

Accurate Transponder Calibrations with the Novel Three-Transponder Method

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Transponders are, besides trihedral corner reflectors, the most commonly used measurement standards in radiometric SAR calibration. They allow signal recording for the reconstruction of the azimuth pattern of the SAR system, adjustments of the backscattering matrix for polarimetric applications, and radar cross sections (RCSs) which are potentially much larger than those of passive point targets. These advantages led DLR to develop, manufacture, and install three new, accurate C-band “Kalibri” transponders in South Germany, which are now being used for the calibration and monitoring of the Copernicus Sentinel-1A satellite.

Before the transponders could be used as radiometric measurement standards, they needed to be calibrated themselves. In an effort to find the most accurate RCS calibration approach for the given transponder design, several existing methods were compared [1], and a new, potentially highly accurate method, devised which exploits the specific design of the Kalibri transponders [2]. The new “three-transponder method” is similar in principle to the known “three-antenna method”, but is based on the radar equation instead of the Friis transmission formula. The approach exploits the fact that modern transponders like the “Kalibri” device can also be operated as radars because of the integrated digital sub-system (which is needed to implement a digital delay line and incorporates an AD and DA converter). To conduct a complete measurement, three transponders and three measurements (with one transponder pair each) are required; refined measurement schemas are also possible. In comparison to existing methods, no additional radiometric measurement standard is needed, which so far has been one of the limiting factors in accomplishing lower calibration uncertainties. Measurement traceability is achieved by tracing a comparatively simple length measurement back to a national realization of the meter. Such a length measurements can be performed with high accuracy.

The presentation will include the setup and the measurement results of a first demonstration measurement campaign. Despite remaining challenges in the practical implementation, the uncertainty analysis shows that the method is a good candidate for highly accurate transponder RCS calibrations in the future.

References

- [1] Raab, S., Döring, B. J., Jirousek, M., Reimann, J., Rudolf, D., & Schwerdt, M. (2014). Comparison of Absolute Radiometric Transponder Calibration Strategies. In *Proceedings of the European Conference on Synthetic Aperture Radar*.
- [2] Döring, B. J., Reimann, J., Raab, S., Jirousek, M., Rudolf, D., & Schwerdt, M. (2014). The Three-Transponder Method: A Novel Method for Accurate Transponder RCS Calibration. *Progress In Electromagnetics Research B*, 61, 297–315.