

## Summary

TREQ – SAR assessment	
Project	64 – MBR100/MBR105
Prepared by	Stéphane Caron, Eng.
Tested by	Stéphane Caron, Eng.
Reviewed by	Marc Chouinard, Eng.
Test Result	Pass
Date	2015-12-07

### Purpose of the test

Verify that the MBR100/MBR105 products do not exceed the SAR (Specific Absorption Rate) rating.

### Methodology

Evaluate what is the distance between the antenna and the body and then compare the RF output power of the MBR100/MBR105 with the SAR test exclusion thresholds.

### Acceptance criteria

In order to eliminate the need for SAR testing, the RF output power must be below the SAR test exclusion thresholds according to the FCC, IC, and CE requirements.

### Test Result

The RF output power is below the SAR test exclusion thresholds. Time averaged output power in the FCC/IC band can be considered to be 0.80 mW and is under the FCC limit of 40mW or the IC limit of 15mW. The output power in the CE band can be considered 16.90mW and is under the 40mW applicable limit



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## Signatures

The following undersigned have reviewed, verified, and approve the analysis and test results. They testify to the best of their knowledge that the following data was collected in accordance to the described test procedures and setup, test equipment lists and test unit lists, and that the measurement procedures utilized good laboratory technique.

Signature:

A handwritten signature in blue ink, reading 'Stéphane Caron, Eng.', written over a horizontal line.

Name:

Stéphane Caron, Eng.  
OIQ Engineer Member #: 123315

Title:

Software Engineer

Date:

2015/12/07

Signature:

A horizontal line intended for a signature.

Name:

Marc Chouinard, Eng.  
OIQ Engineer Member #: 5018648

Title:

Technical Team Leader

Date:

2015/12/07

## 1 SAR exclusion assessment

### 1.1.1 Introduction

This analysis verifies if the MBR100/MBR105 output power is under the SAR exclusion levels.

### 1.1.2 Analysis of the distance between the antenna and the body

The following pictures show the typical way that the operator will hold the MBR100 in his hands.



Figure 1 - Typical utilisation, front view



Figure 2 - Typical utilisation, rear view

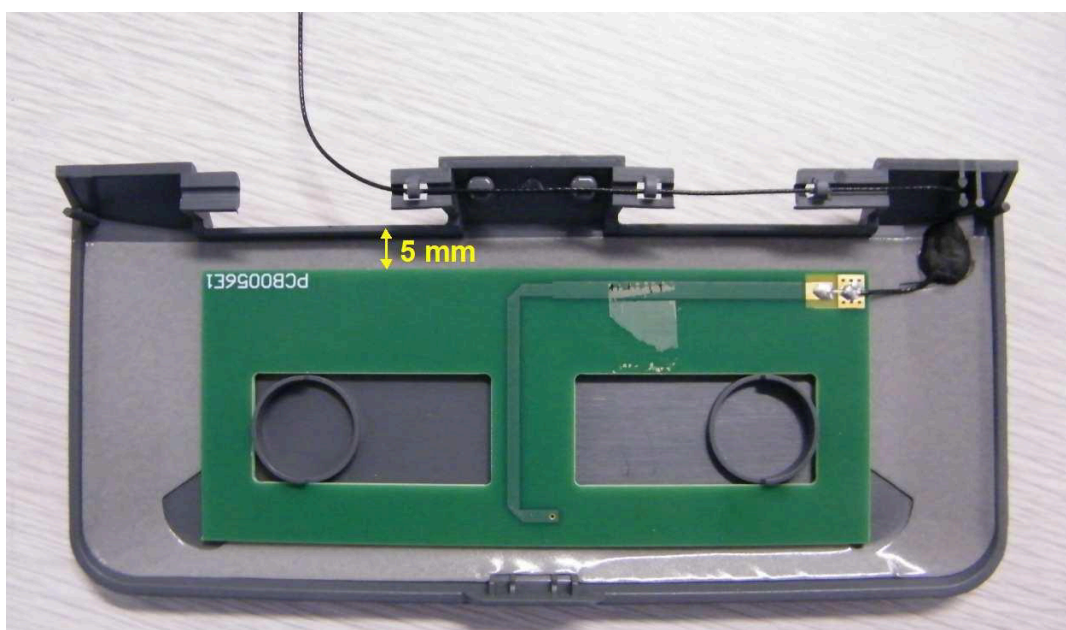


Figure 3 - Antenna position inside the lid



Figure 4 – Another possible position: unit held by the antenna compartment

The distance between the fingers and the edge of the lid assembly are shown on Figure 1 and Figure 2. The shortest distance measured for this typical utilisation is 20 mm. There is a distance between the edge of the lid assembly and the edge of the antenna of 5 mm, as shown on Figure 3.

By adding the shortest distance or the finger from the lid edge with the distance of the antenna with the lid edge, we get a distance of 25 mm for a typical scenario.

Even if it is not the easy way to hold the MBR10x, nothing prevents the user to hold the MBR100 directly by the lid containing the antenna, as shown in the Figure 4. In that case, the distance between the antenna and the hand is about 2 mm.



### 1.1.3 SAR exclusion assessment according to FCC

The radio of the MBR100/MBR105 units is configured with the RF power setting at 13 dBm.

In the operating frequency range of 903 MHz to 927 MHz, the maximum output power is 11.72 dBm according to the measurements taken by Nemko, Inc [1]

The power in mW can be obtained using the equation below:

$$mW = 10^{\left(\frac{dBm}{10}\right)}$$

Using the equation, it is possible to observe that the maximum measured output power in the FCC/IC band is 14.86 mW.

By referring to the section 4.2.3 of “447498 D01 General RF Exposure Guidance v05r01” [2] on page 10, we can see that because the MBR10x is held in the hands, we must use the “10-g extremity SAR Test Exclusion Thresholds”

At section 4.3.1, point 1 [2], it is stated that if the distance is < 5 mm, a distance of 5 mm is applied for SAR test exclusion.

By referring to the Appendix A of “447498 D01 General RF Exposure Guidance v05r01” [2], p. 26 (see Figure 5), we can see in the note (surrounded in blue) that the 10-g Extremity SAR Test Exclusion Power Thresholds are 2.5 times higher than the 1-g SAR Test Exclusion Thresholds indicated in the table.



## Appendix A

### SAR Test Exclusion Thresholds for 100 MHz – 6 GHz and ≤ 50 mm

Approximate SAR Test Exclusion Power Thresholds at Selected Frequencies and Test Separation Distances are illustrated in the following Table. The equation and threshold in section 4.3.1 must be applied to determine SAR test exclusion.

MHz	5	10	15	20	25	mm
150	39	77	116	155	194	SAR Test Exclusion Threshold (mW)
300	27	55	82	110	137	
450	22	45	67	89	112	
835	16	33	49	66	82	
900	16	32	47	63	79	
1500	12	24	37	49	61	
1900	11	22	33	44	54	
2450	10	19	29	38	48	
3600	8	16	24	32	40	
5200	7	13	20	26	33	
5400	6	13	19	26	32	
5800	6	12	19	25	31	
MHz	30	35	40	45	50	mm
150	232	271	310	349	387	SAR Test Exclusion Threshold (mW)
300	164	192	219	246	274	
450	134	157	179	201	224	
835	98	115	131	148	164	
900	95	111	126	142	158	
1500	73	86	98	110	122	
1900	65	76	87	98	109	
2450	57	67	77	86	96	
3600	47	55	63	71	79	
5200	39	46	53	59	66	
5400	39	45	52	58	65	
5800	37	44	50	56	62	

**Note:** 10-g Extremity SAR Test Exclusion Power Thresholds are 2.5 times higher than the 1-g SAR Test Exclusion Thresholds indicated above. These thresholds do not apply, by extrapolation or other means, to occupational exposure limits.

Figure 5 - Extract from the FCC standard

For a distance of 5mm, we can see in Figure 5 that a power threshold of 16 mW is allowed.

That 16 mW must be multiplied by 2.5, so up to 40 mW is allowed.

As the MBR100/MBR105 units transmit data intermittently, the output power may be reduced according to the section 6.3 of “447498 D01 General RF Exposure Guidance v05r01”. [2]

The MBR100/MBR105 has a worst case duty cycle of 5.36% [3], so  $14.86 \text{ mW} \times 5.36\% = 0.80 \text{ mW}$ .



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In summary, we see that the allowed RF output power is 40 mW and the MBR100/MBR105 output power with duty cycle correction applied is 0.80 mW. Thus, because 0.80 mW is below the power threshold of 40 mW, the MBR10x is below the threshold of SAR test.

#### 1.1.4 SAR exclusion assessment according to IC

The radio of the MBR100/MBR105 units is configured with the RF power setting at 13 dBm.

In the operating frequency range of 903 MHz to 927 MHz, the maximum output power is 11.72 dBm according to the measurements taken by Nemko, Inc [1]

The power in mW can be obtained using the equation below:

$$mW = 10^{\left(\frac{dBm}{10}\right)}$$

Using the equation, it is possible to observe that the maximum measured output power in the FCC/IC band is 14.86 mW.

By referring to the table 1 on page 4 of “RSS-102 Issue 5” [4] (see Figure 6), we can see that if the distance is < 5 mm, a power threshold of 17 mW is allowed for a frequency of 835 MHz.

Interpolating the limits for a frequency of 927 MHz results in approximate limit between 15 and 16 mW [5]

As the MBR10x units transmit data intermittently, the output power may be reduced according to the section 3.1 of “RSS-102 Issue 5”. [4]

The MBR100/MBR105 has a worst case duty cycle of 5.36% [3], so 14.86 mW X 5.36% = 0.80 mW.

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

Figure 6 – Extract from the IC standard

In summary, we see that the allowed RF output power is 15 mW (considering interpolation) and the MBR100/MBR105 output power with duty cycle correction applied is 0.80 mW. Thus, because 0.80 mW is below the power threshold of 15 mW, the MBR100/MBR105 is below the threshold of SAR test.



### 1.1.5 SAR exclusion assessment according to CE

The radio of the MBR100/MBR105 units is configured with the RF power setting at 13 dBm in the CE frequency band.

In the operating frequency range of 868 MHz to 869 MHz, the maximum output power is 12.28 dBm according to the measurements taken by Nemko, Inc. [6]

The power in mW can be obtained using the equation below:

$$mW = 10^{\left(\frac{dBm}{10}\right)}$$

Using the equation, it is possible to observe that the maximum measured output power in the CE band is 16.90 mW.

From the harmonised standard IEC 62479:2010 [7] we see in Annex A, Table A.1, that there are two guidelines/standards that apply; the ICNIRP guideline [8] and the IEEE C95.1-2005 standard [9](we consider that IEEE Std C95.1-1999 takes precedence over C95.1-2005).

According to the ICNIRP guideline, the applicable exposure tier for the MBR100/MBR105 products is "General public". The products are not offered to the general public, however, it is not possible to consider that the end users are trained to be aware of the potential risks and take the appropriate precautions. The applicable region of body is "limbs" as explained in the analysis above.

According to the IEEE C95.1-2005 standard, the applicable exposure tier is "Action level". Implementation of a RF safety program or including RF safety caution indications in the manual must be avoided. The applicable region of body is "Extremities and pinna" as explained in the analysis above.

ICNIRP and IEEE have specific restrictions on exposure to pulsed fields. The ICNIRP guidelines have a basic restriction on 6-minute time-averaged SAR. It is possible to consider a maximum 5.36% transmitter output duty cycle on a 6 minute period.

However, without considering the time-averaging effects, the maximum allowed power according the ICNIRP guideline and the IEEE C95.1-2005 standard is 40mW. The MBR100/MBR105 output power is thus under the maximum allowed threshold.

Guideline / Standard	SAR limit, $SAR_{max}$ W/kg	Averaging mass, $m$ g	$P_{max}$ mW	Exposure tier <sup>a</sup>	Region of body <sup>a</sup>
ICNIRP [1]	2	10	20	General public	Head and trunk
	4	10	40	General public	Limbs
	10	10	100	Occupational	Head and trunk
	20	10	200	Occupational	Limbs
IEEE Std C95.1-1999 [2]	1,6	1	1,6	Uncontrolled environment	Head, trunk, arms, legs
	4	10	40	Uncontrolled environment	Hands, wrists, feet and ankles
	8	1	8	Controlled environment	Head, trunk, arms, legs
	20	10	200	Controlled environment	Hands, wrists, feet and ankles
IEEE Std C95.1-2005 [3]	2	10	20	Action level	Body except extremities and pinnae
	4	10	40	Action level	Extremities and pinnae
	10	10	100	Controlled environment	Body except extremities and pinnae
	20	10	200	Controlled environment	Extremities and pinnae
<sup>a</sup> Consult the appropriate standard for more information and definitions of terms.					

Figure 7 - Extract from the CE standard



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### 1.1.6 Conclusion

The product is excluded from SAR test because the RF output power is below the SAR test threshold.

The Table 1 presents the test results:

Tested by	Stéphane Caron, Eng.
Acceptance Criteria	In order to eliminate the need for SAR testing, the RF output power must be below the SAR test exclusion thresholds according to the FCC, IC, and CE requirements.
Test Result	The RF output power is below the SAR test exclusion thresholds. Time averaged output power in the FCC/IC band can be considered to be 0.80 mW and is under the FCC limit of 40mW or the IC limit of 15mW. The output power in the CE band can be considered 16.90mW and is under the 40mW applicable limit
Pass / Fail	Pass
Date	2015-12-03

Table 1: Test Result

## 2 Revision History

Rev.	Date	Responsible	Description of change	Revised page(s)
00	2015-11-27	Stéphane Caron, Eng.	Creation	All
01	2015-12-01	Stéphane Caron, Eng.	Add 10-g results, duty cycle, measured output power	All
02	2015-12-03	Stéphane Caron, Eng.	Add suggested corrections from Marc C. and add section for Industry Canada	All
03	2015-12-07	Stéphane Caron, Eng.	Add suggested corrections from Marc C.	All

### 3 Bibliography

- [1] Nemko, "284333-2TRFWL (fcc-15.247 and rss-247)," 2015-11.
- [2] FCC, "447498 D01 General RF Exposure Guidance v05r01 - Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies," 28 5 2013. [Online]. [Accessed 01 12 2015].
- [3] LSI, "MBR100-105 Duty Cycle Mod-Nemko," 2015-11-11.
- [4] Industry Canada, RSS-102 Issue 5, March 2015.
- [5] LSI, "Extrapolation of IC SAR exemption limits," 2015-12-04.
- [6] Nemko, "284333-1TRFWL (EN 300-220-2)," 2015-11-17.
- [7] IEC, IEC 62479:2010, Assesment of the compliance of low-power electronic and electrical equipment with the basic restrictions related to human exposure to electromagnetic fields (10 MHz to 300 GHz).
- [8] ICNIRP, "Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz)," *Health Physics*, vol. 74, pp. 494-522, 1998.
- [9] IEEE, C95.1-2005, IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.