Faraday Rotation Experiment

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Very high frequency polarimeters, working in conjunction with the Applications Technology Satellites, form a useful tool for monitoring ionospheric weather conditions. This article describes the installation of two such polarimeters at DSS 13.

Two new Faraday rotation tracking systems have been installed at DSS 13. These systems, often called polarimeters, working in conjunction with the Applications Technology Satellites at 136.35 MHz, provide information for the measurement of columnar electron content of the ionosphere. This installation replaces one which has been in service at DSS 13 since 1969. The purpose of this installation, aside from continued data collection, is to evaluate the performance and reliability of each system. This will lead to the selection of one system for use at the 64-m antenna stations in the DSN as part of the DSS Technical Facilities Subsystem. The polarimeters in use are the Teledyne Micronetics, Model 6501B, Faraday Polarization Tracking System, and the Aldi Research Corporation, Model 2000, VHF Polarimeter. Each polarimeter consists of an antenna system and a receiver. Data collection and recording equipment are shared by both polarimeters.

Each antenna system is comprised of a pair of geometrically orthogonal, linearly polarized antennas mounted on reinforced concrete pads about 50 m from the DSS 13 operations building. Each antenna is located to have an unobstructed view of the Applications Technology Satellites (Table 1). While the antennas are very similar, they do differ mechanically. The Teledyne antenna (Fig. 1) can be positioned in azimuth and elevation in fixed 5-deg steps and has a positive lock in each position. The antenna is not counterbalanced, however, and cannot be positioned by one person. The Aldi antenna (Fig. 2) is counterbalanced, provides infinite pointing resolution, and is held in position by a friction clamp arrangement. Some

mechanical fabrication was needed with both systems for the installation of antenna-mounted components. The antennas are connected to the receivers with cabling 70 m in length. The Teledyne system requires two coaxial cables only; the Aldi requires one coaxial cable and one multiconductor cable.

Published specifications for each receiver indicate that the performance of each should be similar. Operation of each receiver is also very similar and quite simple. The designs differ somewhat but basically each receiver provides a method of electronically producing the effect of antenna rotation to produce a modulation envelope on the received signal. It is this modulation envelope, when detected, filtered, and compared with the modulating reference signal, that forms the basis for polarization angle measurement. One significant difference between the receivers is apparent. The Aldi system uses a radio frequency pre-amplifier mounted at the antenna and could suffer less from antenna-to-receiver cabling loss. Both receivers were installed in the same standard equipment cabinet which also houses the laboratory-furnished recording equipment (Fig. 3).

The recording equipment consists of a signal conditioning portion, a time code generator, a digital recorder, a paper tape punch, and two dual-channel analog chart recorders. The chart recorders provide a real-time indication of system performance as well as a permanent record. A punched tape and digital recorder printout make up the remainder of the recorded data. Two outputs from each receiver are presently being recorded. The receiver outputs are calibrated on a daily basis, and the recorded data are sent to the laboratory at regular intervals for data reduction. In addition to the recorded data, a daily log of receiver tuning adjustments, relative signal strengths, and any system changes or malfunctions is maintained.

To provide a basis for fair evaluation of both systems, the manufacturer's installation, calibration, and operation instructions were followed as carefully as possible. The only deviations were in the case of omissions or mistakes in the instructions.

Operation of both systems, to date, has been good except on two occasions. The first resulted from the Aldi system's antenna being blown out of position in azimuth during a windstorm. On the other occasion, while tracking the Applications Technology Satellite Number 5 (ATS-5), the received signal strength from the satellite dropped to a level where the Teledyne system would not operate properly. The Aldi system continued normally although the output was obviously noisier. No other failures of any kind have been encountered.

At the present time, both systems are tracking ATS-1, which provides more than adequate signal strength for both systems.

Table 1. Antenna pointing coordinates

ATS	Azimuth, deg	Elevation, deg
1	232	40
3	119	25
5	162	48

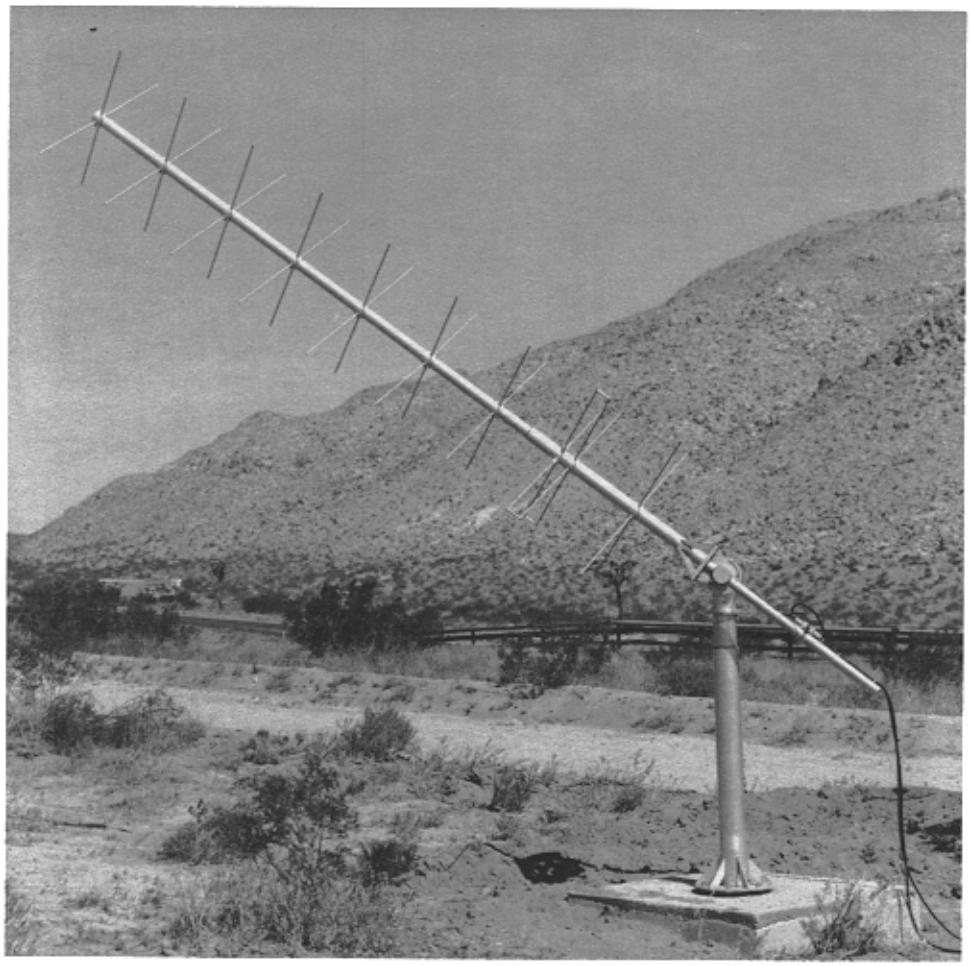

Fig. 1. Teledyne antenna installation

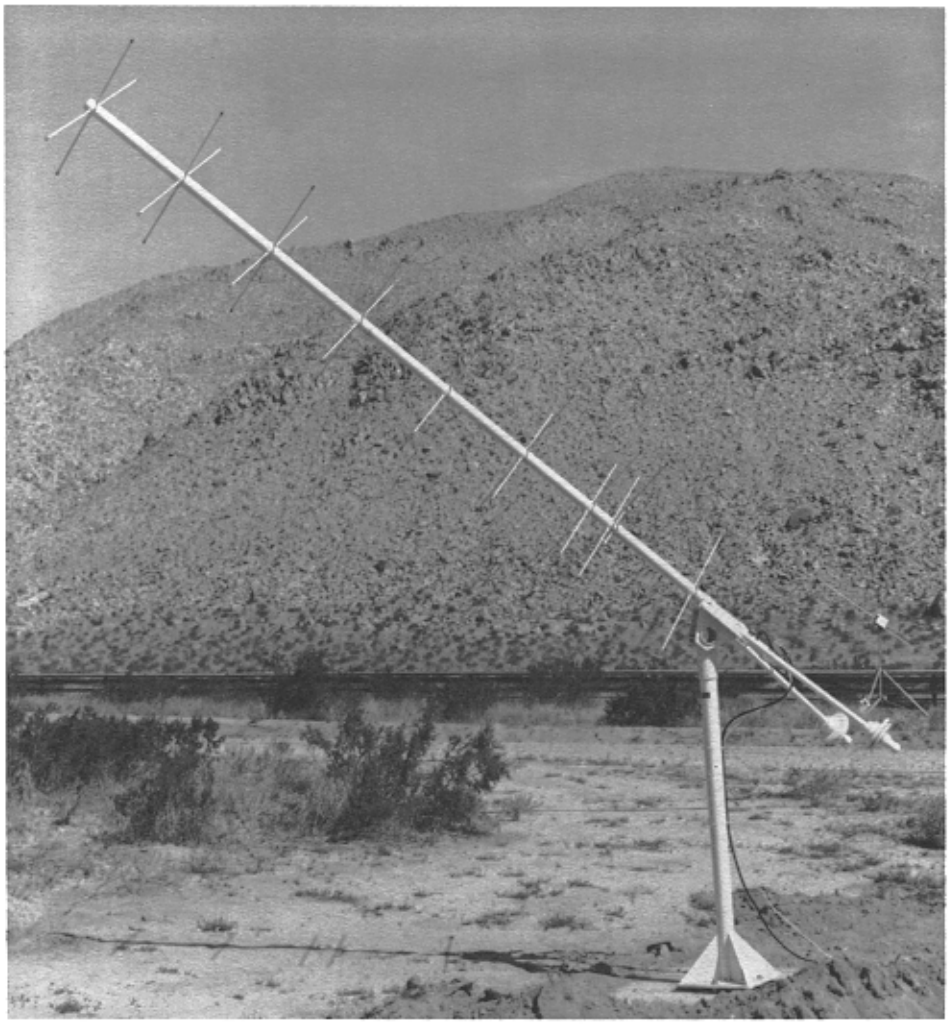

Fig. 2. Aldi antenna installation

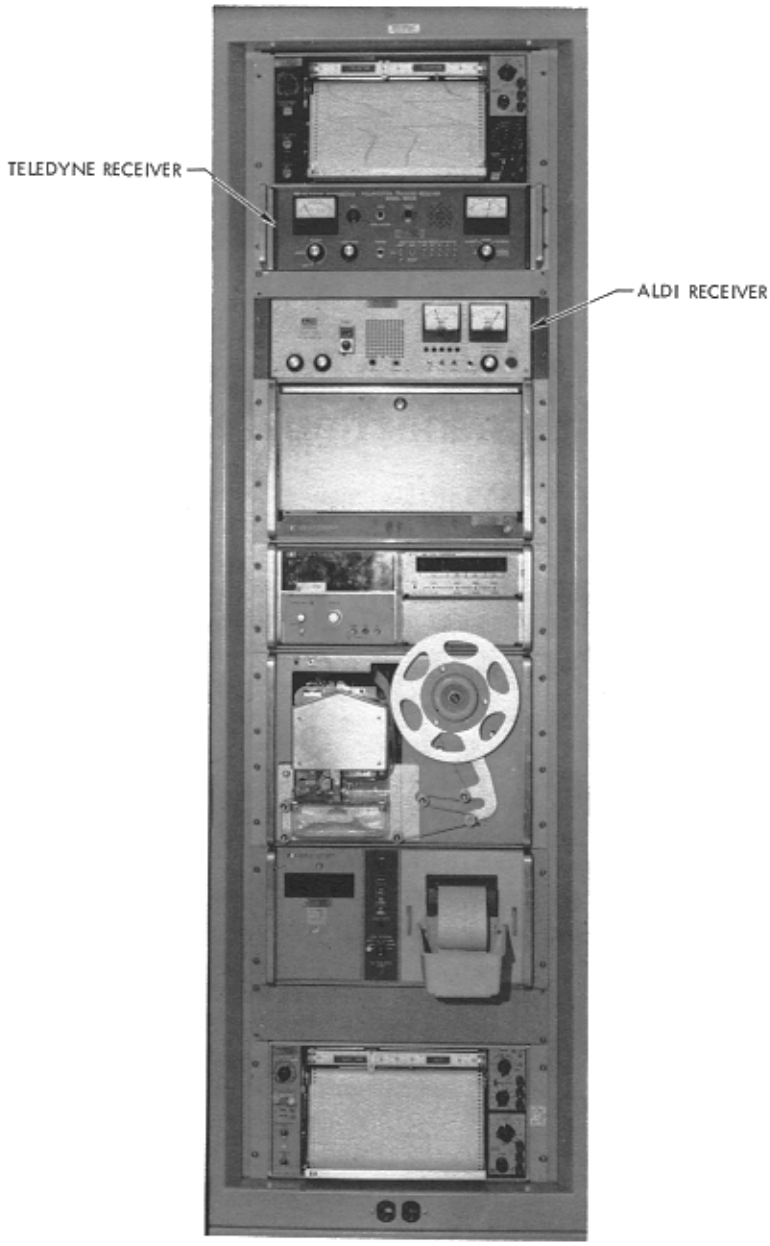

Fig. 3. Receiver and recording equipment installation