Maximum Permissible Exposure (MPE) Evaluation according to the OET Bulletin 65 (Edition 97-01)

Evaluated equipment:

The RipEX2 radio modem for data transmission in the 400 – 470 MHz frequency range

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Evaluated equipment

The RipEX2 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 200 or 150 or 100 or 50 or 25 kHz or 12,5 kHz or 6,25 kHz. The maximum nominal output radio-frequency (RF) power of the RipEX2 radio modem is 10 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 RipEX2 radio modem main specifications for a frequency range around 400 MHz are in Table 1.

Table 1 – RipEX2 radio modem main technical parameters

Parameter	Value
Frequency range	from 400 MHz to 470 MHz
Channel spacing	6,25 / 12,5 / 25 / 50 / 100 / 150 /200 kHz
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 10W:	 580 mA 1,1 A 3,6 A
Configurable RF output power range	from 0,1 W to 10 W
Antenna connector	TNC
RF output impedance	50 Ω

The RipEX2 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.

The main parameters of recommended antennas are listed in Table 2. These are parameters specified by the respective manufacturers. The antennas listed in Table 2 are supplied with the RipEX2 radio modem upon request.

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MPE Calculations

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

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

Where:

S=Power density (in appropriate units, e.g. mW/cm2)

P=Power input to 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 to the centre of radiation of the antenna (appropriate units, e.g., cm)

Tx Frequency = 400 MHz

The exposure at the lowest frequency of the operating range make 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 RipEX2 radio modem will be constant.

Maximum peak power = 42.0 (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 = 368/1500 = 0.245 [mW/cm2]

The FCC limit for exposure of general population / uncontrolled exposure at 400 MHz

P = 15850 [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 public / uncontrolled exposure is met, is:

Ru = 92 cm

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

Rc = 41 cm

The distance, where the limits are met for typical directional and omni directional antennas typically used with RipEX2 radio modem. For directional antennas is safe distance validate in direction side of main beam, where is maximum energy emitted by antenna.

400 - 470 MHz/ 70 cm band - 10 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)
OV400.1	single dipole	4.6	2.9	121.8	54.5
OV400.2	stacked double dipole	7.6	5.8	172.0	76.9
SA400.3	3 elemet directional Yagi	7.6	5.8	172.0	76.9
SA400.5	5 elemet directional Yagi	8.7	7.4	195.2	87.3
SA400.9	9 elemet directional Yagi	12.5	17.8	302.4	135.2

Table #1 – The distance where the FCC limits are met for typical antennas

Conclusion:

It is safe to assume that members of general public will never be present in the distance Ru (or lower) to a fixed installation of antenna of the evaluated equipment. Equally it is safe to assume that e.g. a member of staff performing mast maintenance will spend only negligible fractions of time in the Rc (or lower) distance to the transmitting antenna (the Rc distance actually corresponds with the physical size of the antenna itself). Consequently, in our opinion, the operation of the evaluated equipment would not make a significant environmental effect.