

RF Exposure Report

For

IM21-PRT RFID Module

Version 2.0

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Report Revision History

REVISION HISTORY			
Date	Document Version	Revision Description	Author
22-10-2024	1.0	Initial Issue of Test Report	Lavanya M
11-11-2024	2.0	TCB - Review Comments updated	Lavanya M

RF Exposure Assessment

The limit for Maximum Permissible Exposure (MPE) specified in FCC 1.1310 and RSS 102, Issue 6 Section 2.5.2 is followed. The gain of the antennas used in the product is extracted from the Antenna data sheets provided and the maximum total power input to the antenna is measured. Through the Friis transmission formula and the maximum gain of the antenna, we can calculate the distance, away from the product, where the limit of MPE is reached.

Although the Friis Transmission formula is far field assumption, the calculated result of that is an over-prediction for near field power density. It is taken as worst case to specify the safety range.

According to FCC 1.1310: The criteria listed in the following table shall be used to evaluate the environmental impact of the human exposure to radiofrequency (RF) radiation as specified in 1.1307 (b) showed in Table 1. And as per the RSS 102, Issue 6, Section 2.5.2 the MPE limits mentioned in Table

Limit for MPE as per FCC			
Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)
Limits for Occupational / controlled Exposures			
300 - 1500	F/300
1500 – 100000	5.0
Limits for General population / Uncontrolled Exposure			
300 - 1500	F/1500
1500 – 100000	1.0
F or f = Frequency in MHz			

Limit for MPE as per ISSED
<ul style="list-style-type: none"> at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum EIRP of the device is equal to or less than $1.31 \times 10^{-2} f^{0.6834} W$ (adjusted for tune-up tolerance), where f is in MHz
F or f = Frequency in MHz

Friss Formula

Friss Transmission Formula: $P_d = (P_{out} * G) / (4 * \pi * r^2)$

Where

P_d = power density in mW/cm²

P_{out} = output power to antenna in mW

G = gain of antenna in linear scale

π = 3.1416

R = Distance between observation point and the center of radiator in cm

If we know the maximum gain of the antenna and the total output power to the antenna, through calculation, we will know MPE value at distance 20cm.

EUT Operating Condition

EUT was enabled to transmit and receive at lowest, middle and highest channels.

EUT Classification for RF Exposure Evaluation

The antenna of this product, under normal use condition, is at least 20cm away from the body of the user. Warning statement to the user for keeping at least 20cm or more separation distance from the antenna should be included in the User manual. So, this device is classified as fixed device.

Antenna Details

Sl. No	Coupler	Design	Make	Model	Max Gain (dBi)
1	PCB – RFID Coupler	Microstrip line fed aperture coupler	Laird Technologies*	MAF95123-1 / 234-079-0600	-19.3
		Microstrip line fed aperture coupler	Laird Technologies*	1-971140-001	-24.2
2		Microstrip line fed aperture coupler	Unictron Technologies*	H2B1JH1A1H0200 / 710000068100	-23.0
3		Loop aperture coupler	Honeywell	LUPUS14V2	-14.0
4		stripline coupler	Honeywell	LUPUS32	-27.2
5		Loop aperture coupler	Honeywell	CORVUS10	-20.5

Assessment / Results

Type of Communication / Protocol : RFID EPC Class 1, ISO 18000-6C
Duty cycle considered for Assessment / Evaluation is 100 %

FCC MPE Evaluation :

RFID Coupler 1 : MAF95123-1 / 234-079-0600

Antenna Gain (dBi)	Antenna Gain Linear Scale	Channel Frequency (MHz)	Maximum Output Power (dBm)	Tune-up Tolerance (dB)	Max Power including Tune up (mW)	Power Density (mW/cm ²)	FCC Limit (mW/cm ²)
-19.3	0.011748976	927.250	29.35	± 0.5	966.050	0.002258	0.618

RFID Coupler 2 : 1-971140-001

Antenna Gain (dBi)	Antenna Gain Linear Scale	Channel Frequency (MHz)	Maximum Output Power (dBm)	Tune-up Tolerance (dB)	Max Power including Tune up (mW)	Power Density (mW/cm ²)	FCC Limit (mW/cm ²)
-24.2	0.003801894	927.250	29.35	± 0.5	966.050	0.000730683	0.618

RFID Coupler 3 : H2B1JH1A1H0200 / 710000068100

Antenna Gain (dBi)	Antenna Gain Linear Scale	Channel Frequency (MHz)	Maximum Output Power (dBm)	Tune-up Tolerance (dB)	Max Power including Tune up (mW)	Power Density (mW/cm ²)	FCC Limit (mW/cm ²)
-23.0	0.005011872	927.250	29.35	± 0.5	966.050	0.000963228	0.618

RFID Coupler 4 : LUPUS14V2

Antenna Gain (dBi)	Antenna Gain Linear Scale	Channel Frequency (MHz)	Maximum Output Power (dBm)	Tune-up Tolerance (dB)	Max Power including Tune up (mW)	Power Density (mW/cm ²)	FCC Limit (mW/cm ²)
-14.0	0.039810717	927.250	29.35	± 0.5	966.050	0.007651193	0.618

RFID Coupler 5 : LUPUS32

Antenna Gain (dBi)	Antenna Gain Linear Scale	Channel Frequency (MHz)	Maximum Output Power (dBm)	Tune-up Tolerance (dB)	Max Power including Tune up (mW)	Power Density (mW/cm ²)	FCC Limit (mW/cm ²)
-27.2	0.001905461	927.250	29.35	± 0.5	966.050	0.000366209	0.618

RFID Coupler 6 : CORVUS10

Antenna Gain (dBi)	Antenna Gain Linear Scale	Channel Frequency (MHz)	Maximum Output Power (dBm)	Tune-up Tolerance (dB)	Max Power including Tune up (mW)	Power Density (mW/cm ²)	FCC Limit (mW/cm ²)
-20.5	0.008912509	927.250	29.35	± 0.5	966.050	0.001712889	0.618

ISED MPE Evaluation :

RFID Coupler 1 : MAF95123-1 / 234-079-0600

Antenna Gain (dBi)	Channel Frequency (MHz)	Maximum Output Power (dBm)	Tune-up Tolerance (dB)	Max Conducted Power including Tune up Tolerance	E.I.R.P (dBm)	EIRP (Watts)	ISED EIRP Limit (Watts)
-19.3	927.250	29.35	± 0.5	29.85	10.55	0.011350	1.39

RFID Coupler 2 : 1-971140-001

Antenna Gain (dBi)	Channel Frequency (MHz)	Maximum Output Power (dBm)	Tune-up Tolerance (dB)	Max Conducted Power including Tune up Tolerance	E.I.R.P (dBm)	EIRP (Watts)	ISED EIRP Limit (Watts)
-24.2	927.250	29.35	± 0.5	29.85	5.65	0.00367	1.39

RFID Coupler 3 : H2B1JH1A1H0200 / 710000068100

Antenna Gain (dBi)	Channel Frequency (MHz)	Maximum Output Power (dBm)	Tune-up Tolerance (dB)	Max Conducted Power including Tune up Tolerance	E.I.R.P (dBm)	EIRP (Watts)	ISED EIRP Limit (Watts)
-23.0	927.250	29.35	± 0.5	29.85	6.85	0.00484	1.39

RFID Coupler 4 : LUPUS14V2

Antenna Gain (dBi)	Channel Frequency (MHz)	Maximum Output Power (dBm)	Tune-up Tolerance (dB)	Max Conducted Power including Tune up Tolerance	E.I.R.P (dBm)	EIRP (Watts)	ISED EIRP Limit (Watts)
-14.0	927.250	29.35	± 0.5	29.85	15.85	0.03845	1.39

RFID Coupler 5: LUPUS32

Antenna Gain (dBi)	Channel Frequency (MHz)	Maximum Output Power (dBm)	Tune-up Tolerance (dB)	Max Conducted Power including Tune up Tolerance	E.I.R.P (dBm)	EIRP (Watts)	ISED EIRP Limit (Watts)
-27.2	927.250	29.35	± 0.5	29.85	2.65	0.001840	1.39

RFID Coupler 6 : CORVUS10

Antenna Gain (dBi)	Channel Frequency (MHz)	Maximum Output Power (dBm)	Tune-up Tolerance (dB)	Max Conducted Power including Tune up Tolerance	E.I.R.P (dBm)	EIRP (Watts)	ISED EIRP Limit (Watts)
-20.5	927.250	29.35	± 0.5	29.85	9.35	0.00860	1.39