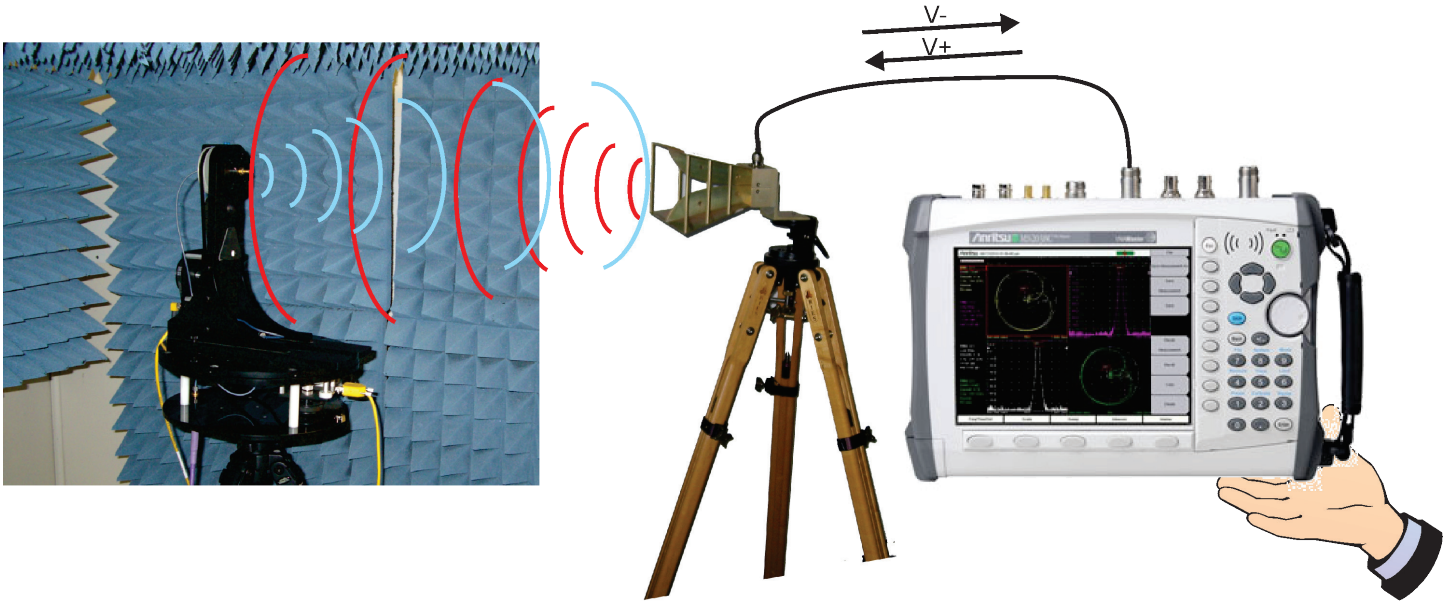
Diamond Engineering
Automated Measurement Systems

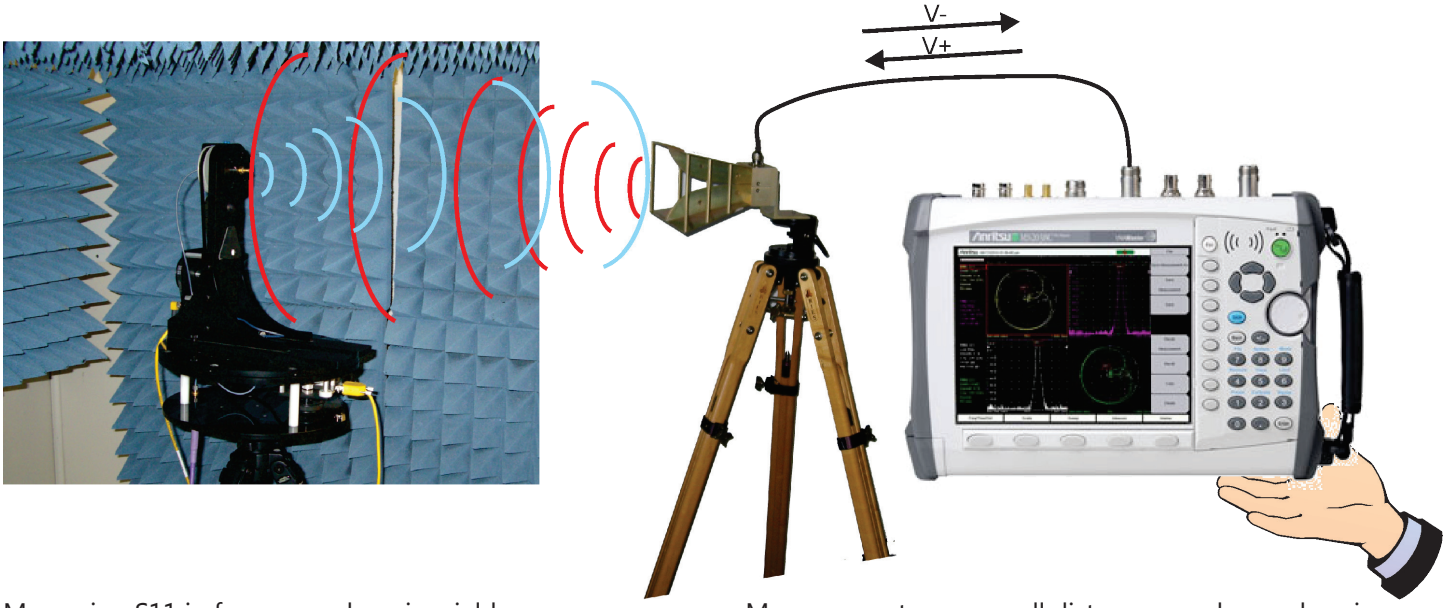
Application Note #0429
May 2012
Revised:

Measuring RCS with hand-held VNA

Application Note



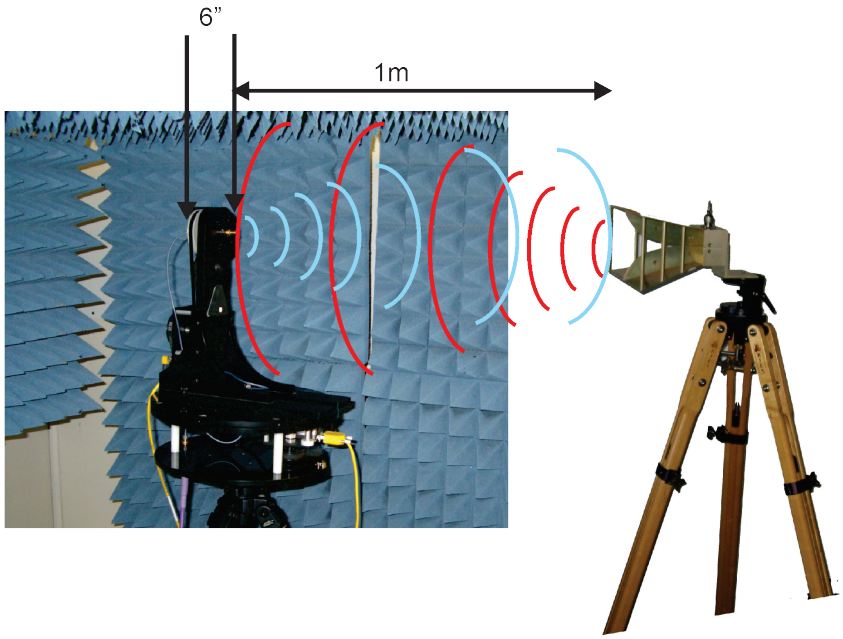
The advent of fast vna's with coherent frequency sources have made possible portable RCS measurement. This note demonstrates the use of the DAMs antenna measurement system and the Anritsu MS2038C hand held vna. The reflections of the DAMs FSM(Full Spherical Mount) will be measured using time domain and gated frequency measurement. The equivalent cross-section of the FSM will be determined in m^2 and dBsm. The DAMs FSM is constructed of Delrin. The bearings are also Delrin to reduce reflection. The homopolymer type Delrin has a dielectric constant of 3.7 and a low loss tangent of .005. The inherently low reflection requires a precision vna with sufficiently high frequency so as to resolve the small reflection cross-section.



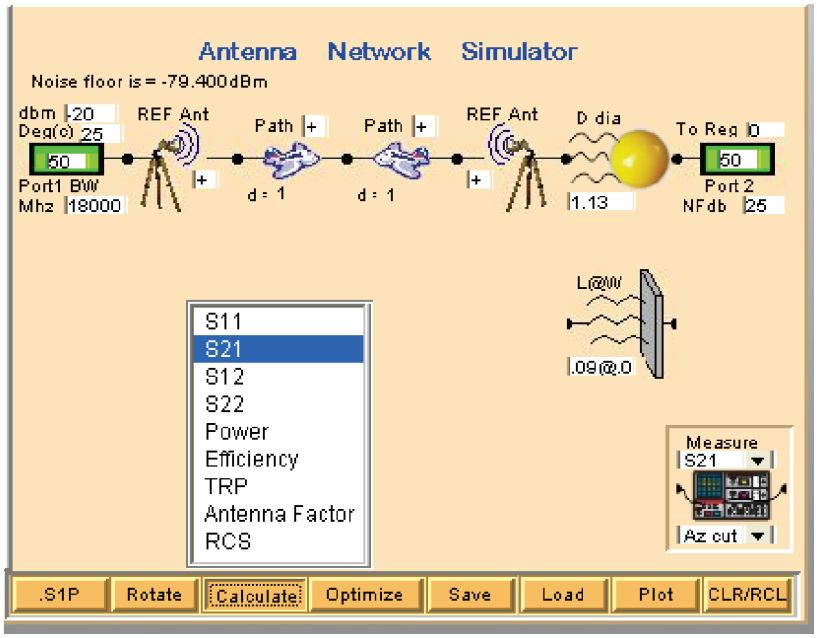
Measuring S11 in frequency domain yields the reference horn reflections. However, when measured over a sufficient number of frequencies, the Chirp Z transform converts the frequency/phase data to time/distance data.

Measurements over small distances can be made using only S11. Larger distances require S21 and two reference antennas. This is because the vna has greater S21 sensitivity and amplifiers can be employed.

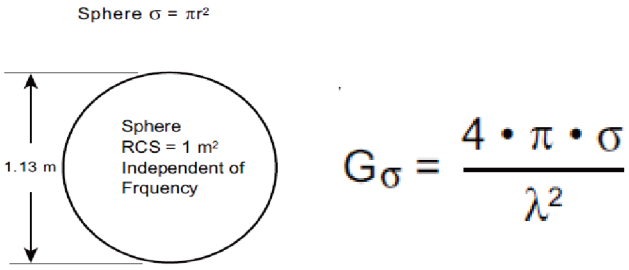
Emulate the RCS measurement using the DAMs Antenna measurement simulator



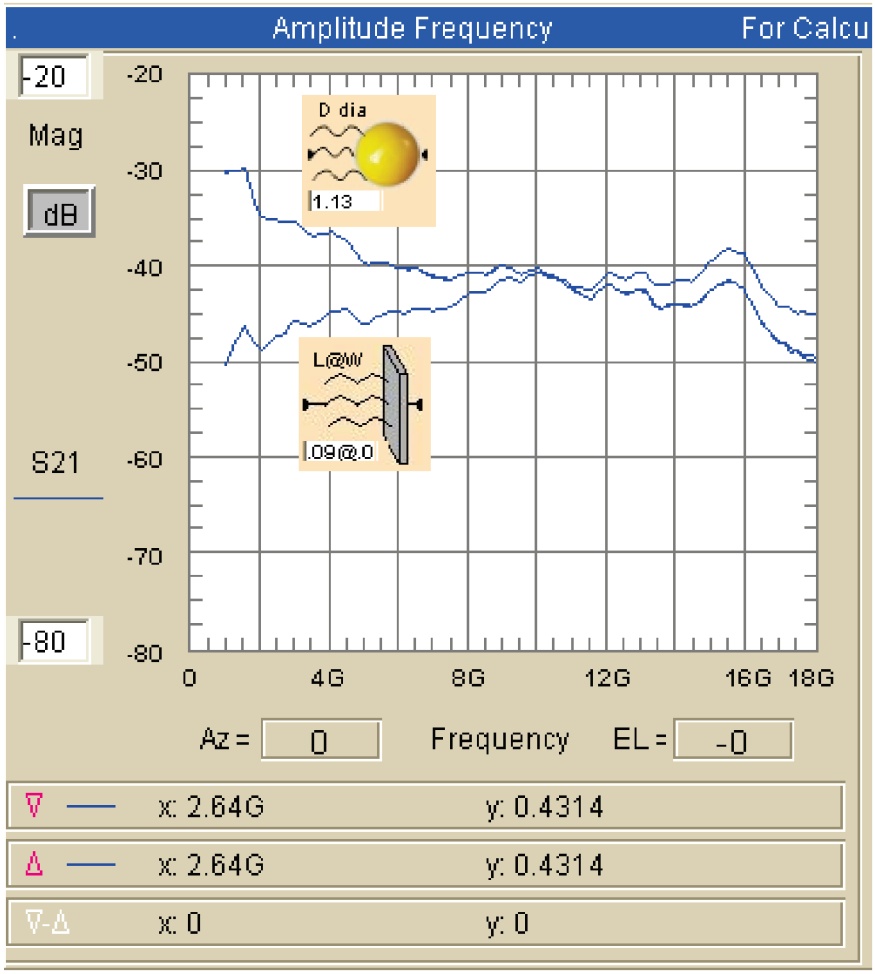
The cascade includes forward and reflected path and two trips through the reference horn



The 1.1m sphere is the standard for dBsm and has a frequency independent reflection crossection of 1m^2



The frequency data are the same at 10GHz for the 1.13m sphere and the .09m^2 plate. The measurement variations are functions of the reference horn. While the sphere has no RCS frequency variation, the plate has no measurement variation. In the DAMs it is necessary to import the reference horn and generate the path loss (buttons turn green).



Calibrate the vna for S11 vector measurement 1 to 18GHz with 401 points, Set the vna display to S11 and measure the reference horn S11.

Initiate time domain and distance. Notice the S11 drops to below -50dB at distance compared to the -10dB at near 0m(the horn reflection). With the plate reference at right angle (Use DAMs jog) store the trace into memory and display data and memory. The rotate the plate to full reflection and observer the position with the marker(1.25m) set to the peak change.

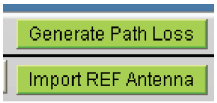
Set the measurement distance to 1.25m with a 6" range and apply the time gate so that only the plate reflection is seen.

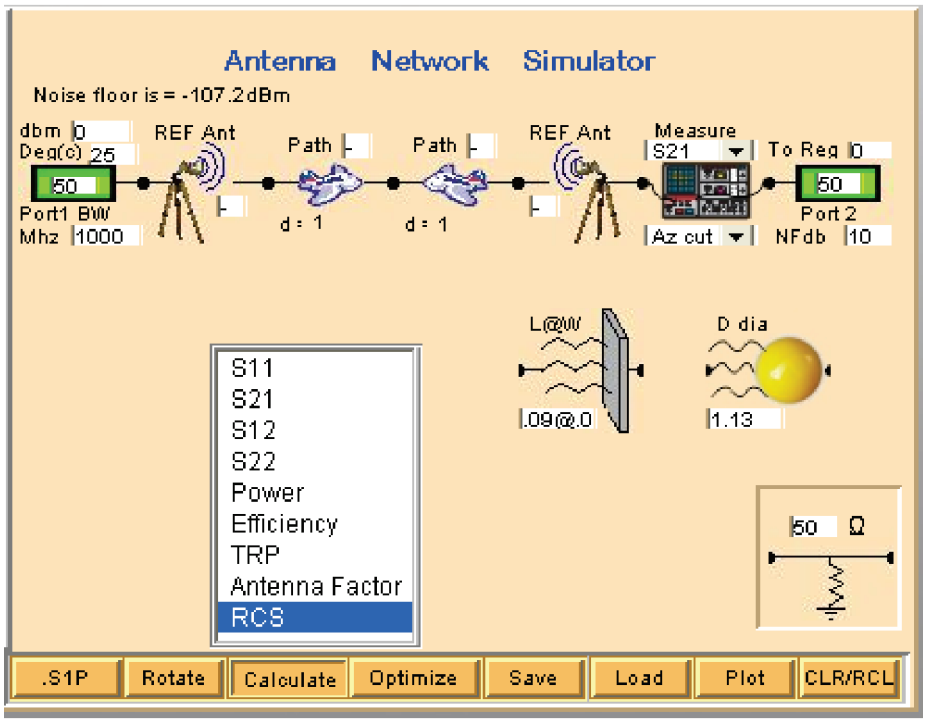
Set mode to Frequency With Time Gate and observe the plates reflection compared to the simulated measurement at 1m with the same size plate.

Now the gate is set and we are prepared to measure the FSM RCS.

With the DAMs Azimuth set to 0-360 with 10 degree steps, load the RCS measurement schematic and invoke the FSM RCS measurement/calculation. Minus (-) is de-embed.

In the DAMs it is necessary to import the reference horn and generate the path loss. The buttons will turn green after they've been calculated (as shown below).





The FSM crossection is more than 100 times smaller than a 1m sphere :