Measurements of Wideband Microwave Propagation within a Small Aircraft for Replacing Wire Harnesses

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Wideband and ultra wideband (UWB) radio propagation within a small aircraft was measured and statistically analyzed. Wideband including UWB technologies have been considered for use in aircrafts, spacecraft, and other closed- or semi-closed spaces because of their anti-multipath capabilities and possible low power consumption. Adaptation of wireless technologies in such spaces could contribute to reduce wire harness weight. Multipath propagation in semi-closed conductive spaces restricting the transmission performance must be scrutinized.

The measurement campaigns were conducted in a Cessna® 150 with an inner volume of approximately 1.3 m^3. Frequency-domain (from 3.1 to 10.6 GHz) propagation gains were measured with a microwave vector network analyzer. The transmitting and receiving antennas were omnidirectional, vertically-polarized, low-VSWR UWB monopole antennas. The transmitting antenna was placed between the control yokes; and its position was defined the origin of the Cartesian coordinate, where x, y, and z axes of the coordinate were parallel to the backward, rightward, and upward directions, respectively. The receiving antenna was scanned within a region $-80 \le x$ [mm] ≤ 220, $580 \le y$ [mm] ≤ 880 in 5-mm intervals. The height of the transmitting and receiving antennas was at approximately 400 mm above the cabin floor. From the frequency-domain power gain data, propagation gains were calculated by summing the power of the gains between the feeding points of the antennas over occupied bandwidths. Propagation gains ranged from -57.5 to -30.2 dB for 6.85-GHz continuous wave and from -41.9 dB to -34.3 dB for 500-MHz bandwidth, for example. The fading depth versus frequency bandwidth at the deepest dead spots were derived from measured data, as shown in Fig. 1, where the center frequency was fixed at 6.85 GHz, and the 7.5-GHz-bandwidth (from 3.1 to 10.6 GHz) propagation gain was set to the 0-dB reference. The fading depth in a small spacecraft (having an inner volume of approximately 0.09 m^3) is also presented in Fig. 1. A bandwidth over 500 MHz was capable of reducing the fading depth to approximately 3 dB for the aircraft.

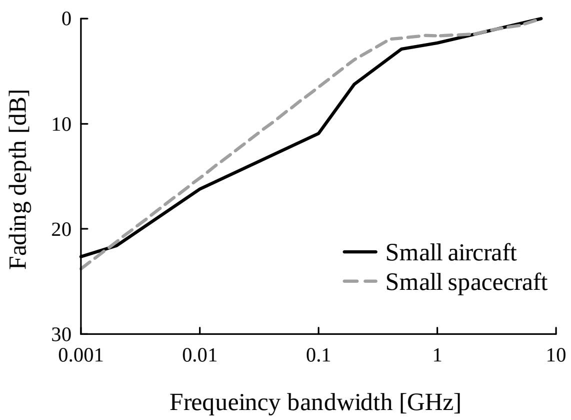

Fig. 1. Fading depth versus occupied bandwidth for the aircraft and the spacecraft.