DSN Research and Technology Support

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The activities of the Development Support Group in operating the Venus Station (DSS 13) and the Microwave Test Facility (MTF) for the period August 16–October 15, 1972, are presented, categorized by JPL section supported. Major activities include a strong planetary radar and pulsar observation program for the Communications Systems Research Section, extensive precision antenna gain measurements for the Communications Elements Research Section, and a major installation and modification effort for dual-carrier experimentation for the RF Systems Development Section. Preliminary activity in measuring the side lobe patterns of the Venus 26-m-diameter antenna is described, and the cessation of clock synchronization transmissions (due to nonavailability of polynomial predicts) is noted.

During the two months ending October 15, 1972, the Development Support Group was engaged in the following activities.

I. DSS 13 Activities

A. In Support of the Communications Systems Research Section

1. Pulsars. Venus Station (DSS 13) continues to devote approximately 24 hours per week (a total of 188 hours during this period) to the observation of pulsars. Information obtained includes pulse-to-pulse spacing, pulse time of arrival, and pulse shape. Pulsars regularly observed (about 22 of the 50 known pulsars) were tabulated in Ref. 1.

2. Planetary radar. Continuing support of the Venus/Mercury 1973 spacecraft mission, ranging measurements to the planets Mercury and Venus, have been regularly made. Ranging measurements were made with a resolution of 5 μs (Venus) and 10 μs (Mercury) for a total of 100 good signal runs. These measurements are made using the 400 kW transmitter and 64-m-diameter antenna at DSS 14 for transmission and reception, with pseudonoise code generation, data processing, and control being performed at DSS 13.

B. In Support of the Communications Elements Research Section

1. Precision antenna gain measurement. The Apollo Lunar Surface Experiments Package (ALSEP) and radio sources Cassiopeia A, Cygnus A, Hydra A, Virgo A, and 3C123 were used as calibration sources from which data were obtained to calculate the absolute gain of the 26-m-diameter DSS 13 antenna. With a known antenna gain, the absolute flux density of the "calibrator" radio sources can be ascertained and used by other stations in the DSN. A total of 269 hours was devoted to stability testing and tracking radio sources, and 60 hours were devoted to tracking ALSEP. All measurements of the radio sources were performed using semiautomated data-taking techniques with the SDS-930 computer performing automatic boresighting. Tracking was performed using a DSS 13 computer program identified as Scan and Correct Using the Receiver (SCOUR).

2. *Weak source observation.* Measurements were made for a total of 185 hours on ten different radio sources (see Table 1 for sources and positions) and an additional 60 hours were spent on sky survey with the antenna fixed at various positions. Data taking is automated using the SDS-910 Computer for antenna pointing and boresighting and an HP 5360A Computing Counter with accessory plotter and printer for control and measurement.

3. *Side lobe patterns (26-m-diameter antenna).* Configurations of spacecraft which require tracking while pointing close to the sun (such as when the spacecraft are going through a sun occultation) result in problems with sun-generated interference entering the antenna through side lobe response. Data are being taken, using the 26-m-diameter antenna at DSS 13, of antenna patterns before and after the quadripod legs are covered with metal covers. From these data, prediction of similar response of the 64-m-diameter antenna can be made, and antenna positioning for close sun tracking can be optimized accordingly. The Communications Elements Research Section has been performing these measurements using a newly developed computer program which scans the antenna across a source with a raster scan similar to a television set raster scan. During this reporting period, a total of 58 hours of "computer-only" and 10 hours of actual antenna tracking were utilized.

C. In Support of the RF Systems Development Section

1. *Acceptance testing of 400-kW klystrons.* Two 400-kW, 2388-MHz klystrons (X3070), one repaired from an earlier failure, and one new, were received from Varian Associates and have successfully undergone complete testing to ascertain that performance is according to specification. These tests were performed in the High Power Test Area at Building G-53A.

2. *Dual uplink carrier testing.* In order to evaluate techniques of dual uplink carrier generation and methods of minimizing intermodulation resulting therefrom, an experimental facility has been established at DSS 13. This facility makes use of the 26-m-diameter antenna and the 100-kW DSN uplink frequency transmitter installed thereon. To perform testing and experimentation, the electronics room on the 26-m-diameter antenna has been equipped with a high-power harmonic filter, diplexer, maser, high-power coupler, two high-power water loads, a side-looking feedhorn, and appropriate waveguide switches, terminations, interconnecting waveguide, etc., to make a versatile test setup.

"Baseline" testing of the uplink system has been accomplished, and measurement of the intermodulation products existing in the receive band has begun. Methods of minimizing these intermodulation products will then be tested with the intent of establishing a technique by which dual carriers can be generated for support of MVM 73 with a minimum of interference to the downlink signal.

D. In Support of the DSIF Operations Section

1. *Clock synchronization transmissions.* Following schedules established by DSN scheduling, clock synchronization transmissions were made as indicated in Table 2. However, due to nonavailability of the necessary polynomial predictions (whose production has ceased), clock synchronization transmissions were terminated on September 27, 1972 (see Table 2).

II. Microwave Test Facility Activities

A. In Support of the RF Systems Development Section

1. *Dual uplink carriers.* The Microwave Test Facility has been engaged in two areas of dual carrier investigation: (1) installation of microwave components to allow diplexing in the DSIF bands on the Venus (DSS 13) 26-m-diameter antenna and (2) in cooperation with the Communications Elements Research Section, investigation of the noise properties of antenna panels and joints under RF radiation.

The installation of the microwave components for high-power diplexing was accomplished in two phases. Phase I consisted of installing a 400-kW harmonic filter and directional coupler at the output of the 100-kW DSIF transmitter in the electronics room of the Venus 26-m-diameter antenna. Phase II was the final test configuration with the addition of a diplexer, transmitting filter, maser, directional coupler, as well as load select and maser calibration waveguide switches. When Phase II was completed, the diplexer could be connected to the 26-m-diameter antenna, a water load, or a side-looking horn for isolation of noise sources. The components installed in Phase II were mounted as a subassembly on a "skid plate" for ease of removal or modification. Figure 1 is a block diagram of the Venus station electronics room as modified. System temperature (Fig. 1 configuration) was calculated to be 35 K and measured at 33 K. This difference can be attributed to waveguide runs that were shorter than originally estimated due to a relocation of the maser.

2. ***Personal electromagnetic radiation monitor.*** The breadboard stage has been completed on a personal RF (non-ionizing) radiation monitor. This unit is a pocket-sized audible-alarm device for warning personnel when they are exposed to an RF power density in excess of a preset limit. This unit is simple in design and operates from a 9-V transistor radio battery. To minimize current drain, the output of the antenna/detector is compared with a preset voltage level using a micropower operational amplifier (RCA CA3078T), and a COS/MOS gate (RCA CD4001E) is used as a gated oscillator. This unit can be set to respond to signals below 1 mW/cm^2 or a higher level, and has a standby power drain of less than 1 mA. Figure 2 is a schematic of the antenna/detector/comparator/gated oscillator stage.

3. ***Clock synchronization buffer crowbar.*** When a fault is detected in the 100-kW X-band clock synchronization transmitter, the radio-frequency drive is removed by means of crystal switches. Since these switches are operating at 7149.5 MHz, their insertion loss was approximately 5 dB. A crowbar circuit which removes the drive by removing beam voltage from the driver klystron was designed by Microwave Test Facility personnel and installed with a resultant increase in available drive, as a result of the removal of the crystal switches, of approximately 5 dBmW. This decreased loss remedied a marginal drive situation and enabled reduction of the operating voltage on the driver klystron with attendant increase in life and reliability.

B. In Support of the Communications Elements Research Section

1. ***Noise bursts on antennas.*** Experiments with antenna panel joints were performed at the Microwave Test Facility (in cooperation with Communications Elements Research Section personnel) to determine the noise characteristics of different methods of joining antenna panels. Figure 3 illustrates the test configuration for testing the various panels. A Cassegrain feed cone (Model SCU) was installed horizontally and illuminated an array of four panels set at a 45-deg angle. Since this particular feed cone did not have an internal diplexer, it was necessary to mount a diplexer, transmission filter, and maser external to the feedcone.

Noise bursts were encouraged by shaking the panels with an eccentric weight on the shaft of a 250-W (⅓ hp) electric motor (Fig. 4). Various methods of joining the panels have been tested and it is planned to further test these techniques on the Venus antenna in connection with other dual-carrier tests.

Reference

1. Jackson, E. B., "DSN Research and Technology Support," in *The Deep Space Network Progress Report*, Technical Report 32-1526, Vol. VIII, pp. 68–73, Jet Propulsion Laboratory, Pasadena, Calif., Apr. 15, 1972.

Table 1. Sources and source positions used in weak source observation program

Source	Position at time of observation	
	Right ascension, deg	Declination, deg
3C33	16.850	13.179
3C45	15.564	08.050
3C147	85.132	49.839
3C248	150.977	30.598
3C273	186.929	2.202
3C348	252.449	5.044
3C353	259.772	−0.957
Beta Lyrae	282.267	33.324
Cygnus X-1	299.326	35.266
Cygnus X-3	300.391	40.870

Table 2. Clock synchronization transmission

Station	Number of transmissions
DSS 41	16
DSS 42	2
DSS 51	6
DSS 62	4

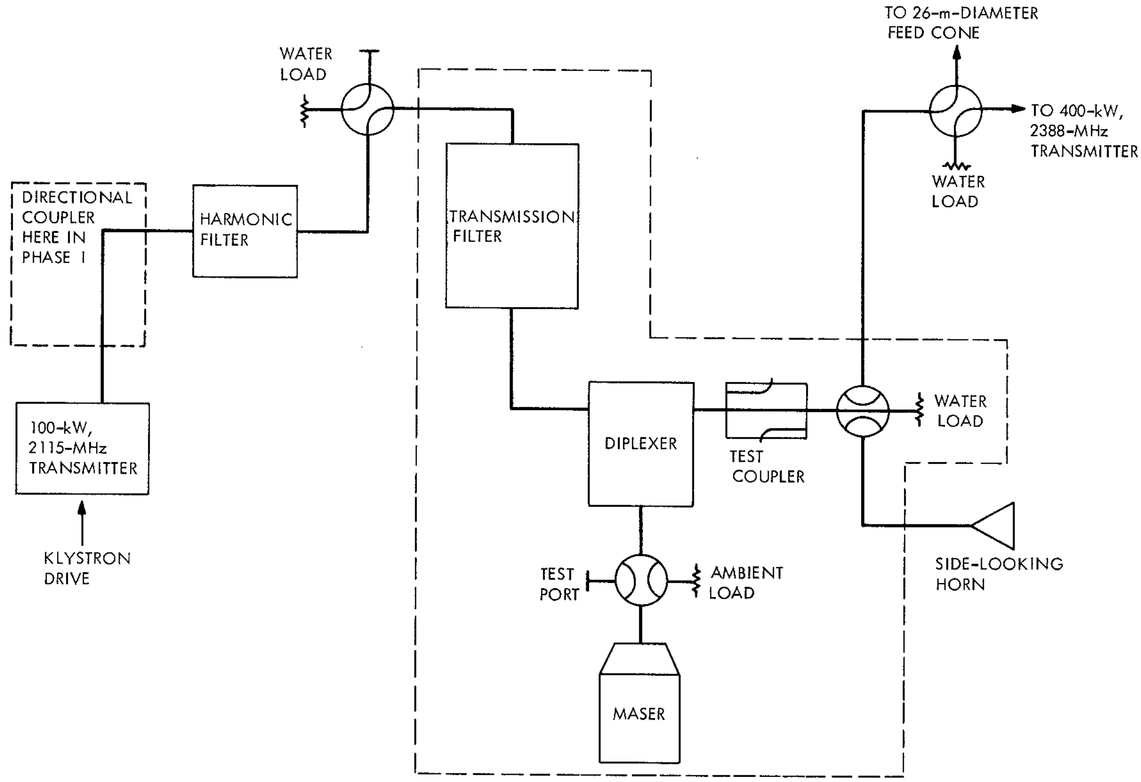

Fig. 1. Microwave configuration for dual carrier experiments at Venus 26-m-diameter antenna

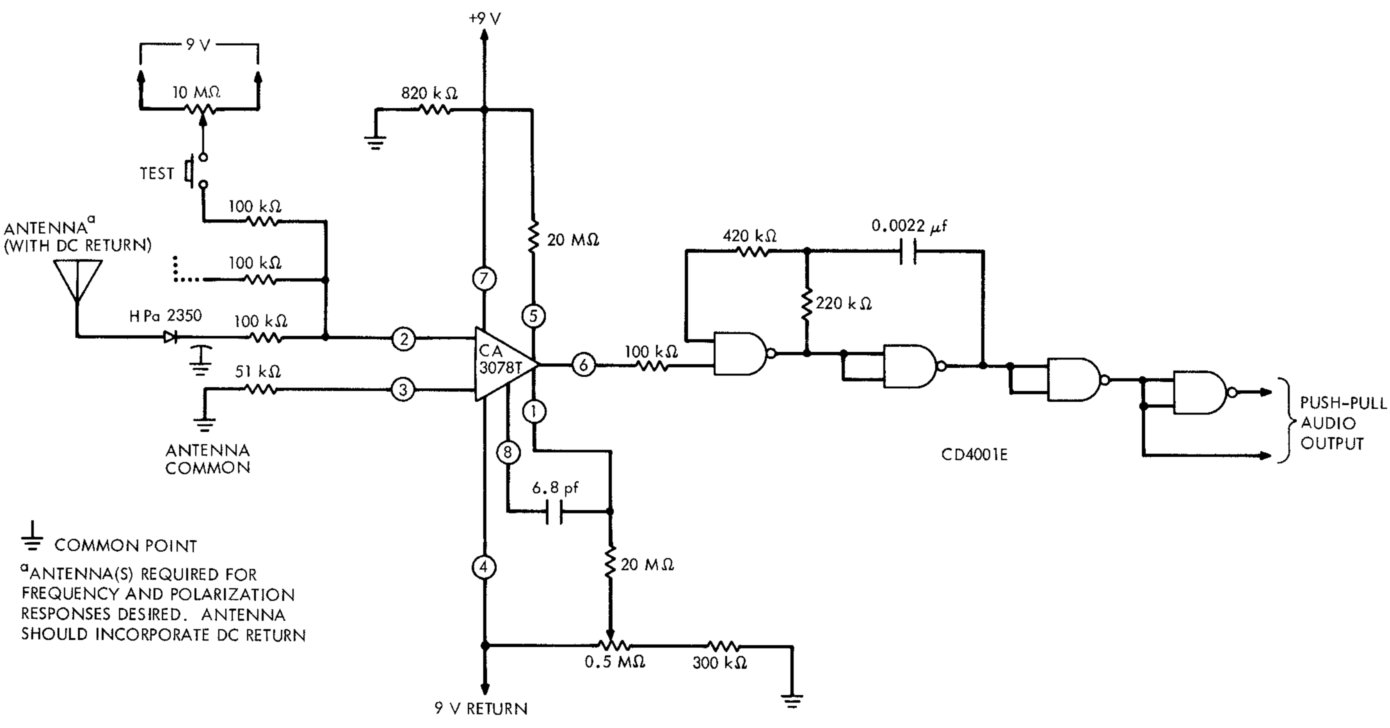

Fig. 2. Schematic diagram of personal non-ionizing radiation monitor

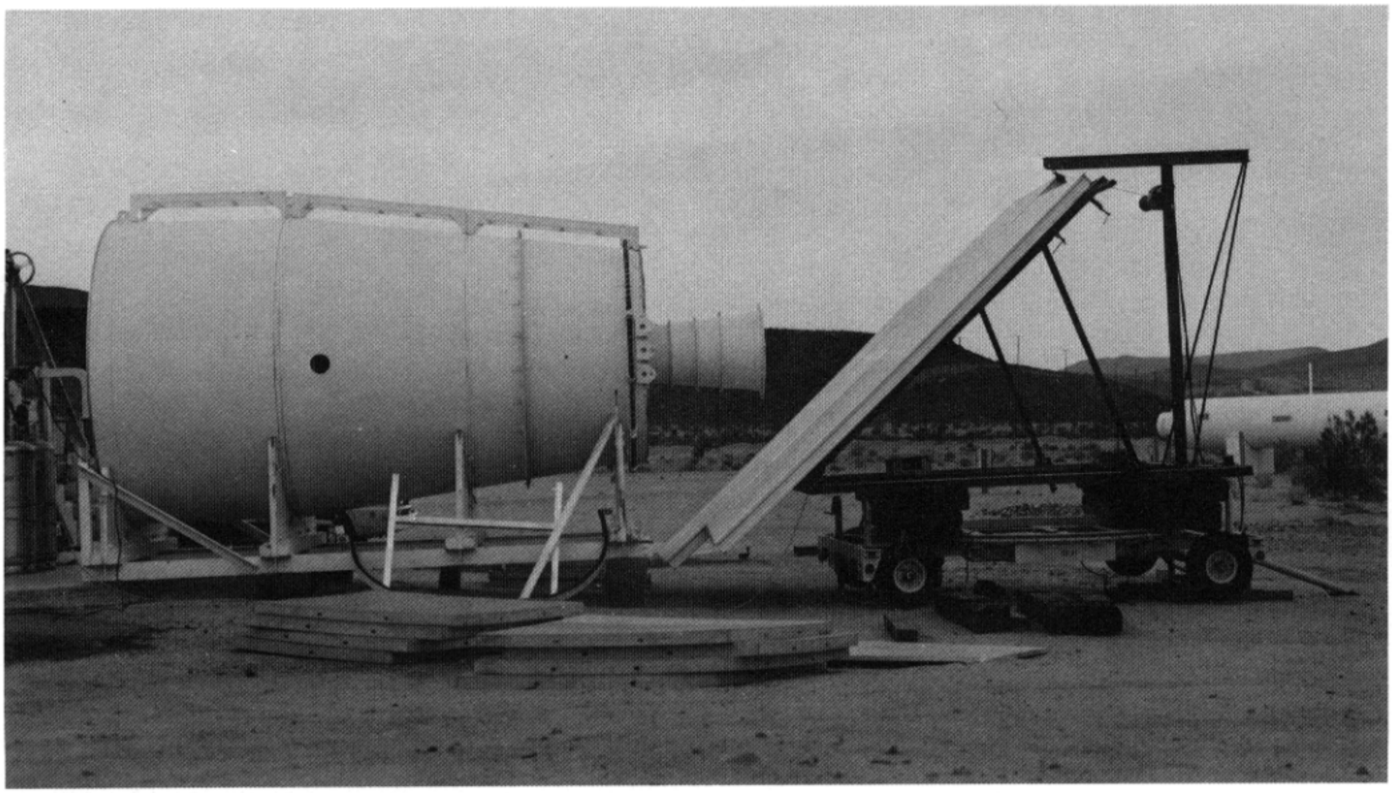

Fig. 3. Test setup for noise burst testing

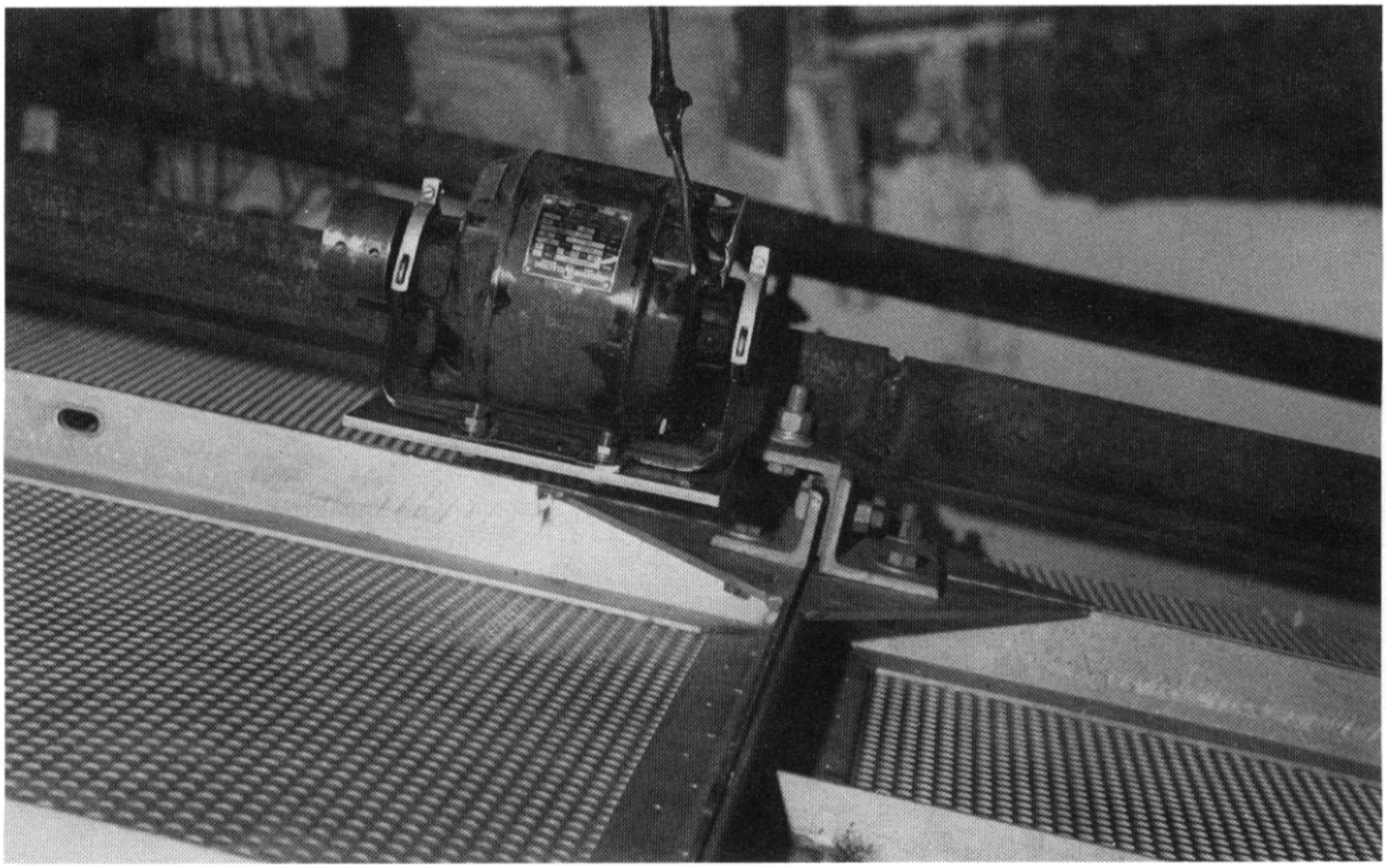

Fig. 4. Details of "panel shaker" arrangement