Guidelines for Limiting Exposure to Time-varying Electric, Magnetic, and Electromagnetic Fields

White Paper

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Introduction

This white paper has been prepared to assist in determining whether RAIN RFID systems operating in the frequency range 865-928 MHz comply with limits for human exposure to the radio frequency (RF) fields. It provides information about protection for people against health effects from direct, non-medical exposures to both short- and long-term, continuous and discontinuous RF electromagnetic fields (EMFs).

Depending on the country or region where the product will be placed on the market, different requirements apply. It is the manufacturers' responsibility to ensure they are using the correct version of the limit sets as specified by national authorities.

The following countries and regions and their regulations concerning human exposure assessment will be considered in this white paper:

1. Canada compliance requirements: ***RSS 102 issue 5***
2. China compliance requirements: ***GB 8704 - 2014***
3. Europe compliance requirements: ***Council recommendation1999/519/EC and Directive 2013/35/EU***
4. United States of America compliance requirements: ***47 CFR 1.1310***

Also, the ICNIRP Draft Guide Lines 2018 will be considered in this paper. ICNIRP (International Commission on Non-Ionizing Radiation Protection) is part of the WHO (World Health Organization). The guidelines are for the protection of humans to EMFs in the frequency range 100 kHz to 300 GHz.

General Overview Radio Frequency Human Exposure

As an EMF propagates away from a source, it transfers power from its source, described in watts (W), which is equivalent to joules (J) per second. The exposure to EMF covers a wide frequency range 0 Hz - 300 GHz. EMF is sometimes known as electromagnetic radiation (EMR) or electromagnetic energy (EME). EMFs are present everywhere in our environment. Electric and magnetic fields are part of the spectrum of electromagnetic energy which extends from static electric and magnetic fields.

When a RF EMF reaches the human body, some of its power is reflected and some is transmitted into the body. This results in complex patterns of fields inside the human body dependent on the EMF source and the frequency, as well as on the physical properties and dimensions of the body. These internal fields are referred to as induced electric fields **E** in (Volts per meter) V/m, and they can affect the body in different ways. After a complex process within the body the EMF energy is converted to heat and can affect health in a range of ways.

Strong enough exposure to EMFs can lead to short term health effects. Exposure to strong low frequency fields can lead to dizziness, seeing light flashes and feeling tingling or pain through stimulation of nerves. Exposure to strong higher frequency EMFs can lead to heating of body tissue, and result in damage to tissues and organs. Radio frequency fields exposure limits have been set, below which these acute effects do not occur.

If the induced low frequency electric field is strong and brief enough, it can stimulate nerves, described as a function of a dosimetric quantity. (Radiation dosimetry in the fields of health physics and radiation protection is the measurement, calculation, and assessment of the ionizing radiation dose absorbed by an object, usually the human body.) Below 6 GHz EMF penetrates deep into tissue, thus depth is considered, described as 'specific absorption rate' (SAR). It is the absorbed W/kg (Watts per kilogram). Above 6 GHz EMF, depth is less relevant.

Research into long-lasting exposure to EMF below the exposure limits is still ongoing. Scientific studies that compare groups of children who live near and far away from an overhead power line indicated that the children exposed to magnetic fields may have a greater chance of getting leukemia, but there is no proof of a causal relationship. There is also no proof of a causal relationship between exposure to EMFs from cell phones and occurrence of cancer in the head such as glioma. There is ongoing research on possible non-specific health effects such as fatigue, loss of concentration, sleep disturbance, headache and 'electro hypersensitivity'. A causal relationship with EMF exposure has not been established.

Nerve stimulation: For frequencies up to 10 MHz EMFs can stimulate nerves. This effect is not known to occur at higher frequencies. The effect of this stimulation varies as a function of the frequency and is typically reported as a 'tingling' sensation for frequencies around 100 kHz. As frequency increases, heating effects predominate and the likelihood of nerve stimulation decreases; at 10 MHz the electric field is typically described as 'warmth'.

Membrane permeabilization: Membrane permeability has been shown in vitro to occur with 18 GHz continuous wave exposure. EMF may cause cell membranes to become permeable that can lead to other cellular changes. There is no need to specifically protect against this effect, as restrictions designed to protect against smaller temperature elevations will also protect against this.

Temperature elevation: EMFs above 10 MHz can generate heat in the body, which can affect health, so it must be kept to a safe level. Strong EMF exposures have occasionally been shown to cause severe harm. For low exposure levels there is extensive evidence that the amount of heat generated is not enough to cause harm, but for exposure levels above the basic restriction levels and below those shown to produce harm, there is still uncertainty. The requirements differentiate between slowly temperature increases, allowing time for temperature to dissipate over a larger tissue mass and brief temperature elevations.

Body core temperature: Body core temperature refers to the temperature deep within the body, such as in the abdomen and brain, and varies substantially as a function of such factors as gender, age, time of day, work rate, environmental conditions, and thermoregulation.

Local temperature: In addition to body core temperature, excessive localized heating can cause pain and thermal damage. However, as there is an extensive literature showing that skin contact with temperatures below 42 °C for extended periods will not cause pain or damage cells, the localized heating would have to be severe to cause a problem.

Rapid temperature rise: For some types of exposure, rapid temperature elevation can result in 'hot spots', heterogeneous temperature distribution over tissue mass. This suggests the need to consider averaging over smaller time-intervals for certain types of exposure. Hot spots can occur for short duration exposures because there is insufficient time for heat to dissipate over tissue. This is more pronounced as frequency increases.

Reduction factors: The requirements take a whole-body average SAR = 4 W/kg, averaged over the body mass and a 6 - or 30-minutes (depending on the regulation) interval, resulting in a core temperature increase of 1 °C.

A reduction factor of 10 was applied to this threshold for occupational exposure to account for scientific uncertainty, as well as differences in thermal baselines, thermoregulation ability and body core temperature health threshold across the population. Although this means that SAR can be larger for smaller time intervals, this will not affect body core temperature rise appreciably because the temperature will be 'averaged-out' within the body over the 6- or 30-minutes interval.

As the general public cannot be expected to be aware of exposures and thus to mitigate risk, a reduction factor of 50 was applied for the general public, reducing the general public restriction to 0.08 W/kg.

Basic restrictions: Restrictions on exposure to electric, magnetic, and electromagnetic fields that are based directly on established health effects. Depending upon the frequency of the field, the physical quantities used to specify these restrictions are current density (J), specific energy absorption rate (SAR), and power density (S). Only power density in air, outside the body, can be readily measured in exposed individuals.

Reference levels: In practice, direct measurements of internal electric fields or SAR are often only feasible under laboratory conditions. Thus, reference levels are provided for practical exposure assessment purposes to determine whether the basic restrictions are likely to be exceeded. Compliance with the reference level will ensure compliance with the relevant basic restriction. If the measured or calculated value exceeds the reference level, it does not necessarily follow that the basic restriction will be exceeded. However, whenever a reference level is exceeded it is necessary to test compliance with the relevant basic restriction.

Reference levels are derived from relevant basic restrictions using measurements and/or computational techniques and some reference levels address perception and adverse indirect effects of exposure to EMFs. The derived quantities are electric field strength (E), magnetic field strength (H), magnetic flux density (B), power density (S), and limb current (IL). Quantities that address perception and other indirect effects are contact current (IC) and, for pulsed fields, specific energy absorption (SA). In any exposure situation, measured or calculated values of any of these quantities can be compared with the appropriate reference level. Respect of the reference level will ensure respect of the relevant basic restriction.

Near field: A region, generally in proximity to an antenna, in which the electric and magnetic fields do not have a substantially plane-wave character and vary considerably from point to point. Instrumentation for the measurement of magnetic fields at certain frequencies may not be commercially available. In this case, the electric field strength shall be measured and used for assessing compliance with the reference levels in this code.

Far field: In the far-field zone of an electromagnetic source, electric field strength, magnetic field strength and power density are interrelated by simple mathematical expressions, where any one of these parameters defines the remaining two.

Controlled environment: Occupational/controlled/workers exposure applies in situations in which persons are exposed to EMF fields because of their employment. They are fully aware of the potential for exposure and can have control over their exposure

Uncontrolled environment or general public exposure: General Public refers to the entire population and includes individuals of all ages, and of varying health status, and this will include particularly vulnerable groups or individuals such as the frail, elderly, pregnant workers, babies and young children.

Time averaging: Many regulations refer to over 6- or 30-minutes SAR time averaging, meaning Power Density S, E^2 and H^2 may be averaged over 6 or 30 minutes. Take 6 minutes averaging as an example. The on time of a system is 36 seconds. This means a duty factor (DF) of 10:1 (360:36). The measured value is 10 W/m² with a DF of 10:1 then its' an average of 1 W/m². Just S/DF where S is power density and DF is duty factor.

If the measured value is 10 V/m with the same DF then it's got to be done on equivalent power density which is proportional to the square of electric field strength, so it's $\sqrt{(E^2/DF)}$ result in $\sqrt{10}$.

Whole body exposure: The case in which the entire body is exposed to the incident fields, applicable when someone is further away from the antenna.

Localized exposure: An exposure of a portion of the body, spatially averaged value over the projected (cross-sectional) area of the body, applicable close to the antenna.

Contact current: This is a current that flows into the body when physical contact is made between the body and a conducting object carrying an induced voltage. Examples: Contact with cars under high voltage transmission lines, handle of a refrigerator etc. Contact current is not considered in this paper, because it is not applicable for RAIN devices.

Computational modelling: Computational modelling, such as finite-difference-time-domain (FDTD), may be used to demonstrate compliance with SAR and/or RF field strength limits.

Regulations in Countries and Regions

In the following sections Human Exposure assessment requirements for Canada, China, European Union and USA are described, focused on the RAIN RFID frequency.

Canada

In Canada compliance to ***RSS 102 Issue 5 "Radio Frequency (RF) Exposure Compliance of Radiocommunications Apparatus (All Frequency Bands)"*** is mandatory within the radio ISED certification process for a RAIN RFID Reader.

Basic restrictions

Table 3: SAR Limits for Devices Used by the General Public (Uncontrolled Environment)

Body Region	Average SAR (W/kg)	Averaging Time (minutes)[20]	Mass Average (g)
Whole Body	0.08	6	Whole Body
Localized Head, Neck and Trunk	1.6	6	1
Localized Limbs	4	6	10

Table 5: SAR Limits for Controlled Use Devices (Controlled Environment)

Body Region	Average SAR (W/kg)	Averaging Time (minutes)[22]	Mass Average (g)
Whole Body	0.4	6	Whole Body
Localized Head, Neck and Trunk	8	6	1
Localized Limbs	20	6	10

Reference levels

Table 4: RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m^2)	Reference Period (minutes)
0.003-10[21]	83	90	-	Instantaneous*
0.1-10	-	$0.73/f$	-	6**
1.1-10	$87/f^{0.5}$	-	-	6**
10-20	27.46	0.0728	2	6
20-48	$58.07/f^{0.25}$	$0.1540/f^{0.25}$	$8.944/f^{0.5}$	6
48-300	22.06	0.05852	1.291	6
300-6000	$3.142f^{0.3417}$	$0.008335f^{0.3417}$	$0.02619f^{0.6834}$	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	$616000/f^{1.2}$
150000-300000	$0.158f^{0.5}$	$4.21 \times 10^{-4} f^{0.5}$	$6.67 \times 10^{-5} f$	$616000/f^{1.2}$

Note: f is frequency in MHz.
*Based on nerve stimulation (NS).
** Based on specific absorption rate (SAR).

Table 6: RF Field Strength Limits for Controlled Use Devices (Controlled Environment)

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m^2)	Reference Period (minutes)
0.003-10[23]	170	180	-	Instantaneous*
1-10	-	$1.6/f$	-	6**
1.29-10	$193/f^{0.5}$	-	-	6**
10-20	61.4	0.163	10	6
20-48	$129.8/f^{0.25}$	$0.3444/f^{0.25}$	$44.72/f^{0.5}$	6
48-100	49.33	0.1309	6.455	6
100-6000	$15.60 f^{0.25}$	$0.04138 f^{0.25}$	$0.6455 f^{0.5}$	6
6000-15000	137	0.364	50	6
15000-150000	137	0.364	50	$616000/f^{1.2}$
150000-300000	$0.354 f^{0.5}$	$9.40 \times 10^{-4} f^{0.5}$	$3.33 \times 10^{-4} f$	$616000/f^{1.2}$

Note: f is frequency in MHz.
*Based on nerve stimulation (NS).
** Based on specific absorption rate (SAR).

Exemption Limits for Routine Evaluation

SAR evaluation is required if the separation distance between the user and the antenna is less than or equal to 20 cm, except when the device operates at or below the applicable output power level for the specified separation distance see table below.

Table 1: SAR evaluation – Exemption limits for routine evaluation based on frequency and separation distance[4,5]

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

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of 30 mm	At separation distance of 35 mm	At separation distance of 40 mm	At separation distance of 45 mm	At separation distance of ≥50 mm
≤300	223 mW	254 mW	284 mW	315 mW	345 mW
450	141 mW	159 mW	177 mW	195 mW	213 mW
835	80 mW	92 mW	105 mW	117 mW	130 mW
1900	99 mW	153 mW	225 mW	316 mW	431 mW
2450	83 mW	123 mW	173 mW	235 mW	309 mW
3500	86 mW	124 mW	170 mW	225 mW	290 mW
5800	56 mW	71 mW	85 mW	97 mW	106 mW

NOTE: If the separation distance between the user and the antenna is greater than 20 cm, RF exposure evaluation is the method used to evaluate the RF field strength levels generated by a device.

Calculations can be made to predict RF field strength and power density levels around typical RF sources. For example, in the case of a single radiating antenna, a prediction for power density in the far-field of the antenna can be made by use of the equation shown below. These equations are generally accurate in the far-field of an antenna but will over-predict power density in the near field, where they could be used for making a "worst case" or conservative prediction.

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

S = power density (in appropriate units, e.g. mW/cm², W/m²)
EIRP = equivalent (or effective) isotopically radiated power (in appropriate units, e.g. mW, W)
R = distance to the center of radiation of the antenna (in appropriate units, e.g., cm, m)

Exemption Limits for Routine Evaluation – RF Exposure Evaluation

RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows 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, where f is in MHz; for 915 MHz this is 1.38 W.

Computational Modelling

Permitted, but prior to the process, the applicant shall consult with Industry Canada to determine if this is deemed acceptable for the type of radiocommunication apparatus for which regulatory compliance is sought.

China GB 8702 - 2014

If the RFID device is used indoor there is no need no need to consider GB 8702. If outdoor use, the power needs to be checked.

Public exposure control limit

Frequency	Electric field strength E(V/m)	Magnetic field strength H(A/m)	Magnetic induction B(μT)	Equivalent plane wave power density S_{eq} (W/m²)
1 ~ 8 Hz	8000	$32000/f^2$	$40000/f^2$	-
8 ~ 25 Hz	8000	4000/f	5000/f	-
0.025 ~ 1.2 kHz	200/f	4/f	5/f	-
1.2kHz ~ 2.9 kHz	200/f	3.3	4.1	-
2.9kHz ~ 57 kHz	70	10/f	12/f	-
57 ~ 100 kHz	400/f	10/f	12/f	-
0.1 ~ 3 MHz	40	0.1	0.12	4
3 ~ 30 MHz	$67/f^{1/2}$	$0.17/f^{1/2}$	$0.21/f^{1/2}$	12/f
30 ~ 3000 MHz	12	0.032	0.04	0.4
3000 ~ 15000 MHz	$0.22f^{1/2}$	$0.00059f^{1/2}$	$0.00074f^{1/2}$	f/7500
15 ~ 300 GHz	27	0.073	0.092	2
Note 1: The unit of frequency f is the unit of the first column in the row. Note 2: From 0.1MHz to 300 GHz, the field parameter is the average root value for any continuous 6 minutes. For pulsed electromagnetic waves, in addition to meeting the above requirements, the instantaneous peak value of the power density shall not exceed 1000 times the limit listed in this table, or the instantaneous peak value of the field strength shall not exceed 32 times the limit value listed in this table.				

Exemption

A device whose equivalent radiated power is less than the value listed in the table below for transmitting an electromagnetic field of 0.1 MHz to 300 GHz without a shielded empty space is exempt.

Equivalent radiated power of the exempted facilities (equipment)

Frequency (MHz)	**EIRP (W)**
0.1~3	300
>3~300000	100

European Union and EFTA countries

In the European Union and the EFTA countries it is mandatory that RAIN devices must comply with ***RE-D (=Radio Equipment Directive) 2014/53/EU.*** One of the issues to be considered is Human Exposure Assessment.
Compliance must be shown to either:

- ***Council Recommendation 1999/519/EC: of 12 July 1999*** on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz)
- ***Directive 2013/35/EU Electromagnetic Fields of 26 June 2013*** on the minimum health and safety requirements regarding exposure of workers to the risk arising from physical agents (electromagnetic fields).

These regulations are derived from the ICNIRP Guidelines 1998.

Basic restrictions

General Public

Frequency range	Magnetic flux density (mT)	Current density (mA/m^2) (rms)	Whole body average SAR (W/kg)	Localised SAR (head and trunk) (W/kg)	Localised SAR (limbs) (W/kg)	Power density, S (W/m^2)
0 Hz	40	—	—	—	—	—
>0-1 Hz	—	8	—	—	—	—
1-4 Hz	—	8/f	—	—	—	—
4-1 000 Hz	—	2	—	—	—	—
1 000 Hz-100 kHz	—	f/500	—	—	—	—
100 kHz-10 MHz	—	f/500	0,08	2	4	—
10 MHz-10 GHz	—	—	0,08	2	4	—
10-300 GHz	—	—	—	—	—	10

In the Workers Directive 2013/35/EU this is called Health effects

Health effects ELVs	SAR values averaged over any six-minute period
ELVs related to whole body heat stress expressed as averaged SAR in the body	0,4 Wkg^{-1}
ELVs related to localised heat stress in head and trunk expressed as localised SAR in the body	10 Wkg^{-1}
ELVs related to localised heat stress in the limbs expressed as localised SAR in the limbs	20 Wkg^{-1}

Reference levels

General Public

Frequency range	E-field strength (V/m)	H-field strength (A/m)	B-field (μT)	Equivalent plane wave power density S_{eq} (W/m²)
0-1 Hz	—	$3{,}2 \times 10^4$	4×10^4	—
1-8 Hz	10 000	$3{,}2 \times 10^4/f^2$	$4 \times 10^4/f^2$	—
8-25 Hz	10 000	4 000/f	5 000/f	—
0,025-0,8 kHz	250/f	4/f	5/f	—
0,8-3 kHz	250/f	5	6,25	—
3-150 kHz	87	5	6,25	—
0,15-1 MHz	87	0,73/f	0,92/f	—
1-10 MHz	$87/f^{1/2}$	0,73/f	0,92/f	—
10-400 MHz	28	0,073	0,092	2
400-2 000 MHz	$1{,}375\ f^{1/2}$	$0{,}0037\ f^{1/2}$	$0{,}0046\ f^{1/2}$	f/200
2-300 GHz	61	0,16	0,20	10

Action levels or Occupational limits

Frequency range	Electric field strength ALs(E) $[Vm^{-1}]$ (RMS)	Magnetic flux density ALs(B) [μT] (RMS)	Power density ALs(S) $[Wm^{-2}]$
100 kHz ≤ f < 1 MHz	$6{,}1 \times 10^2$	$2{,}0 \times 10^6/f$	—
1≤ f < 10 MHz	$6{,}1 \times 10^8/f$	$2{,}0 \times 10^6/f$	—
10 ≤ f < 400 MHz	61	0,2	—
400 MHz ≤ f < 2 GHz	$3 \times 10^{-3} f^{1/2}$	$1{,}0 \times 10^{-5} f^{1/2}$	—
2 ≤ f < 6 GHz	$1{,}4 \times 10^2$	$4{,}5 \times 10^{-1}$	—
6 ≤ f ≤ 300 GHz	$1{,}4 \times 10^2$	$4{,}5 \times 10^{-1}$	50

Evaluation must be performed according to: ***EN 62369-1: 2009: Evaluation of human exposure to electromagnetic fields from short range devices (SRDs) in various applications over the frequency range 0 GHz to 300 GHz - Part 1: Fields produced by devices used for electronic article surveillance, radio frequency identification and similar systems.*** Table 1 in this document shows the measuring or separation distances for the various devices.

Table 1 – Dimensions and distances for Figures 1 to 11

	Figure [g]	Normative dimensions cm [e]			Informative dimensions cm [a,h]		
		a/b/c	X	Z	Height	Width	Depth
General torso grid	1	15	-	85	-	-	-
General head grid [b]	2	10	-	145	-	-	-
Single floor standing unit	3	15	20	85	120-160	-	40-80
Dual floor standing units	4	15	20	85	120-160	70-200	40-80
Single unit in the floor [f]	5	15	-	85	-	60-100	40-80
Single unit in the ceiling	6	15	-	85	210-300	60-100	40-80
Dual floor/ceiling units [f]	7	15	-	85	210-300	60-100	40-80
"Walk- through" unit [f]	8	15	20	85	210-300	70-300	0,5-50
Counter mounted unit [c]	9	15	30	85	70-90	20-40	20-40
Wall mounted unit	10	15	20	-	60-160	20-100	20-50
Hand-held unit [d]	11	15	10	-	70-140	Area: 100-200 cm^2	

[a] These dimensions represent the range over which the majority of equipment falls. Some may fall outside the range.

SAR measurements must be performed if we want to be sure that compliancy with the 1998 ICNIRP Guidelines is shown. Calculations are not allowed close to the antenna because we are still in the near field, where the far field starts at approx. 66 cm for the 915 MHz.

United States of America

In the USA it is mandatory that RAIN devices must comply with FCC requirements Part 15. One of the issues to be considered is Human Exposure Assessment according to ***47 CFR 1.1310.***

TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

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	1.0	6
300–1500			f/300	6
1500–100,000			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			f/1500	30
1500–100,000			1.0	30

f = frequency in MHz
* = Plane-wave equivalent power density

Calculations can be made to predict RF field strength and power density levels around typical RF sources. For example, in the case of a single radiating antenna, a prediction for power density in the far-field of the antenna can be made by use of the below shown equation. These equations are generally accurate in the far-field of an antenna but will over-predict power density in the near field, where they could be used for making a "worst case" or conservative prediction.

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

S = power density (in appropriate units, e.g. mW/cm^{22}, W/m^2)
EIRP = equivalent (or effective) isotopically radiated power (in appropriate units, e.g. mW, W)
R = distance to the center of radiation of the antenna (appropriate units, e.g., cm, m)

Draft ICNIRP Guidelines 2018

In 1998 ICNIRP published their guidelines and many countries and regions, including the European Union, derived their regulations from these guidelines. In July 2018, the updated Draft ICNIRP Guidelines 2018 were published. To determine the levels within these guidelines, ICNIRP identified scientific literature concerning effects of EMF exposure on biological systems and determined if these were both harmful to human health and scientifically proven, meaning reported effects need to be independently judged, be of scientific quality and explicable more generally within the context of the scientific literature.

The guidelines differentiate between occupationally-exposed individuals and members of the general public. ICNIRP limits are protective and sufficiently conservative to make additional precautionary measures unnecessary, even if exceeded by a substantial margin. The choice of adverse health effects, exposure scenarios, application of reduction factors and derivation of reference levels are conducted conservatively.

There are no essential differences in the limits between the 1998 ICNIRP Guidelines and the (Draft) ICNIRP 2018 Guidelines. The basic restrictions are the same for both versions.

The only difference of importance for RAIN RFID:

1. The reference levels 2018 show validity for whole body exposure while the 1998 just mentions "Reference levels".
2. 2018 version there are now two extra tables extra for reference levels for local exposure for time intervals.
3. The 2018 guidelines Reference levels show that averaging is allowed over 30 minutes for E^2 and H^2 for whole body exposure while the 1998 ICNIRP Guidelines show an averaging time over 6 minutes.

SAR measurements must be performed to ensure compliance with the 2018 ICNIRP Guidelines (as well as the 1998 ICNIRP Guidelines). Calculations are not possible close to the antenna because we are still in the near field where the far field starts at approx. 66 cm for the 915 MHz.

> NOTE: The information provided in this document is a guideline and may not be applicable in all circumstances. The RAIN RFID Alliance is not responsible for determining if a product needs testing to meet the published requirements. The RAIN RFID Alliance does not provide testing services. Please consult an expert if you need further information.

ABOUT RAIN RFID ALLIANCE

The RAIN RFID Alliance is an organization supporting the universal adoption of RAIN UHF RFID technology. A wireless technology that connects billions of everyday items to the internet, enabling businesses and consumers to identify, locate, authenticate and engage each item. The technology is based on the EPC Gen2 UHF RFID specification, incorporated into the ISO/IEC 18000-63 standard. For more information, visit www.RAINRFID.org. The RAIN Alliance is part of AIM, Inc. AIM is the trusted worldwide industry association for the automatic identification industry, providing unbiased information, educational resources and standards for nearly half a century.

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