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7.5.1 MEASUREMENTS OF ANTENNA POLAR DIAGRAMS AND EFFICIENCIES USING A PHASE-SWITCHED INTERFEROMETER

R. A. Vincent, B. Candy, and B. H. Briggs

18972

Physics Department
University of Adelaide
Adelaide, South Australia 5001

AB830877

It is desirable for many reasons to know antenna polar patterns and efficiencies accurately. In the past, calibration measurements have been made using balloons and aircraft and more recently satellites. These techniques are usually very expensive. We show that under certain circumstances it is possible to use a simpler and inexpensive technique by connecting together the antenna under test with another antenna (not necessarily the same) to form a phase-switched interferometer as first described by RYLE (1952).

For two antennas separated by a distance d in the EW direction and with respective amplitude polar patterns of the form E_1 (θ) and E_z (θ), the interference pattern is given by

$$P(0) = k_1k_2E_1(\theta)E_2(\theta)\cos(\pi d/\lambda) \tag{1}$$

Here k_1 and k_z are constants determined by preamplifier gains and cable losses. If a point radio source drifts through the center of the beams then the envelope of the interference pattern is determined by the combined polar patterns of the antennas; if one antenna is much larger than the other then $P(\theta)$ is essentially determined by the larger antenna and its pattern can be so measured and compared with the theoretical pattern. We have applied this technique to measurements of the polar diagram of the co-co transmitting array (dimensions of $16\lambda \times 16\lambda$) used with the Adelaide VHF radar (BRIGGS et al., 1984). The second antenna was one of the yagi receiving arrays ($4\lambda \times 4\lambda$).

What does not so far appear to have been recognized is that this technique can also be used to measure the effective area and hence the efficiency, of arrays. This is because $E(\theta)$ is proportional to $\sqrt{A}$, where A is the effective area such that the received power can be written

$$P_{12} = k_1k_2(A_1A_2)^{1/2} \tag{2}$$

Suppose that the first antenna is replaced by a third antenna of known area e.g., a dipole located $\lambda/4$ above a perfect ground, then

$$P_{23} = k_1k_2(A_3A_2)^{1/2} \tag{3}$$

The ratio of (2) to (3) gives the ratio of the areas for antennas 1 and 3 in terms of the ratio of the measured interferometer powers. In principle, this technique is very simple. It does require a suitable radio source which gives measurable powers when using small antennas (e.g., dipoles) and since dipoles have broad patterns, radio sources with similar right ascensions but different declinations to the primary source can be a problem. These problems can partly be overcome by filtering the interference pattern. Measurements of the efficiencies of the Adelaide antennas are in progress.

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