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# Integrated, Dual Orthogonal Antennas for Polarimetric Ground Penetrating Radar

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Ground penetrating radar systems are mostly equipped with single polarized antennas, for example with single linear polarization or with circular polarization. The radiated waves are partly reflected at the ground surface and very often the penetrating waves are distorted in their polarization. The distortion depends on the ground homogeneity and the orientation of the antennas relative to the ground structure. The received signals from the reflecting objects may most times only be classified according to their coverage and intensity. This makes the recognition of the objects difficult or impossible.
In airborne and spaceborne Remote Sensing the systems are meanwhile mostly equipped with front ends with dual orthogonal polarized antennas for a full polarimetric operation. The received signals, registered in 2x2 scattering matrices according to co- and cross polarization, are processed for the evaluation of all features of the targets. Ground penetrating radars could also profit from the scientific results of Remote Sensing. The classification of detected objects for their structure and orientation requires more information in the reflected signal than can be measured with a single polarization [1, 2].
In this paper dual linear, orthogonal polarized antennas with a common single, frequency independent phase center, are presented [3]. The relative bandwidth of these antennas can be 1:3, up to 1:4. The antenna is designed to work in the frequency range between 3 GHz and 11 GHz, but can be easily adapted to the GPR frequency range by scaling.
The size of the antenna scaled for operation in typical GPR frequencies would approximately be 20 by 20 $cm^2$. By the implementation in a dielectric carrier it could be reduced in size if required. The major problem for ultra wide band, dual polarized antennas is the frequency independent feed network, realizing the required phase shifts. For these antennas a network, which is frequency independent over a wide range, has been developed [4].
If OFDM signals are used for the radiation, the carriers can be split in even and odd carriers and fed to the two orthogonally polarized transmit antennas. By using OFDM, the de-correlation of the two subcarrier groups becomes inherently high. Due to the orthogonality of OFDM subcarriers the de-correlation only depends on the quality of the hardware and the signal processing. They can be simultaneously radiated and received by the two antennas. This could result in a significant improvement of the GPR sensor system.
The antenna has been realized and first measurements have been conducted.
During the forthcoming EGU 2015 General Assembly the detailed electromagnetic background and the function of the dual linear, orthogonal polarized antenna will be presented as well as results in GPR relevant frequencies. Also, an approach of a planar feeding network will be presented.

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**References**

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