Recent Changes to the IEEE std 1502 Recommended Practice for Radar Cross-Section Test Procedures

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Abstract— **Radar scattering is typically represented as the RCS of the test object. The term RCS evolved from the basic metric for radar scattering: the ratio of the power scattered from an object in units of power per solid angle (steradians) normalized to the plane-wave illumination in units of power per unit area. The RCS is thus given in units of area (or effective cross-sectional area of the target, hence the name). Note that the RCS of the test object is a property of the test object alone; it is neither a function of the radar system nor the distance between the radar and the test object, if the object is in the far field. Because the RCS of a target can have large amplitude variation in frequency and angle, it is expressed in units of decibels with respect to a square meter and is abbreviated as dBsm (sometimes DBSM or dBm2). In terms of this definition, the RCS of a radar target is a scalar ratio of powers. If the effects of polarization and phase are included, the scattering can be expressed as a complex polarimetric scattering (CPS) matrix. The measurement of the RCS of a test object requires the test object to be illuminated by an electromagnetic plane wave and the resultant scattered signal to be observed in the far field. After calibration, this process yields the RCS of the test object in units of area, or the full scattering matrix as a set of complex scattering coefficients.**

This paper describes the planned upgrades to the old IEEE Std 1502™-2007 IEEE Recommended Practice for Radar Cross-Section Test Procedures [1]. The new standard will reflect the recent improvements in numerical tools, measurement technology and uncertainty estimates in the past decade.

I. INTRODUCTION

Radar reflectivity measurements go back to the earliest days of radar. What are now known as RCS measurements began to be more openly discussed in the literature in the late 1950s and early 1960s [2-6], although much of that work was under the auspices of the military and thus not readily available. This situation began to change with the 1965 publication of a special issue of the Proceedings of the IEEE [7], which concentrated on topics associated with radar reflectivity. Several of the 1965 papers in this issue specifically focused on the requirements of RCS measurements, including an overview of the state of the art in RCS measurements [8-9]. In addition, this issue included papers on range requirements [10], target support issues [11], measurement techniques [1-2], [12], and discussions of typical facilities, both static [13], and dynamic [14]. With the publication of this issue, a growing open-source literature base on RCS measurements became available to practitioners in the field.

The ensuing period marked the beginnings of two measurement trends: the rapid development of new approaches to making measurements; and measuring targets with low RCS. There was a major push to reduce the radar scattering from military vehicles significantly with such programs as the U-2 and SR-71. Along with the objective to produce vehicles with reduced RCS came the requirement to measure these smaller signal levels accurately. In addition, many applications required the full complex polarimetric scattering matrix. Thus, significant efforts were made to improve the technology of RCS measurements, including increasing the dynamic range of the measurement system and adding complex phasor measurements.

During this same time period, significant research was being conducted on the theory of electromagnetic scattering. Universities such as Syracuse University, the University of Michigan, The Ohio State University, and the Georgia Institute of Technology were engaged in understanding the foundations of scattering, with the objectives of taking better measurements and being able to predict analytically and numerically the scattering from increasingly complex objects. Many tools, such as the method of moments (MOM), the geometrical theory of diffraction (GTD), and physical optics (PO), were developed during this period. These developments were significant for the measurement process, because calibration methods of that time period required the ability to predict the scattering from calibration targets to a high degree of accuracy. Furthermore, significant progress in RCS reduction required improvements in theory, prediction, and measurement. Even though the technical community had made great strides in its ability to perform RCS measurements, some areas still required improvement. Among these areas were the needs for community-wide recognized reference standards that could be used for calibration of RCS measurements and for a readily available standardized process for measuring RCS. Although no internationally accepted set of RCS procedures for characterizing the performance of an RCS measurement range existed, some guidance to organize the documentation for the operation and characterization of a range could be found in ANSI-Z-540-1994-1 [15] and the U.S. version of ISO/IEC 17025 [16]. Other important references are [17-18]. These developments led to IEEE Std 1502™-2007 IEEE Recommended Practice for Radar Cross-Section Test Procedures which is currently being updated. Alternately, some modern users of RCS ranges are not using the ANSI and ISO standards exclusively; instead, they are providing a good uncertainty evaluation for each RCS measurement, because they have assessed that it should be more important than characterizing range performance.

More recently, new numerical tools suitable for RCS assessment have been developed like the finite element method (FEM), the boundary element method (BEM), and other commercial software packages. The new standards reflect improvements in numerical tools, measurement technology and uncertainty estimation. Discussion topics include measurement standards, procedures, and practices.

II. Content of the New Standard

The new IEEE Standard, 1502™ IEEE "Recommended Practice for Radar Cross-Section Test Procedures" include the following sections:

1) Overview
2) The radar cross-section measurement process
3) Measurement techniques
4) RCS imaging concepts
5) Organizing radar cross-section range documentation
6) RCS uncertainty analysis
7) Test planning
8) Summary

III. Conclusion

In this paper, the planned changes and updates to the IEEE Standard, 1502™ IEEE "Recommended Practice for Radar Cross-Section Test Procedures have been outlined. The new standard will reflect the recent improvements in numerical tools, measurement technology and uncertainty estimates in the past decade.

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