

RF Exposure Analysis

Revision 2

FCC ID **2APZQ- ZYGO**
Description: **Zygo Underwater Communication Radio**
Model Name: **Zygo**
Model Number: **ZY100**

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TYPE CERTIFICATION

Table of Contents

Introduction.....	2
Product Description	2
Zygo Radios	2
FCC Requirements.....	2
ISED Canada Requirements	3
Product Analysis	4
Bluetooth Radio	4
Low Frequency Radio.....	5
Simultaneous Transmission	5
Conclusion	5

Introduction

This memo evaluates the Zygo system coach's unit for RF exposure testing exclusion to the FCC USA and ISED Canada Requirements.

Product Description

The Swimmersive Zygo is a communication system for swimmers and swimming coaches. The Zygo system has 2 components. A transmitter to stream music to swimmers or for a coach to talk to his swimmers, called the Zygo Coach's Unit. A headset, that only receives, worn by the swimmers, called the Zygo Headset.

It's primary use is to stream music to swimmers as they work out. It also allows a coach to give instructions to swimmers as they work out. When coach's use the unit to give instructions the unit operates push-to-talk (PTT) and the Bluetooth link is not active. In this mode the unit is handheld.

The Zygo transmitter operates in the 174-216 MHz and 2.4 GHz ISM bands.

The unit is battery powered.

Zygo Radios

The Zygo system coach's unit has two radios, a Bluetooth radio, operating in the 2.4 GHz ISM band, and the low frequency transmitter to the headset, that operates in the 174-216 MHz band.

The Bluetooth channel with the highest measured power is the low channel at 2402 MHz with a measured power of 11.0 mW (10.4 dBm).

The low frequency radio channel with the highest measured power is its low channel at 176 MHz with a measured power of 67.3 mW (18.3 dBm). When used by a swimming coach the low frequency radio is a push-to-talk device.

The low frequency radio has a duty cycle of transmission for 3.4 mS followed by a 1.0 mS off time. This calculates to a duty cycle of 5.3 dB.

FCC Requirements

FCC KDB 447498 D01 V06 section 4.3 gives SAR test exclusion guidance:

4.3. General SAR test exclusion guidance

4.3.1. Standalone SAR test exclusion considerations

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- a) For 100 MHz to 6 GHz and *test separation distances* ≤ 50 mm, the 1-g and 10-g *SAR test exclusion thresholds* are determined by the following:

$$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f_{(\text{GHz})}}] \leq 3.0 \text{ for 1-g SAR, and } \leq 7.5 \text{ for 10-g extremity SAR,}^{30} \text{ where}$$

- $f_{(\text{GHz})}$ is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation³¹
- The result is rounded to one decimal place for comparison
- The values 3.0 and 7.5 are referred to as *numeric thresholds* in step b) below

The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm, and for transmission frequencies between 100 MHz and 6 GHz. When

the minimum test separation distance is < 5 mm, a distance of 5 mm according to 4.1 f) is applied to determine SAR test exclusion.

- b) For 100 MHz to 6 GHz and test separation distances > 50 mm, the 1-g and 10-g SAR test exclusion thresholds are determined by the following (also illustrated in Appendix B):
- 1) {[Power allowed at numeric threshold for 50 mm in step a)] + [(test separation distance – 50 mm)·(f(MHz)/150)]} mW, for 100 MHz to 1500 MHz
 - 2) {[Power allowed at numeric threshold for 50 mm in step a)] + [(test separation distance – 50 mm)·10]} mW, for > 1500 MHz and ≤ 6 GHz

The formula can be used to calculate the maximum allowable power. The power of interest is the source-based time-averaged maximum conducted output power of the RF channel.

The formula for the maximum allowable power, based on the guidance of section 4.3 in the KDB, is:

$$P = T \cdot D / \sqrt{f}$$

- P is the source based time-averaged maximum conducted output power in mW
- T is the numeric thresholds of 3.0 and 7.5
- D is the minimum separation distance in m
- f is the RF channel transmit frequency in GHz

For the highest frequency used, 2.48 GHz:

- for a numeric threshold of 3.0 the maximum power is 9.6 mW
- for a numeric threshold of 7.5 the maximum power is 23.8 mW

ISED Canada Requirements

Canadian regulation for RF exposure are contained in Spectrum Management and **Telecommunications Radio Standards Specification RSS-102 Issue 5, March 2015, Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)**. Section 2.5.1, Exemption Limits for Routine Evaluation – SAR Evaluation, provides the following exclusion limits:

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of ≤5 mm	At separation distance of 10 mm	At separation distance of 15 mm	At separation distance of 20 mm	At separation distance of 25 mm
≤300	71 mW	101 mW	132 mW	162 mW	193 mW
450	52 mW	70 mW	88 mW	106 mW	123 mW
835	17 mW	30 mW	42 mW	55 mW	67 mW
1900	7 mW	10 mW	18 mW	34 mW	60 mW
2450	4 mW	7 mW	15 mW	30 mW	52 mW
3500	2 mW	6 mW	16 mW	32 mW	55 mW
5800	1 mW	6 mW	15 mW	27 mW	41 mW

The values listed are for a 1 gram tissue value. If a device is worn on a limb and subject to the 10 gram value the values in the table are multiplied by 2.5:

For limb-worn devices where the 10 gram value applies, the exemption limits for routine evaluation in Table 1 are multiplied by a factor of 2.5.

Hence for a device operating in the 2.4 GHz ISM band the exemption limits are 4 mW and 10 mW for a 5 mm separation distance. However, the Zygo antenna has an 8 mm separation distance, which allows a slightly higher power from the Bluetooth radio.

Product Analysis

Bluetooth Radio

The Bluetooth antenna is located 8 mm from the outside edge of the unit's case, as can be seen in Figure 1. Hence, 8 mm is the closest the antenna can come to the user.

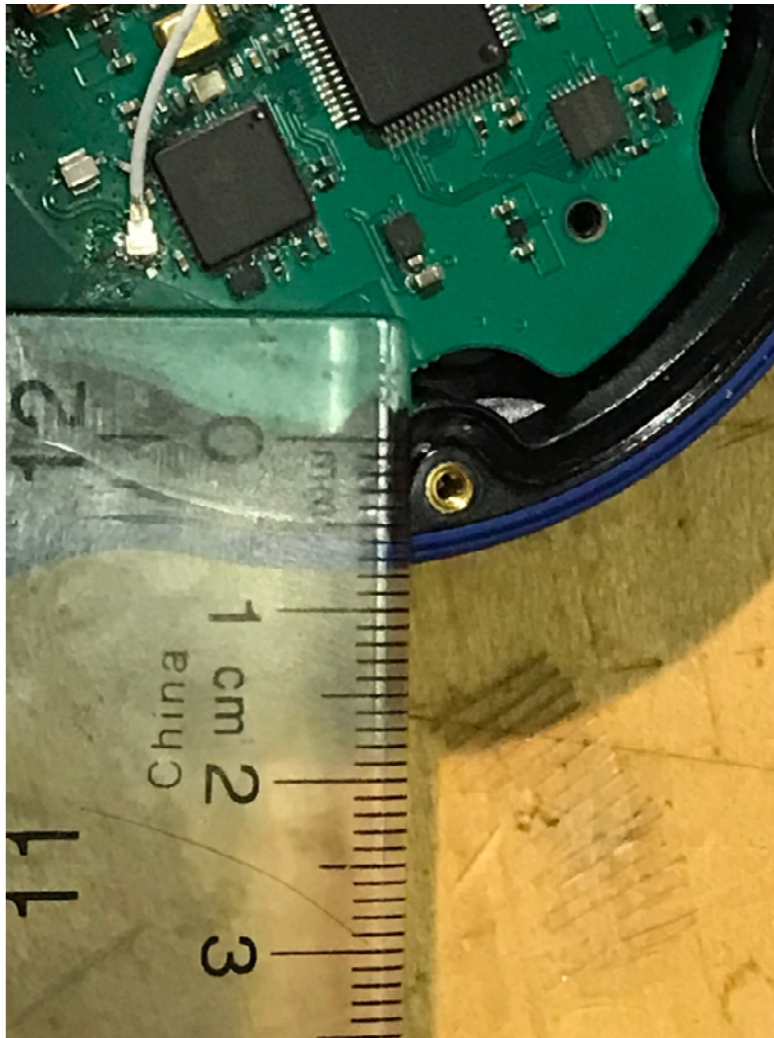


Figure 1 – There is an 8 mm spacing between the Bluetooth antenna and the unit enclosure

Using the formula:

$$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 7.5$$

The worst-case channel calculates to be 2.6 W/kg, below the FCC threshold of 7.5.

Low Frequency Radio

The low frequency radio has a 5.3 dB duty cycle. It calculates to the FCC formula as having 6.83 W/kg, without duty cycle considerations. It meets both the FCC and ISED test exclusion criterion.

Simultaneous Transmission

Simultaneous transmission of both radios is dominated by the larger power of the low frequency radio and remains under the test exemption threshold.

Conclusion

This analysis concludes that both radios in the Zygo coach's unit are below the test exemption threshold and do not require SAR testing.