



Maximum Permissible Exposure Evaluation

For the
Mueller Systems
RFDC Radio Module (FCC ID: SM6-RFDC)
when co-located with the
Proflex 2.4GHz Zigbee Module (FCC ID: TFB-PROFLEX1)

July 29, 2011
WLL Report: 11709-MPE

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Testing Certificate AT-1448

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Abstract

This report has been prepared on behalf of Mueller Systems RFDC Radio Module to document the findings of the maximum permissible exposure evaluation on the Mueller Systems RFDC Radio Module. The purpose of this evaluation is to establish a minimum safe distance as per the RF exposure requirements as defined in FCC §1.1307 & §1.1310.

This report documents the results of testing to the requirements of:

- CFR Title 47 Volume 1 Practice and Procedure; (1.1307) Environmental Assessments

The Evaluation was performed by Washington Laboratories, Ltd, 7560 Lindbergh Drive, Gaithersburg, MD 20879. Washington Laboratories, Ltd. has been accepted as an EMC Conformity Assessment Body (CAB) under the United States/European Union Memorandum of Agreement. Washington Laboratories, Ltd. is accredited by ACLASS under Testing Certificate AT-1448.

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1 Introduction

This report has been prepared on behalf of Mueller Systems RFDC Radio Module Transmitter to show compliance with the RF exposure requirements as defined in FCC §1.1307.

Testing supporting this evaluation was performed at Washington Laboratories, Ltd, 7560 Lindbergh Drive, Gaithersburg, MD 20879. Washington Laboratories, Ltd. has been accepted as an EMC Conformity Assessment Body (CAB) under the United States/European Union Memorandum of Agreement. Washington Laboratories, Ltd. is accredited with ACLASS under Testing Certificate AT-1448.

2 Requirements

Three different categories of transmitters are defined by the FCC in OET Bulletin 65. These categories are fixed installation, mobile, and portable. Additionally, the FCC categorizes the use of the devices based on the user's awareness and the ability to exercise control over his or her exposure. The two categories are defined as Occupational/Controlled Exposure and General Population/Uncontrolled Exposure.

2.1 Transmitter Categories

2.1.1 Fixed Installations

A 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.

2.1.2 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.

2.1.3 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).

2.2 Exposure Categories

The limits for exposure are determined by the type of situation the individual is exposed to. Table 1 lists the limits for the particular environment.

2.2.1 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.

2.2.2 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.

Table 1: MPE Limits

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 Exposures				
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	6
300–1500	N/A	N/A	f/300	6
1500–100,000	N/A	N/A	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
300–1500	N/A	N/A	f/1500	30
1500–100,000	N/A	N/A	1	30

3 Device Summary

Table 1 below summarizes the criteria used to evaluate the RFDC Radio Module.

Table 2: Device Summary of the RFDC Radio Module

Model Evaluated:	RFDC Radio Module & Proflex Zigbee module when co-located
Transmitter Category:	Mobile
Exposure Category:	Limits for General Population/Uncontrolled Exposure
Antenna Gain:	2.5dBi omni whip antenna (RFDC) , 4.83 dBi trace antenna (Proflex1)
Power Output (dBm):	29.8dBm (955mW) RFDC, 19.95dBm (98.9mW) Proflex1
Evaluation Distance:	20cm
Frequency Range:	902.5-927MHz (RFDC), 2405-2475 (proflex1)
Limit:	0.602 mW/cm ² (RFDC), 1.000mW/cm ² (Proflex1)

4 Radio Frequency Radiation Exposure Evaluation

The highest RF output power of the unit was measured and recorded. According to §1.1310 of the FCC rules, the power density limit for General Population/Uncontrolled Exposure is f/1500 mW/cm².

The MPE shall be calculated at 20cm to show compliance with the power density limit. The following formula was used to calculate the Power Density:

$$S = \frac{PG}{4\pi R^2}$$

Where:

S = Power Density

P = Output Power at the Antenna Terminals

G = Gain of Transmit Antenna (linear gain-isotropic)

R = Distance from Transmitting Antenna

Table 3: Transmitter MPE Calculation Summary

One Transmitter

Frequency	902.5	MHz
Limit	0.602	mW/cm ²
Distance (cm), R =	20	cm
Power (dBm), P =	29.8	dBm
TX Ant Gain (dBi), G =	2.5	dB
Power Density:	0.34	mW/cm ² Separation<20 cm
Minimum Distance:	15.0	cm

Second Transmitter

Frequency	2405	MHz
Limit	1.000	mW/cm ²
Distance (cm), R =	20	cm
Power (dBm), P =	19.95	dBm
TX Ant Gain (dB), G =	4.83	dB
Power Density:	0.06	mW/cm ² Separation<20 cm
Minimum Distance:	4.9	cm

Multiple Transmitter Summary

Power Density:	0.62	mW/cm ² Separation<20 cm
Minimum Distance:	19.9	cm Sum of the Distances

Transmitter	Power Density (mW/cm ²)	Limit (mW/cm ²)	Percent of MPE used (%)
#1 – 902-928 Band	0.34	0.602	56.48
#2- Zigbee	0.06	1.000	6.00
Total			62.48

From the above table the RFDC module and the Proflex module when co-located with their radiating elements located within 20cm of each other meets the MPE requirements at a minimum of 19.9cm separation from the user for a mobile device. The user manual for devices containing this combination of radios must state this distance.