Engineering Test Report No. 2301031-03		
Report Date	July 18, 2023	
Manufacturer Name	The Chamberlain Group, Inc.	
Manufacturer Address	300 Windsor Dr Oak Brook, IL 60523	
Product Name Model No.	Industrial DC Operator JHDC7S1BMC, JHDC7S4BMC, JHDC12S1BMC, JHDC12S4BMC	
Date Received	June 1, 2023	
Assessment Dates	June 5 – July 11, 2023	
Specifications	FCC 47 CFR Part 1 §1.1310 & Part 2 §2.1091 and §2.1093 KDB 447498 D01 OET Bulletin 65:1997 RSS-102 Issue 5, Amend. 1	
Test Facility	Elite Electronic Engineering, Inc. 1516 Centre Circle, Downers Grove, IL 60515	FCC Reg. Number: 269750 IC Reg. Number: 2987A CAB Identifier: US0107
Signature		
Tested by	Tylar Jozefczyk	
Signature		
Approved by	Raymond J. Klouda, Registered Professional Engineer of Illinois – 44894	
PO Number	4900090806	

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1. Report Revision History

Revision	Date	Description
–	19 JUL 2023	Initial Release of Engineering Test Report No. 2301031-03

2. Introduction

The FCC, Innovation, Science and Economic Development Canada, European Union and Australia/New Zealand publish standards regarding the evaluation of the RF Exposure hazard of radio communications devices. An evaluation has been performed on The Chamberlain Group, Inc. Industrial DC Operator (Model No. JHDC7S1BMC, JHDC7S4BMC, JHDC12S1BMC, and JHDC12S4BMC) pursuant to the relevant requirements.

3. Subject of Investigation

This document presents the demonstration of RF Exposure compliance on an Industrial DC Operator, (hereinafter referred to as the Equipment under Test (EUT)). The EUT was identified as follows:

EUT Identification	
Description	Industrial DC Operator
Model/Part No.	JHDC7S1BMC, JHDC7S4BMC, JHDC12S1BMC, JHDC12S4BMC (Note: JHDC12S1BMC was used for evaluation; the same board is used in all models.)
Radio Access Technology	Below 1GHz FHSS 802.11b/g/n Bluetooth Low Energy
Bands of Operation	900 – 928MHz 2400 – 2483.5MHz
Conducted Output Power	900MHz: 0.02089W (13.2dBm) Wi-Fi: 802.11g – 0.1513W (21.8dBm) (highest power overall) BLE: 0.0015W (1.8dBm)
Antenna Gain	900MHz: 3.5dBi Wi-Fi/BLE: 5dBi
Note 1 – The Wi-Fi and BLE cannot transmit simultaneously, so each combination will be evaluated separately. Note 2 – The logic control board used is PCB # 003-0635-1. Note 3 – This report also covers the following model numbers: JDC7S1BMC, JDC7S4BMC, TDC7S1BMC, TDC7S4BMC, JHDC12X1BMC, JHDC12X4BMC, TDC12S1BMC, TDC12S4BMC, TDC12X1BMC, and TDC12X4BMC.	

4. Standards and Requirements

The tests were performed to selected portions of, and in accordance with the following specifications.

- Federal Communications Commission "Code of Federal Regulations", Title 47, Chapter I, Subchapter A, Part 1, Subpart I, §1.1310 – “Radiofrequency radiation exposure limits”

- Federal Communications Commission "Code of Federal Regulations", Title 47, Chapter I, Subchapter A, Part 2, Subpart J, §2.1091 – “Radiofrequency radiation exposure evaluation: mobile devices”

- Federal Communications Commission "Code of Federal Regulations", Title 47, Chapter I, Subchapter A, Part 2, Subpart J, §2.1093 – “Radiofrequency radiation exposure evaluation: portable devices”

- KDB 447498 D01 General RF Exposure Guidance v06 – “RF Exposure Procedures and Equipment Authorization Polices for Mobile and Portable Devices”

- OET Bulletin 65 Edition 97-01:1997 – “Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields”

- ANSI/IEEE C95.1:1992 – "Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz"

- RSS-102, Issue 5, Amendment 1 (February 2, 2021) – "Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)"

5. Sample Calculations

The far field power density can be calculated using the following formula:

$$S = \frac{PG}{4\pi R^2} \quad (1)$$

Where:

P = transmit output power (mW)
G = maximum antenna gain relative to an isotropic antenna (linear)
R = evaluation distance (cm).

In cases where multiple antennas are utilized for a single signal, the following formula is applied to calculate the maximum antenna gain:

$$Gain\ (dBi) = G + 10 \log \mathrm{N} \quad (2)$$

Where:

N = number of antennas,
G = gain of a single antenna.

A minimum separation distance can be calculated using the following formulas

$$Minimum\ Seperation\ Distance = \sqrt{\frac{PG}{4\pi(Power\ Density\ Limit)}} \quad (3)$$

Where:

P = transmit output power (mW)
G = maximum antenna gain relative to an isotropic antenna (linear).

For sources with frequencies < 30MHz

$$Seperation\ Distance = R\left(10^{\frac{(FS_{Limit} - FS_R)}{40}}\right)^{-1} \quad (4)$$

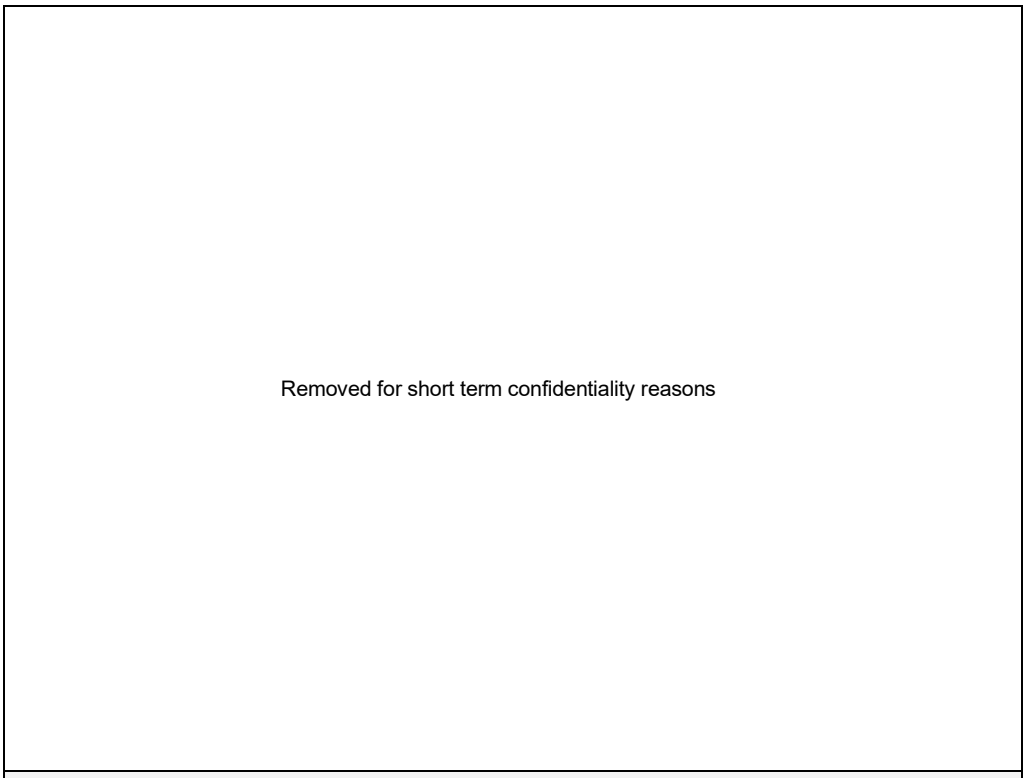
For sources with frequencies > 30MHz

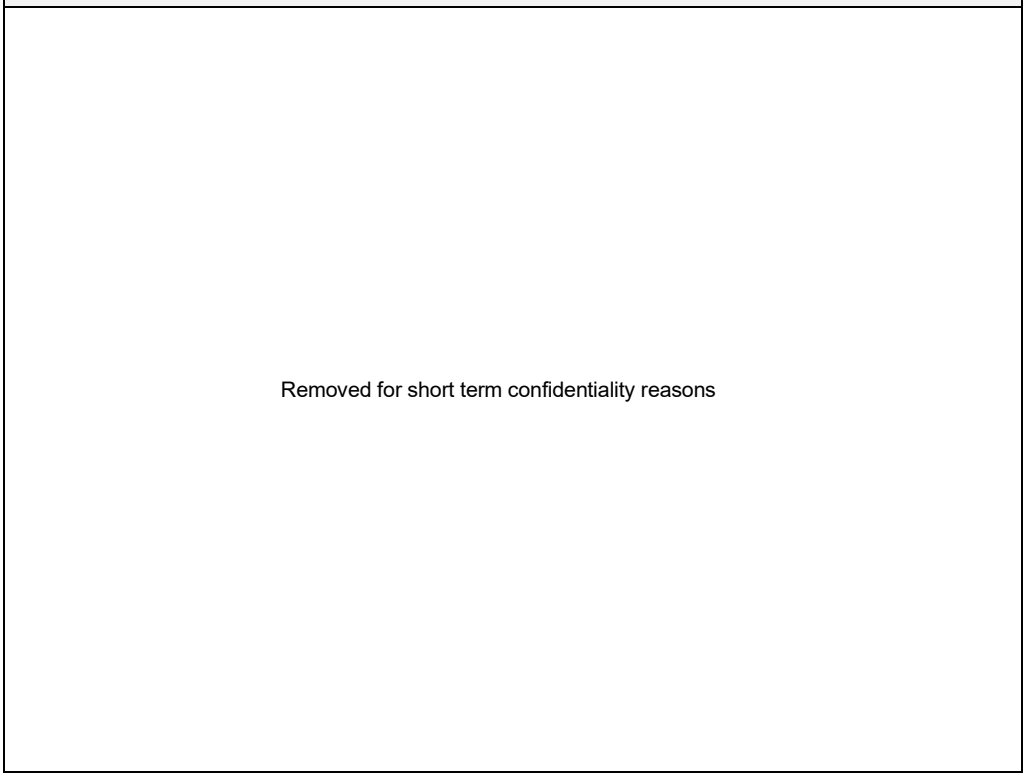
$$Seperation\ Distance = R\left(10^{\frac{(FS_{Limit} - FS_R)}{20}}\right)^{-1} \quad (5)$$

Where:

R = measurement distance
FS_{Limit} = field strength limit
FS_R = measured field strength at distance R.

6. Photographs of EUT





Removed for short term confidentiality reasons
Sub 1GHz Antenna with mount and extension cable
Removed for short term confidentiality reasons
Wi-Fi/BLE Antenna

7. Limits and Requirements

7.1. Requirements mandated by the FCC

Equipment pursuing compliance to the requirements with respect to the limits of human exposure to RF provided in FCC 1.1310, need follow the criteria in FCC 1.1307(b)(1).

Equipment exemption qualification must be demonstrated pursuant to FCC 1.1307(b)(3).

For single RF sources (i.e., any single portable device, mobile device, or fixed RF source): A single RF source is exempt if:

- FCC 1.1307(b)(3)(i)(A): The available maximum time-averaged power is no more than 1mW, regardless of separation distance.
- FCC 1.1307(b)(3)(i)(B): The available maximum time-averaged power or effective radiated power (ERP), whichever is greater, is less than or equal to the threshold P_{th} (mW) described in the following formula. This method shall only be used at separation distances (cm) from 0.5 centimeters to 40 centimeters and at frequencies from 0.3GHz to 6 GHz (inclusive). P_{th} is given by:

$$P_{th}(mW) = \begin{cases} ERP_{20cm}\left(\frac{d}{20cm}\right)^{x} & d \le 20cm \\ ERP_{20cm} & 20cm < d \le 40cm \end{cases}$$

With

$$x = -\log_{10}\left(\frac{60}{ERP_{20cm}\sqrt{f}}\right)$$

Where f is in GHz, and

$$ERP_{20cm}(mW) = \begin{cases} 2040f & 0.3GHz \le f < 1.5GHz \\ 3060 & 1.5GHz \le f < 6GHz \end{cases}$$

- FCC 1.1307(b)(3)(i)(C): Using Table 1 and the minimum separation distance (R in meters) from the body of a nearby person for the frequency (f in MHz) at which the source operates, the ERP (watts) is no more than the calculated value prescribed for that frequency. For the exemption in Table 1 to apply, R must be at least λ/2π, where λ is the free-space operating wavelength in meters. If the ERP of a single RF source is not easily obtained, then the available maximum time-averaged power may be used in lieu of ERP if the physical dimensions of the radiating structure(s) do not exceed the electrical length of λ/4 or if the antenna gain is less than that of a half-wave dipole (1.64 linear value).

RF Source Frequency (MHz)	Threshold ERP (watts)
0.3 – 1.34	1920 R^2
1.34 – 30	3450 R^2 / f^2
30 – 300	3.83 R^2
300 – 1,500	0.0128 R^2
1,500 – 100,000	19.2 R^2

Multiple RF sources are exempt if:

- FCC 1.1307(b)(3)(ii)(A): The available maximum time-averaged power of each source is no more than 1mW and there is a separation distance of two centimeters between any portion of a radiating structure operating and the nearest portion of any other radiating structure in the same device, except if the sum of multiple sources is less than 1mW during the time-averaging period, in which case they may be treated as a single source (separation is not required).

- FCC 1.1307(b)(3)(ii)(B): In the case of fixed RF sources operating in the same time-averaging period, or of multiple mobile or portable RF sources within a device operating in the same time averaging period, if the sum of the fractional contributions to the applicable thresholds is less than or equal to 1 as indicated in the following equation.

$$\sum_{i=1}^{a} \frac{P_i}{P_{th,i}} + \sum_{j=1}^{b} \frac{ERP_j}{ERP_{th,j}} + \sum_{k=1}^{c} \frac{Evaluated_k}{Exposure\ Limit_k} \leq 1$$

Where:

a = number of fixed, mobile, or portable RF sources claiming exemption using paragraph (b)(3)(i)(B) for P_{th}, including existing exempt transmitters and those being added.
b = number of fixed, mobile, or portable RF sources claiming exemption using paragraph (b)(3)(i)(C) for Threshold ERP, including existing exempt transmitters and those being added.
c = number of existing fixed, mobile, or portable RF sources with known evaluation for the specified minimum distance, including existing evaluated transmitters.
P_i = available maximum time-averaged power or the ERP (whichever is greater) for fixed, mobile, or portable RF source i at a distance between 0.5 – 40cm (inclusive).
$P_{th,i}$ = exemption threshold power (P_{th}) according to paragraph (b)(3)(i)(B) for fixed, mobile, or portable RF source i.
ERP_j = ERP of fixed, mobile, or portable RF source j.
$ERP_{th,j}$ = exemption threshold ERP for fixed, mobile, or portable RF source j, at a distance of at least λ/2π according to the applicable formula of paragraph (b)(3)(i)(C).
$Evaluated_k$ = maximum reported SAR or MPE of fixed, mobile, or portable RF source k either in the device or at the transmitter site from an existing evaluation at the location of exposure.
$Exposure\ Limit_k$ = either the general population/uncontrolled maximum permissible exposure (MPE) or specific absorption rate (SAR) limit for each fixed, mobile, or portable RF source k, as applicable from §1.1310.

If it is determined that the equipment under investigation is not exempt from routine evaluation an assessment must be performed to determine compliance in regard to the RF exposure limits by means of measurement or calculation of the electric field, magnetic field, or power density. It may be the case that a minimum separation distance will need to be calculated or measured and maintained from the source of RF to meet the basic restrictions.

In environments where the possibility of simultaneous exposure to fields on different frequencies exists, the exposure shall be considered to be additive. The fraction of the recommended limit incurred within each frequency should be determined, and the sum of all fractional contributions should not exceed 1.0.

Per 1.1310(e)(1), the power density shall not exceed the levels below:

Limits for Occupational/Controlled Exposure			
Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)
0.3 - 3.0	614	1.63	100 *
3.0 – 30	1842 / f	4.89 / f	$900 / f^2$ *
30 – 300	61.4	0.163	1.0
300 – 1,500	—	—	f / 300
1,500 – 100,000	—	—	5
Limits for General/Uncontrolled Exposure			
Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)
0.3 – 1.34	614	1.63	100 *
1.34 – 30	842 / f	2.19 / f	$180 / f^2$ *
30 – 300	27.5	0.073	0.2
300 – 1,500	—	—	f / 1500
1,500 – 100,000	—	—	1.0
f = frequency in MHz * = Plane wave Equivalent Power Density			

7.2. Requirements mandated by Innovation, Science and Economic Development Canada

The RF exposure level shall be determined by either measurement or by calculating the power density at a minimum evaluation distance of 0.2m, as specified by ANSI/IEEE C95.1-1992.

If it is found that the product meets the low power exclusion level criteria listed in RSS 102 Section 2.5.2, no further RF exposure evaluation is required. The low power exclusion level criteria are given in the following table (f is given in MHz):

RF Source Frequency (MHz)	Threshold ERP (watts)
$f < 20$ MHz	$x \leq 1$
20 MHz $\leq f < 48$ MHz	$x \leq \frac{4.49}{f^{0.5}}$
48 MHz $\leq f < 300$ MHz	$x \leq 0.6$
300 MHz $\leq f < 6$ GHz	$x \leq (1.31 * 10^{-2}) * f^{0.6834}$
6 GHz $\leq f$	$x \leq 5$

If it is determined that the measured or calculated power density does not meet the basic restrictions, a separation distance must be measured or calculated such that the basic restrictions are met.

In environments where the possibility of simultaneous exposure to fields on different frequencies exists, the exposure shall be considered to be additive. The fraction of the recommended limit incurred within each frequency should be determined, and the sum of all fractional contributions should not exceed 1.0. The following formula shall apply:

$$\sum_{i=1}^{n} \frac{S_{C,1}}{S_{L,1}} + \frac{S_{C,2}}{S_{L,2}} + \frac{S_{C,3}}{S_{L,3}} + \cdots \frac{S_{C,n}}{S_{L,n}} \leq 1 \qquad (6)$$

where:

S_C = measured/calculated power density.
S_L = RF exposure limit.

Per RSS 102 Section 4, the power density shall not exceed the levels below:

Limits for Occupational/Controlled Exposure			
Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (W/m^2)
0.003 – 10 *	170	180	—
0.1 – 10 *	—	1.6 / f	—
1.29 – 10 *	$193 / f^{0.5}$	—	—
10 – 20	61.4	0.163	10
20 – 48	$129.8 / f^{0.25}$	$0.3444 / f^{0.25}$	$44.72 / f^{0.5}$
48 – 100	49.33	0.1309	6.455
100 – 6000	$15.60\ f^{0.25}$	$0.04138\ f^{0.25}$	$0.6455\ f^{0.5}$
6000 – 15000	137	0.364	50
15000 – 150000	137	0.364	50
150000 – 300000	$0.354\ f^{0.5}$	$9.40 \times 10^{-4}\ f^{0.5}$	$3.33 \times 10^{-4}\ f$
Limits for General/Uncontrolled Exposure			
Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (W/m^2)
0.003 – 10 *	83	90	—
0.1 – 10 *	—	0.73 / f	—
1.1 – 10 *	$87 / f^{0.5}$	—	—
10 – 20	27.46	0.0728	2
20 – 48	$58.07 / f^{0.25}$	$0.1540 / f^{0.25}$	$8.944 / f^{.05}$
48 – 300	22.06	0.05852	1.291
300 – 6000	$3.142\ f^{0.3417}$	$0.008335\ f^{0.3417}$	$0.02619\ f^{0.6834}$
6000 – 15000	61.4	0.163	10
15000 – 150000	61.4	0.163	10
150000 – 300000	$0.158\ f^{0.5}$	$4.21 \times 10^{-4}\ f^{0.5}$	$6.67 \times 10^{-5}\ f$

f = frequency in MHz

* Limits only apply to Specific Absorption Rate and Nerve Stimulation requirements.

8. Assessment Results

8.1. RF Exposure Evaluation Relevant to the Requirements of the FCC

Radio Access Technology	*f* Transmit Frequency (MHz)	ERP/P (dBm)	ERP/P (mW)
Wi-Fi	2462	30.59	1145.512941
900MHz	926.75	13.56	22.69864852

Radio Access Technology	*f* Transmit Frequency (MHz)	ERP/P (mW)	Power Threshold (mW)	Calculated Power Density (mW/cm^2)	Power Density Limit (mW/cm^2)	Fractional Contributions	∑ Fractional Contributions
Wi-Fi	2462	——	——	0.227892559	1.00	0.2279	0.235
900MHz	926.75	——	——	0.004515753	0.62	0.0073	

Radio Access Technology	*f* Transmit Frequency (MHz)	ERP/P (dBm)	ERP/P (mW)
BLE	2402	1.8	1.513561248
900MHz	926.75	13.2	20.89296131

Radio Access Technology	*f* Transmit Frequency (MHz)	ERP/P (mW)	Power Threshold (mW)	Calculated Power Density (mW/cm^2)	Power Density Limit (mW/cm^2)	Fractional Contributions	∑ Fractional Contributions
BLE	2402	——	——	0.000301113	1.00	0.0003	0.007
900MHz	926.75	——	——	0.004156523	0.62	0.0067	

The equipment under investigation is determined to be exempt from routine evaluation.

8.2. RF Exposure Evaluation Relevant to the Requirements of the ISED

Radio Access Technology	*f* Transmit Frequency (MHz)	EIRP (dBm)	EIRP (W)
Wi-Fi	2462	21.8	0.151
900MHz	926.75	13.2	0.021

Radio Access Technology	*f* Transmit Frequency (MHz)	EIRP (dBm)	EIRP (W)
BLE	2402	1.8	0.002
900MHz	926.75	13.2	0.021

8.2.1. Assessment Results for General/Uncontrolled Environments

Based on the initial assessment above, the EUT is required to meet the limits for General Population/Uncontrolled exposure.

Details of the final assessment can be seen below:

Radio Access Technology	*f* Transmit Frequency (MHz)	S_C Calculated Power Density (W/m^2)	S_L Power Density Limit (W/m^2)	S_C:S_L Ratio	∑ S_C:S_L Ratio
Wi-Fi	2462	0.301113413	5.441789657	0.055333527	0.07
900MHz	926.75	0.041565222	2.790986499	0.014892663	

Radio Access Technology	*f* Transmit Frequency (MHz)	S_C Calculated Power Density (W/m^2)	S_L Power Density Limit (W/m^2)	S_C:S_L Ratio	∑ S_C:S_L Ratio
BLE	2402	0.003011134	5.350804563	0.000562744	0.02
900MHz	926.75	0.041565222	2.790986499	0.014892663	

9. Statement of Compliance

The Chamberlain Group, Inc. Industrial DC Operator (Model No. JHDC7S1BMC, JHDC7S4BMC, JHDC12S1BMC, and JHDC12S4BMC) is in compliance with the FCC and Innovation, Science and Economic Development Canada requirements for RF Exposure.