
Long Range RF	Internal/External option	902-928	902	30	4

Table 3 – Transmitter Description

1.4.3 Antenna Description

The following antennas are supported by the equipment under test.

Antenna No	Radio Access Technology	Antenna Model	Gain	Antenna length	Minimum Separation Distance
			dBi	cm	cm
1	Long Range RF	Poynting DIPL-A0049	2	11.5	20

Table 4 – Antenna description

1.4.4 Equipment Configuration

DigiShot Plus transmitting maximum power in 900 MHz band. Exposure calculated at manufacturer's declared minimum separation distance of 20 cm.

2 Assessment Details

2.1 Assessment Method

The assessment method is by calculation of the power density S, electric field strength E, magnetic field strength H or magnetic flux density B.

The calculation uses the spherical model applicable under far field conditions.

$$S = E \times H = \frac{E^2}{\eta} = H^2 \times \eta = \frac{P \times G_i}{4 \times \pi \times r^2}$$

Where:
η - Impedance of free space (377 ohm in far field)
P – Transmitter power W
G_i – Antenna gain ratio relative to isotropic
R – Separation distance m

The magnetic flux density is related to the magnetic field strength by a constant:

$$B = \mu_o \times H$$

Where:
μo – Permeability of free space 4xπ E-7 H/m

Where additional calculations are required by the regional specifications these are detailed below.

The far field region boundary depends on the frequency and wavelength and also on the antenna dimension. The boundary of the far field region is calculated below to demonstrate the validity of using the spherical model.

2.2 Individual Antenna Port Exposure Results

2.2.1 Calculation of Exposure at Specified Separation Distance

The frequencies shown in the tables below have been chosen based on the lowest possible frequency that the EUT can transmit. A full list of the regional requirements is shown in Annex A.

Regional Requirement	Antenna Port	RAT	Frequency (MHz)	RF Exposure Level at compliance boundary of 0.2 m							
				S Power Density (W/m²)		E Field (V/m)		H Field (A/m)		B Field (μT)	
				Result	Limit	Result	Limit	Result	Limit	Result	Limit
FCC	1	LONG RANGE RF	902	0.13	30.07	6.90	N/A	0.0183	N/A	0.0230	N/A
CANADA	1	LONG RANGE RF	902	0.13	19.39	6.90	85.49	0.0183	0.2268	0.0230	N/A

Table 5 – Worker/Occupational Transmitter Summary

The calculations show that the EUT complies with the worker/occupational exposure levels described in in the listed specifications in Annex A at the point of investigation, 0.2 m.

Regional Requirement	Antenna Port	RAT	Frequency (MHz)	RF Exposure Level at compliance boundary of 0.2 m							
				S Power Density (W/m^2)		E Field (V/m)		H Field (A/m)		B Field (µT)	
				Result	Limit	Result	Limit	Result	Limit	Result	Limit
FCC	1	LONG RANGE RF	902	0.13	6.01	6.90	N/A	0.0183	N/A	0.0230	N/A
CANADA	1	LONG RANGE RF	902	0.13	2.74	6.90	32.14	0.0183	0.0853	0.0230	N/A

Table 6 – General Public Transmitter Summary

The calculations show that the EUT complies with the general public exposure levels described in in the listed specifications in Annex A at the point of investigation, 0.2 m.

2.3 Far Field Region Boundary Results

The far field region boundary calculation is shown below:

Near Field / Far Field Boundary	
RAT Name	Antennas - on axis Far Field Region (Ref: IEEE C95.3 Annex B.2)
	$2D^2/\lambda$ (m)
LONG RANGE RF	0.0795

Table 7 – Far Field Boundary

The far field boundary is 0.08 m. Compliance boundaries beyond this distance are in the far field and therefore the approach described in section 2.1 is valid.

2.4 Uncertainty

The basic computation formulas presented in section 2.1 are conservative formulas for the estimation of RF field strength or power density. No uncertainty estimations are required when using these formulas but there is clear guidance on where and when these formulas are applicable.

For the estimate of S, E or H to be conservative, the transmitter power P and antenna gain G_i values shall be the upper bounds of uncertainty therefore maximum values are used.

The spherical formula is valid under far field conditions which are established in section 2.3.

ANNEX A

REGIONAL REQUIREMENTS

Frequency Range (MHz)	Power Density (mW/cm^2)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)
0 - 0.3	-	-	-
0.3 - 3	100	614	1.63
3 - 30	900/f^2	1842/f	4.89/f
30 - 300	1	61.4	0.163
300 - 1500	f/300	-	-
1500 - 100000	5	-	-

Table A.1 – CFR 47 Pt1.1310 (2017) Worker/Occupational Limits

Frequency Range (MHz)	Power Density (mW/cm^2)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)
0 - 0.3	-	-	-
0.3 - 3	100	614	1.63
3 - 30	180/f^2	824/f	2.19/f
30 - 300	0.2	27.5	0.073
300 - 1500	f/1500	-	-
1500 - 100000	1	-	-

Table A.2 – CFR 47 Pt1.1310 (2017) General Public Limits

Frequency Range (MHz)	Power Density (W/m^2)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)
10 - 20	10	61.4	0.163
20 - 48	44.72/f^0.5	129.8/f^0.25	0.3444/f^0.25
48 - 100	6.455	49.33	0.1309
100 - 6000	0.6455*f^0.5	15.60*f^0.25	0.04138*f^0.25
6000 - 150000	50	137	0.364

Table A.3 – Health Canada Safety Code 6 Worker/Occupational Limits

Frequency Range (MHz)	Power Density (W/m^2)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)
10 - 20	2	27.46	0.0728
20 - 48	8.944/f^0.5	58.07/f^0.25	0.1540/f^0.25
48 - 300	1.291	22.06	0.05852
300 - 6000	0.02619*f^0.6834	3.142*f^0.3417	0.008335*f^0.3417
6000 - 15000	10	61.4	0.163

Table A.4 – Health Canada Safety Code 6 General Public Limits