

## **Waveport Vector Green's Function: A Tool for Realistic Use of the Scattered Field Volume Integral Equation in Inverse Scattering**

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One of the standard approaches for solving the electromagnetic (EM) and acoustic inverse problems is to use a volume integral equation formulation, relating the observed scattered field at the receiver locations to the unknown object properties and the total field inside the object. The unknown object profiles are then estimated, often by using iterative local or global optimization methods. While this is a mathematically viable approach that has shown good success in simulations, when it comes to actual inverse scattering experimental demonstrations, we are typically left with the problem of how to actually measure the scattered "field." Measurement systems (e.g., in the EM case) do not measure fields, but voltages. For the EM problem, some researchers have used empirical calibration strategies to relate the measured voltages to electric fields. This is a reasonable method, but it is difficult, even if possible, to come up with a set of calibration parameters for all possible observation scenarios involving different frequencies, observation angles, antenna types, etc. To address this problem, our group has proposed the "vector Greens' function" as an alternate formulation of the volume integral equation, where instead of the scattered electric field, the integral equation is written in terms of the voltage ratios that would be, for example, measured by a network analyzer. This new formulation has a built-in calibration that encompasses general observation scenarios. No additional calibration analysis is necessary, because the measured voltage ratios are directly used in the integral equation. The formulation, which is premised on the 3D modal expansion of the measurement system antenna and waveport model, derives a new Green's function for voltages as opposed to fields, and is therefore called a vector, as opposed to dyadic, Green's function. This presentation will go over the general formulation and various recent enhancement thereto, followed by showing a succession of experimental demonstrations and image reconstruction results.