

**T6 SERIES 3
TRANSMITTER RF EXPOSURE CALCULATION
TEST REPORT**

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REVISION HISTORY

Version	Date	Changes	Sections Affected
1.0	27/05/20	Initial release	None
2.0	11/06/20	Correct typographical error in average power formula	2.1
3.0	08/09/25	Update reference to RSS-102 to Issue 6 of 2023 and 47 CFR Part 2.1091 to 2021	1.1, 1.4
		Correct references to sections in document	1.6, 3.2
		Correct typo in caption of Table 12	5

1 INTRODUCTION

1.1 Purpose

The purpose of this document is to record the calculation of RF exposure for the products identified in the scope to determine the compliance distances in accordance with following requirements:

European Union - BS EN 50385:2017

United States - FCC 47 CFR Part 2.1091:2021

Canada – Industry Canada RSS-102:2023

1.2 Scope

The scope of this document encompasses the T6 Series 3 radios with transmit capability:

Product	Description
T6-TV	VHF transmitter with 50 W unmodulated carrier output power
T6-TU	UHF transmitter with 50 W unmodulated carrier output power
T6-TRV	VHF transceiver with 50 W unmodulated carrier output power
T6-TRU	UHF transceiver with 50 W unmodulated carrier output power

1.3 Definitions, Acronyms, Abbreviations

Term	Meaning
EN	European Standard
FCC	Federal Communications Commission
RSS	Radio Standards Specifications
SAR	Specific Absorption Rate
VHF	Very High Frequency
UHF	Ultra High Frequency

1.4 References

- [1] TR-T6-044, issue 01, Report of the Exposure Calculation of Park Air Systems VHF Amplifier, Model: T6-AV100 and UHF Amplifier, Model: T6-AU100 in accordance with EN 50385, FCC Part 2.1091 and Industry Canada RSS-102

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- [2] BS EN 50385:2017, Product standard to demonstrate the compliance of base station equipment with radiofrequency electromagnetic field exposure limits (110 MHz - 100 GHz), when placed on the market, November 2017
- [3] FCC 47 CFR Part 2.1091:2021
- [4] Industry Canada RSS-102:2023
- [5] Directive 2013/35/EU
- [6] 1999/519/EC: Council Recommendation of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz)
- [7] FCC 47 CFR Chapter 1, Subchapter A, Part 1, Subpart 1, 1.1310
- [8] Safety Code 6 - Limits of Human Exposure to Radiofrequency Electromagnetic Energy in the Frequency Range from 3 kHz to 300 GHz (2015), Health Canada

1.5 Overview

The rest of this test report is organised as follows:

Section 2 contains a description of the relevant conditions to which the exposure compliance distance calculations relate.

Section 3 contains the method of calculation of the exposure compliance distances and the results of those calculations for the products within the scope of this report.

1.6 Test Results Summary

The products are found to be compliant with the relevant limits for exposure to electromagnetic fields at the distances calculated for the general public and worker/occupational scenarios. These distances can be found in section 3.2. The compliance boundary distances for each of the regional requirements is as follows:

Table 1 – VHF Products (T6-TV and T6-TRV) Compliance Boundary Distances

Region	Worker/Occupational Compliance Distance (metres)	General Public Compliance Distance (metres)
European Union	1.0	2.2
United States	1.0	2.2
Canada	1.2	2.7

Table 2 - UHF Products (T6-TU and T6-TRU) Compliance Boundary Distances

Region	Worker/Occupational Compliance Distance (metres)	General Public Compliance Distance (metres)
European Union	1.0	2.2
United States	1.0	2.2
Canada	1.0	2.7

These figures can be found on the “Summary” tab of the spreadsheet attached in section 3.2. Note that the distances are rounded up to the nearest 0.1 m

2 TEST SETUP

2.1 General

For each product, SAR calculations have not been undertaken as the separation between the radiating antenna and human body should be greater than 20 cm.

For each product, the calculations are made on the lowest possible transmit frequency. For VHF it is 112 MHz and for UHF it is 225 MHz. The calculations relate to the product operating in its highest output power mode; amplitude modulation at 95% modulation depth.

For all the products within the scope of this report, the maximum unmodulated carrier power is 50 W (47 dBm). The maximum transmit modulation depth is 95%.

The maximum average power is therefore:

$$P_{average(watts)} = P_{carrier(watts)} \times \left(1 + \frac{(Mod\ Depth/100)^2}{2}\right)$$

$$P_{average(watts)} = 50 \times \left(1 + \frac{(95/100)^2}{2}\right) = 72.56\ W(48.61\ dBm)$$

2.2 Antenna Parameters

The calculations relate to the antennas supplied by Park Air Systems, identified in Table 3, as part of radio systems incorporating the product. Further calculations will be required where an alternative antenna is utilised to determine the appropriate separation distances required.

Table 3 - Product Antenna Parameters

Antenna Identification Number	Antenna Model	Antenna Gain (dBi)
1	Amphenol 7500xxx VHF	2
2	Park Air Z2 VHF	2
3	Amphenol 7502xxx UHF	2
4	Park Air Z2 UHF	2

3 EXPOSURE CALCULATIONS

3.1 Method

Calculation of the exposure compliance distances is by calculation of the power density (S), electric field strength (E), magnetic field strength (H), and magnetic flux density (B).

The spherical model, applicable under far-field conditions, is used:

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

Where:

η is the impedance of free space: 376.730313668 ohms (CODATA 2018)

P is the transmitter power in Watts

G_i is the antenna gain ratio relative to an isotropic antenna

r is the separate distance in metres

Magnetic flux density is related to the magnetic field strength as follows:

$$B = \mu_0 \times H$$

Where:

μ_0 is the permeability of free space: $1.25663706212 \times 10^{-6}$ H/m (CODATA 2018)

3.2 Results



Microsoft Excel
Worksheet

Example calculation of power density compliance limit for the Industry Canada general public limit (1.291 W/m²):

For an antenna with a 2 dBi gain: $G_i = 10^{(\frac{2}{10})} = 1.584893$

$$r = \sqrt{\frac{P \times G_i}{S_{limit} \times 4 \times \pi}}$$

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$$r = \sqrt{\frac{72.56 \times 1.584893}{1.291 \times 4 \times \pi}} = 2.66 \text{ metre}$$

3.2.1 General Public Compliance Distances

EU General Public (T6-TV, T6-TRV, T6-TU, T6-TRU)							
Limit for:				Compliance Distance for:			
Power Density (S)	Electric Field Strength (E)	Magnetic Field Strength (H)	Magnetic Flux Density (B)	Power Density (S)	Electric Field Strength (E)	Magnetic Field Strength (H)	Magnetic Flux Density (B)
W/m ²	V/m	A/m	T	m	m	m	m
2.0000	28.0000	0.0730	9.20E-08	2.14	2.10	2.14	2.13
			Overall Maximum	2.14	metres		

Note that same EU limit applies for the VHF and UHF frequency range of the products (112 to 155.975 MHz, 225 to 399.975 MHz)

FCC General Public (T6-TV, T6-TRV)						
Frequency	Limit for:			Compliance Distance for:		
	Power Density (S)	Electric Field Strength (E)	Magnetic Field Strength (H)	Power Density (S)	Electric Field Strength (E)	Magnetic Field Strength (H)
	W/m ²	V/m	A/m	m	m	m
112	2.0000	27.5000	0.0730	2.14	2.14	2.14
118	2.0000	27.5000	0.0730	2.14	2.14	2.14
127.5	2.0000	27.5000	0.0730	2.14	2.14	2.14
136.975	2.0000	27.5000	0.0730	2.14	2.14	2.14
155.975	2.0000	27.5000	0.0730	2.14	2.14	2.14
			Maximums	2.14	2.14	2.14
			Overall Maximum	2.14	metres	

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Canada General Public (T6-TV, T6-TRV)						
Frequency	Limit for:			Compliance Distance for:		
	Power Density (S)	Electric Field Strength (E)	Magnetic Field Strength (H)	Power Density (S)	Electric Field Strength (E)	Magnetic Field Strength (H)
	W/m ²	V/m	A/m	m	m	m
112	1.2910	22.0600	0.0585	2.66	2.66	2.66
118	1.2910	22.0600	0.0585	2.66	2.66	2.66
127.5	1.2910	22.0600	0.0585	2.66	2.66	2.66
136.975	1.2910	22.0600	0.0585	2.66	2.66	2.66
155.975	1.2910	22.0600	0.0585	2.66	2.66	2.66
			Maximums	2.66	2.66	2.66
			Overall Maximum	2.66	metres	

FCC General Public (T6-TU, T6-TRU)						
Frequency	Limit for:			Compliance Distance for:		
	Power Density (S)	Electric Field Strength (E)	Magnetic Field Strength (H)	Power Density (S)	Electric Field Strength (E)	Magnetic Field Strength (H)
	W/m ²	V/m	A/m	m	m	m
225	2.0000	27.5000	0.0730	2.14	2.14	2.14
300	2.0000	-	-	2.14	-	-
399.975	2.6665	-	-	1.85	-	-
			Maximums	2.14	2.14	2.14
			Overall Maximum	2.14	metres	

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Canada General Public (T6-TU, T6-TRU)						
Frequency	Limit for:			Compliance Distance for:		
	Power Density (S)	Electric Field Strength (E)	Magnetic Field Strength (H)	Power Density (S)	Electric Field Strength (E)	Magnetic Field Strength (H)
	W/m ²	V/m	A/m	m	m	m
225	1.2910	22.0600	0.0585	2.66	2.66	2.66
300	1.2912	22.0617	0.0585	2.66	2.66	2.66
399.975	1.5717	24.3400	0.0646	2.41	2.41	2.41
			Maximums	2.66	2.66	2.66
			Overall Maximum	2.66	metres	

3.2.2 Worker/Occupational

EU Worker/Occupational (T6-TV, T6-TRV, T6-TU, T6-TRU)							
Limit for:				Compliance Distance for:			
Power Density (S)	Electric Field Strength (E)	Magnetic Field Strength (H)	Magnetic Flux Density (B)	Power Density (S)	Electric Field Strength (E)	Magnetic Field Strength (H)	Magnetic Flux Density (B)
W/m ²	V/m	A/m	T	m	m	m	m
-	61.0000	-	2.00E-07	-	0.96	-	0.98
			Overall Maximum	0.98	metres		

Note that same EU limit applies for the VHF and UHF frequency range of the products (112 to 155.975 MHz, 225 to 399.975 MHz)

FCC Worker/Occupational (T6-TV, T6-TRV)						
Frequency	Limit for:			Compliance Distance for:		
	Power Density (S)	Electric Field Strength (E)	Magnetic Field Strength (H)	Power Density (S)	Electric Field Strength (E)	Magnetic Field Strength (H)
	W/m ²	V/m	A/m	m	m	m
112	10.0000	61.4000	0.1630	0.96	0.96	0.96
118	10.0000	61.4000	0.1630	0.96	0.96	0.96
127.5	10.0000	61.4000	0.1630	0.96	0.96	0.96
136.975	10.0000	61.4000	0.1630	0.96	0.96	0.96

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155.975	10.0000	61.4000	0.1630	0.96	0.96	0.96
			Maximums	0.96	0.96	0.96
			Overall Maximum	0.96	metres	

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Canada Worker/Occupational (T6-TV, T6-TRV)						
Frequency	Limit for:			Compliance Distance for:		
	Power Density (S)	Electric Field Strength (E)	Magnetic Field Strength (H)	Power Density (S)	Electric Field Strength (E)	Magnetic Field Strength (H)
	W/m ²	V/m	A/m	m	m	m
112	6.8313	50.7492	0.1346	1.16	1.16	1.16
118	7.0119	51.4156	0.1364	1.14	1.14	1.14
127.5	7.2887	52.4206	0.1390	1.12	1.12	1.12
136.975	7.5547	53.3685	0.1416	1.10	1.10	1.10
155.975	8.0616	55.1300	0.1462	1.07	1.07	1.07
			Maximums	1.16	1.16	1.16
			Overall Maximum	1.16	metres	

FCC Worker/Occupational (T6-TU, T6-TRU)						
Frequency	Limit for:			Compliance Distance for:		
	Power Density (S)	Electric Field Strength (E)	Magnetic Field Strength (H)	Power Density (S)	Electric Field Strength (E)	Magnetic Field Strength (H)
	W/m ²	V/m	A/m	m	m	m
225	10.0000	61.4000	0.1630	0.96	0.96	0.96
300	10.0000	-	-	0.96	-	-
399.975	13.3325	-	-	0.83	-	-
			Maximums	0.96	0.96	0.96
			Overall Maximum	0.96	metres	

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Canada Worker/Occupational (T6-TU, T6-TRU)						
Frequency	Limit for:			Compliance Distance for:		
	Power Density (S)	Electric Field Strength (E)	Magnetic Field Strength (H)	Power Density (S)	Electric Field Strength (E)	Magnetic Field Strength (H)
	W/m ²	V/m	A/m	m	m	m
225	9.6825	60.4185	0.1603	0.97	0.97	0.97
300	11.1804	64.9239	0.1722	0.90	0.90	0.91
399.975	12.9096	69.7642	0.1851	0.84	0.84	0.84
			Maximums	0.97	0.97	0.97
			Overall Maximum	0.97	metres	

5 REGIONAL LIMITS

Table 4 - EU Worker/Occupational Action Levels from Directive 2013/35/EU Annex III Table B1

ALs for exposure to electric and magnetic fields from 100 kHz to 300 GHz

Frequency range	Electric field strength ALs(E) [V m ⁻¹] (RMS)	Magnetic flux density ALs(B) [μT] (RMS)	Power density ALs(S) [W m ⁻²]
100 kHz ≤ f < 1 MHz	$6,1 \times 10^2$	$2,0 \times 10^6/f$	—
1 ≤ f < 10 MHz	$6,1 \times 10^8/f$	$2,0 \times 10^6/f$	—
10 ≤ f < 400 MHz	61	0,2	—
400 MHz ≤ f < 2 GHz	$3 \times 10^{-3} f^{4/3}$	$1,0 \times 10^{-5} f^{4/3}$	—
2 ≤ f < 6 GHz	$1,4 \times 10^2$	$4,5 \times 10^{-1}$	—
6 ≤ f ≤ 300 GHz	$1,4 \times 10^2$	$4,5 \times 10^{-1}$	50

Note B1-1: f is the frequency expressed in hertz (Hz).

Table 5 - EU Council Recommendation 1999/519/EC Annex II Table 2 General Public Limits

Reference levels for electric, magnetic and electromagnetic fields
(0 Hz to 300 GHz, unperturbed rms values)

Frequency range	E-field strength (V/m)	H-field strength (A/m)	B-field (μT)	Equivalent plane wave power density S _{eq} (W/m ²)
0-1 Hz	—	$3,2 \times 10^4$	4×10^4	—
1-8 Hz	10 000	$3,2 \times 10^4/f^2$	$4 \times 10^4/f^2$	—
8-25 Hz	10 000	$4\,000/f$	$5\,000/f$	—
0,025-0,8 kHz	$250/f$	$4/f$	$5/f$	—
0,8-3 kHz	$250/f$	5	6,25	—
3-150 kHz	87	5	6,25	—
0,15-1 MHz	87	$0,73/f$	$0,92/f$	—
1-10 MHz	$87/f^{1/2}$	$0,73/f$	$0,92/f$	—
10-400 MHz	28	0,073	0,092	2
400-2 000 MHz	$1,375 f^{1/2}$	$0,0037 f^{1/2}$	$0,0046 f^{1/2}$	$f/200$
2-300 GHz	61	0,16	0,20	10

Notes:

1. f as indicated in the frequency range column.

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Table 6 - FCC Exposure Limits from CFR Title 47, Chapter 1, Subchapter A, Part 1, Subpart 1, 1.1310

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposure				
0.3-3.0	614	1.63	*100	6
3.0-30	1842/f	4.89/f	*900/f ²	6
30-300	61.4	0.163	1.0	6
300-1,500			f/300	6
1,500-100,000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	*100	30
1.34-30	824/f	2.19/f	*180/f ²	30
30-300	27.5	0.073	0.2	30
300-1,500			f/1500	30
1,500-100,000			1.0	30

f = frequency in MHz * = Plane-wave equivalent power density

Table 7 - Health Canada General Public Limits from Safety Code 6, Table 5

Frequency (MHz)	Electric Field Strength (E _{RL}), (V/m, RMS)	Magnetic Field Strength (H _{RL}), (A/m, RMS)	Power Density (S _{RL}), (W/m ²)	Reference Period (minutes)
10–20	27.46	0.0728	2	6
20–48	$58.07 / f^{0.25}$	$0.1540 / f^{0.25}$	$8.944 / f^{0.5}$	6
48–300	22.06	0.05852	1.291	6
300–6000	$3.142 f^{0.3417}$	$0.008335 f^{0.3417}$	$0.02619 f^{0.6834}$	6
6000–15000	61.4	0.163	10	6
15000–150000	61.4	0.163	10	$616000 / f^{1.2}$
150000–300000	$0.158 f^{0.5}$	$4.21 \times 10^{-4} f^{0.5}$	$6.67 \times 10^{-5} f$	$616000 / f^{1.2}$

Frequency, f, is in MHz.

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Table 8 - Health Canada Worker/Occupational Limits from Safety Code 7, Table 7

Frequency (MHz)	Electric Field Strength (E_{RL}), (V/m, RMS)	Magnetic Field Strength (H_{RL}), (A/m, RMS)	Power Density, (S_{RL}), (W/m ²)	Reference Period (minutes)
10–20	61.4	0.163	10	6
20–48	$129.8 / f^{0.25}$	$0.3444 / f^{0.25}$	$44.72 / f^{0.5}$	6
48–100	49.33	0.1309	6.455	6
100–6000	$15.60 f^{0.25}$	$0.04138 f^{0.25}$	$0.6455 f^{0.5}$	6
6000–15000	137	0.364	50	6
15000–150000	137	0.364	50	$616000 / f^{1.2}$
150000–300000	$0.354 f^{0.5}$	$9.40 \times 10^{-4} f^{0.5}$	$3.33 \times 10^{-4} f$	$616000 / f^{1.2}$

Frequency, f , is in MHz.