Maximum Permissible Exposure (MPE) Evaluation

according to the OET Bulletin 65 (Edition 97-01)

Equipment evaluated:

The RipEX radio modem for data transmission in the 928 – 960 MHz frequency range

Author:	Mgr. Tomáš Mrázek
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Equipment evaluated

The RipEX radio modem is designed for bi-directional data transfer in a radio frequency channel assigned from the specified frequency range. When transmitting, it generates an angle modulated, continuous, constant-envelope radio-frequency signal on the output (antenna) connector. The transmitted signal spectral width is limited to a single channel and never exceeds the respective channel spacing, which is 50 kHz or 25 kHz or 12.5 kHz. The maximum nominal output radio-frequency (RF) power of the RipEX radio modem is 8 Watts. The output RF power variation in extreme conditions is guaranteed by the manufacturer to stay within -3.0 dB to +2.0 dB limits. The RipEX radio modem main specifications for a frequency range 928 – 960 MHz are in Table 1.

Table 1 – RipEX radio modem main technical parameters

Parameter	**Value**
Frequency range	from 928 MHz to 960 MHz
Channel spacing	12.5 / 25 / 50 kHz
Number of channels in the operating range	2560 / 1280 / 640
Channel setting method	software
Supply voltage (nominal)	13.8 V
Supply voltage range	10 V to 30 V
Operating temperature range	-40 °C to +70 °C
Current consumption: Reception: Transmission 1W: Transmission 8W:	 360 mA 1.1 A 3.0 A
Configurable RF output power range	from 0.1 W to 8 W
Antenna connector	TNC
RF output impedance	50 Ω

The RipEX radio modem is connected to the antenna by a coaxial cable. Since the antenna may be connected by a very short cable, the cable loss shall be considered negligible in the calculation.

MPE Calculations

The formula according to the OET Bulletin 65 (Edition 97-01) is:

$$R = \sqrt{\frac{P * G}{4 * \pi * S}}$$

S = Power density (in appropriate units, e.g. mW/cm²)
P = Power input to the antenna (in appropriate units, e.g. mW)
G = Power gain of the antenna in the direction of interest relative to an isotropic radiator
R = Distance from the centre of radiation of the antenna (appropriate units, e.g. cm)

Tx Frequency = 928 MHz

The exposure at the lowest frequency of the operating range makes the worst case, since the limits given in §1.1310 of the FCC Rules increase with frequency (in the frequency range applicable to the evaluated equipment) whereas the radiation from RipEX radio modem will be constant.

Maximum peak power = 41.03 (dBm)
The maximum peak power is calculated as the nominal maximum power increased by the margin allowed by the applicable FCC standard (+2dB)

Antenna gain = 2.15 (dBi)
The antenna gain of the half-wave dipole is considered as the worst-case scenario. The areas of exposure never lie in the direction of the main lobe of the transmitting antenna. In fact, the higher the gain of the antenna is, the lower the radiation in the directions relevant for exposure evaluation will be.

S = 0.62 [mW/cm²]
The FCC limit for exposure of general population / uncontrolled exposure in the 928 – 960 MHz frequency range.

P = 12679 [mW]
The numerical value of maximum TX power

G = 1.64
The numerical value of half-wave dipole gain

The worst case scenario also assumes 100% duty cycle. Though the equipment assessed allows for that, it never happens in reality thanks to the packet-oriented transmission environment.

Calculated minimum separation distance from antenna, where the limit for general population / uncontrolled exposure is met, is:

R_u = 52 cm

The distance, where the limit for occupational / controlled exposure is met, is:

R_c = 23 cm

The distance, where the limits are met for typical directional and omni directional antennas typically used with RipEX radio modem. The safe distance for directional antennas is validated in the direction of the main beam centre, where it is nevertheless unreasonable to expect the presence of general public.

Table 2 – The distances where the FCC limits are met for typical antennas (8 W) are:

928 – 960 MHz – 8 Watt RF power					
Antenna code	Antenna description	Gain G (dBi)	Gain G (-)	Distance where the FCC limits is met for	
				General Population / Uncontrolled Exposure (cm)	Occupational / Controlled Exposure (cm)
OV900.1	single dipole	4.65	2.92	69.0	30.8
SA900.5	5 element directional Yagi	8.65	7.33	109.3	48.9
SA900.12	12 element directional Yagi	14.15	26.00	205.9	92.1

Conclusion:

It is safe to assume that the general population will never be at the distance R_u (or nearer) to a fixed antenna installation of the equipment evaluated. Equally it is safe to assume that e.g. a member of staff performing mast maintenance will spend only negligible fractions of time at the distance R_c (or nearer) to the transmitting antenna. It is still important to follow the MPE calculations with respect to possible exposure when planning where to install the antennas. Consequently, in our opinion, the operation of the evaluated equipment would not make a significant environmental effect.