RFID budget link in UHF band

To understand RF problem in RFID, an illustration of link budget is shown in fig.1.

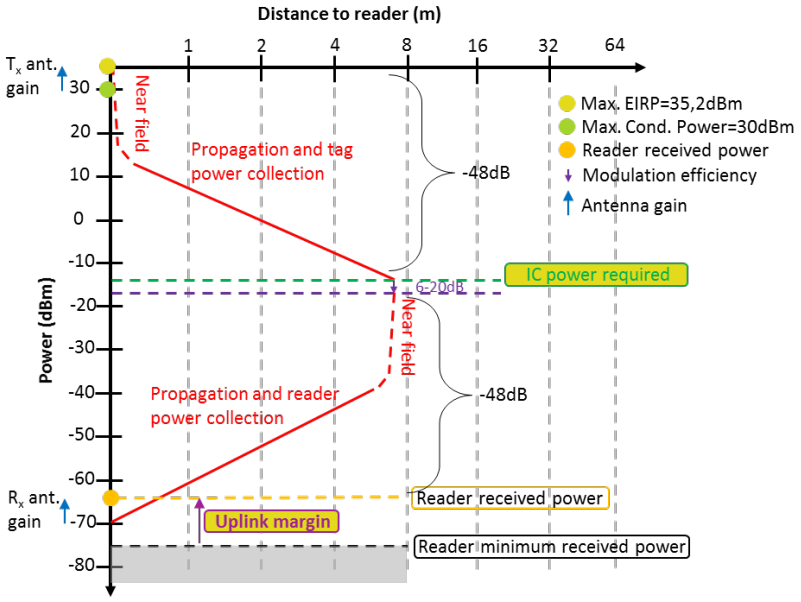

Fig. 1. Budget link example of a UHF RFID communication

In Europe, ETSI regulations authorize RFID devices to radiate on four channels (865-868 MHz) with a maximum power level of 2 Watt Equivalent Radiated Power (ERP) or 3.28 Watt EIRP or 35.2dBm EIRP [1]. The starting point of power budget is then set to P=35.2dBm. Then, a free space propagation is assumed in this example, before power collection by tag antenna, supposed isotropic. If received power is superior to IC required power, tag become functional and communication can start. When order are received by the tag, it will answer by backscattering through a modulation, propagates again and finally reader antenna collects the available power. If received power is higher than the minimum reader power threshold, the link is a success. The amount of power between minimum reader power threshold and effective received power constitutes the return link margin.

- Budget link dissymmetry, THE critical point to understand

Looking at Fig. 10, one must note the dissymmetry between forward link and return link. Indeed, starting at maximum power (35.2dBm), functional range is fixed by the IC power required, also called IC sensitivity. Classical sensitivity oscillates between -10 and -20dBm for the best ICs. Let us take -13dBm. In order to power up tag IC, forward link power loss must not be superior to 48dB. Taking into account a power loss of 6dB in tag modulation efficiency and assuming a reader sensitivity of -75dBm, the return link permitted power loss is about 75-19= 65dB. It is then obvious that limiting factor is the reader to tag link. In other words, if forward link is achieved, by reciprocity return link will be automatically checked (considering a monostatic reader and no variation geometry variation during return link).

This is a very important point to understand since, knowing IC required power, RFID link existence or quality is then fully determined by radio coverage (E-field amplitude) at tag location through the following equation:

$$E = \frac{4\pi}{\lambda_o}\sqrt{\frac{30 \times P_R}{G_R}}$$

Our numerical study will be based on this principle.

- Budget link in realistic channel conditions

At UHF frequencies, multipath environment [2] causes large signal fading. If tag is present in a fading location (do in Fig. 2), available power can be decreased by 20 or 30dB. As a consequence, IC is not powered up and tag reading will fail. Our study will show how to mitigate this multipath propagation effects in order to improve RFID radio coverage quality and then RFID read reliability.

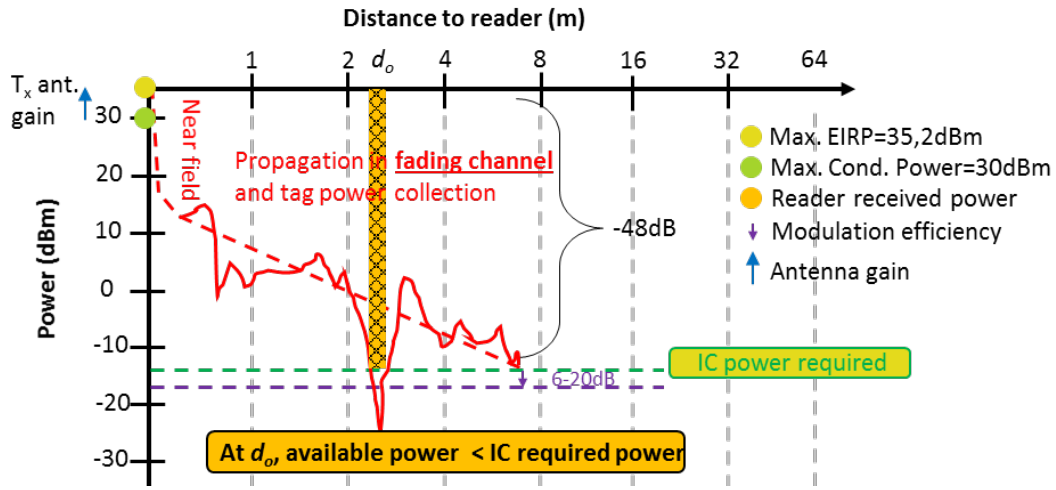

Fig. 2. Budget link example of a UHF RFID communication in a multipath environment

References

[1] ETSI 302 208-x, "Electromagnetic compatibility and radio spectrum matters (ERM) – Radio frequency identification equipment operating in the band 865 MHz to 868 MHz with level powers up to 2W".

[2] T.S. Rappaport, "Wireless communications: principles and practice," Prentice Hall, 2002.