Preliminary study on diffuse OWC for intra-CubeSat communication

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We experimentally design a diffuse optical wireless communication link for CubeSat applications. We present the bit error rate performance as a function of the received optical power after reflection from the wall.
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Nowadays, CubeSats are playing a significant role in space economy. CubeSat market is expected to grow 19% by 2023 [1]. They are small cubic satellite units (10 cm per side), in which harness and wiring represent a significant percentage of its mass; therefore, it is essential to find alternative wireless solutions. Recently, Optical Wireless Communication (OWC) is gaining momentum to solve these issues. OWC exploits low cost COTS optical sources such as light-emitting diodes (LEDs); it shows no electro-magnetic interference and it can work in diffused communication addressing the issue of weight and cable management, especially in those environments that are small and full of obstructions [2].

Here, we report a preliminary study on a non-line-of-sight (NLOS) infrared (IR) OWC link for intra-CubeSat communication. We considered a black hardboard box as a wall of the CubeSat in order to emulate the reflections and we performed communication measurements with the setup shown in Fig. 1. On the transmitter (TX) and receiver (RX) side, we used a 850 nm IR LED with electrical bandwidth of 11 MHz and a silicon Avalanche Photodiode (APD) with a 10×10 mm active area, respectively.

We generated a 1 Mbit/s (typical in CubeSat communications) pseudorandom binary sequence (PRBS) by the means of an arbitrary waveform generator (AWG). Then, the electrical signal is superimposed to a forward current by the means of a bias-T in order to correctly drive the IR LED. Thereafter, the produced light is back-reflected from the wall to the RX and collected by the APD. A transimpedance amplifier (TIA) converted the generated photocurrent in a voltage signal, which is acquired by a real time oscilloscope (RTO). Finally, the received signal is checked by the PC for bit error rate (BER) measurements.

In order to evaluate the RX sensitivity, we repeated the measurement at different attenuation levels using different optical attenuators on the RX side.

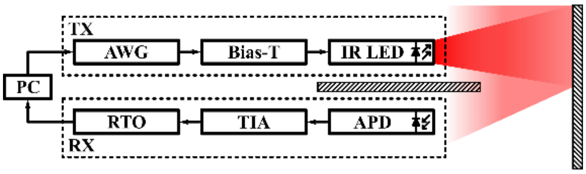

Fig. 1. Block diagram of the setup.

In Fig. 2., we presented the BER measurements as a function of the received optical power. Forward error correction (3.8×10^{-3}) is taken into account for the link sensitivity at -44.7 dBm. Beyond -43.5 dBm, no error is obtained after a transmission of 4×10^{5} bits. However, reducing the power causes errors as expected.

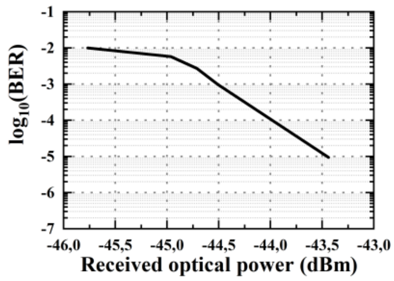

Fig. 2. BER as a function of RX optical power.

We demonstrated a simple NLOS IR OWC link for intra-CubeSat communication in NLOS, with reflection from the wall. We present BER performances in the range of -45.7 and -43.4 dBm. A sensitivity of -44.7 dBm was found for a target BER of 3.8×10^{-3}.

Acknowledgment

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