Using 418 or 433.92 MHz Modules under FCC 15.231 (e)

Application Note: 102

under FCC Regulation Part 15, Section 231, Paragraph (e)

Radiometrix modules operate on license exempt frequencies of 418MHz or 433.92MHz. Their Effective Radiated Power (ERP) outputs and spurious emissions meet the UK and European

Type approval requirements. However, Electric Field Strength limit imposed by FCC is very much lower than European power limit as shown below.

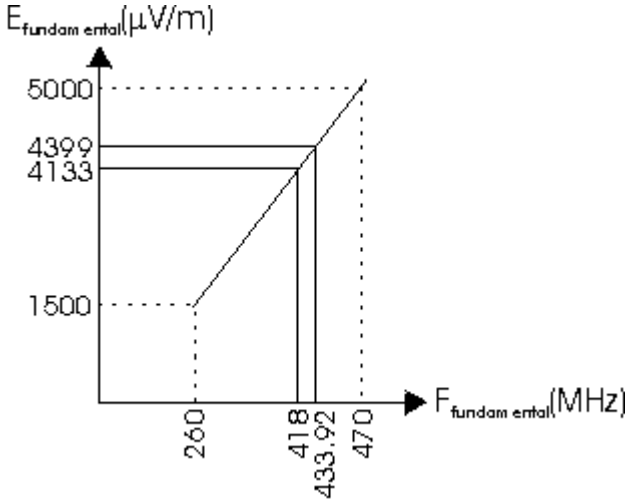

Figure 1: Electric Field Strength limits on signal & spurious emission

The following Table shows the conversion from dBm to Electric Field Strength in m V/m for common power and spurious emission level

Power	P (dBm)	E (µV/m) @3m	E (dBµV/m) @3m	Comments
10mW	10	182,574	105.2	European limit for 433.92MHz
1mW	0	57,735	95.2	Typical 418MHz modules
0.25mW	-6	28,868	89.2	UK limit for 418MHz modules
5.8µ W	-22	4399	72.9	FCC limit for 433.92MHz
5.1µ W	-23	4133	72.3	FCC limit for 418MHz
75nW	-41	500	54	FCC Spurious Emission limit for >470MHz
1µ W	-30	1,826	65.2	European Spurious Emission limit for > 1 to 4GHz
0.25µ W	-36	915	59.2	European Spurious Emission limit for 25-47, 74-87.5, 118-174, 230-470, 862-1000 MHz
4nW	-54	115	41.2	European Spurious Emission limit for 47-74, 87.5-118, 174-230, 470-862 MHz

The above limitations on Electric Field Strength would require

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25dB (max) power attenuation on 418MHz modules
35dB (max) power attenuation on 433.92MHz module.

The above values are only required if used with a high gain antennas like dipole or yagi antenna.

When using antennas like 1/4 wavelength whip, helical or loop antenna, ERP will be less than the Power Output at the RF pin of the Transmitter. i.e. required attenuation value will be few dBs less than the calculated values.

Note: An imperial 'rule of thumb' for in-building operation requires a 15dB change in path loss capability to change the range by a factor of two. This is a very cruel law when compared to free space propagation where only a 6dB change is required to double / halve the range.

To reduce the Effective Radiated Power (ERP) either one of the following can be used:

1. Passive attenuation network
2. Very short monopole antenna

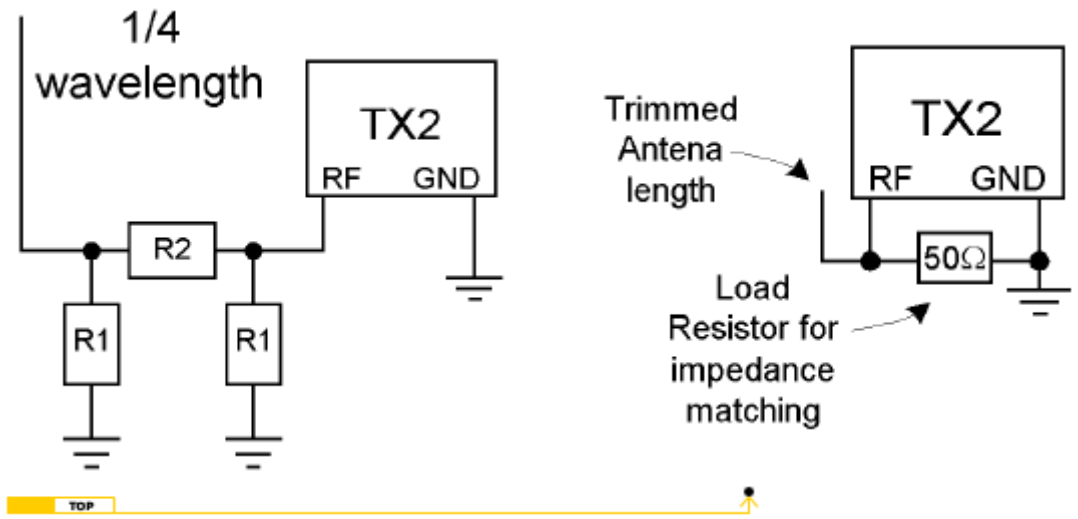

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Figure 2: Methods to reduce ERP

The following Table gives Pi-Network Resistor values for Attenuators (50Ω)

Attenuation (dB)	R1 (Ω)	R2 (Ω)
5	179	30
10	96	71
15	72	136
20	61	248
25	56	443
30	53	790
35	52	1405

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It is recommended that the above Pi-Network is implemented with a good ground plane using Surface Mount Resistors.

Power or Electric Field Strength Equation

$$P_r = \frac{GP_t}{4\pi r^2} = \frac{E^2}{Z_o}$$ Equation (1)

where P_r received power density [W/m^2]

P_t transmitted power [W]

G numerical gain of the transmitting antenna relative to an isotropic source

r distance of the measuring point from the electrical center of the antenna in meters

E electric field strength [V/m]

So characteristic impedance of free space [Ω]

FCC specifies limit in terms of the Electric Field Strength in μ V/m at a distance of 3m.

Using Equation (1),

When G=1, r=3m, So≅ 120π Ω,

$$P_t = 0.3E^2$$ Equation (2)

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