Investigation of HPM and UWB Susceptibility on GPS Receivers

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This paper presents results from HPM (High Power Microwave) and UWB (Ultra Wide Band) susceptibility testing done on GPS receivers. In total six GPS receivers of three different types have been tested (GPS A, B and C), see Figure 1.

Three different measurement set-ups have been used. The first consists of a RADAN 303B source equipped with a sub-ns slicer, which generates UWB-pulses of about 150 kV fed into a TEM horn antenna. Field levels of several tens of kV/m were attained. The main power of the spectrum is below 1 GHz. Only single pulse shots were used. The second set-up (HPM) consists of a 700 kW magnetron, with a fixed frequency of 3 GHz. The magnetron is capable of generating electric fields up to 100 kV/m (depending on the distance). In this case pulse bursts were used. For the first two set-ups, the GPS receivers were tested together three and three. The electric field was increased by decreasing the distance between the source antenna and the device under test (DUT). The third set-up consists of a Milmega (AS0102-30P) amplifier, which generates moderate microwave pulses in the 1-2 GHz band. This set-up generates electric fields up to 55 V/m and was used to determine minimum interference levels for the GPS receivers, one at the time.

The results from the third measurement set-up show that the GPS receivers are quiet easy to disturb with in-band microwave pulses. Measurements with the first and second set-up show that it is relatively easy to cause interference, which requires operator-intervention (level 4), for both UWB and HPM-pulses. Some of the UWB (RADAN) interference test results are presented in Figure 2. To cause permanent physical damage higher field levels and/or longer pulse widths are required. During high level HPM testing (using the magnetron), permanent damage first occurred in the receiver circuits, this was at lower levels compared to the corresponding UWB measurements. This conclusion is based on the fact that the GPS receivers showed to have normal operation, except that there was no reception of satellite signals. The orientation of the GPS receivers also showed to affect the susceptibility levels (three different orientations were tested in the UWB interference tests, top, front and side). Since the numbers of GPS receivers tested were limited, it is hard to draw final conclusions. The susceptibility of GPS receivers should be further investigated.

Figure 1 Photo of the three types of GPS receivers, from the left GPS A, B and C.

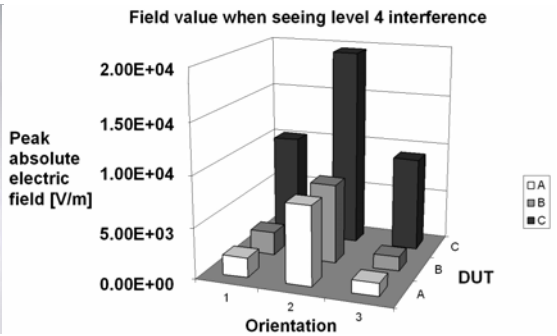

Figure 2 The measured peak electric field when level 4 interference occurred for the GPS receivers at different orientations (during UWB tests).