

# **Element Materials Technology**

(formerly PCTEST) 18855 Adams Court, Morgan Hill, CA 95037 USA Tel. 408.538.5600 http://www.element.com



## RF EXPOSURE EVALUATION **Maximal Permissible Exposure [MPE]**

**Applicant Name:** 

Apple Inc. One Apple Park Way Cupertino, CA 95014

**United States** 

**Date of Testing:** 

6/7/2023 - 8/3/2023

**Test Report Issue:** 

8/15/2023

**Test Site/Location:** 

Element Materials Technology, Morgan Hill, CA, USA

**Test Report Serial No.:** 1C2305020014-18.BCG

FCC ID: BCG-A2986

579C-A2986 IC:

APPLICANT: Apple Inc.

**Application Type:** Certification Model/HVIN: A2986, A2987

**EUT Type:** Watch

**FCC Rule Part:** FCC Part 1 (§1.1310) and Part 2 (§2.1091)

**ISED Specification:** RSS-102 Issue 5

This equipment has been shown to be capable of compliance with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in FCC KDB 447498 D01. Test results reported herein relate only to the item(s) tested.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

RI Ortanez

**Executive Vice President** 





FCC ID: BCG-A2986 MAXIMUM PERMISSIBLE EXPOSURE Approved by: element IC: 579C-A2986 **REPORT** Technical Manager Test Report S/N: **Test Dates: EUT Type:** Page 1 of 13 1C2305020014-18.BCG 6/7/2023 - 8/3/2023 Watch



# TABLE OF CONTENTS

1.0	RF E	EXPOSURE EVALUATION – MAXIMUM PERMISSIBLE EXPOSURE (MPE)	3
	1.1	Introduction	3
		EUT Description	
	1.3	MPE Requirements Overview	5
	1.4	Procedure	6
	1.5	Summary of Results	11
2.0	CON	ICLUSION	. 13

FCC ID: BCG-A2986 IC: 579C-A2986	element	MAXIMUM PERMISSIBLE EXPOSURE REPORT	Approved by: Technical Manager
Test Report S/N:	Test Dates:	EUT Type:	Page 2 of 13
1C2305020014-18.BCG	6/7/2023 - 8/3/2023	Watch	Page 2 of 13



# 1.0 RF EXPOSURE EVALUATION - MAXIMUM PERMISSIBLE EXPOSURE (MPE)

#### 1.1 Introduction

This document is prepared to show compliance with the RF Exposure requirements as required in §1.1310 of the FCC Rules and Regulations and RSS-102 of Industry Canada.

The limit for Maximum Permissible Exposure (MPE), specified in FCC §1.1310 is listed in Table 1-1, and specified in RSS-102 is listed in Table 1-2. According to FCC §1.1310 and RSS-102: the criteria listed in the following tables shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in §1.1307(b).

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm²)	Average Time (Minutes)
(A	A) Limits For Occupa	ational / Control Exp	osures (f = frequenc	y)
30-300	61.4	0.163	1.0	6
300-1500			f/300	6
1500-100,000			5.0	6
(B) Lim	its For General Pop	ulation / Uncontrolle	ed Exposure (f = free	uency)
30-300	27.5	0.073	0.2	30
300-1500			f/1500	30
1500-100,000			1.0	30

Table 1-1. FCC Limits for Maximum Permissible Exposure (MPE)

FCC ID: BCG-A2986 IC: 579C-A2986	element)	element MAXIMUM PERMISSIBLE EXPOSURE REPORT		
Test Report S/N:	Test Dates:	EUT Type:	Page 3 of 13	
1C2305020014-18.BCG	6/7/2023 - 8/3/2023	Watch	Fage 3 01 13	



Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (W/m²)	Reference Period (Minutes)				
(A) RF Field Streng	(A) RF Field Strength Limits For Controlled Use Devices (Controlled Environment) (f = frequency)							
20-48	129.8/ f <sup>0.25</sup>	0.3444/ f <sup>0.25</sup>	44.72/ f <sup>0.5</sup>	6				
48-100	49.33	0.1309	6.455	6				
100-6000	15.60 f <sup>0.25</sup>	0.04138 f <sup>0.25</sup>	0.6455 f <sup>0.5</sup>	6				
600-15000	137	0.364	50	6				
15000-150000	137	0.364	50	616000/ f <sup>1.2</sup>				
150000-300000	0.354 f <sup>0.5</sup>	9.40 x 10 <sup>-4</sup> f <sup>0.5</sup>	3.33 x 10 <sup>-4</sup> f	616000/ f <sup>1.2</sup>				
(B) RF Field Streng	gth Limits For Devic	es Used by the Gen (f = frequency)	eral Public (Uncontr	olled Environment)				
20-48	58.07/ f <sup>0.25</sup>	0.1540/ f <sup>0.25</sup>	8.944/ f <sup>0.5</sup>	6				
48-300	22.06	0.05852	1.291	6				
300-6000	3.142 f <sup>0.3417</sup>	0.008335 f <sup>0.3417</sup>	0.02619 f <sup>0.6834</sup>	6				
6000-15000	61.4	0.163	10	6				
15000-150000	61.4	0.163	10	616000/ f <sup>1.2</sup>				
150000-300000	0.158 f <sup>0.5</sup>	4.21 x 10 <sup>-4</sup> f <sup>0.5</sup>	6.67 x 10 <sup>-5</sup> f	616000/ f <sup>1.2</sup>				

Table 1-2. ISED Limits for Maximum Permissible Exposure (MPE)

#### 1.2 EUT Description

The Equipment Under Test (EUT) is the **Apple Watch FCC ID: BCG-A2986** and **IC: 579C-A2986**. The device contains the following capabilities:

850/1700/1900 WCDMA/HSPA, Multi-band LTE, 802.11b/g/n WLAN, 802.11a/n UNII, 802.15.4 ab NB , Bluetooth (1x, EDR, HDR4, HDR8, LE1M, LE2M), NFC, UWB, 60.5GHz Transmitter.

EUT consists of a Apple Watch handheld device containing a 60.5GHz unlicensed/license-exempt data communications transmitter module. A proprietary Wireless Serial Dock with a corresponding 60.5GHz module is needed to activate transmission on the Apple Watch. A magnetic alignment fixture locks the Apple Watch in place on top of the Wireless Serial Dock, thus allowing communication between the Dock and Apple Watch. The Wireless Serial Dock is powered by a USB-C port.

FCC ID: BCG-A2986 IC: 579C-A2986	element	MAXIMUM PERMISSIBLE EXPOSURE REPORT	Approved by: Technical Manager
Test Report S/N:	Test Dates:	EUT Type:	Dogo 4 of 12
1C2305020014-18.BCG	6/7/2023 - 8/3/2023	Watch	Page 4 of 13



#### 1.3 MPE Requirements Overview

Three different categories of transmitters are defined by the FCC KDB 447498 D01. These categories are fixed installation, mobile, and portable and are defined as follows:

- Fixed Installations: fixed location means that the device, including its antenna, is physically secured at a permanent location and is not able to be easily moved to another location. Additionally, distance to humans from the antenna is maintained to at least 2 meters.
- Mobile Devices: a mobile device is defined as a transmitting device designed to be used in other than fixed locations and to be generally used in such a way that a separation distance of at least 20 centimeters is normally maintained between the transmitter's radiating structures and the body of the user or nearby persons. Transmitters designed to be used by consumers or workers that can be easily re-located, such as a wireless modem operating in a laptop computer, are considered mobile devices if they meet the 20 centimeter separation requirement. The FCC rules for evaluating mobile devices for RF compliance are found in 47 CFR §2.1091.
- Portable Devices: a portable device is defined as a transmitting device designed to be used so that the radiating structure(s) of the device is/are within 20 centimeters of the body of the user. Portable device requirements are found in Section 2.1093 of the FCC's Rules (47 CFR§2.1093).

The FCC also categorizes the use of the device as based upon the user's awareness and ability to exercise control over his or her exposure. The two categories defined are Occupational/ Controlled Exposure and General Population/Uncontrolled Exposure. These two categories are defined as follows:

- Occupational/Controlled Exposure: In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. This exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means. Awareness of the potential for RF exposure in a workplace or similar environment can be provided through specific training as part of a RF safety program. If appropriate, warning signs and labels can also be used to establish such awareness by providing prominent information on the risk of potential exposure and instructions on methods to minimize such exposure risks.
- General Population/Uncontrolled Exposure: The general population / uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity. Warning labels placed on low-power consumer devices such as cellular telephones are not considered sufficient to allow the device to be considered under the occupational/controlled category, and the general population/uncontrolled exposure limits apply to these devices.

The **Apple Watch FCC ID: BCG-A2986 and IC: 579C-A2986** is evaluated to the General Population/Uncontrolled Exposure requirements.

FCC ID: BCG-A2986 IC: 579C-A2986	element	MAXIMUM PERMISSIBLE EXPOSURE REPORT	Approved by: Technical Manager
Test Report S/N:	Test Dates:	EUT Type:	Dogo F of 12
1C2305020014-18.BCG	6/7/2023 - 8/3/2023	Watch	Page 5 of 13



#### 1.4 Procedure

The procedure used to determine the RF power density was based upon a calculation for determining compliance with the MPE requirements.

The power generated by the 60.5GHz transmitter used in this product was initially calculated using radiated measurement techniques as outlined in the RF Part 15.255 report (1C2305020014-17.BCG). Through use of the Friis transmission formula and knowledge of the maximum antenna gain to be used, the power density level is calculated at a distance of 20cm.

All different frequencies per technology have been investigated and only the worst power density ratios have been reported.

#### **Friis Transmission Formula**

Friis transmission formula:  $P_d = (P_{out}*G) / (4\pi r^2)$ 

Where,

 $P_d$  = Power Density (mW/cm<sup>2</sup>)  $\pi$  = 3.1416

P<sub>out</sub> = output power to antenna (mW) r = distance between observation point and center of the radiator (cm)

G = gain of antenna in linear scale

#### **Calculated MPE**

The power density limit for General Population/Uncontrolled Exposure at each frequency is determined based on the information in Table 1-1.

	FCC		ISED	
Frequency	2412	MHz	2412	MHz
Limit	1.000	mW/cm <sup>2</sup>	5.366	W/m <sup>2</sup>
Limit Distance (cm), R =	20.00	cm	0.20	m
Power (dBm), P =	23.50	dBm	23.50	dBm
Power (mW), P =	223.872	mW	0.224	W
Tx Ant Gain (dBi), G =	-4.4	dBi	-4.4	dBi
Power Density (S) at 20cm =	0.01617	mW/cm <sup>2</sup>	0.16171	W/m <sup>2</sup>
Minimum Distance =	2.54328	cm	0.03472	m

Table 1-3. Calculated MPE for WLAN

FCC ID: BCG-A2986 IC: 579C-A2986	element	element MAXIMUM PERMISSIBLE EXPOSURE REPORT		
Test Report S/N:	Test Dates:	EUT Type:	Page 6 of 13	
1C2305020014-18.BCG	6/7/2023 - 8/3/2023	Watch	Page 6 01 13	



	FCC		ISED	
Frequency	2441	MHz	2441	MHz
Limit	1.000	mW/cm <sup>2</sup>	5.410	W/m <sup>2</sup>
Limit Distance (cm), R =	20.00	cm	0.20	m
Power (dBm), P =	17.54	dBm	17.54	dBm
Power (mW), P =	56.754	mW	0.057	W
Tx Ant Gain (dBi), G =	-4.4	dBi	-4.4	dBi
Power Density (S) at 20cm =	0.00410	mW/cm <sup>2</sup>	0.04099	W/m <sup>2</sup>
Minimum Distance =	1.28054	cm	0.01741	m

Table 1-4. Calculated MPE for Bluetooth

	FCC		ISED	
Frequency	2441	MHz	2441	MHz
Limit	1.000	mW/cm <sup>2</sup>	5.410	W/m <sup>2</sup>
Limit Distance (cm), R =	20.00	cm	0.20	m
Power (dBm), P =	15.87	dBm	15.87	dBm
Power (mW), P =	38.637	mW	0.039	W
Tx Ant Gain (dBi), G =	-4.4	dBi	-4.4	dBi
Power Density (S) at 20cm =	0.00279	mW/cm <sup>2</sup>	0.02791	W/m <sup>2</sup>
Minimum Distance =	1.05656	cm	0.01436	m

Table 1-5. Calculated MPE for Bluetooth HDR

	FCC		ISED	
Frequency	2404	MHz	2404	MHz
Limit	1.000	mW/cm <sup>2</sup>	5.354	W/m <sup>2</sup>
Limit Distance (cm), R =	20.00	cm	0.20	m
Power (dBm), P =	17.48	dBm	17.48	dBm
Power (mW), P =	55.976	mW	0.056	W
Tx Ant Gain (dBi), G =	-4.4	dBi	-4.4	dBi
Power Density (S) at 20cm =	0.00404	mW/cm <sup>2</sup>	0.04043	W/m <sup>2</sup>
Minimum Distance =	1.27173	cm	0.01738	m

Table 1-6. Calculated MPE for Bluetooth LE

FCC ID: BCG-A2986 IC: 579C-A2986	element)	element MAXIMUM PERMISSIBLE EXPOSURE REPORT	
Test Report S/N:	Test Dates:	EUT Type:	Dogo 7 of 12
1C2305020014-18.BCG	6/7/2023 - 8/3/2023	Watch	Page 7 of 13



	FCC		ISED	
Frequency	5220	MHz	5220	MHz
Limit	1.000	mW/cm <sup>2</sup>	9.095	W/m <sup>2</sup>
Limit Distance (cm), R =	20.00	cm	0.20	m
Power (dBm), P =	17.00	dBm	17.00	dBm
Power (mW), P =	50.119	mW	0.050	W
Tx Ant Gain (dBi), G =	-11.6	dBi	-11.6	dBi
Power Density (S) at 20cm =	0.00069	mW/cm <sup>2</sup>	0.00690	W/m <sup>2</sup>
Minimum Distance =	0.52528	cm	0.00551	m

Table 1-7. Calculated MPE for UNII

	FCC		ISED	
Frequency	7987.2	MHz	7987.2	MHz
Limit	1.000	mW/cm <sup>2</sup>	10.000	W/m <sup>2</sup>
Limit Distance (cm), R =	20.00	cm	0.20	m
Power (dBm), P =	-11.94	dBm	-11.94	dBm
Power (mW), P =	0.0640	mW	0.0001	W
Tx Ant Gain (dBi), G =	-7.1	dBi	-7.1	dBi
Power Density (S) at 20cm =	0.000002	mW/cm <sup>2</sup>	0.00002	W/m <sup>2</sup>
Minimum Distance =	0.03151	cm	0.00032	m

Table 1-8. Calculated MPE for UWB

	FCC		ISED	
Frequency	60500	MHz	60500	MHz
Limit	1.000	mW/cm <sup>2</sup>	10.000	W/m <sup>2</sup>
Limit Distance (cm), R =	20.00	cm	0.20	m
Power (dBm), P =	3.94	dBm	3.94	dBm
Power (mW), P =	2.477	mW	0.002	W
Tx Ant Gain (dBi), G =	4.0	dBi	4.0	dBi
Power Density (S) at 20cm =	0.00124	mW/cm <sup>2</sup>	0.01238	W/m <sup>2</sup>
Minimum Distance =	0.70371	cm	0.00704	m

Table 1-9. Calculated MPE for 60.5GHz

FCC ID: BCG-A2986 IC: 579C-A2986	element)	element MAXIMUM PERMISSIBLE EXPOSURE REPORT	
Test Report S/N:	Test Dates:	EUT Type:	Page 8 of 13
1C2305020014-18.BCG	6/7/2023 - 8/3/2023	Watch	Page 6 01 13



	FCC		ISED	
Frequency	5728.75	MHz	5728.75	MHz
Limit	1.000	mW/cm <sup>2</sup>	9.692	W/m <sup>2</sup>
Limit Distance (cm), R =	20.00	cm	0.20	m
Power (dBm), P =	15.94	dBm	15.94	dBm
Power (mW), P =	39.264	mW	0.039	W
Tx Ant Gain (dBi), G =	-9.4	dBi	-9.4	dBi
Power Density (S) at 20cm =	0.00090	mW/cm <sup>2</sup>	0.00897	W/m <sup>2</sup>
Minimum Distance =	0.59896	cm	0.00608	m

Table 1-10. Calculated MPE for 802.15.4 ab-NB

	FCC		ISED	
Frequency	824.7	MHz	824.7	MHz
Limit	0.550	mW/cm <sup>2</sup>	2.577	W/m <sup>2</sup>
Limit Distance (cm), R =	20.00	cm	0.20	m
Power (dBm), P =	25.50	dBm	25.50	dBm
Power (mW), P =	354.813	mW	0.355	W
Tx Ant Gain (dBi), G =	-25.9	dBi	-25.9	dBi
Power Density (S) at 20cm =	0.00018	mW/cm <sup>2</sup>	0.00181	W/m <sup>2</sup>
Minimum Distance =	0.36332	cm	0.00531	m

Table 1-11. Calculated MPE for LTE (Low Band - B26)

	FCC		ISED	
Frequency	1914.3	MHz	1914.3	MHz
Limit	1.000	mW/cm <sup>2</sup>	4.582	W/m <sup>2</sup>
Limit Distance (cm), R =	20.000	cm	0.200	m
Power (dBm), P =	24.5	dBm	24.5	dBm
Power (mW), P =	281.838	mW	0.282	W
Tx Ant Gain (dBi), G =	-9.5	dBi	-9.5	dBi
Power Density (S) at 20cm =	0.00629	mW/cm <sup>2</sup>	0.06291	W/m <sup>2</sup>
Minimum Distance =	1.58633	cm	0.02343	m

Table 1-12. Calculated MPE for LTE (Mid Band - B2)

FCC ID: BCG-A2986 IC: 579C-A2986	element	element MAXIMUM PERMISSIBLE EXPOSURE REPORT	
Test Report S/N:	Test Dates:	EUT Type:	Page 9 of 13
1C2305020014-18.BCG	6/7/2023 - 8/3/2023	Watch	Page 9 01 13



	FCC		ISED	
Frequency	2502.5	MHz	2502.5	MHz
Limit	1.000	mW/cm <sup>2</sup>	5.503	W/m <sup>2</sup>
Limit Distance (cm), R =	20.00	cm	0.20	m
Power (dBm), P =	23.50	dBm	23.50	dBm
Power (mW), P =	223.872	mW	0.224	W
Tx Ant Gain (dBi), G =	-6.6	dBi	-6.6	dBi
Power Density (S) at 20cm =	0.00974	mW/cm <sup>2</sup>	0.09744	W/m <sup>2</sup>
Minimum Distance =	1.97422	cm	0.02661	m

Table 1-13. Calculated MPE for LTE (High Band - B7)

FCC ID: BCG-A2986 IC: 579C-A2986	element MAXIMUM PERMISSIBLE EXPOSURE REPORT		Approved by: Technical Manager
Test Report S/N:	Test Dates:	EUT Type:	Page 10 of 13
1C2305020014-18.BCG	6/7/2023 - 8/3/2023	Watch	Page 10 of 13



# **Summary of Results**

	Power Density (mW/cm²)	Limit (mW/cm²)	Percent MPE Used (%)
Transmitter #1 WLAN	0.016171	1.000000	1.617071
Transmitter #2 Bluetooth	0.004099	1.000000	0.409948
Transmitter #3 Bluetooth HDR	0.002791	1.000000	0.279080
Transmitter #4 Bluetooth LE	0.004043	1.000000	0.404324
Transmitter #5 UNII	0.000690	1.000000	0.068981
Transmitter #6 UWB	0.000002	1.000000	0.000248
Transmitter #7 60.5GHz	0.001238	1.000000	0.123802
Transmitter #8 802.15.4 ab-NB	0.000897	1.000000	0.089687
Transmitter #9 LTE - Low Band	0.000181	0.549800	0.033001
Transmitter #10 LTE - Mid Band	0.006291	1.000000	0.629114
Transmitter #11 LTE - High Band	0.009744	1.000000	0.974382
Total			4.62964

**Table 1-14. FCC Cumulative Results for Multiple Transmitters** 

FCC ID: BCG-A2986 IC: 579C-A2986	element MAXIMUM PERMISSIBLE EXPOSURE REPORT		Approved by: Technical Manager
Test Report S/N:	Test Dates:	EUT Type:	Dogo 11 of 12
1C2305020014-18.BCG	6/7/2023 - 8/3/2023	Watch	Page 11 of 13



	Power Density (W/m²)	Limit (W/m²)	Percent MPE Used (%)
Transmitter #1 WLAN	0.161707	5.366018	3.013540
Transmitter #2 Bluetooth	0.040995	5.410026	0.757757
Transmitter #3 Bluetooth HDR	0.027908	5.410026	0.515858
Transmitter #4 Bluetooth LE	0.040432	5.353849	0.755202
Transmitter #5 UNII	0.006898	9.094766	0.075847
Transmitter #6 UWB	0.000025	10.000000	0.000248
Transmitter #7 60.5GHz	0.012380	10.000000	0.123802
Transmitter #8 802.15.4 ab-NB	0.008969	9.691558	0.092541
Transmitter #9 LTE - Low Band	0.001814	2.577105	0.070404
Transmitter #10 LTE - Mid Band	0.062911	4.582064	1.372992
Transmitter #11 LTE - High Band	0.097438	5.502808	1.770699
Total			8.54889

Table 1-15. ISED Cumulative Results for Multiple Transmitters

FCC ID: BCG-A2986 IC: 579C-A2986	element MAXIMUM PERMISSIBLE EXPOSURE REPORT		Approved by: Technical Manager
Test Report S/N:	Test Dates:	EUT Type:	Page 12 of 13
1C2305020014-18.BCG	6/7/2023 - 8/3/2023	Watch	Page 12 01 13



### 2.0 CONCLUSION

The device's 60.5GHz transmitter meets the mobile RF exposure limit at a 20cm separation distance as specified in §2.1091 of the FCC Rules and Regulations and Health Canada Safety Code 6. An appropriate RF exposure compliance statement will be placed in the user's manual.

FCC ID: BCG-A2986 IC: 579C-A2986	element	element MAXIMUM PERMISSIBLE EXPOSURE REPORT	
Test Report S/N:	Test Dates:	EUT Type:	Dogo 12 of 12
1C2305020014-18.BCG	6/7/2023 - 8/3/2023	Watch	Page 13 of 13