

ALPHA ChipSat Radio EMC Analysis

The ALPHA Cubesat mission uses Monarch ChipSat units (gram-scale satellite-on-a-chip PCBs) to transmit mission data to the ground station at Cornell University.

Analysis of ChipSat Non-Interference with 902-928 MHz Band

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Scope

Through analysis, show that the ChipSat space service at 915 MHz does not interfere with protected land base station services in the 902-928 MHz band.

Protection Criteria for the IMT Systems

For non-interference, space services require field strength below the following values:

TABLE 1

Field strength to be protected for land mobile service systems

System to be protected	Class of station	Frequency (MHz)	Noise Figure (dB)	Feeder Loss (dB)	Receiving antenna gain (dBi) at 90°	Field strength to be protected (dBμV/m)			Receiving antenna height (m)
						200 kHz GSM-R	200 kHz GSM	5 MHz LTE	
GSM or LTE system	Receiving base station	880-915	5	3	-1.5* ($G_{max}=15$)	16	19	33	30
	Receiving mobile station	925-960	9	0	0 (GSM-R and GSM) -3 (LTE)	15	18	35	1.5

* -1.5 dB of omnidirectional vertical antenna gain at the elevation angle of 90 degree as the worst case is used for calculation. (See *recommends* 2.2 of Recommendation ITU-R [F.1336-4](#)).

The minimum field strength allowed is 16 dBμV/m. Only interference with the Receiving Base Stations is considered because the Receiving Mobile Stations are outside the frequency band of the ChipSat transmitters.

Analysis

From Recommendation ITU-R P.525-4, the field strength is calculated as

$$e = \frac{\sqrt{30p}}{d}$$

where:

e : r.m.s. field strength (V/m)

p : equivalent isotropically radiated power (EIRP) of the transmitter in the direction of the point in question (W)

d : distance from the transmitter to the point in question (m).

From the ALPHA FCC filing, there are four ChipSats, all with radios operating at 915 MHz, and having the same ERP. The ERP is 0.01 W, and converting from ERP, the EIRP, p , is 0.017 W. The distance, d , is 416 km.

The electric field strength, e , can then be calculated as:

$$e = 1.72 \cdot 10^{-6} \text{ V/m} = 4.71 \text{ dB}\mu\text{V/m}.$$

Conclusion

For the ChipSat spacecraft parameters, the electric field strength is calculated to be 4.71 dB μ V/m at the land mobile service system. This value is below the minimum non-interference requirement of 16 dB μ V/m for Receiving Base Stations. Therefore, the ChipSat spacecraft will not interfere with Receiving Base Stations in the 902-928 MHz band or the Receiving Mobile Stations in the 925-960 MHz band.

