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Technical Memorandum 33-426

Volume V

Tracking and Data System Support for the Pioneer Project

Pioneer VI. Extended Mission: July 1, 1966 – July 1, 1969

N. A. Renzetti

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Preface

The work described in this report, the fifth in a series, was performed by the Tracking and Data Acquisition organization of the Jet Propulsion Laboratory. The report covers the technical activities of the Deep Space Network as related to the *Pioneer VI* extended mission. Volumes I through IV of the series present the nominal missions of *Pioneers VI, VII, VIII,* and *IX*. This volume is the first to record the extended mission activities of the *Pioneers*. It covers the support given to special *Pioneer* experiments made possible by the Mars 210-ft-diam antenna at Goldstone as well as solar syzygys, radial and spiral experiments, and superior conjunction and occultation experiments, which were made possible by the use of two or more spacecraft.

Acknowledgment

The author acknowledges the assistance of W. R. Barton, R. Santiestevan, R. E. Purdue, A. J. Siegmeth, and J. W. Thatcher in compiling this report. The author also acknowledges the support, in the form of informal reports and material, of the operations staffs of the various networks (NASCOM and DSN).

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Abstract

The *Pioneer VI* mission (inward trajectory, heliocentric orbit) employed six scientific instruments to accumulate information relative to interplanetary high-energy particles, solar phenomena, and plasma. The tracking of the spacecraft also made possible the support of a celestial mechanics experiment based on the radio metric data generated by the Deep Space Network. The network provided support for all of the science and engineering telemetry data return and transmission of commands to the spacecraft.

Part I. *Pioneer* Project and *Pioneer VI* Mission

I. Introduction

A. Objectives

Pioneer VI was the first in a second generation of unmanned spacecraft launched by the *Pioneer* Project under NASA control to collect data on interplanetary phenomena. The *Pioneer* Project was designed to provide a means to study the magnetic field, spatial plasma, cosmic rays, high-energy particles, electron density, electric fields, and cosmic dust within a region of 0.75 to 1.20 astronomical units (AU) from the sun. Data was analyzed to obtain knowledge of solar disturbances and the relationship between solar and galactic fields. The Project was initiated in 1958 as part of U.S. participation in the International Geophysical Year. Near-real-time data reduction and analysis was a part of a *Pioneer* space weather report teletyped regularly to U.S. Space Disturbance Forecast Centers.

Pioneer V, in closing out the first *Pioneer* generation, remained active in space more than 3 mo and was not lost to earth contact until it was 27.5 million km from earth. This was a new record.

Pioneer VI was launched December 16, 1965, on an inward trajectory to heliocentric orbit, perehelion near 0.80, and aphelion near 0.98. (The launch vehicle was a thrust-augmented improved *Delta* or DSV-35.) Completing the near-earth phase on launch day, the spacecraft was successfully tracked by the 85-ft-diam antenna stations of the Deep Space Network (DSN) until June 29, 1966. The *Pioneer VI* spacecraft was then officially acquired by the DSN's only 210-ft-diam antenna station for what was designated an "extended flight" phase.

Before launch, the life expectancy for *Pioneer VI* spacecraft was estimated to be 6 to 8 mo. Later, the estimate was changed to 5 yr or more, with the capability of the completed 210-ft-diam antenna at Mars station (DSS 14), Goldstone, Calif. Improvements also increased the capabilities of the 85-ft-diam antenna stations. The spacecraft was expected to return to satisfactory contact

Table 1. DSN station designations and locations

Location	Station number	Geodetic latitude	Geodetic longitude	Height above mean sea level, m	Geocentric latitude	Geocentric longitude	Geocentric radius, km
Goldstone, Calif. (Pioneer)	11	35.38950°N	243.15175°E	1037.5	35.20805°N	243.15080°E	6372.0341
Goldstone, Calif. (Echo)	12	35.29986°N	243.19539°E	989.5	35.11861°N	243.19445°E	6372.0176
Goldstone, Calif. (Venus)	13	35.24772°N	243.20599°E	1213.5	35.06662°N	243.20507°E	6372.2599
Goldstone, Calif. (Mars)	14	35.42528°N	243.12222°E	1160	35.24376°N	243.12127°E	6372.1341
Woomera, Australia	41	31.38314°S	136.88614°E	144.8	31.21236°S	136.88614°E	6372.5317
Tidbinbilla,[a] Australia	42	35.40111°S	148.98027°E	654	35.21962°S	148.98027°E	6371.6686
Johannesburg, South Africa	51	25.88921°S	27.68570°E	1398.1	25.73876°S	27.68558°E	6375.5415
Madrid, Spain (Robledo)	61	40.429°N	355.751°E	800	40.238°N	355.751°E	6370.0868
Cerebros, Spain	62	—	—	—	—	—	—
Cape Kennedy, Fla.	71	28.48713°N	279.42315°E	4.0	28.32648°N	279.42315°E	6373.2913
Ascension Island[b]	72	7.95474°S	345.67242°E	526.7	7.89991°S	345.67362°E	6378.2386

[a]Formerly listed as Canberra.
[b]No longer operated by DSN.

with the DSN's 85-ft-diam antenna stations during the second half of 1970. (*Pioneer VI* support by the DSN was to be terminated if the telemetry bit error rate reached an unacceptable level.)

This document reports the first three years of extended flight phase support in annual increments. Table 1 lists the DSN stations and locations during the period reported.

B. Tracking and Data Acquisition Support

The Tracking and Data System (TDS) began support of *Pioneer VI* during the near-earth phase (launch until deep space station two-way lock with the spacecraft) by tracking the spacecraft. It thereby acquired launch vehicle and spacecraft telemetry data (generating metric data through C-band radar tracking of the transponder on the launch vehicle and S-band radio tracking of the transponder on the spacecraft) and also transmitted commands to the spacecraft.

The TDS was made up of the Air Force Eastern Test Range (AFETR), Manned Space Flight Network (MSFN), NASA Communications System (NASCOM), and the DSN. This report is concerned with the activities of the DSN, which was under management and technical direction of the Jet Propulsion Laboratory, California Institute of Technology. Ames Research Center (ARC) was the manager of the *Pioneer* Project.

1. DSN configurations. The DSN had the capability for two-way communication with spacecraft travelling as near as 10,000 miles from earth and as far as interplanetary distances. Facilities of the DSN were the Deep Space Instrumentation Facility (DSIF) for data acquisition and transmission, the Ground Communications Facility (GCF) for data transfer, and the Space Flight Operations Facility (SFOF) for data processing. DSN systems were tracking, telemetry, command, simulation, monitoring, and operations control. Figure 1 diagrams the DSN and *Pioneer* Project systems. Figure 2 is a DSN facility-system matrix.

The 85-ft-diam antenna stations that supported the *Pioneer VI* spacecraft in the deep space flight phase were Pioneer (DSS 11) and Echo (DSS 12), both at Goldstone, Calif., Woomera (DSS 41) and Tidbinbilla (DSS 42), in Australia, Johannesburg (DSS 51), in South Africa, and Robledo (DSS 61), Madrid, Spain. The DSN objectives were:

(1) Acquire spacecraft engineering and science data via telemetry.

(2) Provide for positive control of spacecraft.

(3) Provide for accurate spacecraft navigation by generating radio metric data.

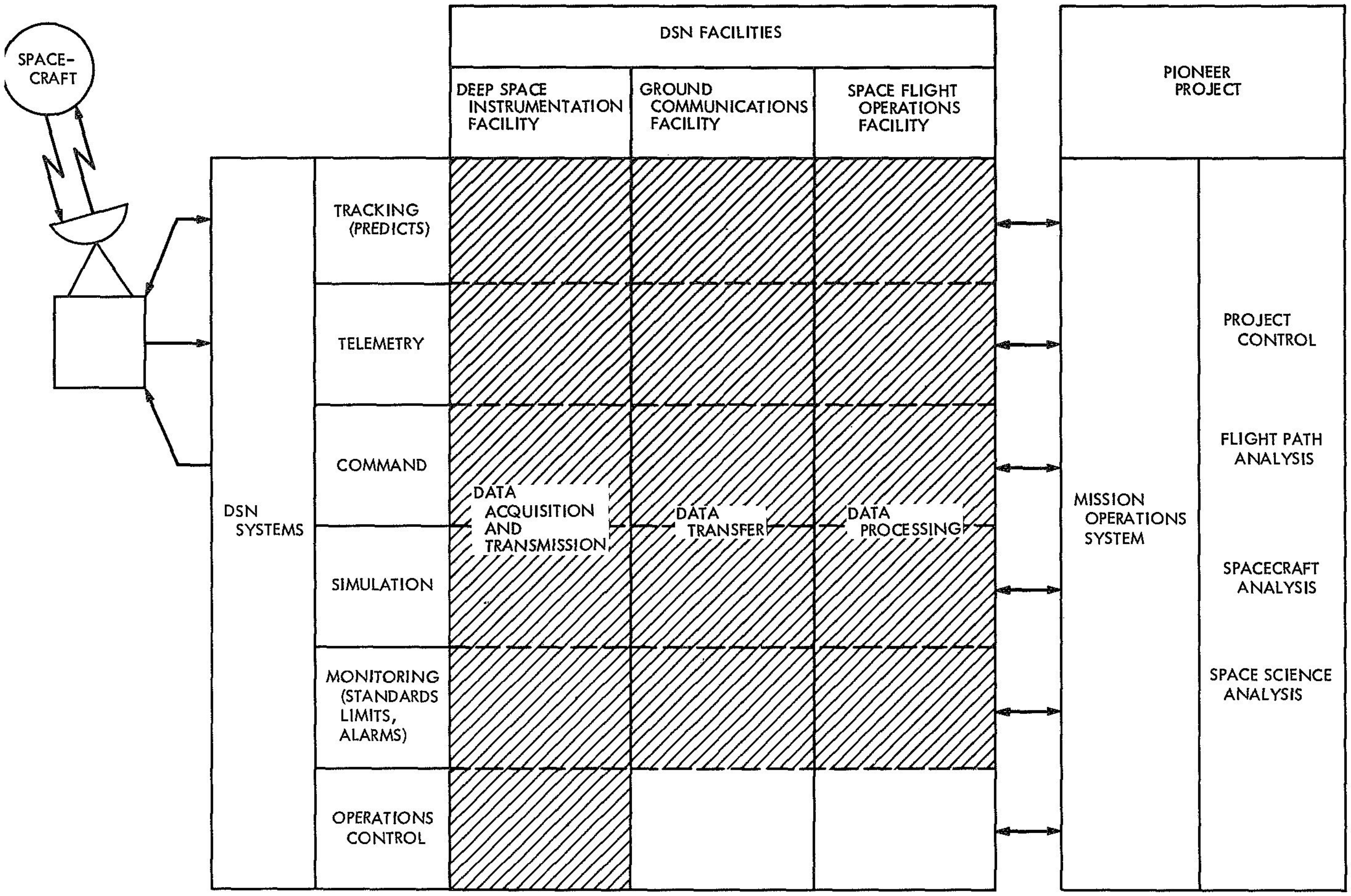

Fig. 1. DSN and *Pioneer* Project systems diagram

(4) Provide support for a number of complex missions concurrently.

(5) Provide master data records of validated data in near-real-time.

The DSN was capable of providing 24-h coverage for spacecraft. This requirement was important for flexibility in planning missions and providing maximum data return and also for immediate detection of spacecraft failure and initiation of recovery procedures. If mission density required two such 24-h-coverage networks, then the alternate network provided coverage for a station outage. Station locations were approximately 120 deg apart in longitude and within a band of 35 deg latitude on each side of the equator. This provided continuous coverage of spacecraft in the ecliptic plane in most cases.

The amount of data processing or data compression activity at tracking stations depended greatly on the

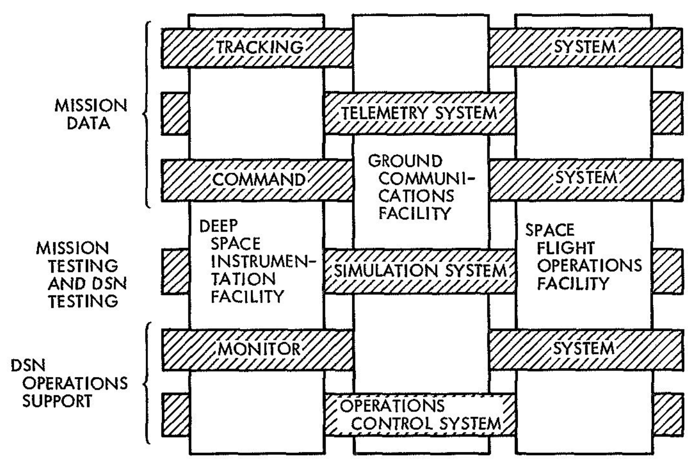

Fig. 2. DSN facility, system matrix

bandwidth, signal-to-noise quality, and reliability of the ground interstation communications network. The characteristics of ground communications facilities dictated that data processing and compression be available at tracking stations. Ideally, in the interests of simplifying the deep space station design and reducing station costs, it was desirable to transmit the baseband data directly from the receiver to a central facility, where the data would be detected and/or formatted for local use. This required a reliable, continuously available, wideband (<2 MHz) duplex channel between the control center and each station. The situation required that a certain amount of data processing and compression for tracking data formatting, telemetry bit and word detection, and command formatting be used at the stations. The ground communication system could make use of a common carrier to convey this material to the stations, but it was more economical, when standard communication circuits were required for several networks, to have a centralized agency; NASCOM (National Aeronautics and Space Administration Communication Network) provided this service. Such centralized service provided high-speed data lines (2400 bits/s), voice, limited wideband lines, and teletypewriter circuits via ground or communications satellite facilities.

The control center (SFOF) provided a central processing system and areas dedicated to several spacecraft mission control operations. The control center also provided the control function for operation of the space communication stations, ground communication facilities, and the control center itself.

2. *Pioneer* design concepts. The *Pioneer* data system was developed to provide (1) a highly efficient telemetry channel compatible with the DSN, (2) a capability for the DSN to generate two-way coherent doppler measurements while the spacecraft was tracked, and (3) an earth-to-spacecraft command capability to control the spacecraft subsystems and science payload.

a. Spacecraft radio frequency subsystem. The radio frequency subsystem included three antennas (one high-gain and two omnidirectional), a transmitter driver, two redundant traveling-wave-tube (TWT) power amplifiers, two redundant receivers, coaxial switches, filters, and diplexers. Switch position was controlled by ground command. The beam of each of the antennas was axially symmetrical with the spacecraft spin axis, which was perpendicular to the ecliptic plane. The beamwidth of the omnidirectional, or low-gain, antenna was 110 deg, and the beamwidth of the high-gain antenna was 5 deg.

The power output of the spacecraft transmitter exciter was 44 W and could be switched by ground command to the low-gain antenna or used as a driver for the two TWT power amplifiers. Each amplifier had a power output of approximately 7.7 W and could be turned on or off or switched to either the low- or the high-gain antenna by ground command. The auxiliary oscillator was modulated by a 2048-Hz squarewave subcarrier as part of a PCM/PSK/PM telemetry system.

The spacecraft had two partially redundant (redundançy limited by the antenna configurations) phase-lock receivers. Each operated on a different frequency and was powered at all times; the desired receiver was thus selected by the frequency of the ground transmitter.

b. Spacecraft command subsystem. The command subsystem consisted of two redundant decoders and a command distribution unit (CDU). The input signal to both decoders was the demodulated signal from either of the spacecraft receivers. The desired decoder was selected by command address.

The command message was a 23-bit word arranged in the following order:

5 bits, preamble.

3 bits, decoder address.

7 bits, command complement.

7 bits, command.

1 bit, post-squelch.

The command and command complement were compared within the decoder on a bit-by-bit basis, and the command-execute signal from the decoder was inhibited when errors occurred. The ones and zeros within the message were represented by two audio tones. The command carrier was phase-modulated by these tones at the rate of 1 bit/s.

c. Spacecraft telemetry subsystem. The generation of timing and status signals, analog-to-digital conversion, data retrieval and processing for telemetry, and data storage on the spacecraft was accomplished by the digital telemetry unit (DTU), the signal conditioner, and the data storage unit (DSU).

The output of the DTU was a 2048-Hz squarewave which was biphase-modulated with the time-multiplexed PCM bit train using a non-return-to-zero-mark format. This squarewave phase-modulated the transmitted carrier in all modes of operation.

The DSU had a capacity of 15,232 bits. Readout from the memory unit was destructive and, once initiated, could not be temporarily interrupted by ground command without destroying the remaining data in the unit. Furthermore, the unit had to be cleared of any data stored there, either by ground command or by readout of stored data, before a new storage cycle was begun.

By ground command, one of four operating modes and one of five bit rates could be selected for operation of the DTU. The operating modes were (1) real-time, (2) telemetry store, (3) duty cycle store, and (4) memory readout. The bit rates were 512, 256, 64, 16, and 8 bits/s.

Data quality for *Pioneer VI* was determined by the error-rate printout on the engineering data. In addition, Ames Research Center kept plots of error-rate printout values. An error-rate printout of 0.116 corresponded to one error in 1000 bits of information and was used as a criterion for good data. (If the parity error rate was not less than this value, the bit rate was dropped to the next lower value.) Primary interest was in data for the time interval beginning 3 h prior to the time of maximum spacecraft elevation and extending until 3 h after. Some passes terminated more than 3 h before the spacecraft reached maximum elevation, and parity error rates were calculated from such data as was available.

Varying amounts of data were lost or degraded in locking the receiver in a two-way mode on each pass; the amount varied because of the round-trip light time (RTLT), which increased as the spacecraft's distance from earth increased. Spacecraft acquisition time also contributed a small portion of lost or bad (degraded) metric data. Receiver-lock was essential for good data recovery.

In the real-time mode, the information was transmitted directly in the format and bit rate selected. In the telemetry-store mode, data was stored and transmitted simultaneously in the selected format and bit rate. In the duty-cycle-store mode, data was stored intermittently in groups of 224 bits each at a rate of 512 bits/s. The period between groups stored could be selected by ground command to provide partial data coverage for periods up to 19 h. The memory-readout mode provided the capability for retrieving the data stored. When readout was complete, the DTU reverted automatically to the real-time mode in the format and at the bit rate in use prior to the readout.

The spacecraft data word was composed of 7 bits. The first 6 bits transmitted were generally information and the seventh indicated parity. Odd parity was employed by sampling the first, third, and fifth bits.

d. Mission-dependent ground equipment. This equipment consisted of a demodulator/synchronizer, a command encoder, and a computer buffer. A DSN computer was used at the station to:

(1) Provide selected telemetry data for teletype transmission to the SFOF.

(2) Monitor the engineering data for out-of-limit occurrences.

(3) Provide computer typewriter printout of selected data.

(4) Display selected spacecraft parameters as required.

(5) Transmit command messages on instructions from the SFOF.

(6) Check command messages for validity before transmission.

(7) Verify that commands were being transmitted correctly.

(8) Maintain a command accountability list.

The complete data stream was recorded on magnetic tape for subsequent data processing and analysis.

3. ***Extended flight phase support requirements.*** Almost from launch of the *Pioneer VI* spacecraft, mission requirements for TDS support increased. Changes resulted, in the main, from the spacecraft's increased life expectation, and the added possibilities from an extension of reach by the DSN.

a. Guidelines. Mars station (DSS 14), which was not yet operable at launch, was made available on a best-effort basis for *Pioneer VI*. However, the support Instrumentation Requirements Document (SIRD) and the NASA Support Plan (NSP) for *Pioneers VI, VII,* and *C* were completed in 1967. Looking ahead to extended phase coverage of *Pioneer VII*, which had been launched in August 1966, and spacecraft of outside projects, the NSP adjusted the early support commitment. The new guidelines called for the Mars station to furnish a minimum of 180 h per month for tracking and data acquisition support for *Pioneer* spacecraft. This minimum tracking time was to be increased whenever possible. (Requirement revisions were made on a periodic basis.)

b. Early Operation. Regular acquisition of *Pioneer VI* by DSS 14, with the Goldstone Echo station (DSS 12) and the microwave link, officially took place June 29, 1966. At that time the 210-ft-diam antenna was used for downlink only; the 10-kW transmitter at Echo was used for uplink. To conduct command and real-time data transmission activities, the microwave link was used between the Mars and Echo stations. Last acquisition of *Pioneer VI* by Echo was July 13, 1966. (Previous to use for *Pioneer VI*, DSS 14 had its first operational use in support of the *Mariner* Mars 1964 mission solar occultation experiment in March of 1966. Only the station receive capability, augmented with R&D equipment, was used. As the station's capabilities had become available during construction, they were verified through use of the *Mariner IV* spacecraft S-band telecommunications system.)

c. Restrictions. Because the Mars station was the only facility with the 210-ft-diam antenna, required hardware modification and testing at the station sometimes interrupted regular tracking operations. (DSN plans called for construction of two additional 210-ft-diam antenna stations: one in Australia and one in Spain.)

4. Advanced antenna system facility description. The 210-ft-diam advanced antenna system (AAS) at Goldstone, Calif. (Fig. 3), increased the DSN range two and a half times. Under limited communications conditions, the system reached to the edge of the solar system. The improved capability provided six and a half times more transmitting power and receiving sensitivity for the DSN than was available with 85-ft-diam antennas. The 210-ft antenna had a gain of approximately 60 dB in transmitting and 62 dB in receiving. The 85-ft antennas had a gain of 51 dB transmitting and 53 dB receiving. The beamwidth was 0.1 deg at Mars and 0.35 deg for 85-ft antennas.

The added capability permitted either extension of communication distances in space or acquisition of more data from spacecraft at shorter ranges. Because the new station located more of the complex equipment on the ground, less complex and more reliable communication equipment could be carried by spacecraft. The 210-ft antenna, a parabolic reflector with an azimuth-elevation mount, had a specified lifetime of 10 yr and an expected lifetime of 20 to 50 yr. It was capable of operation 24 h a day, 365 days a year.

The operating and signal-processing techniques used for the 210-ft antenna were basically the same as those used for the 85-ft antennas. The huge reflector was tuned to collect spacecraft signals coming from such distances that their energy was measured in billionths of a billionth of a watt. These signals were amplified and fed into receivers, and the data forwarded to the SFOF in Pasadena.

Tracking of the spacecraft began as it appeared above the horizon. Frequency, time, and angle data of the predicted trajectory was supplied by teletype from the SFOF and other DSN stations. Signal acquisition and lock-on were normally achieved in 4 to 10 min. The antenna was then switched to the automatic mode and tracked until the spacecraft disappeared below the horizon.

The 210-ft antenna operated in either of two pointing modes, depending on the nature of the mission being covered. It was pointed so as to track the spacecraft signal automatically, as did the 85-ft antennas, or the pointing information was sent to the 210-ft antenna master equatorial reference system, which then designated the path for the antenna.

Like other DSN antennas operated at frequencies of 2100 MHz transmitting and 2300 MHz receiving, the DSS 14 antenna incorporated a Cassegrain cone feed, mounted at the center of the reflector. (During March of 1968, an ultracone was installed. This improved the downlink signal strength by some 5 dBmW for one-way tracking.) The Cassegrain design was similar to that of an optical telescope. Signals reflected from the main dish hit a subreflector mounted on a truss-type support extending outward from the center of the dish. The subreflector focused the signal into the feed horn in the Cassegrain cone, where it was amplified by a maser.

The maser was capable of accomplishing maximum amplification of the signal while, at the same time, generating a minimum of background noise. Because heat was a major source of noise, the maser was immersed in liquid helium to maintain its temperature at 4.2°K. The

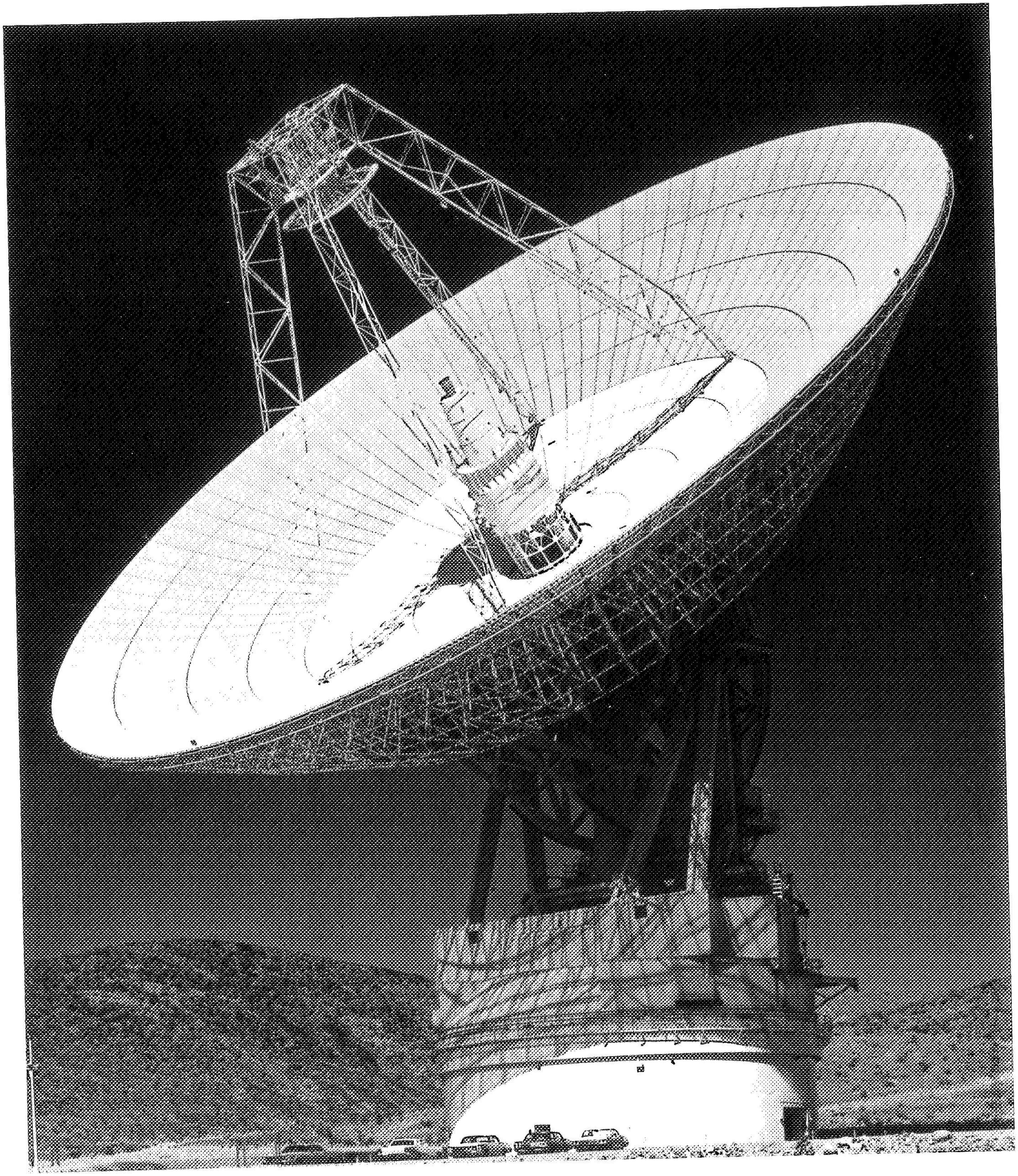

Fig. 3. View of 210-ft-diam antenna

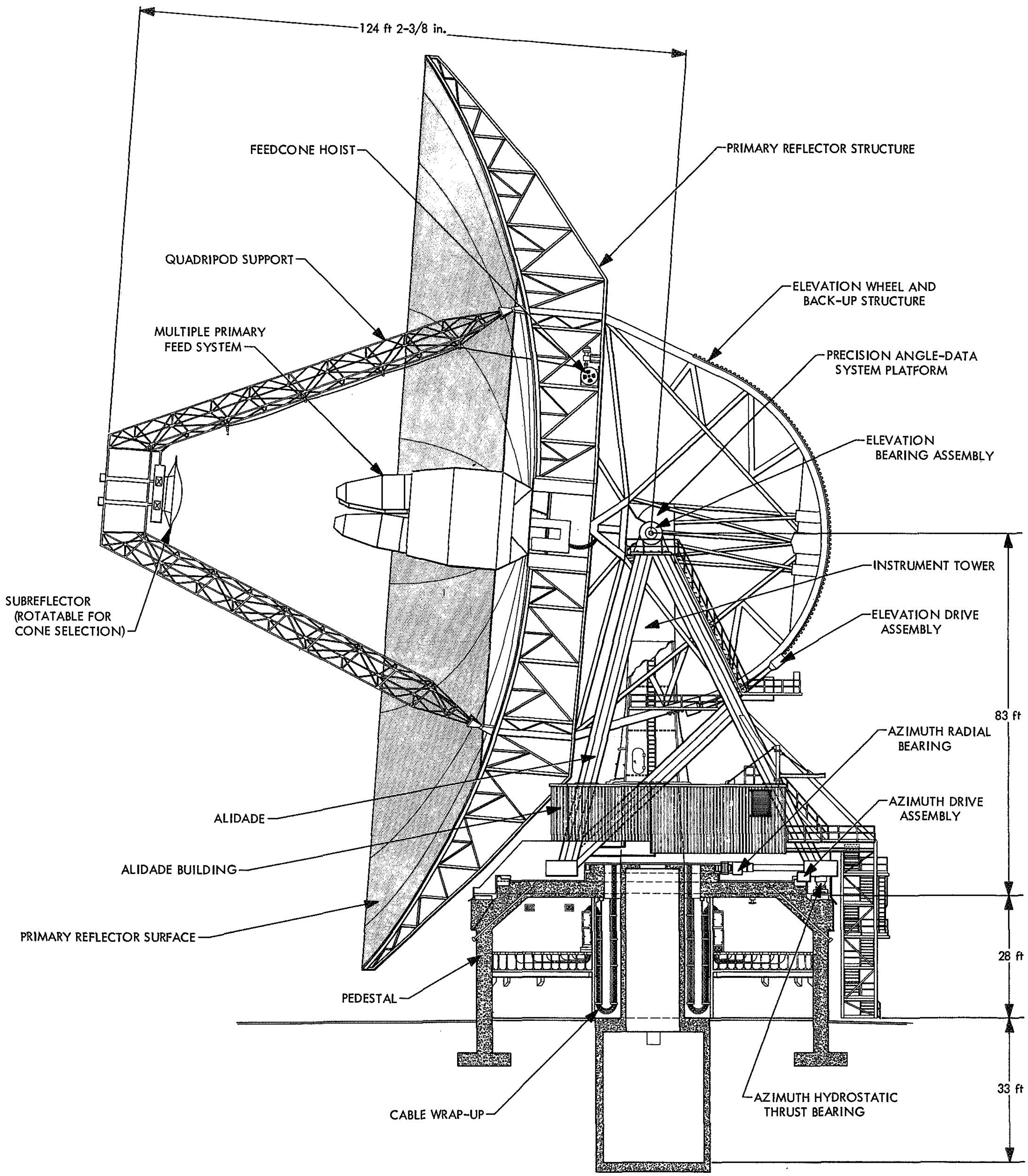

Fig. 4. Profile of 210-ft-diam antenna

Table 2. Antenna dimensions and weights

Antenna dimensions	
Diameter, ft	210
Focal length, ft	88.941
Focal length/diameter ratio	0.4235
Surface area, ft^2	37,491 (0.85 acre)
Depth of paraboloid, ft	31
Pedestal wall thickness, ft	3.5
Outside diameter of pedestal, ft	83
Overall height of instrument tower,[a] ft	139
Total concrete, yd^3	2500
Antenna weights, lb	
Overall	16,000,000
On elevation bearings	2,530,000
On azimuth bearings (including bearings)	5,000,000
On soil	16,000,000
Total rotating	5,000,000
Total tipping	2,500,000
Component	
Hyperboloid	4,100
Feed cone and equipment	62,000
Quadripod	39,000
Primary reflector surface	58,000
Reflector assembly (including reflector, wheels, and elevation counterweight)	2,370,000
Alidade and buildings	2,200,000
Azimuth bearings	400,000
Pedestal and foundation	10,000,000
Instrument tower (including wind shield)	
Steel	96,000
Concrete	1,151,000

[a]Height of concrete section, 68 ft, including 33 ft below grade.

spacecraft signal was usually maser-amplified on the order of 40,000 times before it was fed into the receiver, where it was further amplified.

The receiver used four separate channels: two reference (or sum) channels for doppler information, spacecraft telemetry, and TV signals, and two channels carrying angle-tracking data for automatic antenna pointing. The data from all four channels, depending on the information they conveyed, was transmitted to the SFOF.

Dimensions and weights of the 210-ft antenna are given in Table 2. A profile of the antenna is presented in Fig. 4.

II. Scientific Events and Measurements

A. Special Coverage

Special coverage was given *Pioneer* spacecraft during occultations and syzygys; analyses of solar events were made, and investigations were made of magnetosheath and bow shock. During a solar event of high scientific value, continuous tracking coverage for 30 to 50 h following the event was required for *Pioneer* spacecraft. Dependent upon the location and characteristics of a specific event, coverage was shared by the *Pioneers* as determined by the *Pioneer* Project at the time of the event. For magnetosheath and bow shock, on-board plasma and magnetometer instruments needed to be operating and the resultant scientific data received by launch plus 3 to 3½ h or 8 to 10 earth radii altitude.

Continuous tracking during a 1-mo period was required for *Pioneer VI* to cover solar occultation (November 21 through November 24, 1968). An analysis of the solar corona and atmosphere near the solar disk as the spacecraft occulted was desired.

Pioneer VI carried six scientific instruments, which totalled 34.1 lb or 25% of the total spacecraft weight. Nine W of power was required for the instruments when one plasma detector was operating in low-power mode and 18 W when in the high-power mode (approximately 18 and 35% of the total spacecraft power).

The instruments covered approximately 280 $in.^2$ of the spacecraft platform. Approximately 72% of the telemetry data was allocated directly to the scientific instruments when telemetering in the scientific data mode. This mode was used throughout the mission except for rare occasions. Approximately 33% of the command capability was allocated directly to the scientific instruments for controlling the operating conditions.

Power to the scientific instruments was supplied directly from the spacecraft primary bus. Each instrument, therefore, had its own converter. Power to all instruments was turned off by a single ground command. Each instrument could be turned on individually by ground command. One scientific experiment, the celestial mechanics investigation, required no special instruments on the spacecraft. However, funding for this investigation was not available until the 1968 fiscal year.

B. Experiments

The experiments, managers, and principal investigators are listed in Table 3.

1. Celestial mechanics investigation (JPL). The three primary objectives of the *Pioneer* celestial mechanics experiment (PCME) were:

(1) Obtain primary determinations of the masses of the earth and moon and the astronomical unit.

(2) Use the tracking data from the whole series of *Pioneer* probes in a program designed to improve the ephemeris of the earth.

(3) Investigate the possibility of a test of general relativistic mechanics with the *Pioneer* orbits.

The experiment made use of the on-board receiver and transmitter equipment in conjunction with DSS equipment to obtain two-way doppler measurements. *Pioneer* data was appropriate for this experiment because of the absence of midcourse orbit corrections and near-planetary encounters. In addition, solar-radiation pressure effects were slight for the *Pioneer* configuration.

2. Cosmic ray telescope (University of Chicago). The intensity and energy spectra of protons and alpha particles, and electron energy over a limited range, as well as particle anisotropy, were measured by this instrument. It had three solid-state lithium-drift detectors, a plastic scintillator cylinder designed to exclude particles not confined to the telescope angle of 60 deg, a photomultiplier tube, and associated electronics. Proton and alpha particle energy spectra measurement was divided into these four energy windows: (1) 0.6–13 MeV per nucleon; (2) 13–70 MeV per nucleon; (3) 70–190 MeV per nucleon; and (4) greater than 190 MeV per nucleon. Detection of electron energy spectra was limited to the energy windows of 0.16–1 and 1–20 MeV per nucleon.

3. Cosmic ray anistropy detector (Southwest Center for Advanced Studies). Measured were the anistropy of low-energy primary and solar cosmic radiation and its variation with energy, time, and nuclear species. The instrument comprised a scintillator crystal, an anticoincidence scintillator, two photomultiplier tubes, and associated electronics. The acceptance cone for the detector was 107 deg. Energy window discrimination was achieved by means of a four-channel, on-board, pulse-height analyzer.

Table 3. *Pioneer VI* experiments

Experiment/scientific instrument	Management	Principal investigator
Single-axis magnetometer	NASA/GSFC	N. Ness
Plasma cup detector	MIT	H. Bridge
Quadrispherical plasma analyzer	NASA/ARC	John H. Wolfe
Radio propagation detector	Stanford University	V. R. Eshleman
Cosmic ray anisotropy detector	Southwest Center for Advanced Studies	Kenneth McCracken
Cosmic ray telescope	University of Chicago	J. Simpson
Celestial mechanics investigation[a]	JPL	John D. Anderson
Solar occultation investigation only (10/20/68–12/6/68)		
Faraday rotation investigation (S-band)	JPL	Gerald S. Levy
Spectral broadening investigation (S-band)	JPL	R. Goldstein
Relativity investigation	JPL	John D. Anderson Leonard Efron

[a]Requires no on-board instrumentation; uses two-way doppler tracking as data source.

4. Plasma cup detector (Massachusetts Institute of Technology). A detector that used a Faraday cup with an energy-determining grid, a split collector, and associated electronics made up this instrument. The viewing angle was ±20 deg in the plane perpendicular to the spacecraft spin axis and ±60 deg in the plane parallel to the spin axis. Measured were the energy spectrum, flux, and angular distribution of both positive ions and electrons of the interplanetary plasma.

The energy per unit charge of the positive ions was determined in 14 intervals extending from 0.1 to 9.5 kV; the energy of the electrons in four energy bands extending from 0.1 to 1.6 keV, and the flux sensitivity range from 2×10^5 to 2×10^9 particles per cm^2/s.

5. Quadrispherical plasma analyses (Ames Research Center). This instrument, like the plasma cup detector, measured the energy spectrum, flux, and angular distribution of both positive ions and electrons of the interplanetary plasma. The instantaneous viewing angle was approximately 15 deg in the plane perpendicular to the spacecraft spin axis or equatorial plane and ±80 deg in the plane parallel to the spin axis. The latter was divided into eight channels symmetrical about the equatorial plane and with widths, starting at the equatorial plane, of 15, 15, 20, and 30 deg.

The energy per unit charge of the positive ions was determined in 16 logarithmically spaced bands extending from 0.2 to 10 kV; the energy of the electrons in 8 logarithmically spaced bands extending from 0.002 to 0.5 kV; and the flux sensitivity from 10^5 to 10^9 particles per cm^2/s.

Besides a quadrispherical electrostatic analyzer, 8 separate and contiguous current collectors provided 8 sectors and associated electronics. The current or flux measurement was expressed as a 7-bit word and, together with other information identifying energy levels, positive or negative particles, collector, and equatorial interval, was stored in a core memory. The instrument recorded data concurrently with telemetering data.

6. Magnetometer (Goddard Space Flight Center). The magnetometer, with a range of $\pm 64\gamma$, sequentially measured the magnitude of the three orthogonal components of the interplanetary magnetic field. Capable of four different data recording sequences, the instrument had a single flux gate sensor and associated electronics. A mechanical flip mechanism, which rotated the sensor through 180 deg, permitted detection and elimination of permanent magnetization of the core. The flip mechanism contained 22 small squibs grouped in pairs for redundancy. Each pair of squibs was activated by ground command.

7. Radio propagation (Stanford University). This experiment involved the transmission of two modulated coherent carriers of approximately 49.8 and 423.3 MHz from the ground and the reception of these signals by receivers aboard the spacecraft. The receivers were designed to measure the relative phase of the modulation envelopes of the two carrier frequencies which, since the higher frequency was relatively unaffected by the presence of ionization, provided a value for the integrated electron density. In addition, the rate of change of phase of one carrier with respect to the other was measured, thus accurately determining the time variation of the integrated electron density. Signal strength was also measured.

Instrumentation comprised two ground-based transmitters operating into a 150-ft-diam parabolic antenna located on the Stanford University campus, a dual-channel, phase-locked-loop receiver aboard the spacecraft, the spacecraft telemetry, and the DSN. All elements of the system operated simultaneously to provide closed loop operation.

The experiment was terminated July 13, 1966, when the Stanford radio propagation instrument onboard the *Pioneer VI* spacecraft ceased to transmit useful scientific data. The spacecraft communication distance and the Stanford on-board receiver sensitivity threshold combined to end the acquisition of useful data. The need for JPL to produce Stanford predicts in support of the mission ceased with the end of the experiment.

Part II. Extended Flight Phase, First Annual Period (July 1, 1966 – July 1, 1967)

I. Introduction

A. Synopsis of Significant Events

The *Pioneer VI* spacecraft was used in making observations of several solar disturbances and a radar bouncing experiment with the planet Mercury during the first annual phase of extended flight. A special series of observations by the spacecraft was made in August 1966, on passes 235, 236, and 237, to learn of any solar activity that might affect a *Lunar Orbiter* launch. The first solar alert of the period was on pass 207 (July 10, 1966). During the last part of May, special coverage was provided for two periods of solar flare activity. Coverage of 27 h was provided for the first period and 12 h for the second. Other solar flare observation passes noted were passes 210 and 428. The radar bouncing experiment with Mercury was performed on pass 557 (June 25, 1967).

B. Significant Changes in Project Requirements

The need for JPL to produce Stanford University predicts ceased with the end of the experiment (July 13, 1966). However, because the *Pioneer* Project Office was using the round-trip flight time information transmitted in conjunction with the Stanford predicts that were no longer produced, JPL was requested to transmit a copy of the nominal predicts for one of the deep space stations to the Project Office on a regular basis.

C. Support Beyond Minimum Commitments

During the first annual period reported here (the first year after DSS 14 officially took tracking responsibility), there were increasing responsibilities for TDS facilities and personnel. Five major launches were supported within a 5-wk interval in the August–September period. *Pioneer VII* was launched August 17. And, in addition to scheduled tracking of *Pioneer VI*, DSS 14 tracked *Mariner IV* on a once-a-month basis, and performed Mercury bistatic experiments in conjunction with Venus station (DSS 13).

D. Overall Performance of Network

That the DSN met its growing responsibilities was acknowledged in a December 19, 1966, message from the *Pioneer* Project Manager, Charles F. Hall, to the personnel at the JPL and the DSN facilities.

"The *Pioneer VI* mission on Day 350, 0731.20 GMT, 1966, has successfully completed an operational lifetime of one year. The scientific data collected over this period has proven to be valuable to the scientific community in initiating an understanding of the solar system and its environment. *Pioneer VI* is continuing its success with regularly scheduled tracking missions utilizing the Mars 210-ft antenna system. Your efforts as part of the *Pioneer* team have played an important role in establishing the above statements as facts. As part of the *Pioneer* family we invite you to join us in celebrating this occasion."

1. Data rate. DSS 14 obtained good data from *Pioneer VI* at a data bit rate of 64 bits/s, providing at least a 9 dB improvement in performance by DSS 14 over other deep space stations. At 64 bits/s and an error rate of one error per 1000 bits, the station extended the range capability for 64 bits/s from 33 million km to 110 million km. The largest portion of gain was attributed to a considerable improvement in system noise temperature (29°K) and other ground system performance elements.

2. Prime tracking function. DSS 14 assumed the prime tracking function of the *Pioneer VI* spacecraft effective with pass 196. The bit rate was 64 bits/s. However, DSS 12 (Echo station at Goldstone) continued to provide the command and telemetry processing, through its ground operational equipment, and recording. Command transmission was provided as needed. During command operations, the DSS 12 antenna receiver/exciter, transmitter, and the tracking data handling subsystem were placed in operation. (The spacecraft was at 8 bits/s duty cycle store during nontracking periods.)

II. Engineering and Operations

A. Tracking Interruption

The most serious problem during the first annual period of activity of the extended flight phase was an antenna mechanical problem that shut down the 210-ft-diam antenna Mars station for a month and a half. Because of a recurring hydrostatic thrust bearing anomaly that caused short tracking interruptions, the station was shut down for major rework by JPL from March 10 to April 28, 1967. Reshimming between the annular ring and the bearing surface finally eliminated mechanical distortion occurring when the pad passed over the bearing surface. (It was possible during this rework effort to put the antenna into normal operation for a 5-h period. This was done to provide maximum capability listening support during the *Surveyor III* terminal sequence and initial operation on the moon.)

1. Bearing improvement. After initial installation of the ground shims, the bearing film height was improved to a minimum of 0.004 in., with 10 areas showing less than 0.005 in. By comparison, on January 27, 1967, there were 21 areas in which film height was 0.003 in. or less. In addition, the overall height variation of the runner was reduced from 0.070 in. measured during construction to 0.015 in., and "dramatic" improvements were made in the flatness in local areas. During May, engineering evaluation and appropriate local area reshimming were continued to improve the minimum film height and to attain a satisfactory bearing pump redundancy operating condition with permanent shims.

2. Other antenna changes. Adjustments were made to reduce the axis cross coupling of the infrared spectrometer (IRS) autocollimation in order to reduce the bias voltage used to offset the fixed alignment error in the cross elevation axis.

During the shutoff period, sensitive level measurements of the thermal stability of the instrument tower indicated the angular movement of the top of the instrument tower was greater than 15 arc seconds. Plans were made to insulate the outside of the wind and thermal shield to reduce the heat transferred into the instrument tower. A new reference groove was cut in the azimuth gear for measuring the runner profile.

The 20-kW transmitter was modified to make the transmitter usable at both the DSN operation frequency band 2110–2120 MHz and the DSN experimental frequency of 2388 MHz. The conversion consisted of replacing the klystron then in use with a klystron with a broader tuning range (2100–2400 MHz). An additional waveguide directional coupler was added to the waveguide systems for power monitoring at 2388 MHz. An automatic switching circuit was used to switch the monitoring circuits to the directional coupler corresponding to the frequency being used. The 20-kW transmitter modification which allowed operation at either 2110–2120 MHz or 2388 MHz increased flexibility, enabling the station to perform special scientific and advanced engineering experiments in addition to the two-way coherent tracking and/or command mission support.

The existing 20-kW waterload was moved to the position allocated for the 100-kW waterload. This move was required so that the diplexer could be bypassed when the transmitter was operating at 2388 MHz. Waveguide was installed from the waterload position to the 2388-MHz transmitter input port of the special 2110–2120-, 2290–2300-, 2388-MHz feed cone.

B. Anomalies Related to Data Losses

On the whole, DSN support of the *Pioneer VI* mission during the period of this report was considered good. The big exception, the shutdown of DSS 14 from pass 423 to pass 502, has been noted previously. Before and after shutdown, instances of lost data were minor and attributed in part to burn-in or random failure of the relatively new equipment in use. Some of the instances of lost data and equipment anomalies and the steps made for improvement are described in the following paragraphs. More are noted subsequently in tabular material presenting pass chronology.

When the station became operational again (pass 502), occasional low-film indications necessitated braking of the antenna during some passes. In each instance, checking of the actual film thickness revealed a satisfactory condition. As a result of braking, though, some data was lost. The shimming correction was refined. Table 4 shows the signal strength expected for pass 505. The indicated average was −163.8 dBmW. DSS 14 used its diplexer for uplink, but not for downlink. A special cone configuration wherein the uplink is left-hand circular polarization (LHCP), through the diplexer, and the downlink is right-hand circular polarization (RHCP), bypassing the diplexer, was used. This was possible because of the use of an experimental cone and because the spacecraft was linearly polarized. The system noise temperature was lower in this configuration, averaging about 29°K instead of the normal 36°K with the diplexer included. The signal was thus improved by about 0.8 dB.

The transmitter went off because of an interlock failure on the power cabinet during pass 515. As a result, 2.5 h of engineering telemetry data was lost before demodulator lock. This time included the long round-trip light time involved in acquisition. Pass 517 was cut short to provide command capability for DSS 51 with *Pioneer VII*.

On pass 557, DSS 14 was in a receive-only mode because of a transmitter modification. This modification was incorporated to allow radar bouncing at 2388 MHz for performing experiments with the planet Mercury.

Table 4. Abbreviated telecommunication design control (channel 6, pass 505)

No.	Parameter	Value	Tolerance	
1	Total transmitter power, dBmW	+38.4	+0.2	−0.2
2	Transmitting circuit loss, dB	−1.6	+0.5	−0.65
3	Transmitting antenna gain, dB	+11.0	+0.5	−0.5
4	Transmitting antenna pointing loss	Included in (3)		
5	Space loss, dB (2292 MHz, R = 200 × 10^{-6} km)	−265.6		
6	Polarization loss, 0.7-dB elliptical ratio, dB	−3.0	+0.3	−0.3
7	Receiving antenna gain (210-ft), dB	61	+1.0	−0.5
8	Receiving antenna pointing loss, dB	0		
9	Receiving circuit loss, dB	−0.2	+0.1	−0.1
10	Net circuit loss, dB	−198.4	+2.4	−2.1
11	Total received power, dBmW	−160.0	+2.6	−2.3
12	Receiver noise spectral density (N/B[a]), dBmW/Hz (temperature system = 29°K)	−184.1	+0.7	−0.9
13	Carrier modulation loss (θ = 0.9 ± 5%), dB	−4.1 dB	+0.5	−0.5
14	Received carrier power, dBmW	−164.1	+3.1	−2.8
15	Carrier APC noise BW ($2B_{LO}$ = 12 Hz), dB	10.8	+0.0	−0.5

[a]Noise power/bandwidth.

DSS 12 was requested to try to acquire uplink for command purposes, and 2 h was scheduled for this purpose during the end of the pass. However, because of the marginal signal strength at the spacecraft (Table 5) and the limited time available (RTLT was 25 min), satisfactory lock was not obtained.

Although the transmitter was down on passes 551, 559, and 561, no data was lost because the station was able to track in a one-way mode. In contrast to the ground transmitter, the receiver was in both one- and two-way lock case.

C. RF Performance

1. Uplink, downlink signal strengths. Tables 6 through 11 present downlink receiver signal strengths for passes 197 through 561. Figures 5 and 6 present examples of spacecraft uplink receiver signal strength and uplink signal strength vs time, respectively.

Table 5. DSS 12 uplink, pass 557

No.	Parameter	Value	Tolerance	
1	Total transmitter power, dBmW	+70.0	+0.5	−0.0
2	Transmitting circuit loss, dB	−0.4	+0.1	−0.1
3	Transmitting antenna gain, dB	+51.0	+1.0	−0.5
4	Transmitting antenna pointing loss	Included in 3		
5	Space loss, dB (2110.9 MHz; R = 2.294 × 10[8] km)	−266.14	0.0	−0.0
6	Polarization loss, dB	−3.0	+0.5	−0.5
7	Receiving antenna gain, dB	+10.5	+0.5	−0.5
8	Receiving antenna pointing loss	Included in 7		
9	Receiving circuit loss, dB	−1.5	+0.25	−0.25
10	Net circuit loss, dB	−209.54	+2.35	−1.85
11	Total received power, dBmW	−139.54	+2.85	−1.85
12	Receiver noise spectral density (N/B), dBmW/Hz	−164.0	+1.0	−0.5
13	Carrier modulation loss, dB	−3.46	+0.4	−0.4
14	Received carrier power, dBmW	−143.0	+3.25	−2.25
15	Carrier APC noise bandwidth ($2B_{LO}$ = 20 ± 5 Hz), dB	+13.0	+1.25	−1.0
	Carrier performance			
16	Threshold SNR in $2B_{LO}$, dB	6.0		
17	Threshold carrier power, dBmW	−145.0	+2.25	−1.5
18	Performance margin, dB	+2.0	+4.75	−4.5
	Command data performance			
19	Modulation loss (1.25 rad ± 0.5%), dB	−2.83	+0.21	−0.27
20	Received data subcarrier power, dBmW	−142.37	+3.06	−2.12
21	Bit rate (1/T), bits/s	0.0		
22	Required system temperature (N/B), dB	+1.94	+1.2	−1.0
23	Threshold subcarrier power, dBmW	−144.6	+2.25	−1.5
24	Performance margin, dB	+2.23	+4.56	−4.37

Figure 7 indicates measured downlink receiver signal strength vs predicted signal strength, showing where (passes 411 through 416) recalibration occurred after an error was discovered in the RF cabling calibration. Discovery of the error helped to explain the 1- to 2-dBmW-higher signal strength reported by the station as compared with the expected signal strength. The recalibration of the system at DSS 14 was accomplished on

Table 6. Downlink receiving signal strength, passes 197–257

Pass	DSS	Day	Average value, dBmW
197	14	181	−156.8
202		186	−156.3
206		190	−156.7
207	14	191	−156.7
208	14/12	192	−166.4/−156.5
210		194	−166.8
211		195	−156.9
215		199	−156.8
218		202	−157.9
223		207	−157.2
226		211	−157.4
230	14/12	214	−157.3
232[a]	14	216	−158.1
235		219	−158.8
236		220	−157.8
237		221	−157.9
238		222	−158.0
248	14	232	−157.7
250	14/12	234	−157.8
254	14/12	238	−158.4
257	14/12	241	−158.5

[a]Record-only track

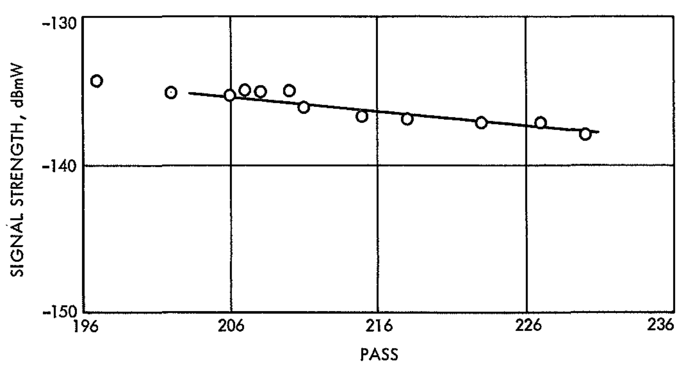

Fig. 5. Uplink receiver signal strength, passes 196–257

February 2, with a 2-dBmW adjustment being made as a result. The actual downlink signal strength on pass 416 therefore reflected that 2-dBmW adjustment. The predicted value, as of pass 416, was within a 1-dBmW

Table 7. Downlink and uplink receiver signal strength, passes 260–320, DSS 14

Pass	Day	Downlink, dBmW	Uplink, dBmW
260	244	−158.0	−128
265	249	−158.4	−127
267	251	−158.6	−127
271	255	−158.3	−127
274	258	−158.5	—
278	262	−158.9	−127
282	266	−158.7	−125
285	269	−158.7	−128
288	272	−159.2	−128
292	276	−159.0	−127
295	279	−158.3	−128
296	280	−158.7	−128
299	283	−158.8	−127
302	286	−158.7	−127
306	290	−159.4	−128
309	293	−158.1	−128
313	297	−158.7	−128
315	299	−158.9	−128
316	300	−158.8	−128
320	304	−159.3	−128

Table 8. Downlink receiver signal strength,[a] passes 322–408

Pass	Day	Predicted, dBmW	Receiver (average), dBmW	Threshold, dBmW	Pass	Day	Predicted, dBmW	Receiver (average), dBmW	Threshold, dBmW
322	306	−160.0	−157.8	−172	364	348	−160.9	−156.2	−173
324	308	−160.0	−158.7	−172	366	350	−160.9	−157.4	−172
327	311	−160.1	−158.4	−172	369	353	−161.0	−158.1	−173
329	313	−160.1	−158.2	−173	371	355	−161.0	−158.5	−173
331	315	−160.2	−158.3	−172	372	356	−161.0	−158.3	−173
334	318	−160.2	−158.5	−173	377	361	−161.1	−158.5	−173
336	320	−160.3	−158.0	−173	380	364	−161.2	−158.8	−173
338	322	−160.3	−158.5	172	387	006	−161.3	−158.4	−172
343	327	−160.5	−158.6	−173	390	009	−161.3	−157.6	−172
348	332	−160.5	−157.8	−173	392	010	−161.3	−158.1	−173
350	334	−160.6	−158.4	−173	394	013	−161.3	−157.9	−173
355	339	−160.7	−157.3	−172	404	023	−161.4	−159.4	−171
357	341	−160.7	−158.3	−173	406	025	−161.4	−158.4	−173
359	343	−160.8	−157.8	−173	408	027	−161.5	−158.4	−173

[a]Bandwidth = 12 Hz; maser amplification.

Table 9. Downlink receiver signal strength,[a] passes 411–443

Pass	Day	Predicted, dBmW	Receiver (average), dBmW	Threshold, dBmW
411	030	−161.6	−158.5	−172
416	035	−161.6	−160.6	−174
418	037	−161.6	−160.6	−175
420	039	−161.7	−161.0	−175
422	041	−161.7	−160.4	−175
425	044	−161.8	−160.7	−175
427	046	−161.8	−161.1	−175
428	047	−161.9	−161.0	
429	048	−161.9	−160.8	−175
432	051	−162.0	−161.2	−175
439	058	−162.0	−161.4	−175
443	062	−162.1	−162.4	−176

[a]Bandwidth = 12 Hz; maser amplification.

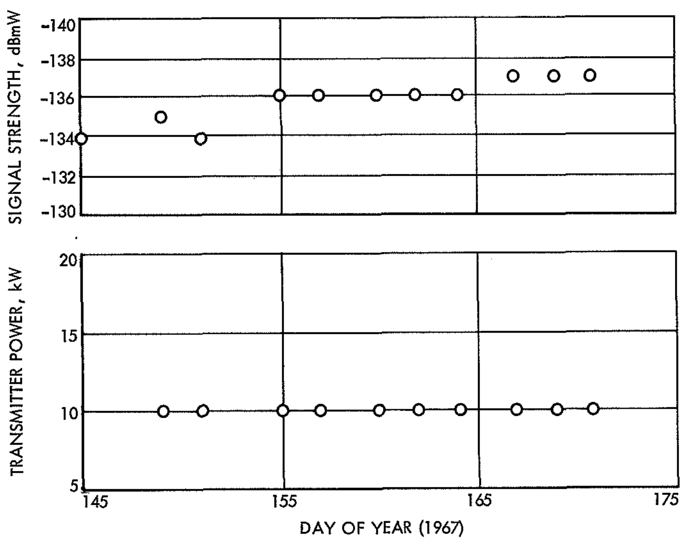

Fig. 6. Uplink signal strength vs time, passes 536–561, DSS 14

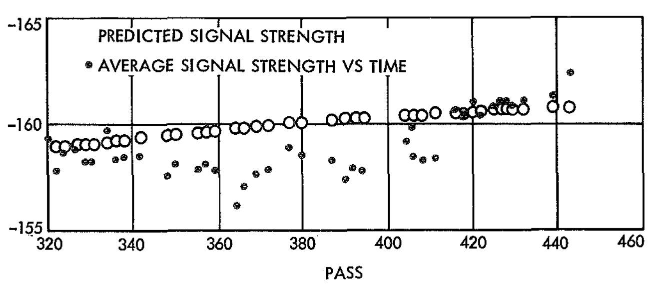

Fig. 7. Downlink measured signal strength vs predicted

tolerance (Table 9). (RF cabling calibration was performed every 6 mo as DSS 14 procedure.)

Data on *Pioneer VI* indicated that DSS 14 was 9 dBmW better than the 85-ft antenna station network. DSS 14 transmitted on one polarization and received on another while tracking *Pioneer VI*. Uplink power for the chan-

Table 10. Downlink receiver signal strength,[a] passes 502–523

Pass	Day	Predicted, dBmW	Receiver (average), dBmW	Threshold, dBmW
502	121	−162.4	−163.4	−174
505	124	−162.4	−163.8	−175
508	127	−162.5	−164.1	−175
510	129	−162.5	−163.4	−174
515	134	−162.5	−164.4	−175
517	136	−162.5	−164.0	−174
519	138	−162.6	−164.4	−173
522	141	−162.6	−163.9	−175
523	142	−162.6	−164.1	−174

[a]Bandwidth = 12 Hz; maser amplification.

Table 11. Downlink receiver signal strength,[a] passes 536–561, DSS 14

Pass	Day	Predicted, dBmW	Receiver (average), dBmW	Threshold, dBmW
526	145	−162.6	−164.0	−175
529	148	−162.6	−164.3	−174
532	151	−162.7	−164.7	−174.5
536	155	−162.7	−165.1	−175
538	157	−162.7	−164.8	−174.5
541	160	−162.8	−164.6	−174
543	162	−162.8	−164.7	−174
545	164	−162.8	−164.8	−174
548	167	−162.8	−164.2	−174
550	169	−162.8	−164.5	−173.5
552	171	−162.8	−164.6	−175
555	174	−162.9	−165.0	−174
557	176	−162.9	−165.2	−174
559	178	−163.0	−164.8	−174.5
561	180	−163.1	−164.7	−174.5

[a]Bandwidth = 12 Hz; maser amplification.

nel 7 receiver had a range of −131 to −136 dBmW for 10-kW ground transmitter power from pass 196 through pass 561. The calculated threshold for channel 7 was −147 dBmW, leaving a −11- to −16-dBmW margin before threshold would be reached.

2. *Percentage in-lock performance for the DSS.* The performances for tracking commitments, transmitter on, and receiver two-way lock status are given in Figs. 8 through 11 and in Table 12. The percentages show the DSS performance during two-way lock with the spacecraft, but do not indicate the amount of data taken. The difference between two-way lock time and tracking time is mainly a result of the long round-trip light time required (20 to 25 min) to lock the receiver in two-way (Fig. 12). However, from pass 555 through pass 561, the

Table 12. Tracking performance: in-lock vs actual and scheduled, passes 536–561

	Time, min	Percentage[a]
Scheduled	7710	100.00
Actual	7763	100.68
Transmitter on	6190	80.28
Receiver in-lock One- and two-way	7185	93.19
Good tracking data	6918	89.72

[a]The indicated percentages are calculated with the scheduled time used as a reference.

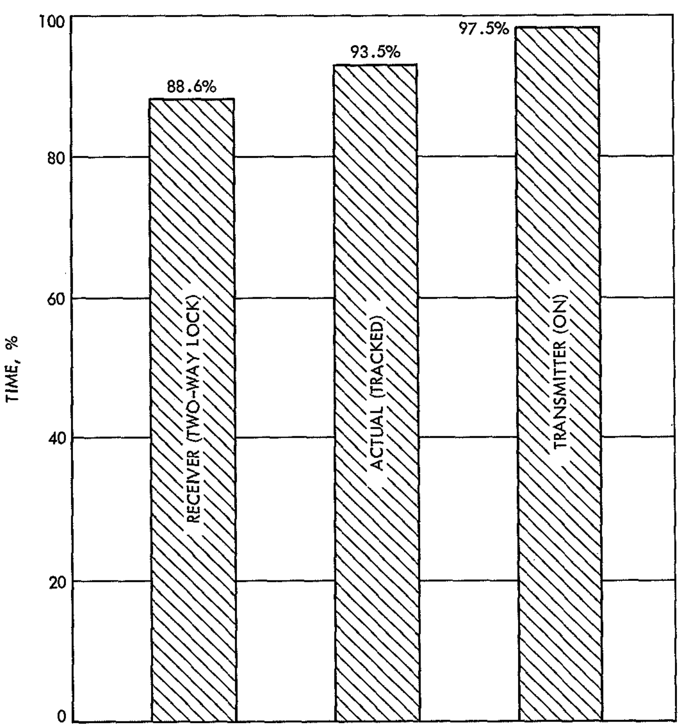

Fig. 8. Tracking performance, passes 322–443

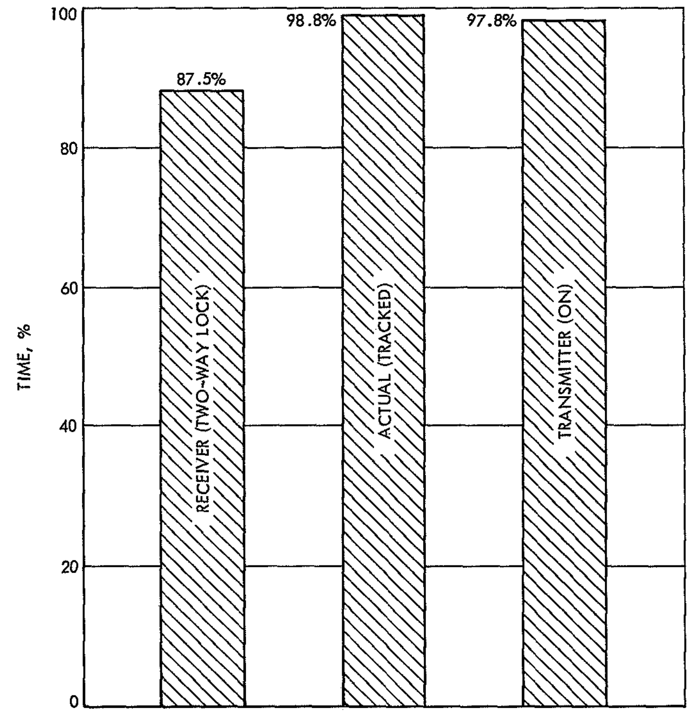

Fig. 9. Tracking performance, passes 502–523

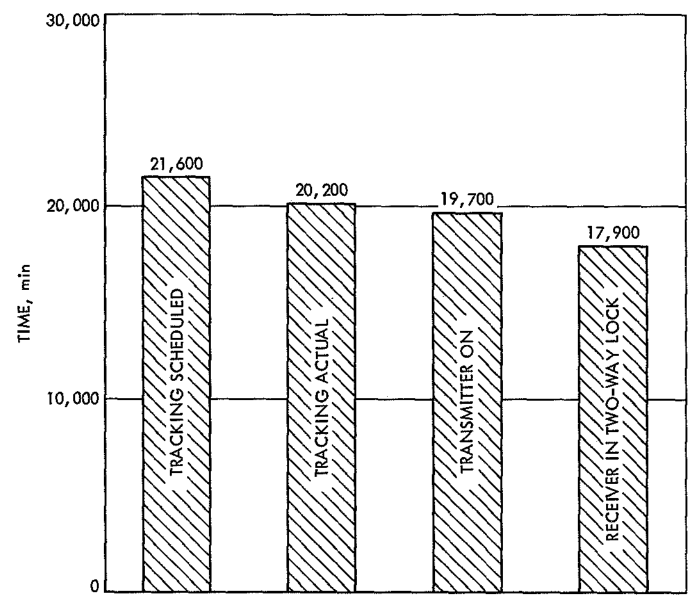

Fig. 10. Tracking performance: in-lock vs actual and scheduled, passes 322–443

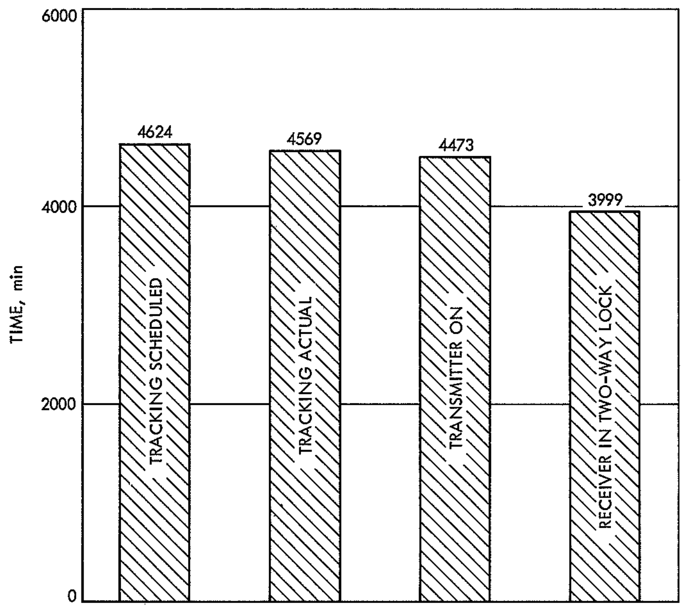

Fig. 11. Tracking performance: in-lock vs actual and scheduled, passes 502–523

DSS 14 transmitter was down for repairs. As a result, the "transmitter-on" percentage was only 80.28 of the scheduled tracking time. The receiver was in both one- and two-way lock case. The one-way data preceding two-way lock was not computed in the percentage. In contrast, from pass 322 through pass 523 the percentage was 97.7. During the transmitter down time (pass 555 through pass 561), no data was lost because the station was able to track in a one-way mode.

D. Parity Error Rate

Figures 13–15 and Tables 13–17 present parity error rate information for the period covered by this document. Generally, DSS 14 performance was free of errors at 16 bits/s. However, the telemetry was not error-free at 16 bits/s during passes 536 through 561. Tables 18 and 19 give system noise temperature data. (A parity error rate of 0.116 was equivalent to one error in 1000 consecutive bits of information and was regarded as the limiting value for the uncoded and convolution-coded unit modes of information.)

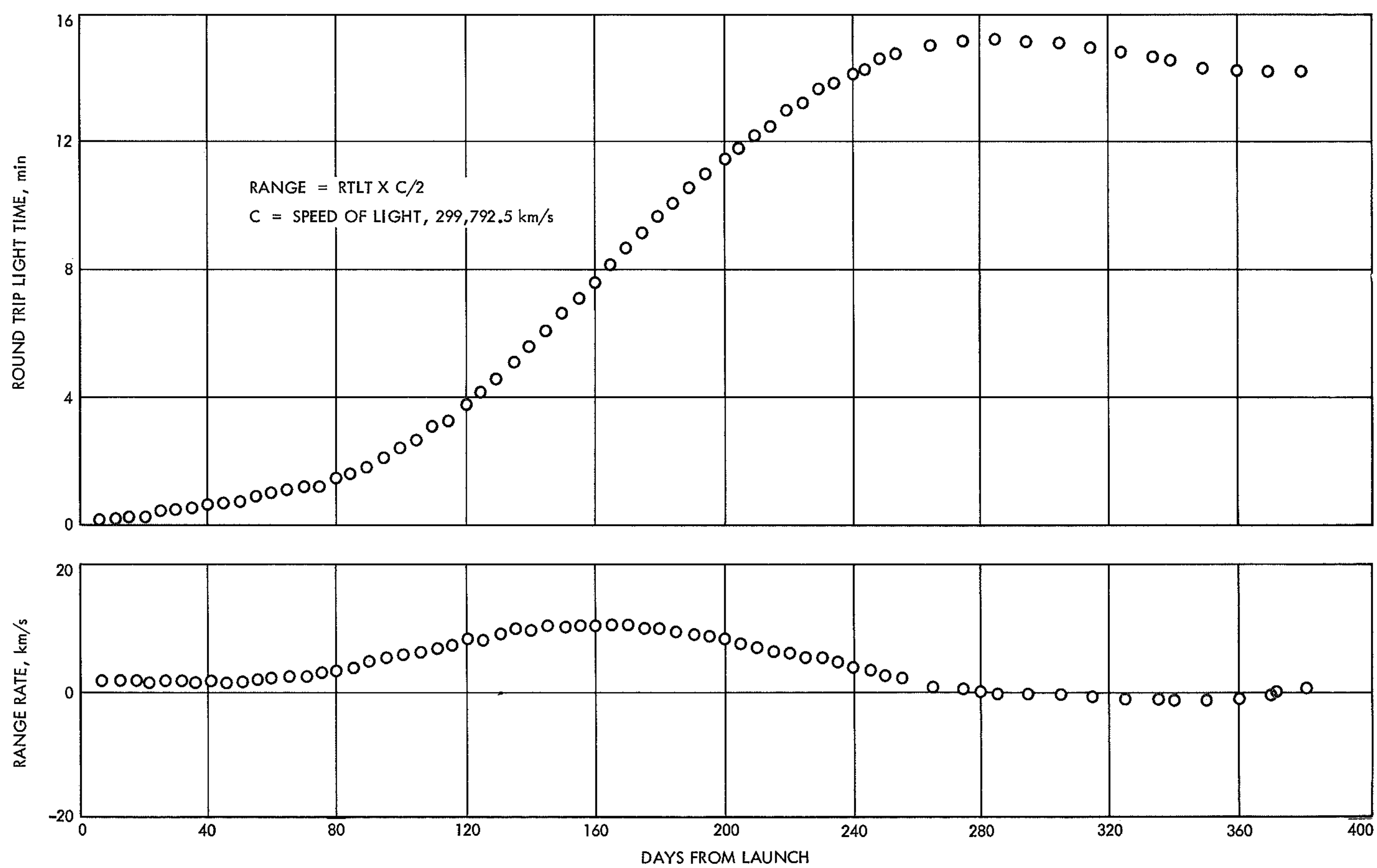

Fig. 12. Round-trip light time vs day of year

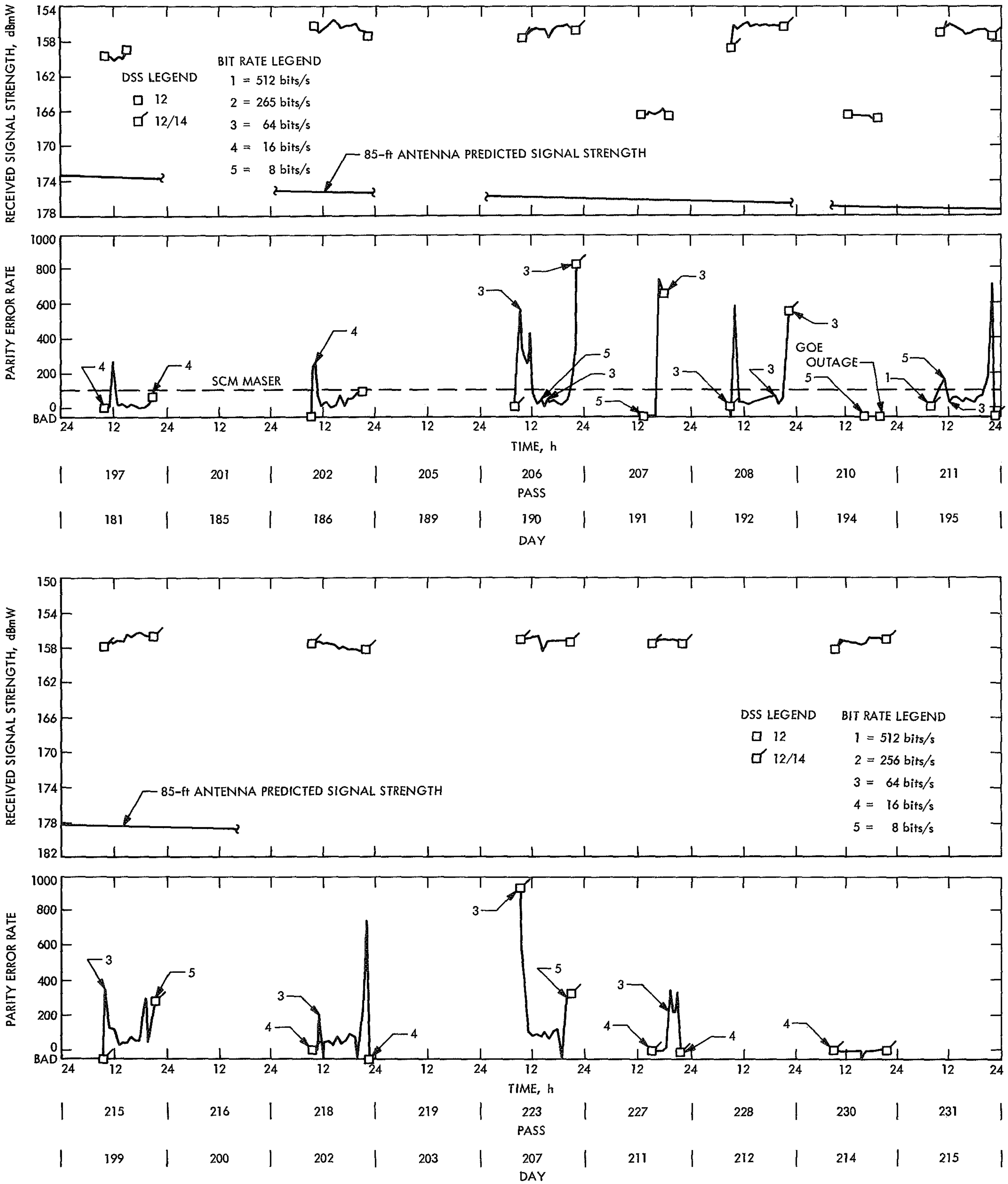

Fig. 13. Received signal strength and parity error rate, passes 197–257

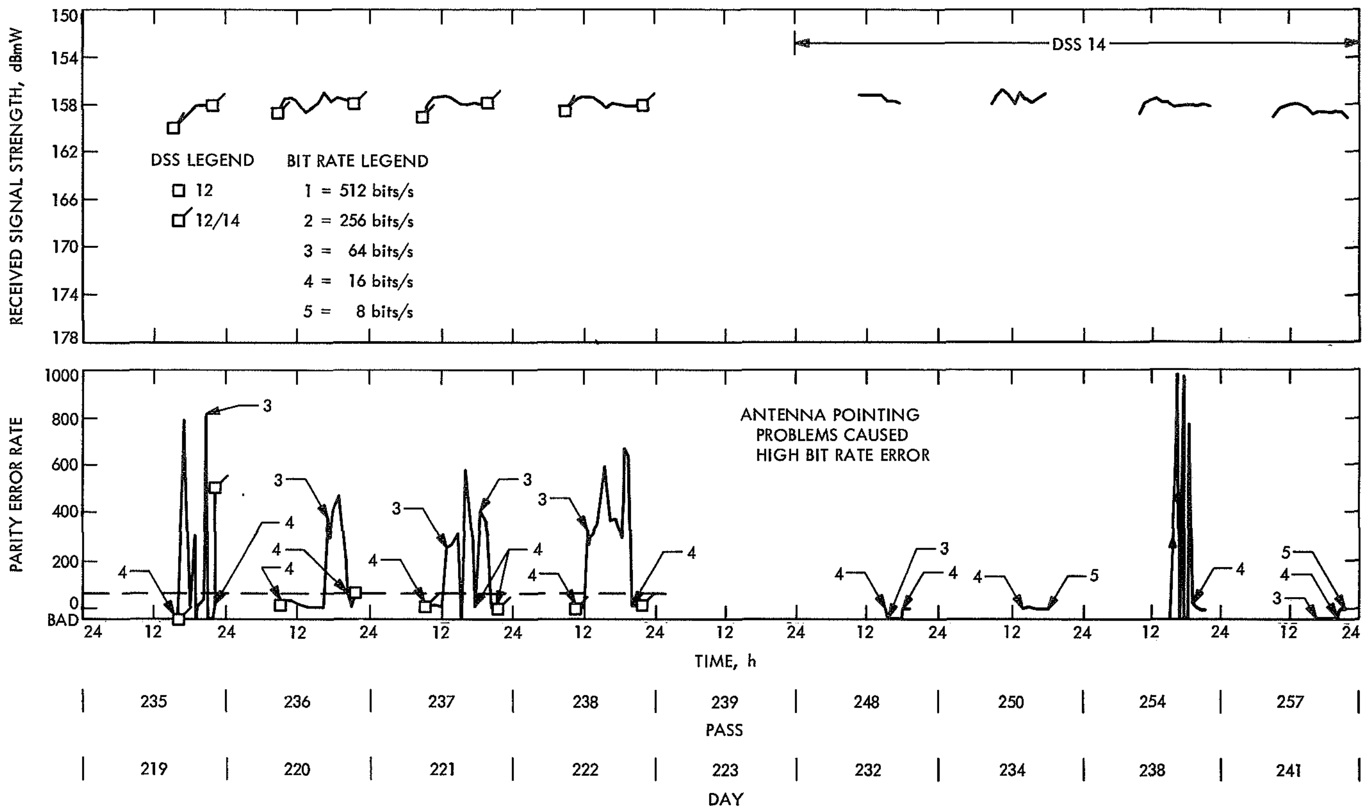

Fig. 13 (contd)

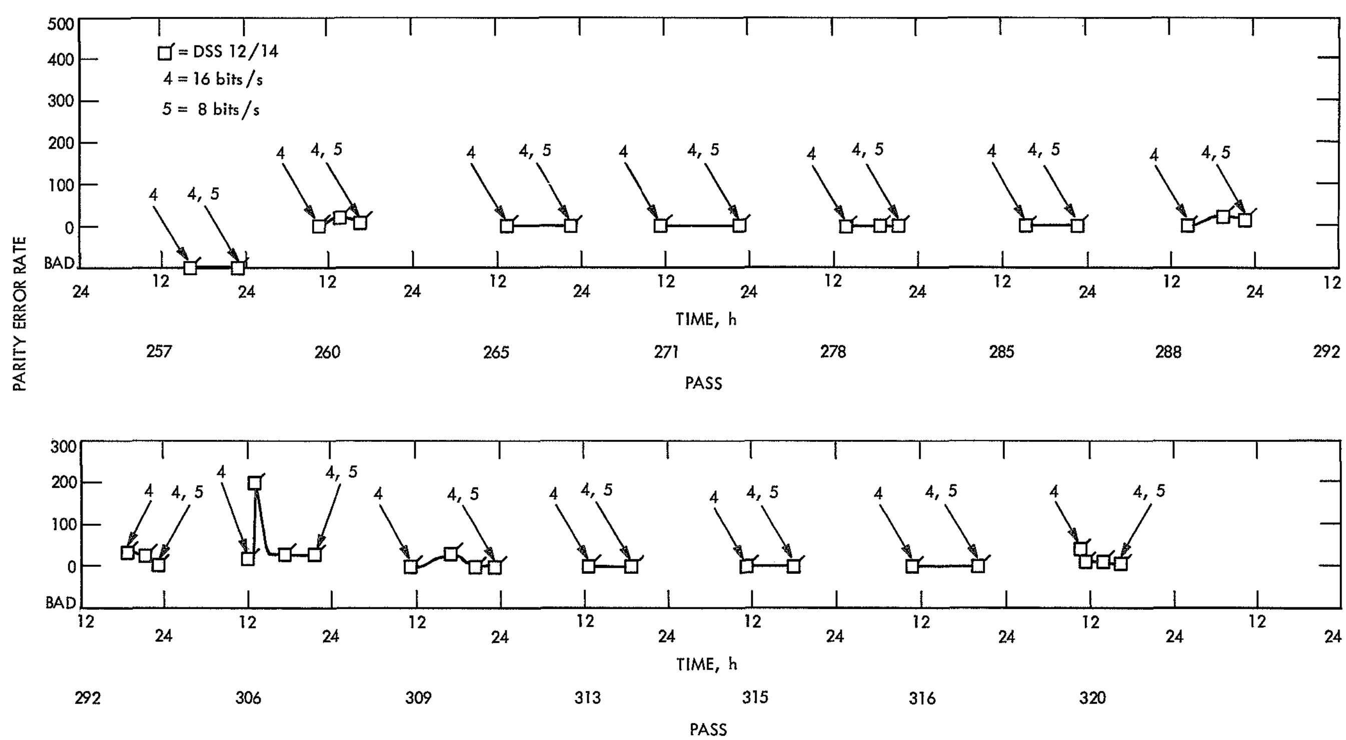

Fig. 14. Received signal strength and parity error rate, passes 257–320

Table 13. Predicted vs actual bit rate change, passes 196–257

Predicted			Actual		
TFL,[a] days	Bit rate, bits/s	Range, km × 10^6	TFL,[a] days	Bit rate, bits/s	Range, km × 10^6
69	512	9.1255085	74	512	11.8
84	256	13.463865	91	256	18.0
114	64	27.0773285	119	64	34.2
130	16	39.0452085	144	16	54.8
176	8	76.295235	164	8	72.8

L + 159 days: parity error rate reached specified maximum of 1×10^{-3} or 0.10%.

L + 166 days: 85-ft antenna data threshold reached. Parity error rate 1×10^{-3} at 8 bits/s.

L + 196 days: DSS 14 (210-ft antenna) began tracking at 64 bits/s with zero bit error rate.

[a]Time from launch on December 16, 1965 (Day 350) at 0731:20 GMT.

Table 14. Parity error rate (bit rate = 16 bits/s), passes 322–416

Pass	Day	Parity error rate (average)	Receiver signal strength (average), dBmW	Pass	Day	Parity error rate (average)	Receiver signal strength (average), dBmW
322	306		−157.8	366	350	0.004	−157.4
324	308	0.001	−158.7	369	353	0.035	−158.1
327	311	0.005	−158.4	371	355	Record only	−168.5
329	313	0.002	−158.2	372	356	0.001	−158.3
331	315	0.006	−158.3	377	361	0.001	−158.5
334	318	0.003	−158.5	380	364	0.004	−158.8
336	320	0.005	−158.0	387	006	0.003	−158.4
338	322	0.000	−158.5	390	009	0.002	−157.6
343	327	0.007	−158.6	392	011	0.001	−158.1
348	332	0.050	−157.8	394	013	0.002	−157.9
350	334	0.000	−158.4	404	023	0.020	−159.4
355	339	0.020	−157.3	406	025	0.001	−158.4
357	341	0.005	−158.3	408	027	0.005	−158.4
359	343	0.006	−157.8	411	030	0.006	−158.5
364	348	0.000	−156.2	416	035	Record only	−160.6

Table 15. Parity error rate (bit rate = 16 bits/s), passes 418–443

Pass	Day	Parity error rate (average)	Receiver signal strength (average), dBmW
418	037	0.002	−160.6
420	039	0.010	−161.0
422	041	0.005	−160.4
425	044	0.000	−160.7
427	046	0.050	−161.1
428	047	0.000	−161.0
429	048	0.002	−160.8
432	051	0.005	−161.2
439	058	0.010	−161.4
443	062	0.050	−162.4

Table 16. Parity error rate, passes 502–523

Pass	Day	Parity error rate (average, computed)	Bit rate, bits/s	Receiver signal strength (average), dBmW
502	121	N/A	16	−163.4
505	124	0.0563	16	−163.8
508	127	0.0603	16	−164.1
510	129	0.0925	16	−163.1
515	134	0.074	16	−164.4
517	136	0.107	16	−164.0
519	138	0.115	16	−164.4
522	141	0.119	16, 8	−163.9
523	142	N/A	16, 8	−164.1

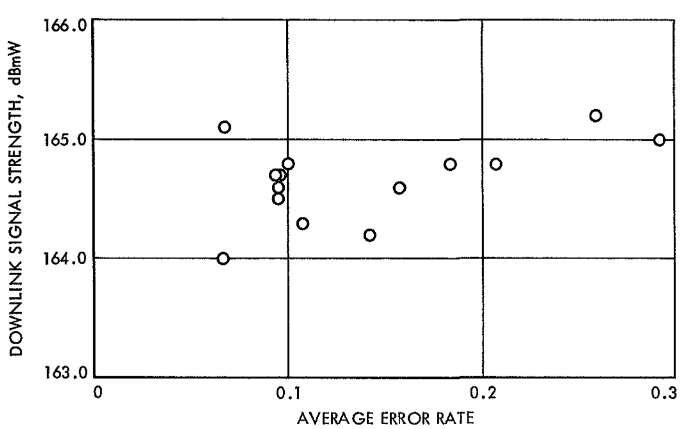

Fig. 15. Parity error rate vs signal strength, passes 536–561, DSS 14

Table 17. Parity error rate (bit rate = 16 bits/s), passes 526–561

Pass	Day	Parity error rate (average)	Receiver signal strength (average), dBmW
526	145	0.0670	−164.0
529	148	0.1123	−164.3
532	151	0.0933	−164.7
536	155	0.0675	−165.1
538	157	0.1006	−164.8
541	160	0.1571	−164.6
543	162	0.0961	−164.7
545	164	0.1788	−164.8
548	167	0.1360	−164.2
550	169	0.0911	−164.5
552	171	0.0961	−164.6
555	174	0.305	−165.0
557	176	0.2635	−165.2
559	178	0.2115	−164.8
561	180	0.2287	−164.7

E. Predicted Frequency Performance

Figure 16 is a plot of the rest frequency measurements from launch for channel 7. Predicted curves for rest frequency were superimposed in order to show the accuracy of the predictions. Figure 17 plots channel 6 rest frequency. Figure 18 is an updated plot of measured auxiliary oscillator frequency. The data compared favorably with the predicted values. Spacecraft receiver and transmitter auxiliary oscillator temperatures are given in Fig. 19. Parameters monitored in non-real-time were as follows.

(1) Station tracking time and mode configuration.

(2) Pre and post signal-to-noise ratio.

(3) Command performance.

(4) On-off events such as the transmitter, receiver, bit rate mode changes, and power level changes.

(5) Demodulator, analog tape recorder, and TCP in-lock percentage.

(6) Two-way RF in- and out-of-lock times in percentages.

Table 18. System noise temperature, °K, DSS 14

Pass	Prepass		Postpass	
	Receiver 1	Receiver 2	Receiver 1	Receiver 2
197	30.3	—	30.8	—
202	29.9	—	32.5	—
206	29.8	—	29.5	—
207	37.6	—	37.9	—
208	28.4	—	29.3	29.6
210	39.6	—	37.4	—
211	30.2	—	—	—
215	27.8	—	29.8	—
218	28.4	—	30.2	—
223	30.0	—	29.1	—
226	29.6	29.1	30	—
230	31.4	30.5	30.4	—
232	—	—	31.5	—
235	31.4	—	31.9	—
236	31.6	31.9	32.9	—
237	—	—	33.0	—
238	—	—	33.0	—
248	—	—	30.8	—
250	—	—	31.0	—
254	—	—	—	—
257	—	—	—	—

(7) Average receiver AGC, average bit error rate, and average uplink power readings.

(8) Tracking data/doppler mode, VCO frequency, and angle performance.

(9) Tracking frequencies, tuning rates, lock times, and drop-lock times for spacecraft acquisition.

Most of these parameters are stored on computer cards for further statistical computation.

F. Predicts and Commands

Predicts generated for *Pioneer VI* to July 1, 1967, are presented in Table 20. A total of 4487 commands had been transmitted by July 1, 1967, the end of this reporting period, with 1219 transmitted during the period. Tables 21 and 22 present a summary of operations.

Table 19. System noise temperature, °K, pre- and postcalibration

Pass	Day	Precalibration	Postcalibration
260	244	32.7	30.2
265	249	30.4	30.3
267	251	28.5	29.3
271	255	28.7	29.6
274	258	—	—
278	262	—	30.9
282	266	—	29.6
285	269	—	—
288	272	—	—
292	276	—	30.0
295	279	29.3	29.4
296	280	29.1	29.0
299	283	28.8	28.7
302	286	30.0	31.2
306	290	30.1	31.2
309	293	29.4	30.0
313	297	29.6	30.1
315	299	30.7	30.1
316	300	30.0	30.5
320	304	29.6	29.2

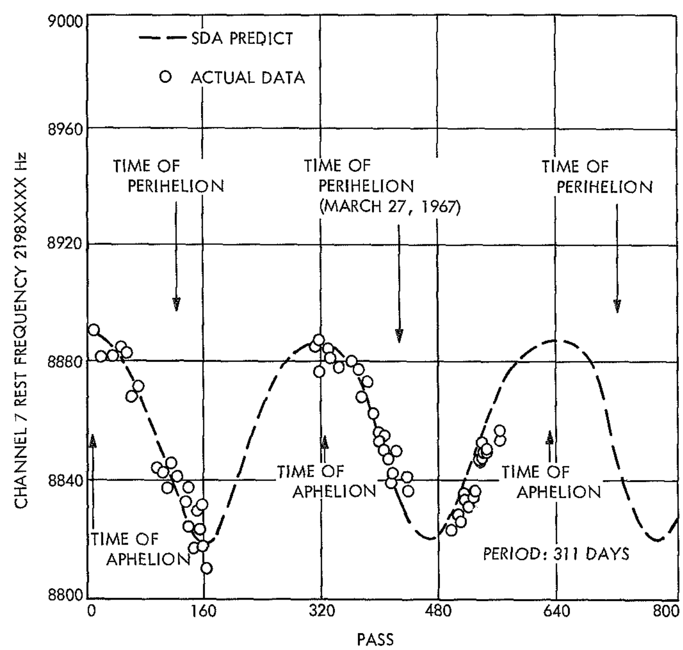

Fig. 16. Channel 7 best-lock rest frequency vs pass number

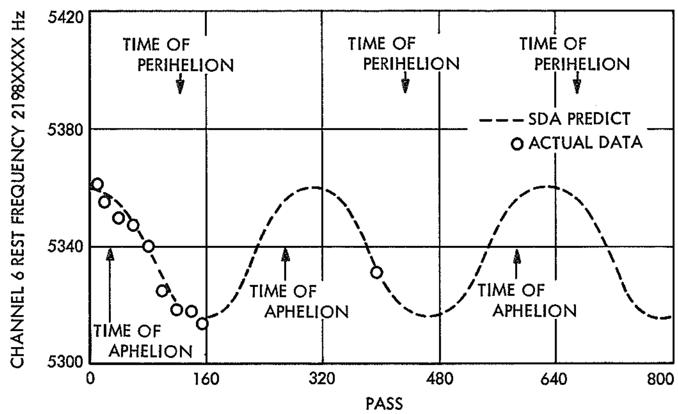

Fig. 17. Channel 6 best-lock rest frequency vs pass number

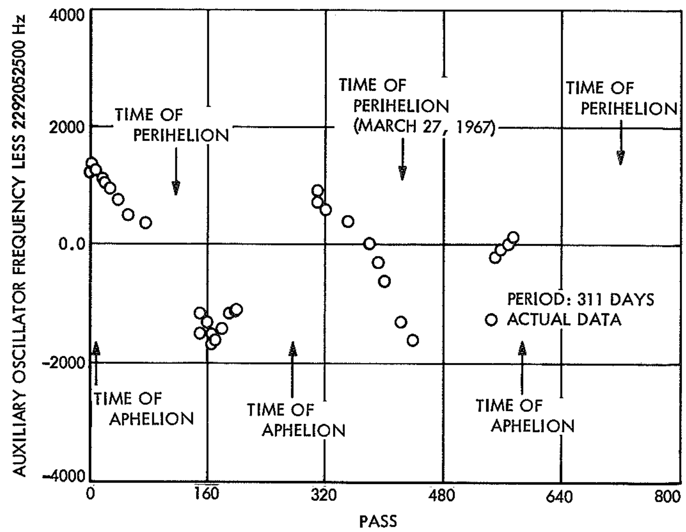

Fig. 18. Auxiliary oscillator frequency vs pass number

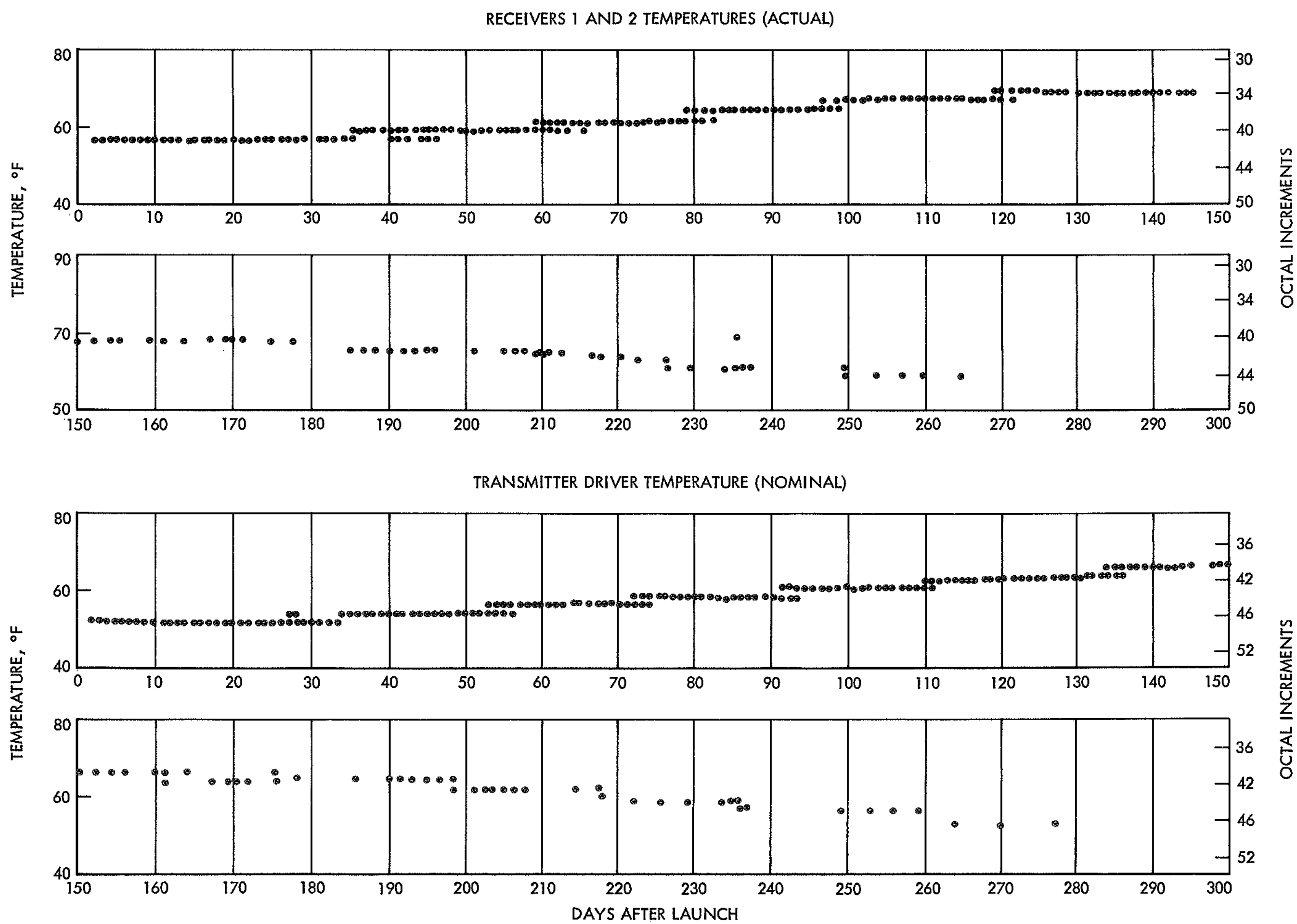

Fig. 19. Spacecraft receiver and transmitter auxiliary oscillator temperatures

Table 20. Prediction summary

Predict No.[a]	Deep Space Stations	Auxiliary oscillator frequency, MHz	Ground transmitter synthesizer frequency, MHz	Coverage	Sample rate, s
61A	14	2292.052500	21.985295	10/23/66–11/24/66	900
61B	14	2292.052500	21.988900	10/23/66–11/11/66	300
61C	14	2292.052500	21.988900	11/10/66–11/24/66	300
62A	14	2292.052500	21.985295	10/23/66–1/1/67	900
62B	14	2292.052500	21.988900	10/23/66–1/1/67	300
63A	14	2292.052500	21.985295	12/30/66–2/2/67	300
63B	14	2292.052500	21.988870	12/30/66–2/2/67	300
63C	12, 14	2292.052500	21.988870	12/20/66–12/22/66	60
63C	12, 14	2292.052500	21.988870	12/22/66–1/2/67	300
63D	12	2292.052500	21.985295	12/20/66–1/2/67	300
64A	14	2292.052500	21.985295	1/31/67–3/2/67	300
64B	14	2292.052500	21.988855	1/31/67–3/2/67	300
65A	14	2292.050500	21.985317	2/28/67–4/1/67	900
65B	14	2292.050500	21.988825	2/28/67–4/1/67	900
66A	14	2292.051400	21.985324	5/1/67–6/1/67	900
66B	14	2292.051400	21.988842	5/1/67–6/1/67	900
67B	14	2292.051950	21.988855	6/1/67–7/1/67	900
67Z*	Stanford	2292.051400	21.985324	6/1/67–7/1/67	300

[a]A = channel 6. B = channel 7. *= made on magnetic tape for 1 mo. C and D = special predict runs for DSS 12 for the last 10 days in December 1966. DSS tracked one pass (noncommittal) at very low signal (−167 dBmW). The tracking data was for correlation with tracking data from the then new 210-ft antenna (DSS 14).

Table 21. Summary of operations, passes 196–257

Pass	Deep Space Station	Number of commands	Average received signal level, dBmW	Transmitter power, kW	Ground modes	Remarks
196	14/12	6	−154.3	10	1- and 2-way	This was the first official tracking pass of *Pioneer VI* by DSS 14. Bit rate, 64 bits/s
197	14/12	10	−156.8	10	↓	Bit rate, 64 bits/s
202	14/12	5	−156.5	10	↓	Bit rate, 64 bits/s
206	14/12	10	−156.7	10	↓	Bit rates, 8 and 64 bits/s
207	12	14	−166.4	10	↓	Pass tracked in support of a solar flare alert. Bit rate, 8 bits/s
208	14/12	7	−156.5	10	↓	TCP computer failed twice, cause undetermined. Bit rate, 64 bits/s
210	12	8	−166.8	10	↓	Pass tracked in support of a solar flare alert. Command 3–100 delayed 6 min due to synthesizer failure. Bit rate, 8 bits/s
211	14/12	5	−156.9	10	↓	Bit rate, 64 bits/s
215	14/12	10	−157.4	10	↓	Bit rates, 8 and 64 bits/s
218	14/12	11	−157.9	10	↓	Bit rate, 64 bits/s
223	14/12	9	−157.3	10	↓	Transmitter interrupted twice due to high body current. Bit rate, 64 bits/s
226	14/12	7	−157.4	10	1- and 2-way	Bit rate, 64 bits/s
230	14/12	2		10	1- and 3-way	Bit rate, 64 bits/s
232	14	None		10	1-way	Bit rate, 64 bits/s. This was a record-only pass.
235	14/12	15		15	1- and 2-way	First pass using the DSS 14 transmitter. This and the three passes following were in support of the *Lunar Orbiter* launch wherein special observations were to be made by *Pioneer VI* of solar activity which might affect *Lunar Orbiter*. Bit rate, 64 bits/s
236	14/12	16		10	↓	Bit rate, 16 bits/s
237	14/12	16		10	↓	Transmitter off briefly due to beam current interlock operation. Bit rates, 16 and 64 bits/s
238	14/12	15		10	↓	Antenna made emergency stop in both axes due to tangling of coolant lines in cable wrap. Transmitter off twice (unscheduled) due to klystron air interlock operation and arc detector interlock operation. Bit rate, 64 bits/s
248	14/12	8		10	1- and 2-way	Station experienced brief primary power failure at 0245 GMT. A problem in transmitting the command microwave tones developed between the multiple mission support area at DSS 12 and the transmitter at DSS 14. It was corrected after several minutes and the cause was unreported. Bit rate, 64 bits/s
250	14/12	10		10	1- and 2-way	Bit rate, 64 bits/s
254	14/12	17		10	1- and 2-way	Transmitter off twice due to arcing in the waveguide. Bit rate, 64 bits/s
257	14/12	20		10	1- and 2-way	Transmitter kicked off four times for brief periods; cause undetermined. 400-Hz power supply interrupted briefly. Bit rates, 16 and 64 bits/s

Table 22. Summary of Operations, Passes 260–561

Pass No.	Station (DSS)	Day of Year (GMT)	Acq. (GMT)	End of Track (GMT)	Ground Modes (Start and End Times GMT) 1-Way	2-Way	3-Way	Avg. Recd. Sig. Level (dbm)	Commands Total	Equipment Failures and Anomalies; Significant Events; Remarks
260	14	244	090642	1709	090642 093740	093740 170725		-158.5	28	Pass abbreviated due to Mariner IV mission requirements.
265	14	249	091047	222150	091047 094925	095341 222150		-158.8	42	None
267	14	251	090914	2225	090914 093831	093831 222410		-158.5	None	None
271	14	255	090949	221830	090949 094300	094414 221615		-158.4	24	None
274	14	258	091104	180000	091104 095932	100051 180000		-158.6 -158.4	None	Record-only pass. Station was secured early by Operations Control Chief to prepare for Surveyor test.
278	14/12	262	091238	221800	091238 094845	095022 221620		-158.7	20	None
282	14	266	091919	180800	091919 093000	093000 180800		-158.8	None	None
285	14	269	091542	220300	091542 094748	094910 220300		-158.8	21	None
288	14	272	091740	220300	091740 094625	094625 220120		-158.98	11	None
292	14	276	091935	2158	091935 094722 215620 215800	094722 215620		-159.2	12	None
295	14	279	092140	2152	0921 095247 215057 2152	095247 215057		-158.36	10	None
296	14	280	092148	190000	092148 094826	094839 190000		-158.8	None	Record-only pass.
299	14	283	092456	1858	092456 095802	095944 185800		-158.9	11	At 1738 a glitch occurred in the Beta Computer, possibly caused by station personnel working behind Alpha Computer. At 1802 DSS 12 had a major power failure because of storm activity in the area. Power was restored and computer was back in lock at 180315.
302	14	286	093154	1858	093154 100915	100915 1856		-158.8	12	None
306	14/12	290	093726	185614	193726 101414	101414 185614		-159.3	13	At 094300, Tracking Data Handling equipment garbled the voltage-controlled oscillator printout. At 105800, Datex AZ encoder was not operating properly. Encoder was cleaned, and was back in proper operation at 112000. Receiver dropped lock several times between 093726 and 101540.
309	14	293	093450	185800	093450 101700	101700 185630		-158.4	11	Command encoder was switched at DSS 12. At 0935, the telemetry line to DSS 12 failed. Trouble was caused by an intermittent cable at DSS 12 and was repaired at 1039. From 1700 to 1730, the Western Union line to JPL was not working. Trouble developed in the Telemetry and Command Processing System (TCP), causing command zero printouts. Trouble was corrected by changing TCP computer.

Table 22 (contd)

Pass No.	Station (DSS)	Day of Year (GMT)	Acq. (GMT)	End of Track (GMT)	Ground Modes (Start and End Times GMT) 1-Way	2-Way	3-Way	Avg. Recd. Sig. Level (dbm)	Commands Total	Equipment Failures and Anomalies; Significant Events; Remarks
313	14/12	297	0934	1858	0934 105300	105433 185714		-158.83	11	Station Controller indicated that Predicts 61B appeared to have been generated with wrong station coordinates.
315	14	299	093610	154800	093610 100359	100359 154800		-158.9	7	Station tracked 108 minutes past scheduled time due to error in reading schedule.
316	14/12	300	093650	1858	093650 100319	100319 185620		-158.6	11	Pass scheduled for Day 301 but moved ahead one day due to VIP visitors to Ames Research Center. TCP lost lock due to inadvertent disconnection of telemetry patch to microwave line at DSS 14.
320	14	304	094145	1600	094145 100411	100411 155530		-158.5	11	None
322	14	306	094440	1400	094440 101509	101550 1400		-158.3	12	All doppler data was lost for entire pass due to operator making a bad patch.
324	14	308	094236	183130	094236 1000 103530 105934	110104 183110		-158.6	10	Station was required to shut down at 1830Z, due to Mariner IV commitment. Requirement verbally confirmed by OCC.
327	14	311	0945	181600	0945 1013	1013 181600		-158.4	14	None
329	14	313	094648	1357	094648 101512	101512		-158.3	9	None
331	14	315	094810	1818	094810 102412	102412 181540		-158.8	13	None
334	14	318	113340	2117	113340 120855	121050 211700		-158.68	13	Station experienced difficulty in obtaining spacecraft and, after obtaining it, difficulty in retaining lock. Problem traced to Maser.
336	14	320	095637	1958	095637 102610	102715 195800		-158.3	13	None
338	14	322	095536	211300	095536 102555	103154 211300		-158.3	13	None
343	14	327	095943	195400	095943 101000	111413 195400		-158.5	13	DIS subsystem failed to pull predict tape. Antenna was driven off spacecraft by DIS, which pulled Angle Data early.
350	14	334	100815	1947	100815	123352		-158.2	13	Transmitter turned off several times during pass due to leaking heat exchanger water hose. Water tank was manually filled for remainder of pass, and water hose replaced after completion of pass. At 132834, transmitter turned off due to operator hitting wrong switch while filling water tank.
355	14	339	125442	2050	125442 133042	133147		-157.4	12	Loose connector on waveguide switch caused 2 hour, 40 minute delay in acquisition.
357	14	341	101753	2038	101753 104853	104924 2038		-158.4	13	None
359	14	343	102141	2037	102141 104640	104716		-157.4	13	None
364	14	348	102932	2040	102932 100502	110502 2040		-155.8	13	None
366	14	350	103138	2022	103138 110042	110116 2022		-157.8	14	None

Table 22 (contd)

Pass No.	Station (DSS)	Day of Year (GMT)	Acq. (GMT)	End of Track (GMT)	Ground Modes (Start and End Times GMT) 1-Way	2-Way	3-Way	Avg. Recd. Sig. Level (dbm)	Commands Total	Equipment Failures and Anomalies; Significant Events; Remarks
369	14	353	103414	2024	103414 110630 111645 114133 114415 121315 133015 135406	110710 111329 114207 114259 121345 132852 135437 2024		-157.6	10	Station had considerable trouble staying 2-way on channel 7 when tuning above 8880 Mc. Slower tuning rate was attempted but did not help. At 135437 station retained acquisition on channel 7 at 8880 Mc, which was 10 cycles below track syn frequency.
371	12	355	103940		103940 115509	120044 203000		-168.4	0	Pass for tracking data only. No commands were sent and no telemetry data were received.
372	14	356	104109	202900	104109 110744	110827 2029		-158.2	11	None
377	14	361	105004	2023	105004 113520	113600 2023		-158.6	13	None
380	14	364	105420	202300	105420 112326	112417 202045		-158.8	13	None
387	14	006	1158	202500	1158 1304 1833 1849	1304 1831 1849 2022		-158.4	12	Power failure occured at station several hours before track time causing Maser to warm up. Inability to start one of the auxiliary power units contributed to Maser warming up. Master equatorial failure due to tripped circuit breaker in HA channel RCVR in lock.
390	14	009	111443	202200	111443 114403	114443 202200		157.6	11	16 bps, TXR 10 kw
392	14	011	111758	1952	111758 114508	120600 195050		-158.0	7	Transmitter power 10 kw, TLM bit rate 16
394	14	013	112112	202200	112112 1320 180530 184400	132033 180255 184457 202112		-158.3	17	TXR at 15 kw, TLM bit rate 16 bps
404	14	023	113815	202200	113815 1205	120609 202100		159.4	13	TXR power at 10 kw. TLM bit rate 16 bps
406	14	025	114200	2023	114200 120925	120959 202055		-158.5	15	Bit rate 16 bps. TXR at 10 kw
408	14	027	114617	2023	114617 121452	121624		-158.5	15	Bit rate 16 bps. TXR at 10 kw
411	14	030	115023	2022	115023 121953	122050 202157		-158.6	15	TXR at 10 kw. TLM at 16 bps
416	14	035	120218	2031	120218 203100			-160.6	0	Record only.
418	14	037	1203	1954	1203 123031	123132 195142		-160.7	16	TLM at 16 bps. TXR at 10 kw
420	14	039	120516	1953	120516 123031	123220 195300		-160.9	15	TLM at 16 bps. TXR at 10 kw

Table 22 (contd)

Pass No.	Station (DSS)	Day of Year (GMT)	Acq. (GMT)	End of Track (GMT)	Ground Modes (Start and End Times GMT) 1-Way	2-Way	3-Way	Avg. Recd. Sig. Level (dbm)	Commands Total	Equipment Failures and Anomalies; Significant Events; Remarks
422	14	041	121100	1954	121100 123650 184415 192502	123720 183438 192614 195115		160.4	13	TXR at 10 kw. TLM at 16 bps
425	14	44	121423	2038	121423 124230	124407 203800		-160.9	14	TXR at 10 kw. TLM at 16 bps
427	14	046	121500	1527	121500 124220	124250 1527		-161.3	8	TXR at 10 kw. TLM at 16 bps and 8 bps
428	14	047	161428	2029	161428 164059	164405 2029		-161.1	7	TXR at 10 kw. TLM at 16 and 8 bps. Solar flare pass.
429	14	048	121645	2038	121645 124238	124405 203715		-160.85	19	TXR at 10 kw. TLM at 16 bps
432	14	051	121942	2023	121942 133244	133750 2022		-161.18	15	TXR at 10 kw. TLM at 16 bps
439	14	058	122403	1856	122403 125647	125832 1855		-161.4	11	TXR at 10 kw. TLM at 16 bps
443	14	062 March 3. 1967	1254	1908	1254 132805	133030 1908		162.3	11	TXR at 10 kw. TLM at 16 bps
502	14	121 May 1, 1967	114644	2130	1146	1246 2122		-163.46	11	TXR at 10 kw. TLM at 8 bps. Antenna stopped 3 times due to low oil alarm on pad No. 3.
505	14	124	1330		1330 1406	1406 2023		-163.766	14	TXR at 10 kw. TLM at 8 bps
508	14	127	140000		140000 144047	144221 2056		164.2	12	TXR at 10 kw. TLM at 16 bps
510	14	129	1200	1800	1200 124030	124525 1854		163.2	12	TXR at 10 kw. TLM at 8 bps
515	14	134	113915	1800Z	113915 122654	122840 1800		-163.7	11	TXR at 10 kw. TLM at 16 bps
517	14	136	112506	2116Z	112506 121448	121624 2116		-163.7	14	Pass cut short 1 1/2 hours to provide command capability for 51 PN-7 pass.
519	14	138	112658		112658 121242	121358		-164.3	12	TXR at 10 kw. TLM at 16 bps
522	14	141	1120	222500	112045 120909	121655 222500		164.4	14	TXR at 10 kw. TLM at 8 and 16 bps
523	14	142	111815	192500	111815 120236	120314 192500		164.2	16	TXR at 10 kw. TLM at 16 bps
526	14	145	111532	1817	111532 120703	120752 1817		164.1	13	TXR at 10 kw. TLM at 8 and 16 bps

Table 22 (contd)

Pass No.	Station (DSS)	Day of Year (GMT)	Acq. (GMT)	End of Track (GMT)	Ground Modes (Start and End Times GMT) 1-Way	2-Way	3-Way	Avg. Recd. Sig. Level (dbm)	Commands Total	Equipment Failures and Anomalies; Significant Events; Remarks
529	14	148	111258	2300	111250 120700	120800 2255		164.3	13	TXR at 10 kw. TLM at 8 and 16 bps
532	14	151	112540	1900	1125 1215	1215 1900		164.7	13	TXR at 10 kw. TLM at 8 and 16 bps
536	14	155	1115	2243	1115 1206	1206 2243		-165.0	18	TLM bit rate at 8 and 16 bps. TXR power at 10 kw
538	14	157	110330	2314	110330 114856	115030		-164.8	13	TLM bit rate at 8 and 16 bps. TXR power at 10 kw
541	14	160	110044	1904	110044 114809	114856 1904		-164.5	13	TLM bit rate at 8 and 16 bps. TXR power at 10 kw
543	14	162	111345	2257	111345 120310	120339		-164.7	17	TLM bit rate at 8 and 16 bps. TXR power at 10 kw
545	14	164	105839	1842	105839 114729	114821		-164.7	15	TLM bit rate at 8 and 16 bps. TXR power at 10 kw
548	14	167	105515	185700	105515 114726	114902 185700		-164.4	14	TLM bit rate at 8 and 16 bps. TXR power at 10 kw
550	14	169	105243	2319	1052 1218	1218 2319		-164.4	17	TLM bit rate at 8 and 16 bps. TXR power at 10 kw
552	14	171	105215	1900	105215 114204	114245 1857		-164.6	14	TLM bit rate at 8 and 16 bps. TXR power at 10 kw. Command 3/016 sent 6 seconds early because of GOE time error.
555	14	174	104952	1600	104952			-165.0	None	TLM bit rate at 16 bps.
557	14/12	176	111335	1846	111335 170329 181145 182523	1718 181101 184125 1846		-165.8	None	Attempted to use DSS 12 for uplink DSS 14 for downlink. DSS 14 unable to hold 2-way lock, signal level varying between -170 dbm and threshold. Station 14 performed RCV search with RCV 2 at channel 6 frequency and was obtaining intermittent lock at that frequency: DSS 12 TXR apparently not able to hold S/C RCV in two-way, causing switching between channel 6 and 7. Dropped S/C PN-6 at 1846 to reconfigure to PN-7.
559	14	178	1051	1605	105100			-164.5	None	TLM bit rate at 16 bps
561	14	180	104545	1604	104545 1604			-164.7	None	TLM bit rate at 16 bps

G. Pass Chronology

Tracking periods covered are identified by the pass number, which is the number of times since launch that the spacecraft was above the horizon of a particular station. Unless otherwise noted, the following entries refer to DSS 14.

Pass 196. A failure in the azimuth A lubricating system was corrected by readjustment of a microswitch. A failed TDH doppler frequency counter was repaired by replacing a loose wire that had been shorting. Because of an operator error, the station tracked in the 4.5-kHz telemetry bandwidth.

Pass 197. An operator inadvertently hit the antenna offset, causing loss of lock for 2 min.

Pass 207. Numerous random receiver glitches[1] occurred at DSS 12 because of low signal level. After transmitter failure at DSS 12, the transmitter was reset; there was no repetition of the failure.

Pass 208. Restarting of the computer program and reseating of loose cards resulted in normal operation for TCP 920 computer programs after a failure. Operation of FR-1400 recorder B modulator tracks returned to normal after a drive belt was replaced. There had been no output during posttrack calibration, and tape speed was 75% off.

Pass 210. The GOE computer buffer power supply was replaced after DSS 12 was unable to obtain TCP

[1]Momentary intermittent anomalies.

lock for first 3 h 32 min of track. DSS 12 also experienced numerous receiver glitches resulting from low signal strength. Replacement of a fuse restored normal operation after a DSS 12 doppler counter was inoperative for 27 min.

Pass 211. A backup computer was employed when the TCP 920 computer failed because of an intermittently operating module. The module was replaced.

Pass 218. Because of a wiring error, the wrong data condition code was printed. The wiring error was corrected.

Pass 223. When DSS 12 transmitter failed twice because of high body current, the focus current was adjusted, returning operation to normal.

Pass 226. Investigation was started when the VCO counter in the TDH and a spare counter failed because of bad circuit boards.

Pass 230. Because of tape recorder stoppage, 1 min 50 s of data was lost before the recorder was restarted.

Pass 232. The TDH doppler counter failed in transmitter 2 mode during prepass calibration; transmitter 1 mode was used for pass.

Pass 235. The station elevation axis encoder hung up three times and caused signal losses during tracking; interim Datex encoding system was the cause.

Pass 235. The station prepared six trouble/failure reports (TFRs) for failure of TDH punch 1 and 2. Transmitter failure resulted from beam voltage overcurrent, body overcurrent, and low water flow. Antenna brake red indicator light was on.

Pass 237. The DSS 14 transmitter went off because of beam current interlock.

Pass 238. The antenna came to emergency stop in both axes because of a coolant line entangled in the cables. The transmitter went off once because of a klystron air interlock, and then again because of the detector.

Pass 248. DSS 14 received no command modulation from DSS 12 GOE for a portion of the pass because of microwave link breakdown.

Pass 254. The station transmitter was off twice because of arcing in the waveguide.

Pass 257. The transmitter was off four times. The servo brake went on because of a blown fuse in the 400-Hz power source. The fuze was replaced and operation returned to normal.

Pass 299. A local storm caused a major power failure at DSS 12; approximately 2 min of GOE computer data was lost.

Pass 309. The telemetry microwave link to DSS 12 was out for 4 min until the faulty cable at DSS 12 was isolated and repaired. The TCP computer B failed at DSS 12, requiring switch to computer; 12 min was lost.

Pass 316. The telemetry patch to the microwave line at DSS 14 was inadvertently pulled, causing the GOE/TCP at DSS 12 to lose lock. The problem was corrected after 2 min 46 s had elapsed.

Pass 322. Because of incorrect frequency bias, some of the doppler data was bad.

Pass 343. While tuning to lock channel 7, the DSS 14 antenna was driven off spacecraft because the DIS did not pull the paper tape.

Pass 350. Because of a heat exchanger problem, the transmitter was off.

Pass 371. The station was on spare synthesizer for a special tracking data requirement.

Pass 416. The antenna was in a brake mode for a special film height test.

Passes 418 through 422. The DSS 14 transmitter was on and off in a series of TCP/GOE and TCP locks.

Passes 425 through 432. The bit rate was switched from 16 to 8 bits/s.

Pass 443. This was the last pass tracked by DSS 14 until pass 502, during which time the station was shut down for major bearing rework.

Pass 502. DSS 14 was again operational on day 121 (May 1, 1967). The transmitter was at 10 kW and the telemetry at 8 bits/s. The antenna stopped three times because of low oil alarm on pad 3.

Pass 515. The transmitter went off because of power cabinet interlock failure; 2.5 h of telemetry data was lost before demodulator locked.

Pass 517. The pass was cut short to provide command capability for DSS 51 with *Pioneer VII.*

Pass 526. The receiver went out of lock because of a glitch in the master equatorial system.

Pass 536. The receiver went out of lock as a result of the master equatorial hitting the prelimits.

Pass 552. The transmitter subsystem was turned off for 60 s because of a beam voltage overload.

Passes 555, 559, and 561. Tracked without maintaining any uplink (one-way).

Pass 557. The pass was an effort by DSS 12 and DSS 14 to track *Pioneer VI* jointly. DSS 12 provided the uplink but was unable to hold good lock on the spacecraft receiver. DSS 14 maintained the downlink.

Pass 561. The TDH incorrectly listed spacecraft ID as *Pioneer VII.* The ID was corrected to read *Pioneer VI.*

Tables 21 and 22 give a more extensive summary of operations by pass.

Part III. Extended Flight Phase, Second Annual Period (July 1, 1967 – July 1, 1968)

I. Introduction

Deep Space Network support of *Pioneer VI* continued to meet and, in some instances, surpass Project requirements. Support during this reporting period included spacecraft coverage of solar flares in November and April. There was also a requirement for reorientation of the spacecraft antenna with earth on pass 620 in August. The maneuver (type II) was performed satisfactorily despite a spacecraft storage bottle leak, which depleted the propulsion gas supply. A total of 193 commands were transmitted on the pass.

A significant change in support was caused by loss of the use of the high-gain antenna aboard the spacecraft in late 1967, which finally resulted in abandonment of attempts to transmit commands for the remainder of this reporting period. A significant improvement in downlink signal strength was obtained in March with the DSS 14 reconfiguration for ultracone. Tracking interruptions were a result of the *Mariner V* encounter with Venus and the Pulsar Observation Project. All tracking was accomplished by DSS 14; the bit rate was 8 bits/s.

When the annual report period began, the *Pioneer VI* spacecraft was some 231 million km from earth. At the end of the period, the spacecraft was some 293 million km from earth, the greatest distance of separation reached thus far. The spacecraft began retrograde motion on September 16 while approximately 238 million km from earth; by November it had come approximately 6 million km nearer earth before again starting to recede.

II. Engineering and Operations

A. Tracking

Pioneer VI was tracked by DSS 14 for a total of 1107 h 15 min during the period from July 1, 1967 to July 1, 1968 (passes 564 through 928). The tracking time by quarter was as follows:

Tracking period	Passes	Total tracking time, h-min
Jul, Aug, Sep 1967	564–648	309:7
Oct, Nov, Dec 1967	675–746	212:36
Jan, Feb, Mar 1968	747–837	228:2
Apr, May, Jun 1968	838–928	357:30

B. Significant Problems and Improvements

Loss of the ability to track the spacecraft in a two-way coherent mode was the most serious problem that developed during the second annual period of the *Pioneer VI* extended flight phase. The most significant improvement during the period was transfer of the DSS 14 antenna to an ultracone configuration (Fig. 20). The S-band Cassegrain ultracone, which had been modified at JPL for polarization diversity, was installed on March 5. *Pioneer* spacecraft radiated linearly polarized signals, and the DSS antennas used a circularly polarized feed. Because of this, only half the received signal was indicated at the receiver. Use of the linear-to-circular polarizer at DSS 14 improved the downlink signal strength from the spacecraft by some 5 dBmW above predicted value for one-way tracking modes.

1. Tracking interruptions. The longest tracking interruption during the report period was from September 24 to October 21, 1967. During this time (pass 648 to pass 675), the *Pioneer VI* spacecraft was not tracked by DSS 14 because of the priority of the *Mariner V* encounter with Venus. There was also a four-day interruption in April 1968 for the Pulsar Observation Project.

2. Tracking mode. Prior to October, *Pioneer VI* was tracked most of the time in two-way mode on channel 7. But after the tracking interruption for the *Mariner* Venus encounter, two major problem areas developed, beginning as small error indications and increasing in magnitude.

The first problem was a station problem. Loss of word/frame (W/F) synchronization in the TCP printout occurred at random, but because of low error rate the loss was not considered excessive at the time. When the loss of W/F sync increased, the source of the problem was traced to several bad cards in the computer buffer. The cards were replaced.

The second problem area seemed to be within the spacecraft. The ground receiver had random momentary glitches, and the ground transmitter had to be increased from 10- to 15-kW output for the spacecraft to accept commands. Ground receivers, the transmitter, and the microwave lines checked out satisfactorily in analysis. On following passes the receiver glitches increased to more than one per min in both one- and two-way configurations. The transmitter was increased to 20 kW, but ultimately no commands were acceptable on channel 7.

Two-way tracking was maintained for a period on channel 6 by using spacecraft receiver 1. However, use of channel 6 lowered the threshold because it made necessary dependence on a low-gain antenna instead of a high-gain antenna (Fig. 21).

The problem of spacecraft acquisition of commands became greater when receiver 2 broke into oscillation and cross-feeding impaired receiver 1. Finally, it was no longer possible to maintain two-way lock in coherent mode on channel 6. However, before channel 6 became too noisy to accept commands, a noncoherent command was initiated in November. For a period, tracking was performed in a two-way noncoherent mode. In this mode, receiver 1 was locked on the station transmitter via channel 6 with a control loop between the receiver and the auxiliary (driver) oscillator. This permitted reception of commands by the spacecraft. Consequently, the downlink carrier frequency from the spacecraft was independent of the station transmitter, and the data received was identified by the same data conditions code (DCC) 8150 used for one-way tracking. Reasonable parity error rates at 8 bits/s were obtained in this mode.

3. Dual maser configuration. On pass 686, a special R&D test was performed in an attempt to establish two-way lock on channel 7 by using a dual maser configuration. (This configuration had been used during the *Mariner V* Venus encounter.) For this experiment the two masers were used by DSS 14 as an R&D rotating linear feed. The signals were transmitted to the spacecraft, which radiated linearly polarized signals (Fig. 22). The masers, in effect, linearly summed the energy of the right circular polarization (RCP) and the left circular polarization (LCP). The resulting parity error rate and the received power were compared between receiver 1 (modified) and receiver 2 (standard) as follows:

Receiver	Signal level, dBmW	Bit rate, bits/s	Parity error rate
Modified	−159.9	16	0.039
Standard	−163.0	16	0.420
Standard	−162.9	8	0.07

The bit rate of a normal *Pioneer VI* track at that time was 8 bits/s, with a parity error rate of less than 0.1. With the modified receiver and a bit rate of 16 bits/s,

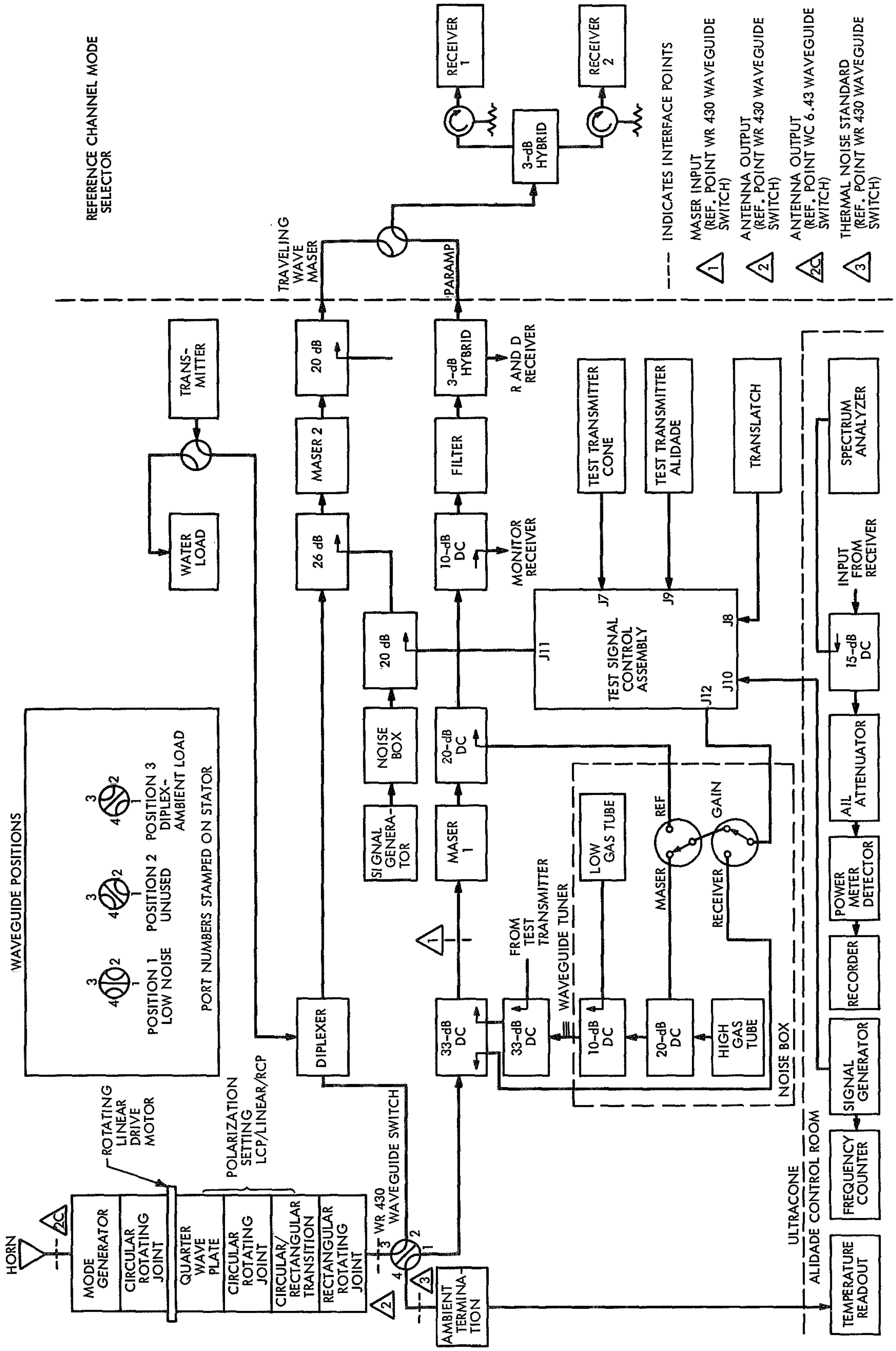

Fig. 20. Block diagram, S-band ultracone

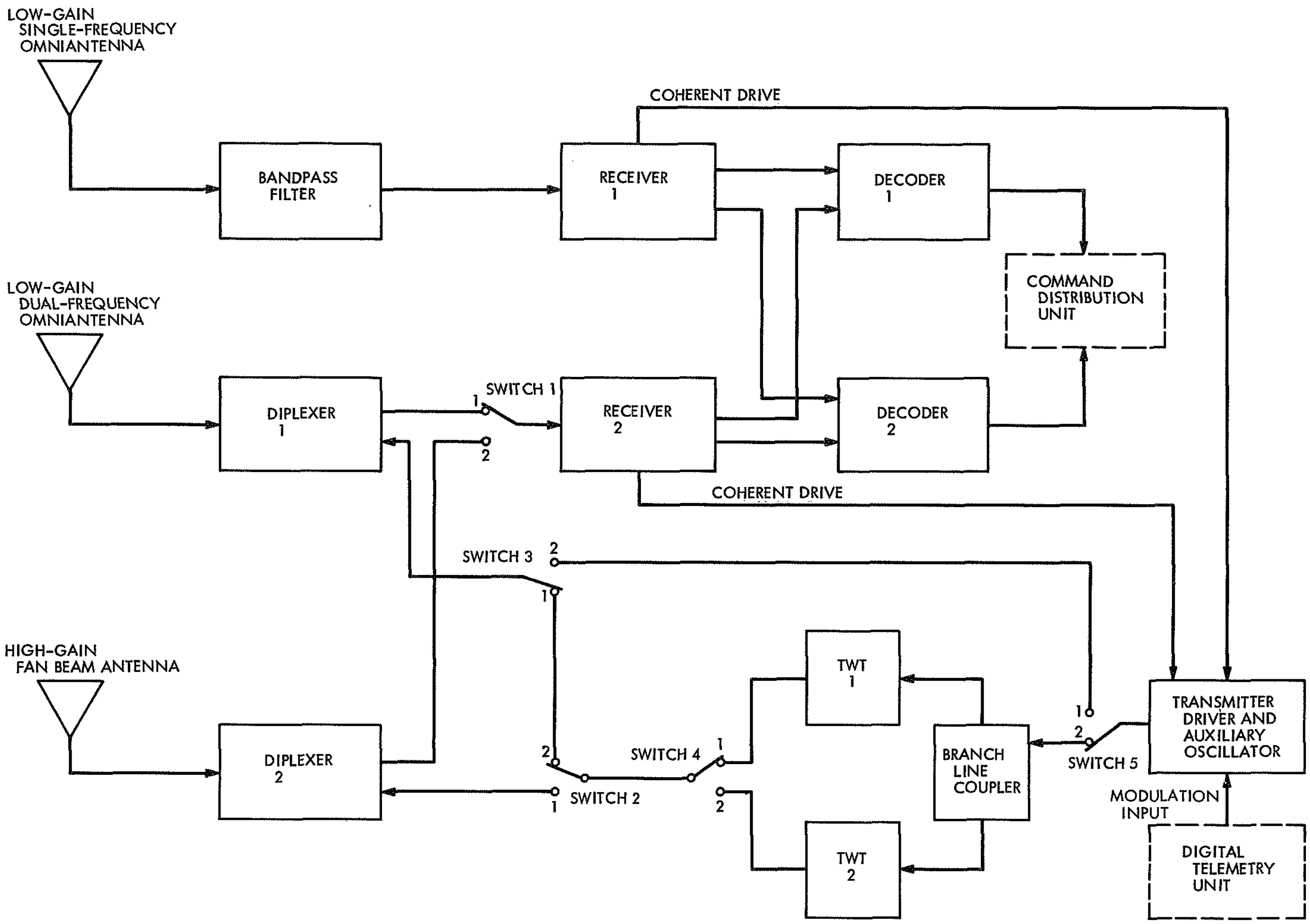

Fig. 21. Communications subsystem functional block diagram

the parity error was also less than 0.1, showing an increase of approximately 3 dBmW. The received signal level increased by 3 dBmW when switched between the standard and the modified receiver. However, the attempt to lock on channel 7 was unsuccessful, and although the configuration was switched back to channel 6 before the end of the pass, no good two-way data was obtained. All attempts to transmit commands then proved unsuccessful and the spacecraft was tracked in one-way mode only.

4. Ultracone configuration. Despite the spacecraft's great distance from earth, the ultracone provided tracking at a bit rate of 8 bits/s with low parity error rate readings. Handicaps were as follows: a spacecraft receiver problem prevented receipt of commands; the spacecraft duty cycle store was a fixed 16-bits/s operation. The normal procedure at DSS 14 was to go to duty cycle store mode at the end of a track, then to pick up the stored data at the beginning of the next track. The major difficulty was spacecraft reception of a command to change the 16-bits/s rate to a receivable 8-bits/s rate. The time spent in getting an acceptable command to the spacecraft caused the loss of considerable data.

The improved downlink signal strength (5 dBmW) gained from the ultracone made it possible to check the degree of malfunction in the spacecraft receiver 2. Beginning with pass 820, an attempt was made to lock in the spacecraft on channel 7 for two-way noncoherent tracking. Although there was intermittent success in locking in the receiver, attempts to get commands accepted failed. Apparently the receiver 2 malfunction had not lessened in degree. Telemetry was sent at fixed bit rate of 8 bits/s only, because of the marginal signal resulting from the spacecraft's distance from earth.

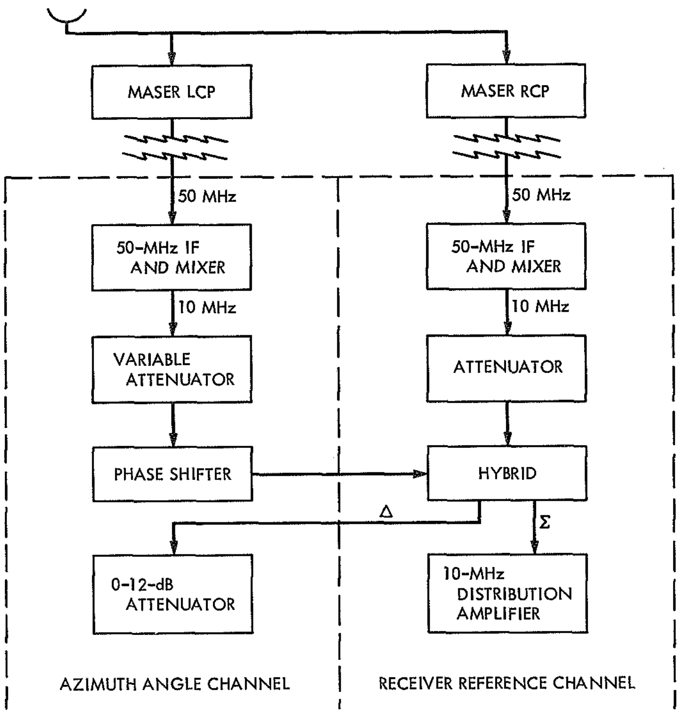

Fig. 22. Configuration of modified receiver in rotating linear feed experiment

C. Anomalies Related to Data Losses

Some instances of data losses and the anomalies that caused them during this report period are singled out here. The pass chronology contains additional information. On pass 581, 47 min of data was lost when the TCP was unable to lock at DSS 12; the spacecraft was in duty cycle store. On pass 584, the GOE at DSS 12 was unable to lock up the demodulator when the spacecraft was in one-way mode; 49 min of data was lost. Then, on pass 585, engineering data was missed at DSS 12 at the beginning of the pass; the telemetry was transmitted upon completion of the track.

A transmitter 400-Hz power failure caused a loss of data during some passes during January of 1968 (passes 747 through 777). The failure occurred when one of the two generators dropped off line; the load was too high for the other alone. As a result, the transmitter failed. On pass 852, 1 h 50 min of data was lost, and during passes 855 and 860 smaller amounts of data were lost. The losses occurred because the TCP program halted and had to be restarted many times in order to correct the data format. A bad connector was replaced.

A commercial power failure caused the loss of 1 h 35 min of data on pass 874. The power loss resulted from an overload relay in the 400-Hz motor-generator circuit. On pass 895, 15 min of data was lost when the antenna was positioned at zenith for signal variation check. No problem was discovered and the antenna was returned to spacecraft point without further incident. Tables 23, 24, and 25 present abbreviated telecommunication design control data for passes 591, 614, and 897.

D. RF Performance

1. Downlink. Table 26 presents receiver signal strength for passes 595 through 928. Figures 23 through 29 present predicted and actual downlink signal strength. Figure 30 shows predicted and actual signal strength vs time from launch. The downlink signal strength was within ±2 dBmW of the predicted signal strength in

Table 23. Abbreviated telecommunication design control, pass 591

No.	Parameter	Value	Tolerance, dB	
1	Total transmitting power, dBmW	+38.4	+0.2	−0.2
2	Transmitting circuit loss, dB	−1.6	+0.5	−0.65
3	Transmitting antenna gain, dB	+11.0	+0.5	−0.5
4	Transmitting antenna pointing loss	Included in (3)		
5	Space loss, dB (2292 MHz; R = 2.38 × 10[8] km)	−267.2		
6	Polarization loss, 0.7 dB elliptical ratio	−3.0	+0.3	−0.3
7	Receiving antenna gain (210-ft), dB	61	+1.0	−0.5
8	Receiving antenna pointing loss, dB	0		
9	Receiving circuit loss, dB	−0.2	+0.1	−0.1
10	Net circuit loss, dB	−200	+2.4	−2.1
11	Total received power, dB	−161.6	+2.6	−2.3
12	Receiver noise spectral density (N/B), dBmW/Hz (temperature system = 29°K)	−184.1	+0.7	−0.9
13	Carrier modulation loss (θ = 0.9 ±5%), dB	−4.1	+0.5	−0.5
14	Received carrier power, dBmW	−165.7	+3.1	−2.8
15	Carrier APC noise BW ($2B_{LO}$ = 12 Hz), dB	10.8	+0.0	−0.5

Table 24. Abbreviated telecommunication design control, pass 614

No.	Parameter	Value	Tolerance, dB	
1	Total transmitter power, dBmW	+38.4	+0.2	−0.2
2	Transmitting circuit loss, dB	−1.6	+0.5	−0.65
3	Transmitting antenna gain, dB	+11.0	+0.5	−0.5
4	Transmitting antenna pointing loss	Included in (3)		
5	Space loss (2292 MHz; R = 2.4 × 10^8 km) (21 August 1967)	−267.2		
6	Polarization loss, dB	−3.0	+0.3	−0.3
7	Receiving antenna gain (210-ft antenna), dB	61.8	+0.3	−0.3
8	Receiving antenna pointing loss, dB	0		
9	Receiving circuit loss, dB	−0.2	+0.1	−0.1
10	Net circuit loss, dB	−199.2	+1.7	−1.9
11	Total received power, dBmW	−160.8	+1.9	−2.1
12	Carrier modulation loss (0 = 0.9 ±5%), dB	−4.1	+0.5	−0.5
13	Received carrier power, dBmW	−164.9	+2.4	−2.6

most cases throughout July, August, and September of 1967. The margin was 2.5 dBmW for the only five passes in October. For the remainder of 1967, the received signal strength values increased ±3 dBmW. This increase apparently resulted from the dual maser installation at DSS 14.

During January and February of 1968, the data was plotted from telemetry clusters in two groups: one roughly 3 dBmW above the predicted curve and the other roughly 5 dBmW above (Fig. 30). The 3-dBmW increment was credited to the dual-maser configuration as in the previous period. The 5 dBmW resulted from a 2-dBmW error communicated to the network and originating in a calculation of line-loss between the maser and the receiver in the control building.

During March and April the predicted signal strength was exceeded by 5 dBmW and 4 dBmW, respectively; the improvement was attributed to the new ultracone

Table 25. Abbreviated telecommunication design control, pass 897

No.	Parameter	Value, dB	Tolerance, dB	
1	Total transmitter power, dBmW	38.4	0.2	−0.2
2	Transmitting circuit loss, dB	1.4	0.5	−0.6
3	Transmitting antenna gain, dB	11.0	0.5	−0.5
4	Transmitting antenna pointing loss	Included in (3)		
5	Space loss, dB (2292 MHz; R = 2.91 × 10^8 km)	268.9		
6[a]	Polarization loss, dB	3.0 or 0	0.3	−0.3
7	Receiving antenna gain (210-ft), dB	61.8	0.5	−0.5
8	Receiving antenna pointing loss, dB	0		
9	Receiving circuit loss, dB	0.2	0.1	−0.1
10[a]	Net circuit loss, dB	200.7 or 197.7	1.9	−2.0
11[a]	Total received power, dB	−162.3 or 159.3	2.1	−2.2
12	Receiver noise spectral density (N/B) (temperature system = 19°K, listen only), dBmW	185.8	0.7	−0.9
13	Carrier modulation loss (θ = 0.9 ±5%), dB	4.1	0.5	−0.5
14[a]	Received carrier power, dBmW	−166.4 or 163.4	2.6	−2.7
15	Carrier APC noise BW ($2B_{LO}$ = 12 Hz), dB	10.8	0.0	−0.5
16	Measured carrier power, dBmW	−163.5		
17	Calculated (14), measured (16) with polarized unit installed, dB	−0.1		

[a]Circular or linear configuration

configuration. The strength was fairly close to the predicted curve with the linear to circular polarizer operating during May. During June, the polarizer was on and the diplexer was bypassed to provide an optimum downlink signal. Good data was obtained during 98.6% of the tracking time.

Table 26. Summary of Operations, Passes 595–928

Pass No	DSS No	Day of Year	Acq. Time	End of Track	Ground Mode Start/Stop Time 1-Way	2-Way	3-Way	Signal Strength Avg (dbm)	Configuration Loop BW (Hz)	Temp Pre/ Post (°K)	Thres Pre/ Post (dbm)	No. of Cmds	Average PER	Bit Rate	Comments
595	14	214	1528	1909				-165.5	12	29.7 N/A	-174 N/A	7	.040 .812	8 16	
597	14	216	1043	1401	1043 1121	1122 1401	---	-165.6	12	28.9 28.9	-175 -175	5	.030	8	
599	14	218	1044	1930	1044 1124	1124 1930		-166	12	28.2	-174	8	.150	8	
600	14	219	1044	2200	1044 1124	1124 2157	---	-165.8	12	28.3 30.0	-174 -175	17	.050	8	
601	14	220	1045	1900	1045 1127	1128 1900		-165.9	12	28.8	-175	13	.210	8	Record only from 1443 to 1550 due to TCP Bravo failure. TFR 12-TCP-103242. Computer Alpha not available.
602	14	221	1534	1902	1534 1618	1618 1902		-165.8	12	28.7	-174	7	.110	8	
604	14	223	1123	1425	1122 1210	1210 1425	---	-165.7	12	28.3 29.2	-174 -174	7	.200	8 16	
605	14	224	1048	1401	1048 1150	1151 1401	---	-166.0	12	29.3 29.6	-174 -175	9	.400	8 16	
608	14	227	1048	1604	1048 1136	1137 1604	---	-165.5	12	30.2 30.5	-174 -174	9	.400	16 8	TCP had a program failure. TFR 12-TCP-100418. Command 3/053 not enabled due to TCP failure. Command retransmitted when TCP restart was successful. Data lost will be reported in monthly report.
611	14	230	1122	1604	1122 1204	1215 1604	---	-166	12	28.3 28.2	-174 -174	9	.090	8	
613	14	232	1103	1930	1103 1154	1200 1930	---	-165.5	12	29.7	-169	8	.200	8 16	Antenna in prelimit - TFR 10021. Master Equatorial was driven in the wrong direction for acquisition during precals. The M. E. was returned to correct position.
614	14	233	1052	1853	1052 1336	1138 1853	---	-164	12	30.0	-169	13	.150	8 16	TCP and GOE lost lock at MMSA due to loss of TLM from DSS 14. DSS 14 discovered bad AIS patch cord.
616	14	235	1504	1920	1504 1552	1552 1920	---	-166	12	31.4 30.2	-174 -174	9	.400	16	Retuned transmitter. Microwave outage caused loss of command capability at 15552. COMM restored. TFR is 103943. TCP lost W/F sync for 45 seconds. Playback of tape indicates a short loss of TLM due to microwave outage.
618	14	237	1058	1400	1058 1144	1146 1400	---	-165.5	12	28.6 28.6	-169	8	.200	8 16	
620	14	239	1055	2159	1055 1138	1138 2159		-166.1	12	27.7 27.6	-175 -175	193	.200	8 16	Type I orientation.
621	14	240	1159	1928	1159 1244	1244 1928		-165.3	12	27.9 N/A	-169 N/A	13	.050	8	
623	14	242	1134	1847	1134 1218	1218 1847	---	-164.9	12	28.2 N/A	-175 N/A	14	.080	8 16	At 1633Z the antenna lost S/C signal due to pointing errors. TFR 14 ADS-100212. Problem was in the Azimuth Channel of the Auto-Collimator of the Master Equatorial.
625	14	244	1125	1600	1125 1209	1209 1600	---	-165.3	12	28.6 28.8	-174 -174	11	.100	8 16	
626	14	245	1420	1904	1420 1504	1505 1904	---	-165	12	31.5 N/A	-174 N/A	9	.060	8 16	
627	14	246	1120	1401	1120 1208	1209 1401	---	-165.8	12	28.6 28.8	-174 -174	4	.070	16	
628	14	247	1100	1859	1100 1141	1141 1859	---	-165.7	12	28.2 N/A	-175 N/A	10	.070	8 16	
629	14	248	1110	1441	1110 1151	1151 1441	---	-165.5	12	28.3 N/A	-174 N/A	8	.035	8	
634	14	253	1112	1431	1112 1213	1214 1431	---	-165.3	12	28.7 28.5	-174 -175	5	---	8 16	PER: 1157 - Bad 1231 - Bad 1415 - .022 Went 8 bps at 1245
635	14	254	1212	1559	1212 1302	1303 1559	---	-165.4	12	28.7 29.6	-174 -175	7	.000 .713	8 16	
638	14	257	1118	2201	1118 1212	1213 2201	---	-163.3	12	29.5 28.1	-174 -175	11	.025	8	At 1625 DIS Input TTY failed. IMP stopped at 1628. DIS input TTY replaced with spare-IMP started. TFR 14-101586. At 1628 REC B went to stop mode: Relay K-10 was replaced.
641	14	260	1112	1943	1112 1203	1205 1943		-164.5	12	29.1	-174	10	.070	8	

Table 26 (contd)

Pass No	DSS No	Day of Year	Acq. Time	End of Track	Ground Mode Start/Stop Time 1-Way	2-Way	3-Way	Signal Strength Avg (dbm)	Configuration Loop BW (Hz)	Temp Pre/ Post (°K)	Thres Pre/ Post (dbm)	No. of Cmds	Average PER	Bit Rate	Comments
646	14	265	1132	2000	1132 1224 1639 1823	1230 1638 1824 2000	--- ---	-165.5	12	29.7 N/A	-174 N/A	11	.200	8	At 1612 TXR kicked off. H.V. cable feeding Klystron was arcing. Cable repaired.
648	14	267	118	2001	1118 1216 1542 1615	1217 1541 1616 2001	--- ---	-165.5	12	28.2	-174	7	.230	8	At 1242 DIS TTY IMP failed. TFR 14-DIS-101531. At 1252 TTY changed - IMP became operational. At 1541 RCV dropped lock due to beam current overload kicked off on Klystron power supply. No reason for drop out. Retuned and checked gain. Error rate abnormally high for reported signal strength. Klystron creating noise problem during pass. Subsequently corrected.
675	14	294	1547	2128	1547 1636	1639 2128		-163.3	12	28.0	-173	7	.080	8	Lost W/F sync throughout pass. TCP or GOE problem - not known. TXR power increased to 15KW for command transmission. Replaced computer buffer to correct W/F sync-investigating command problem.
677	14	296	1144	2257	1144 1220	1233 2257		-163.3	12	28.7	-172	10	.080	8	Numerous loss of W/F sync at stations 12/14 - trouble shooting problem. TXR power to 20KW for command transmission. Replaced computer buffer to correct W/F sync-investigating command problem.
678	14	297	1253	2257	1253 1330	1334 2257		-163.3	12			23	.100	8	Although 23 commands were transmitted to S/C, not all commands were effective. Net control reporting does not reflect which commands were effective. TCP in and out of lock many times throughout pass.
683	14	302	1654	2252	1654 2042	2042 2252		-164.3	12	27.7	-173	5	N/A		Unable to establish uplink on channel 7, believed to be spacecraft anomaly.
684	14	303	1152	2132	1152 1351	1357 2132		-163.7	12	27.8	-173	11	.032	8	Unable to establish uplink on channel 7.
686	14	305	1155	2248	1155 2248			+62.6	12	27.4	-173	0	0.200	16	Unable to establish uplink on Channel 7.
688	14	307	1159	1800	1159 1244	1246 1800		-163.5	12	28.2	-173	4	Bad	8	Frequent receiver glitches caused bad PER. Probably due to S/C anomaly.
689	14	308	1159	2244	1159 1340 2115 2244	1342 1624 1626 2115 Non-coherent		-163.6	12	28.3	-172	18	Bad 0.090	8 8	Bad PER in both one-way and two-way coherent modes as result of receiver glitches. Upon going noncoherent, glitches stopped and PER became good. Analyzed by ARC as S/C problem. SDA reported that SPE was fluctuating from 5 kHz to 20 kHz indicating that Receiver No. 2 was oscillating.
691	14	310	1214	2242	1214 1932	1932 2242 Non-coherent		-163.1	12	27.8	-173	13	0.038	8	Two commands were not sent as a result of microwave line mismatch between DSS 12 and 14. Project reported that none of the 13 commands were received by the S/C.
693	14	312	1203	2128	1203 1819	1819 2128 Non-coherent		-162.7	12	28.2	-173	13	0.090	8	None of the commands were received by the S/C as a result of S/C anomaly.
695	14	314	1206	2101	1206 1340	1340 2101 Non-coherent		+62.7	12	26.9	-172	0	0.076	8	SDA signal strength appeared to be 2.5 dbm better than theoretically predicted.
700	14	319	1212	2015	1212 1315	1315 2015 Non-coherent		-162.7	12	30	-173	0	0.038	8	
701	14	320	1214	2100	1214 1316	1316 2100 Non-coherent		-162.8	12	27.8	-173	1	0.039	8	
703	14	322	1216	2000	1216 1300	1300 2000 Non-coherent		-163.5	12	27.8	-173	0	0.050	8	
705	14	324	1219	2000	1219 1300	1300 2000 Non-coherent		-163.1	12	28	-171	0	0.041	8	

Table 26 (contd)

Pass No.	DSS No.	Day of Year	Acq. Time	End of Track	Ground Mode Start/Stop Time 1-Way	2-Way	3-Way	Signal Strength Avg (dbm)	Configuration Loop BW (Hz)	Temp Pre/ Post (°K)	Thres Pre/ Post (dbm)	No. of Cmds	Average PER	Bit Rate	Comments
707	14	326	1230	1500	1230 1315	1315 1500 Non-coherent									
709	14	328	1323	1935	1329 1420	1420 1935 Non-coherent		-162.6	12	28.3	-173	0	0.039	8	Unable to obtain stable DSIF transmitter output above 10 kw.
712	14	331	1230	1845	1230 1348	1348 1845 Non-coherent		-163.6	12	28	-172	0	0.099	8	
714	14	333	1234	1945	1234 1335	1335 1945 Non-coherent		-162.8	12	27.4	-173	0	0.110	8	
715	14	334	1235	1500	1235 1330	1330 1500 Non-coherent		-162.9	12	27.9	-173	0	0.079	8	
718	14	337	1250	2000	1250 2000			-162.7	12	28.2	-173	0			Record only pass.
721	14	340	1250	1600	1250 1448	1449 1600		-163.4	12	28.8	-173	0	0.070	8	
724	14	343	1251	1908	1251 1358	1400 1908		-163	12	27.8	-171	0	0.029	8	Noncoherent tracking mode.
725	14	344	1253	1930	1253 1350	1354 1930		-163	12	26.3	-172	0	0.062	8	Noncoherent tracking mode.
726	14	345	1255	1601	1255 1345	1347 1601		-162.6	12	27.2	-173	0	0.080	8	Noncoherent tracking mode.
727	14	346	1259	1501	1259 1408	1410 1501		-163	12	28.3	-172	0	0.080	8	Noncoherent tracking mode.
732	14	351	1305	2001	1305 2001			-163.7	12	28.2	-173	0	N/A	N/A	Record only.
734	14	353	1309	2001	1309 1340	1340 2001 Non-coherent		-163.5	12	27.5	-172	0	0.076	8	
736	14	355	1313	1500	1313 1500			-163.7	12	27.2	-172	0	0.100	8	
738	14	357	1316	1500	1316 1500			-164.0	12	27.6	-173	0	0.100	8	
739	14	358	1451	2000	1451 2000			-163.7	12	None	None	None	0.100	8	
741	14	360	1322	1500	1322 1500			-163.5	12	28.3	-173		0.180	8	
742	14	361	1323	1500	1323 1500			-163.4	12	28.1	-173		0.170	8	
743	14	362	1325	1505	1325 1505			-163.3	12	28.8	-172		0.150	8	
747	14	001	1336	1511	1336 1511			-162.9	12	27.4	-172	0			
748	14	002	1335	1500	1335 1500			-162.8	12	28.5	-172	0			
749	14	003	1336	1512	1336 1512			-163.3	12	27.6	-172	0			
750	14	004	1337	1514	1337 1514			-163.3	12	27.6	-174	0	0.300	8	
751	14	005	1705	2000	1705 2000			-163.7	12	27.9	-173	0	0.142	8	
752	14	006	1342	1951	1342 1951			-164.2	12	26.9	-173	0	0.177	8	
756	14	010	1348	1501	1348 1501			-163.5	12	27.6	-173	0	0.500	8	
757	14	011	1349	1501	1349 1501			-164	12	28.8	-171	0	0.268	8	
758	14	012	1350	1500	1350 1500			-164.1	12	27.6	-173		0.383	8	

N/A Not Applicable
Times are given in Greenwich Mean Time

Table 26 (contd)

Pass No.	DSS No.	Day of Year	Acq. Time	End of Track	Ground Mode Start/Stop Time 1-Way	2-Way	3-Way	Signal Strength Avg (dbm)	Configuration Loop BW (Hz)	Temp Pre/Post (°K)	Thres Pre/Post (dbm)	No. of Cmds	Average PER	Bit Rate	Comments
759	14	013	1351	2001	1351 2001			-163.9	12	N/A	N/A		0.153	8	LC unless indicated.
760	14	015	1725	2001	1725 2001			-163.4	12	26.8	-173		0.250	8	Unable to monitor AGC volts for RCV 1. RCV 2 was used as prime. Replaced RCV 1 AGC amplifier and filter.
762	14	016	1355	1500	1355 1500			-164.1	12	27.2	-173		0.576	8	
763	14	017	1356	1500	1356 1500			-164.3	12	28.3	-173		0.500	8	
765	14	019	1454	2200	1454 1600	1600 2200		-165.4	12	27.9	-173	4	0.150	8	LC unless indicated.
766	14	020	1400	2000	1400 1405	1405 2000		-164.9	12	28.5	-173	3	0.273	8	At 1450 bad patch on science data line through Comm; no data lost.
767	14	021	1723	2000	1723 1803	1803 2000		-163.5	12	28.5	-173	2	0.100	8	
768	14	022	1602	1840	1602 1840			-163.7	12	28.0	-173	0	0.230	8	Unable to acquire S/C uplink; reason unknown
769	14	023	1604	1840	1604 1703	1703 1840		-163.6	12	28.1	-173	2	0.300	8	
771	14	025	1800	2000	1800 1849	1849 2000		-161.5	12	28.9	-173	2	0.020	8	Dual maser operation improved parity error.
772	14	026	1752	2000	1752 1810	1810 2000		-161.1	12	28.3	-173	2	0.000	8	
773	14	027	1405	2015	1405 2015			-161.2	12	29	-173	2	0.040	8	LC unless indicated.
774	14	028	1759	2000	1759 2000			-165.2	12	27.8	-174	0	0.210	8	Dual maser inoperative. TFR 105305. TXR 400 cycle failed prior to pass due to power fluctuations. TFR 105304. Data not affected.
775	14	029	1406	1845	1406 1845			-164.4	12	28	-173	3	0.210	8	
776	14	030	1408	1830	1408 1830			-163.5	12			2	0.318	8	No pretrack or post track calibrations, noncoherent mode.
777	14	031	1408	1830	1408 1830			-161.4	12	28.2	-173	2	0.030	8	
786	14	040	1700	2000	1700 1752	*1752 2000		-161.2	12	28.7	-173	2	0.030	8	*Spacecraft noncoherent mode.
787	14	041	1417	2000	1417 1557	*1557 2000		-161.3	12	35.2	-172	4	0.040	8	*Spacecraft nonchoerent mode.
788	14	042	1513	2001	1815 1909	*1909 2001		-161.2	12	28.5	-172	0	0.000	8	Spacecraft noncoherent mode at 1610. Loss of commercial power delayed acquisition. Parity error of 0.000 based on one reading.
789	14	043	1615	1900	1615 1706	*1706 1900		-161.9	12	28.0	-173	2	0.120	8	*Spacecraft noncoherent mode.
790	14	044	1614	1900	1614 1722	*1722 1900		-161.5	12	27.2	-173	2	0.050	8	*Spacecraft noncoherent mode.
791	14	045	1624	1900	1624 1716	*1716 1900		-161.5	12	28.5	-173	4	0.110	8	*Spacecraft noncoherent mode. 400-cycle power failure from 1545 to 1633. No data lost.
792	14	046	1612	1900	1612 1648	*1648 1900		-163.3	12	28.5	-172	4	0.480	8	*Spacecraft noncoherent mode. Spacecraft agc incorrect at 1720 due to faulty prepass instructions. Prepass instructions read T2 R2 instead T1 R1 in dual Maser configuration.
794	14	048	1602	1900	1602 1722	*1722 1900		-164.3	12	26.9	-174	4	Bad	8	Maser 2 inoperative. No linear polarization mode. *Noncoherent.
795	14	049	1542	1900	1542	*1751 1900		-165.0	12	29.0	-174	3	Bad	8/16	Maser 2 inoperative. No linear polarization mode. *Noncoherent.
798	14	052	1556	1900	1556 1702	*1702 1900		-162.0	12	27.6	-173	4	0.500	8	Dual Maser configuration. *Spacecraft in noncoherent mode.
799	14	053	1733	1930	1733 1740	*1740 1930		-164.8	12	29.2	-173	2	Bad	8	Maser 2 inoperative. No linear polarization mode. *Spacecraft in noncoherent mode.
801	14	055	1530	1900	1530 1742	*1742 1900		-162	12	26.7	-174	2	0.000/ 0.460	8	Dual Maser linear configuration. *Noncoherent mode.

*Noncoherent Mode

Table 26 (contd)

Pass No.	DSS No.	Day of Year	Acq. Time	End of Track	Ground Mode Start/Stop Time 1-Way	2-Way	3-Way	Signal Strength Avg (dbm)	Configuration Loop BW (Hz)	Temp Pre/Post (°K)	Thres Pre/Post (dbm)	No. of Cmds	Average PER	Bit Rate	Comments
802	14	056	1541	1900	1541 1700	*1700 1900		-161.2	12	26.6	-173	4	0.000/ 0.110	8	Dual Maser linear configuration. *Noncoherent mode.
804	14	058	1544	1900	1544 1731	*1731 1900		-164.2	12	27.4	-174	2	0.653/ 0.919	8	*Noncoherent mode, standard configuration. Maser 2 down.
805	14	059	1554	1900	1554 1750	*1750 1900		-161.4	12	26.8	-173	2	0.000/ 0.291	8	*Noncoherent mode. Dual Maser linear configuration.
806	14	060	1542	1900	1542 1704 1710 1840	*1704 1710 *1840 1900		-161.2	12	27.6	-173	0	0.038/ 0.191	8	*Noncoherent mode. Dual Maser linear configuration. 171002 TXR off due to TXR beam overcurrent.
807	14	061	1621	1900	1621 1735	*1735 1900		-161.0	12	27.5	-173	2	0.060	8	Dual maser configuration from 1625.
808	14	062	1616	1900	1616 1728	*1728 1900		-161.2	12	27.8	-172	2	0.150	8	Dual maser configuration.
809	14	063	1621	1900	1621 1725	*1725 1900		-161.7	12	27.4	-173	4	0.038	8	Dual maser configuration.
812	14	066	1726	2000	1726 2000			-161	12	18.6		0	0.000	8	Station was advised to track S/C due to a Class 3 solar flare. TXR down. Kicking interlocks.
813	14	067	1456	2000	1456 2000			No AGC Curve	12			0	0.000 0.039	8	Transmitter off due to arcing in 400-cycle motor generator. 184500 - 2245. Communication cable cut by construction equipment; lost all communications. Maser 1 down.
814	14	068	1417	2000	1417 2000			-161.7	12	31.6	-172	0	0.010	8	At 1300, 400-cycle power failed. Power on again at 1328. This track had numerous problems with power.
815	14	069	1718	2000	1718 2000			-162.6	12	20.8	-173	0	0.010	8	Ultracone mode. Linear polarization.
816	14	070	1707	2000	1707 2000			-161.5	12	21.0	-173	0	0.000	8	Linear diplexer configuration. No uplink indication.
817	14	071	1515	1900	1515 1900			-161.8	12	21.1	-173	4	0.030	8	Linear diplexer configuration. No uplink indications.
818	14	072	1528	1900	1528 1900			-162.0	12	20.9	-173	2	0.012	8	At 1605, Demod will not lock up. Brought up station 12 to support TLM for Pass 818 and Pioneer VII, Pass 574. At 184310, TXR off. Lost 400-cycle fan in power support. Jumpered around interlock for Pioneer VII pass. TFR 105335. No uplink indications. Linear diplexer configuration.
819	14	073	1523	1900	1523 1900			-161.9	12	28.8	-173	0	0.000	8	Linear diplexer configuration. At 164800, TXR power dropped to 8 kw due to problem with motor-driven attenuator. At 1703, the transmitter (XMTR) went off. DSS 12 provided TLM support.
820	14	074	1514	1910	1514 1815	**1815 1910		-161.9	12	29.9	-173	2	0.000	8	Linear diplexer configuration.
822	14	076	1532	1900	1532 1900	*	*	-162.0	12	30.2	-172	2*	0.000	8	Commands sent with no uplink indication.
823	14	077	1503	1900	1503 1603	** 1603 1900		-161.0	12	28.7	-173	6	0.000	8	Linear diplexer feed.
824	14	078	1507	2000	1507 1853	**1853 2000		-161.5	12	28.7	-173	4	0.000	8	Linear diplexer feed.
825	14	079	1520	1903	1520 1903			-160.8	12	29.6	-172	2*	0.000	8	Commands sent with no uplink indication.
826	14	080	1457	1900	1457 1711	†1711 1900		-163.5	12	29.9	-173	6	0.691	8	RCP diplexer configuration.
827	14	081	1445	1900	1445 1900			-161.0	12	30.1	-172	0	0.000	8	Linear diplexer feed. At 165230, antenna was placed in the brake mode for 2 minutes due to an unauthorized crane in the area.
829	14	083	1523	2000	1523 1641 1732 1845	***1641 1732 1845 2000		-161.5	12	28.2	-173	4	0.000	8	At 1619, bad card found in doppler counter. At 1641, XMTR power unstable to end of track. Cable arcing. At 1802, station time was found off by + 2 seconds.
830	14	084	1459	2000	1459 1720	***1720 2000		-161.7	12	29.0	-173	8	0.000	8	

* One way only.
** Two-way noncoherent Channel 7.
*** Noncoherent mode Channel 7.
† Two-way noncoherent Channel 6.

*Noncoherent mode
Note: Unless otherwise indicated, all times are GMT.

Table 26 (contd)

Pass No.	DSS No.	Day of Year	Acq. Time	End of Track	Ground Mode Start/Stop Time 1-Way	2-Way	3-Way	Signal Strength Avg (dbm)	Configuration Loop BW (Hz)	Temp Pre/ Post (°K)	Thres Pre/ Post (dbm)	No. of Cmds	Average PER	Bit Rate	Comments
831	14	085	1457	2030	1457 1928 1959 2030	*1928 1959		-160.9	12	29.3	-173	6	0.038	8	P1/W0/B12 from 1457 to 2030.
832	14	086	1455	1900	1455 1553 1726 1900	*1553 1726		-161.4	12	29.2	-173	4	0.039	8	P1/W0/B12 from 1455 to 1900.
833	14	087	1448	1900	1448 1900			-163	12	28.6	-173	0	0.038	8	P1/W0/B12 from 1448 to 1900. 1. At 1519 TDH doppler resolver counter bad. 2. Doppler data bad from 1715 to 1805. 3. At 171930, XMTR off due to overbody current until remainder of pass.
834	14	088	1453	1900	1453 1808 1856 1900	*1808 1856		-163	12	28.4	-173	2	0.000	8	P1/W0/B12 from 1453 to 1900. At 171900, XMTR output power appeared unstable. Problem in instrumentation only.
835	14	089	2117	0028	2117 0028			-162.5	12	30.6	-174	0	0.076	8	P1/D1/B12 from 2117 to 0028.
836	14	090	1451	2000	*1451 2000			-163	12	29.0	-173	2	0.076	8	P1/W0/B12 from 1451 to 2000.
837	14	091	1441	2000	*1441 2000			-163.2	12	30	-173	2		8	P1/D1/B12 from 1441 to 2000.
838	14	092	1455	2000	1455 2000			-162.7	12	30	-173	0	0.000	8	P1/D1/B12; from 1455 to 1639 P1/D0/B12; from 1639 to 2000
839	14	093	1456	1900	1456 1900			-162.9	12	49.5	-175	0	0.000	8	P1/D0/B12; from 1458 to 164733 P1/D1/B12; from 164733 to 1900 Maser 1 failed at 164733. Switched to Maser 2 (TFR 105358) 1700; doppler resolver not operating properly (TFR 105359).
840	14	094	1459	1900	1459 1900			-162.9	12	28.7	-173	0	0.000	8	P1/D1/B12; from 1459 to 1900 Maser 1 down at start of pass. ERN as of 094/1530.
841	14	095	1446	1900	1446 1900			-162.9	12	18.75	-175	0	0.000	8	P1/D0/B12; from 1446 to 1900.
843	14	097	1330	2000	1330 2000			-163.2	12	23.4	-175	0	0.000	8	P1/D0/B12.
844	14	098	1329	2000	1329 2000			-163.2	12	22.0	-175	0	0.000	8	P1/D0/B12.
845	14	099	1419	2000	1419 2000			-162.2	12	22.4	-175	0	0.020	8	Landline link cable cut at Station 1730. Record-only to end of track.
846	14	100	1352	1900	1352 1900			-163.4	12	22.3	-176	0	0.000	8	P1/D0/B12.
847	14	101	1417	1900	1417 1900			-163	12	29.8	-174	0	0.000	8	P1/D1/B12; from 1417 to 1427. P1/D0/B12; from 1427 to 1900.
848	14	102	1345	1900	1345 1900			-163.3	12	16.7	-176	0	0.000	8	P1/D0/B12.
850	14	104	1335	2000	1335 2000			-163.1	12	19.7	-176	0	0.000	8	P1/D0/B12; from 1335 to 2000.
851	14	105	1343	2000	1343 2000			-163.6	12	18.4	-176	0	0.000	8	P1/D0/B12; from 1343 to 2000.
852	14	106	1639	2200	1639 2200			-163.2	12	19.9	-176	0	0.000	8	P1/D0/B12; from 1639 to 2200. Demod bad from 1639 to 1908. Changed at 1908 with Demod scheduled for shipment to DSS 42.
853	14	107	1657	2000	1657 2000			-163.6	12	19.7	-176	0	0.000	8	P1/D0/B12; from 1657 to 2000.
854	14	108	1312	1900	1312 1900			-163	12	20	-175	0	0.000	8	P1/D0/B12; from 1312 to 1900. Signal strength low at acquisition. Off S/C at 1323 to make checks. At 1341 back on S/C with normal signal level. Test transmitter switched out and problem cleared.
855	14	109	1310	1923	1310 1923			-163.3	12	29.6	-174	0	0.076	8	At 1338, switched to Maser 2 since the signal level was 3 db low on Maser 1. 1342 - 1720 (TCP) restarted several times due to bad science data; cause unknown. P1/D0/B12 from 1310 to 1327. P1/D0/B12 from 1327 to 1329. P1/D0/B12 from 1329 to 1338. P1/D1/B12 from 1338 to 1923.
859	14	113	1956	0055	1956			-162.7	12	19.8	-176	0	0.000	8	P1/D0/B12 from 1955 to 0055. Several TCP failures.

*Noncoherent mode Channel 7.

Table 26 (contd)

Pass No.	DSS No.	Day of Year	Acq. Time	End of Track	Ground Mode Start/Stop Time 1-Way	2-Way	3-Way	Signal Strength Avg (dbm)	Configuration Loop BW (Hz)	Temp Pre/Post (°K)	Thres Pre/Post (dbm)	No. of Cmds	Average PER	Bit Rate	Comments
860	14	114	1515	1900	1515 1900			-163.3	12	18.4	-174	0	0.000	8	P1/D0/B12 from 1515 to 1900. TCP program hung up several times.
861	14	115	1520	1900	1520 1900			-163.2	12	18.4	-176	0	0.000	8	P1/D0/B12 from 1520 to 1900. 153500 TCP halted; reason unknown.
862	14	116	1321	2200	1321 2200			-163.4	12	18.4	-175	0	0.000	8	P1/D0/B12 from 1321 to 2200.
864	14	118	1328	2200	1328 2200			-163.5	12	20.0	-175	0	0.000	8	P1/D0/B12 from 1328 to 2200.
865	14	119	1321	2200	1321 2200			-163.8	12	20.9	-175	0	0.038	8	P1/D0/B12 from 1321 to 2200.
866	14	120	1415	1930	1415 1930			-163.3	12	20.1	-175	0	0.000	8	P1/D0/B12 from 1415 to 1930.
867	14	121	1323	1700	1323 1700			-163.4	12	17.7	-175	0	0.000	8	P1/D0/B12 from 1323 to 1930.
869	14	123	1318	1700	1318 1700			-163.3	12	18.2	-175	0	0.000	8	P1/D0/B12 from 1318 to 1700.
871	14	125	1252	1730	1252 1730			-164.4	12	19.3	-176	0	0.000	8	P1/D0/B12 from 1252 to 1730.
872	14	126	1251	2000	1251 2000			-163.9	12	18.6	-175	0	0.000	8	P1/D0/B12 from 1251 to 2000.
873	14	127	1253	1700	1253 1700			-163.9	12	18.5	-176	0	0.000	8	P1/D0/B12 from 1253 to 1700.
874	14	128	1258	1700	1258 1344 1517 1700			-163.7	12	19.2	-176	0	0.000	8	P1/D0/B12 from 1258 to 1700. At 1345, the commercial power failed and came back on again at 1346. At 1512, the 400-cycle motor-generator sets came back on; continued track.
875	14	129	1248	1700	1248 1700			-163.5	12	18.6	-176	0	0.000	8	P1/D0/B12 from 1248 to 1700.
877	14	131	1246	1700	1246 1700			-164.4	12	18.8	-176	0	0.000	8	P1/D0/B12 from 1246 to 1700. From 1250 through 1606, the engineering and science data garbled; readjusted current level out of comm buffer
878	14	132	1245	1700	1245 1700			-163.8	12	19.3	-176	0	0.000	8	P1/D0/B12 from 1245 to 1700.
879	14	133	1244	1700	1244 1700			-164	12	18.2	-176	0	0.038	8	P1/D0/B12 from 1244 to 1700.
880	14	134	1245	1700	1245 1700			-163.4	12	18.4	-176	0	0.000	8	P1/D0/B12 from 1245 to 1700.
881	14	135	1258	1700	1258 1700			-163.4	12	18.6	-176.2	0	0.000	8	P1/D0/B12 from 1258 to 1700.
882	14	136	1247	1700	1247 1700			-164	12	18.7	-176	0	0.000	8	P1/D0/B12 from 1247 to 1700.
883	14	137	1241	1700	1241 1700			-163.2	12	19.0	-176	0	0.000	8	P1/D0/B12 from 1241 to 1700.
885	14	139	1239	1700	1239 1700			-163.4	12	16.7	-176	0	0.000	8	P1/D0/B12 from 1239 to 1700.
886	14	140	1238	1700	1238 1700			-164	12	17	-176	0	0.000	8	P1/D0/B12 from 1238 to 1700.
887	14	141	1238	1700	1238 1700			-163.3	12	17	-176	0	0.000	8	P1/D0/B12 from 1238 to 1700.
888	14	142	1237	1700	1237 1700			-163.5	12	16.2	-176	0	0.000	8	P1/D0/B12 from 1237 to 1700.
889	14	143	1237	1700	1237 1700			-163.6	12	16.6	-176	0	0.000	8	P1/D0/B12 from 1237 to 1700. At 1233, the master equatorial torquer failed, switched antenna to Precision Mode 2.
891	14	145	1239	1700	1239 1700			-164.3	12	17.5	-176	0	0.000	8	P1/D0/B12 from 1239 to 1700.
892	14	146	1234	1700	1234 1700			-163.8	12	17.2	-176	0	0.000	8	P1/D0/B12 from 1234 to 1700.
893	14	147	1233	1700	1233 1700			-163.7	12	19.6	-176	0	0.000	8	P1/D0/B12 from 1233 to 1700.
894	14	148	1233	1630	1233 1630			-163.5	12	17.4	-176	0	0.000	8	P1/D0/B12 from 1233 to 1630

Table 26 (contd)

Pass No.	DSS No.	Day of Year	Acq. Time	End of Track	Ground Mode Start/Stop Time 1-Way	2-Way	3-Way	Signal Strength Avg (dbm)	Configuration Loop BW (Hz)	Temp Pre/Post (°K)	Thres Pre/Post (dbm)	No. of Cmds	Average PER	Bit Rate	Comments
895	14	149	1232	1700	1232 1700			-163.5	12	18.3	-176	0	0.083	8	P1/D0/B12 from 1232 to 1318, P1/D1/B12 from 1318 to 1623, and P1/D0/B12 from 1623 to 1700. Excessive parity error rate. Antenna was positioned off point at 1343 to troubleshoot; back on point at 1358 – no problem found.
896	14	150	1258	1730	1258 1730			-163.4	12	18	-176	0	0.000	8	P1/D0/B12 from 1258 to 1730
897	14	151	1406 1730	1730	1406			-163.5	12	17.1	-176	0	0.076	8	P1/D0/B12 from 1406 to 1730.
899	14	153	1251	1730	1251 1730			-163.7	12	17.6	-176		0.000	8	P1/D0/B12 from 1251 to 1730.
900	14	154	1245	1730	1245 1730			-163.6	12	18.4	-176		0.000	8	P1/D0/B12 from 1245 to 1730.
901	14	155	1229	1600	1229 1600			-163.2	12	17.7	-176		0.000	8	P1/D0/B12 from 1229 to 1600.
902	14	156	1232	1700	1232 1700			-164.1	12	18.2	-176		0.000	8	P1/D0/B12 from 1232 to 1700.
903	14	157	1228	1700	1228 1700			-163.3	12	19.4	-176		0.000	8	P1/D0/B12 from 1228 to 1700.
904	14	158	1227	1700	1228 1700			-164.4	12	18.5	-176		0.000	8	P1/D0/B12 from 1227 to 1700.
906	14	160	1227	1700	1227 1700			-163.2	12	18.8	-176	0	0.000	8	P1/D0/B12 from 1227 to 1700. TXR down.
907	14	161	1226	1700	1226 1700			-163.8	12	18.4	-176	0	0.000	8	P1/D0/B12 from 1226 to 1700.
908	14	162	1227	1630	1227 1630			-163.7	12	18.6	-176	0	0.000	8	P1/D0/B12 from 1227 to 1630.
909	14	163	1226	1730	1226 1730			-163.5	12	18.8	-176	0	0.000	8	P1/D0/B12 from 1226 to 1730.
910	14	164	1438	1830	1438 1830			-163.3	12	18.4	-176	0	0.000	8	P1/D0/B12 from 1438 to 1830.
911	14	165	1225	1730	1225 1730			-163.7	12	18.4	-176	0	0.000	8	P1/D0/B12 from 1225 to 1730.
913	14	167	1401	1730	1401 1730			-163	12	29	-174	0	0.000	8	
914	14	168	1354	1730	1354 1730			-162.9	12	30	-174	0	0.000	8	
915	14	169	1225	1600	1225 1600			-163.3	12	18	-176	0	0.000	8	
917	14	171	1227	1730	1227 1730			-163	12	30.8	-174	0	0.000	8	
918	14	172	1225	1730	1225 1730			-163.1	12	29.4	-174	0	0.000	8	
920	14	174	1225	1730	1225 1730			-162.2	12	29.8	-173	0	0.070	8	P1/D1/B12 from 1225 to 1730. Maser 1 warm.
921	14	175	1225	1730	1225 1730			-163.3	12	18.4	-176	0	0.000	8	P1/D0/B12 from 1225 to 1730.
922	14	176	1225	1600	1225 1600			-163.2	12	17.5	-176	0	0.000	8	P1/D0/B12 from 1225 to 1600.
923	14	177	1225	1730	1225 1730			-163.5	12	17.1	-176	0	0.000	8	P1/D0/B12 from 1225 to 1730.
924	14	178	1226	1730	1226 1730			-163.5	12	17.9	-176	0	0.000	8	P1/D0/B12 from 1226 to 1730.
925	14	179	1225	1730	1225 1730			-163.2	12	17.5	-176	0	0.000	8	P1/D0/B12 from 1255 to 1730.
927	14	181	1746	2130	1746 2130			-162.8	12	16.9	-176	0	0.039	8	P1/D0/B12 from 1746 to 2130.
928	14	182	1225	1730	1225 1730			-163.2	12	17.1	-178	0	0.000	8	P1/D0/B12 from 1225 to 1730.

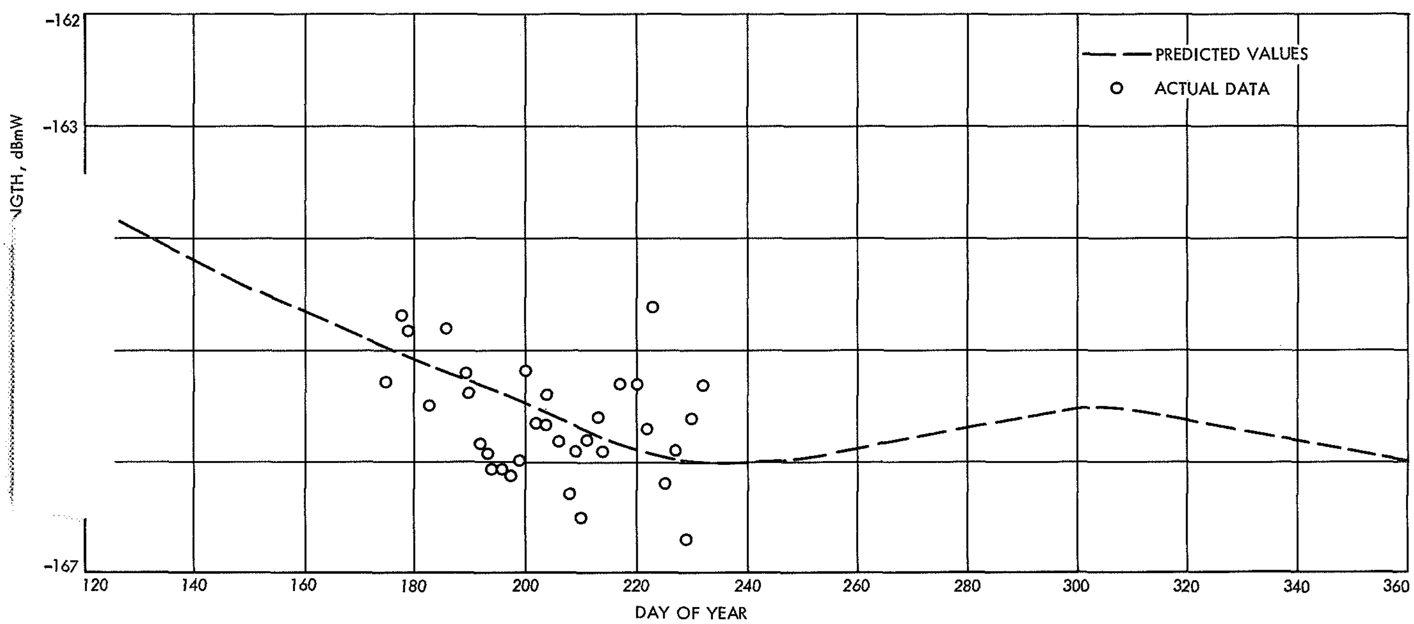

Fig. 23. Predicted and actual downlink signal strength vs day of year (August 1967)

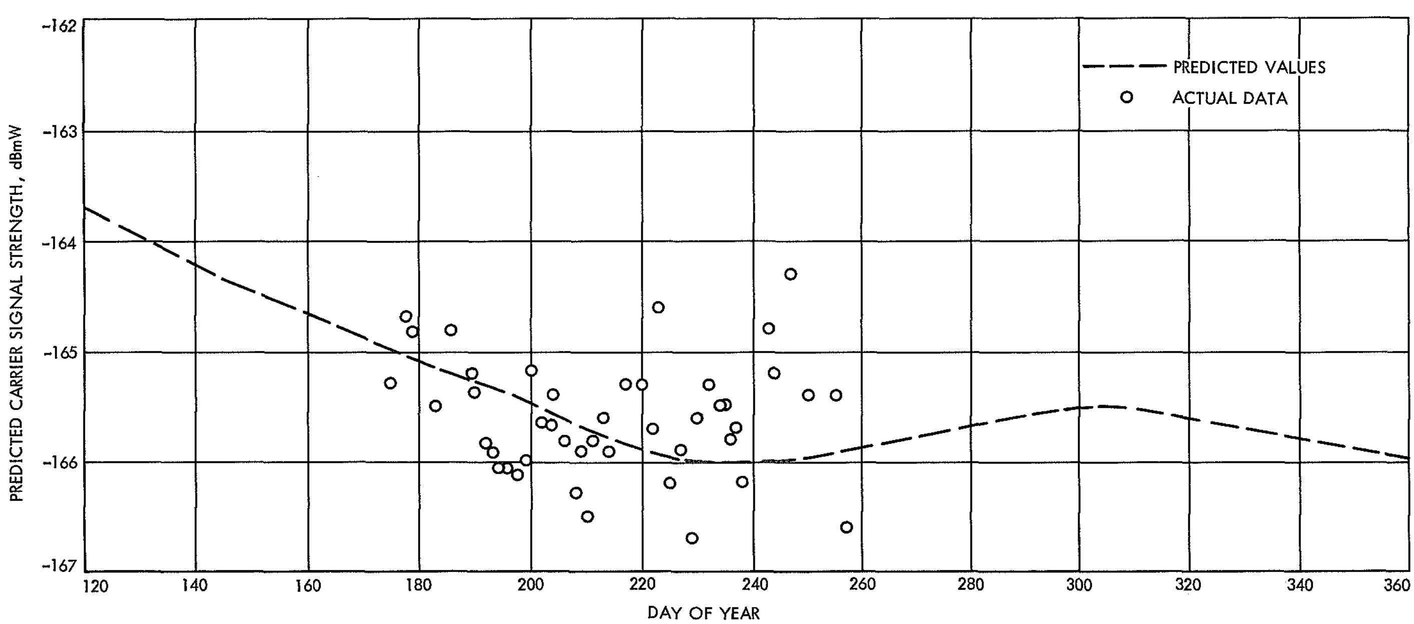

Fig. 24. Predicted and actual downlink signal strength vs day of year (September 1967)

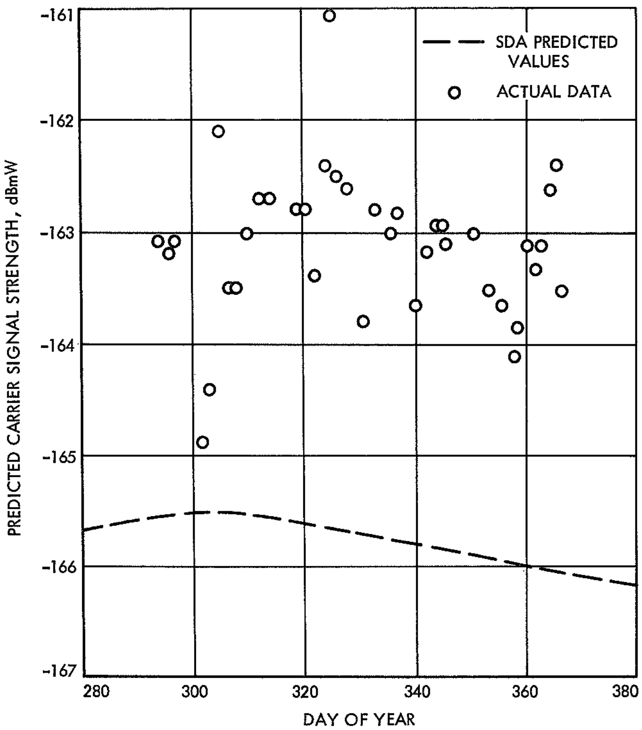

Fig. 25. Predicted and actual downlink signal strength vs day of year (October, November, December 1967)

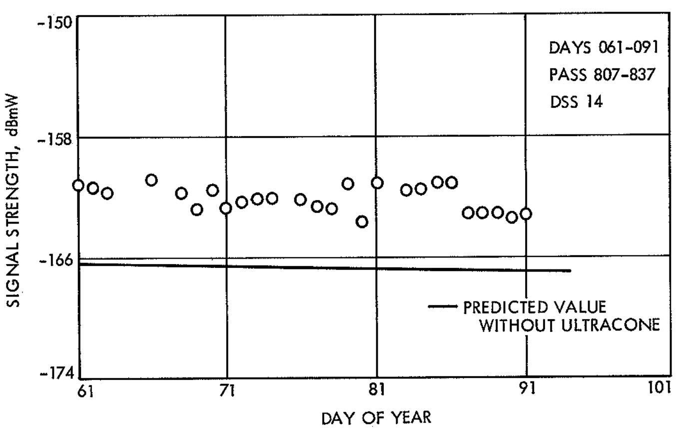

Fig. 26. Predicted and actual downlink signal strength vs day of year (March 1968)

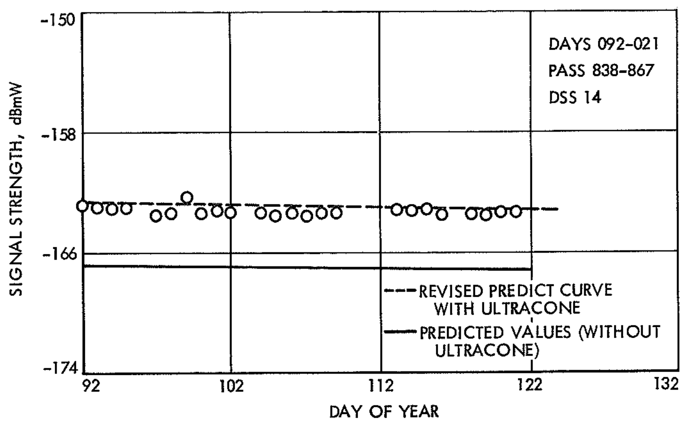

Fig. 27. Predicted and actual downlink signal strength vs day of year (April 1968)

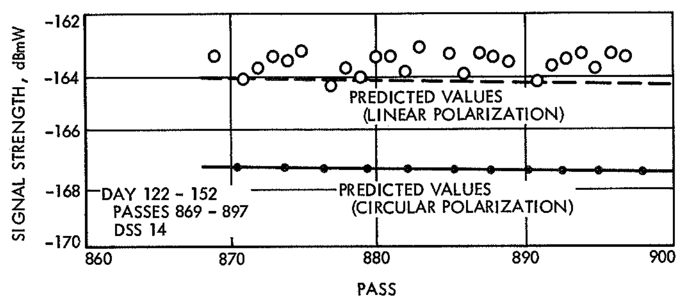

Fig. 28. Predicted and actual downlink signal strength vs pass number (May 1968)

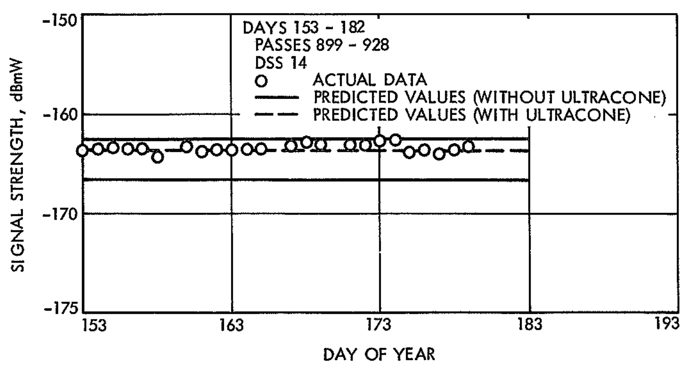

Fig. 29. Predicted and actual downlink signal strength vs day of year (June 1968)

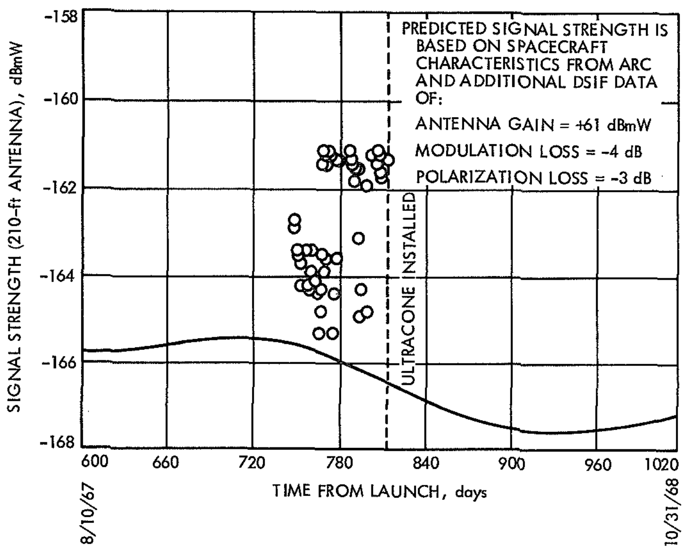

Fig. 30. Predicted and actual signal strength vs time from launch

2. Uplink. Uplink communication, as noted, proved unsatisfactory after February because of a failure in the spacecraft preventing use of channel 7 and the insufficient strength of the channel 6 low-gain antenna. Figures 31 through 34 illustrate uplink signal strength during the periods when uplink was accomplished and reported.

Signal strengths for DSS 14 during August are plotted in Fig. 31. The data lies in a bandwidth within ±2 dBmW of −137 dBmW. (Uplink signal strength for channel 7, then in use, had an average maximum of −137 dBmW.) Included in Fig. 31 is a plot of ground transmitter power as reported by the posttrack reports. During this time, passes 604, 605, and 608 were special uplink test passes for which the transmitter power was increased from the normal 10 to 20 kW. The average signal strength was −140 dBmW with the automatic gain control.

Passes 646 and 648 (September) were special communications processor tests employing channel 6 and receiver 1 (Fig. 32). The lower uplink signal strength, −142 dBmW, was consistent with the use of the low-gain antenna by receiver 1, channel 6. (The uplink signal strength for channel 6 normally had an average maximum of −136 dBmW for 20 kW ground transmitter power.) Use of channel 6 and the low-gain antenna, noted previously, later became a necessity.

During the final three months of 1967, an average uplink signal strength of −134 dBmW was recorded for channel 6, receiver 1 with 20 kW of ground transmitter power. This was about 5 dBmW less than recorded in previous months for channel 7, receiver 2 with 10 kW of transmitter power. This indicated that the low-gain antenna of receiver 1 provided a signal roughly 8 dBmW below that of the high-gain antenna used by receiver 2.

During January and February, transmitter power of 20 kW was used for all two-way noncoherent tracking.

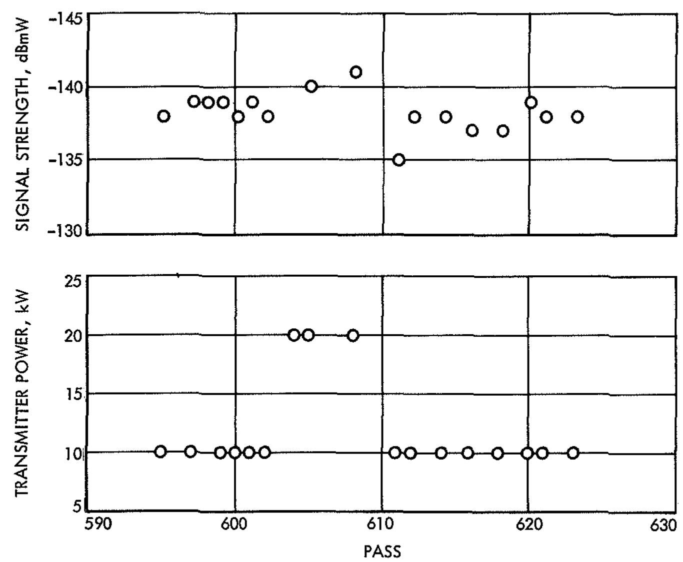

Fig. 31. Transmitter power vs uplink signal strength (August 1967)

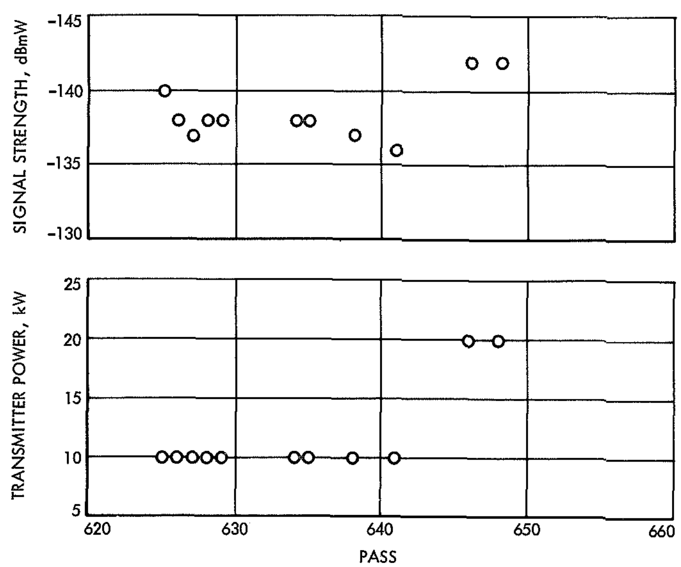

Fig. 32. Transmitter power vs uplink signal strength (September 1967)

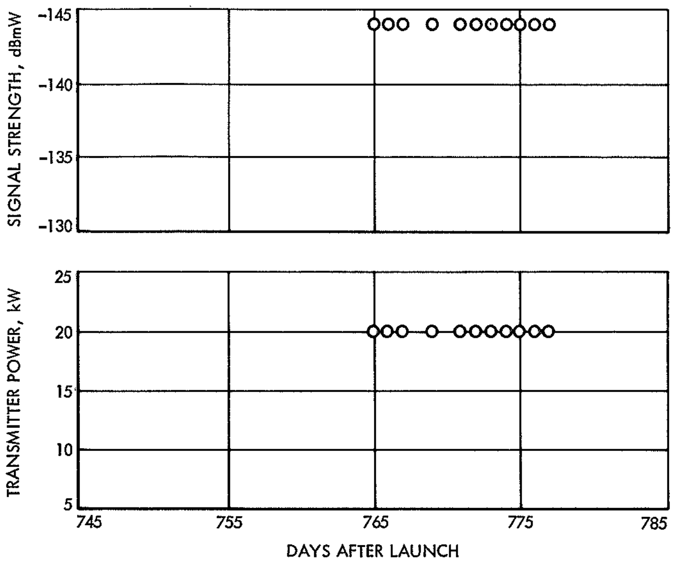

Fig. 33. Uplink signal strength and transmitter power vs days after launch, DSS 14 (1967)

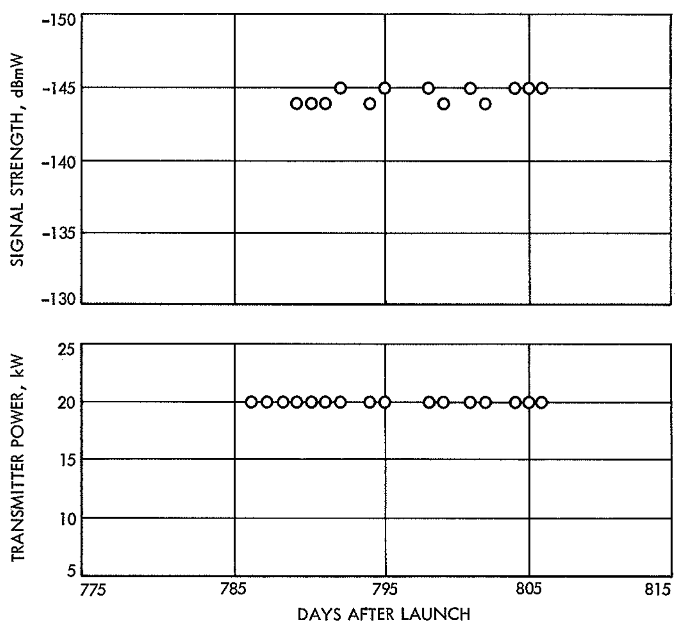

Fig. 34. Uplink signal strength vs time (February 1968), DSS 14

An uplink signal strength of −144 dBmW was recorded for each two-way noncoherent pass during January. The uplink signal was noisy and erratic during February (Fig. 34) compared with January, when all points fell on the −144 dBmW line.

3. ***Percent in-lock vs actual scheduled.*** Table 27 presents the overall actual minutes of radio frequency tracking vs minutes scheduled, plus the percentages of requirement fulfilled and the good data for several pass periods. During passes 595 through 623, 84% of all tracking data was good. The quality of the remaining 16% was degraded or lost because of the long RTLT and teletype outages. During that period, nearly 27 min was required to lock the receiver in two-way mode, resulting in at least 27 min of bad data per pass. During some passes, DSS 14 extended spacecraft interrogation beyond tracking commitment; actual minutes of tracking exceeded the scheduled time.

Table 27. Tracking in-lock vs actual and scheduled

Subsystem summary	Time, min	Percentage
Passes 595–623		
Scheduled	6092	100.0
Actual	6267	102.9
Transmitter on	6087	97.1[a]
Receiver in-lock (one- and two-way)	6193	98.8[a]
Good tracking data	5280	84.3[a]
Passes 625–648		
Scheduled	4346	100.0
Actual	4019	92.5
Transmitter on	3732	92.9[a]
Receiver in-lock (one- and two-way)	3964	98.6[a]
Good tracking data	3173	79.0[a]
Passes 747–777		
Scheduled	4005	100.0
Actual	4587	114.5
Transmitter on	2842	61.9[a]
Receiver in-lock (one- and two-way)	4587	99.9[a]
Good tracking data	3958	86.2[a]

[a]The indicated percentages are calculated with the actual time used as a reference.

E. Parity Error Rate

Average parity error and bit rates for DSS 14 are given in Tables 28 through 31. Figures 35 through 42 are plots of parity error rate vs downlink signal strength and day of year. (A parity error rate of 0.116 was equivalent to one error in 1000 consecutive bits of information and was regarded as the limiting value for the uncoded and convolution-coded unit modes of information.)

Table 28. Parity error rate,[a] passes 595–623, DSS 14

Pass	Day	Predicted down-link signal strength (average), dBmW	Receiver signal strength (average), dBmW	Parity error rate (average),[b] 8 bits/s
595	214	−165.6	−165.4	0.07
597	216	−165.6	−165.8	0.17
599	218	−165.7	−166.3	0.10
600	219	−165.7	−165.9	0.12
601	220	−165.7	−166.5	0.15
602	221	−165.7	−165.8	0.11
604	223	−165.8	−165.6	0.21
605	224	−165.8	−165.9	0.41
608	227	−165.9	−165.3	0.26
611	230	−165.9	−165.3	0.14
613	232	−165.9	−165.7	0.16
614	233	−165.9	−164.6	0.14
616	235	−166.0	−166.2	0.17
618	237	−166.0	−165.9	0.22
620	239	−166.0	−166.7	0.10
621	240	−166.0	−165.6	0.04
623	242	−166.0	−165.3	0.09

[a]Bandwidth = 12 Hz.

[b]Parity error rate is calculated only for the time interval extending from 3 h before until 3 h after time of maximum elevation of the spacecraft. It is averaged from ARC plots.

Table 29. Parity error rate,[a] passes 625–649, DSS 14

Pass	Day	Predicted down-link signal strength (average), dBmW	Receiver signal strength (average), dBmW	Parity error rate (average),[b] 8 bits/s
625	244	−166.0	−165.5	0.08
626	245	−166.0	−165.5	0.04
627	246	−166.0	−165.8	0.08[b]
628	247	−166.0	−165.7	0.05
629	248	−166.0	−166.2	0.03
630	249	−166.0	Unscheduled pass	
634	253	−166.0	−164.8	0.04[b]
635	254	−166.0	−165.2	0.00
638	257	−166.0	−164.3	0.03
641	260	−166.0	−165.4	0.07
646	265	−166.0	−165.4	0.08
648	267	−165.9	−166.6	0.14
649	268	−165.9	Unscheduled pass	

[a]Bandwidth = 12 Hz.

[b]Parity error rate is calculated only for the time interval extending from 3 h before until 3 h after time of maximum elevation of the spacecraft. It is averaged from ARC plots.

Table 30. Parity error rate,[a] passes 747–777, DSS 14

Pass	Day	Predicted down-link signal strength (average), dBmW	Receiver signal strength (average), dBmW	Parity error rate (average),[b] 8 bits/s
747	001	−165.6	−162.8	No data
748	002	−165.6	−162.8	No data
749	003	−165.6	−163.3	No data
750	004	−165.6	−163.3	0.300
751	005	−165.6	−163.7	0.142
752	006	−165.6	−164.2	0.177
756	010	−165.7	−163.5	0.500
757	011	−165.7	−164.5	0.268
758	012	−165.7	−164.1	0.383
759	013	−165.7	−163.9	0.153
760	014	−165.7	−163.4	0.250
762	016	−165.7	−164.1	0.576
763	017	−165.7	−164.3	0.500
765	019	−165.8	−165.4	0.150
766	020	−165.8	−164.9	0.273
767	021	−165.8	−163.5	0.100
768	022	−165.8	−163.7	0.230
769	023	−165.8	−163.6	0.300
771	025	−165.9	−161.5	0.020
772	026	−165.9	−161.1	0.000
773	027	−165.9	−161.2	0.040
774	028	−165.9	−165.2	0.210
775	029	−165.9	−164.4	0.210
776	030	−165.9	−163.5	0.318
777	031	−165.9	−161.4	0.030

[a]Bandwidth = 12 Hz.

[b]Parity error rate is calculated only for the time interval extending from 3 h before until 3 h after time of maximum elevation of the spacecraft. It is averaged from ARC plots.

Table 31. Parity error rate,[a] passes 786–806

Pass	Day	Predicted down-link signal strength (average), dBmW	Receiver signal strength (average), dBmW	Parity error rate (average),[b] 8 bits/s
786	040	−166.04	−161.23	0.032
787	041	−166.05	−161.39	0.040
788	042	−166.05	−161.43	0.000
789	043	−166.06	−161.72	0.120
790	044	−166.07	−161.58	0.050
791	045	−166.08	−161.45	0.110
792	046	−166.09	−163.10	0.480
794	048	−166.12	−164.30	Bad
795	049	−166.13	−164.92	Bad
798	052	−166.15	−161.90	0.500
799	053	−166.17	−164.80	Bad
801	055	−166.19	−162.95	0.230
802	056	−166.20	−161.20	0.055
804	058	−166.23	−164.20	0.760
805	059	−166.24	−161.40	0.145
806	060	−166.24	−161.32	0.113

[a]Bandwidth = 12 Hz.

[b]Parity error rate is calculated only for the time interval extending from 3 h before until 3 h after time of maximum elevation of the spacecraft. It is averaged from ARC plots.

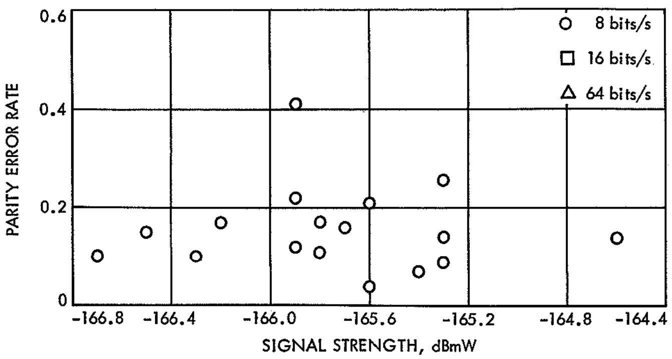

Fig. 35. Parity error rate vs downlink signal strength (August 1967)

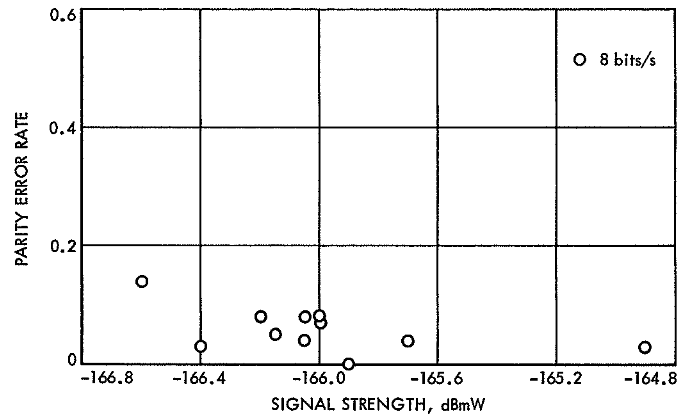

Fig. 36. Parity error rate vs downlink signal strength (September 1967)

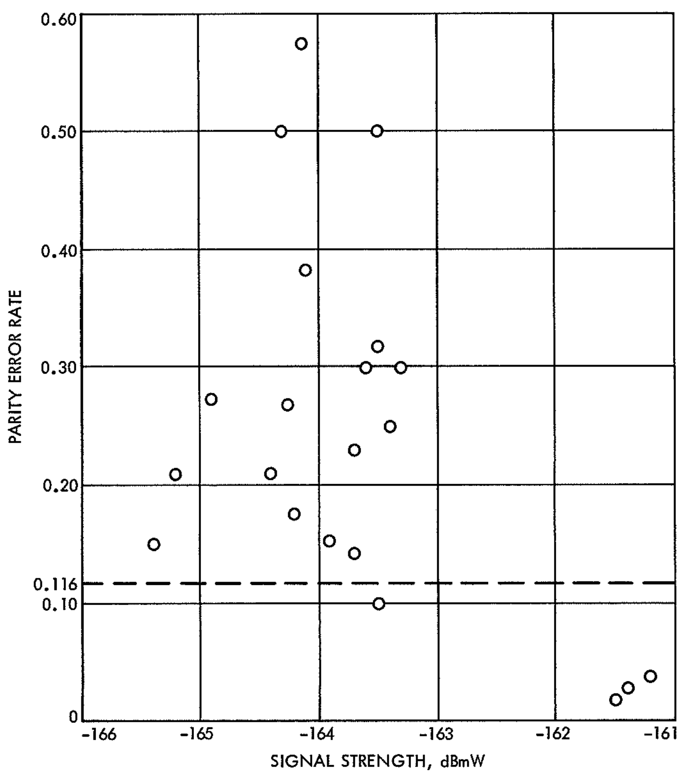

Fig. 37. Parity error rate vs downlink signal strength (January 1968)

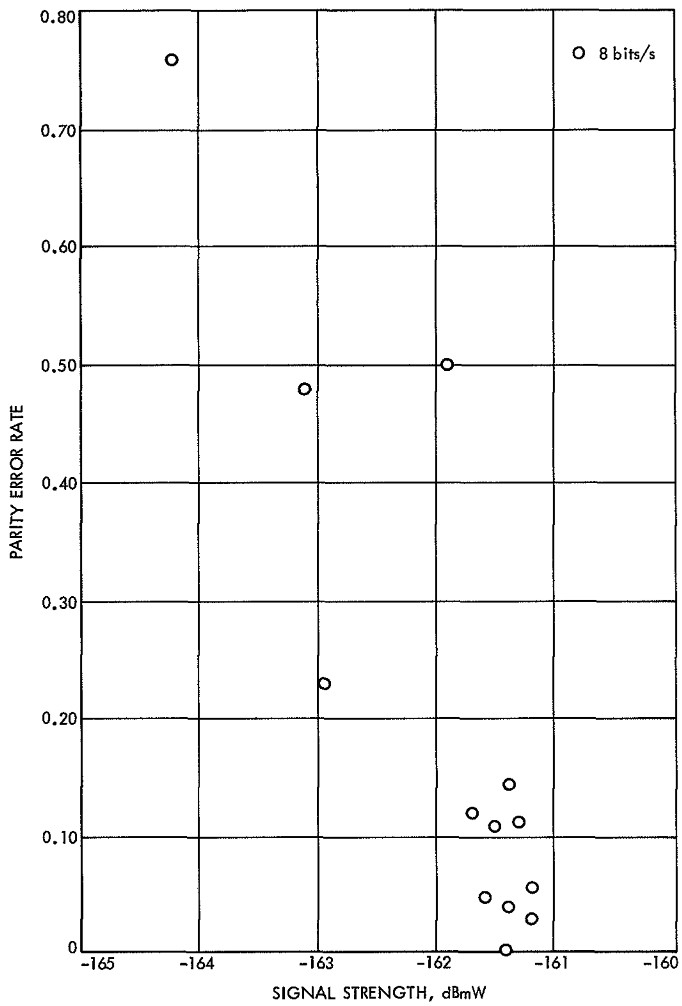

Fig. 38. Parity error rate vs downlink signal strength (February 1968)

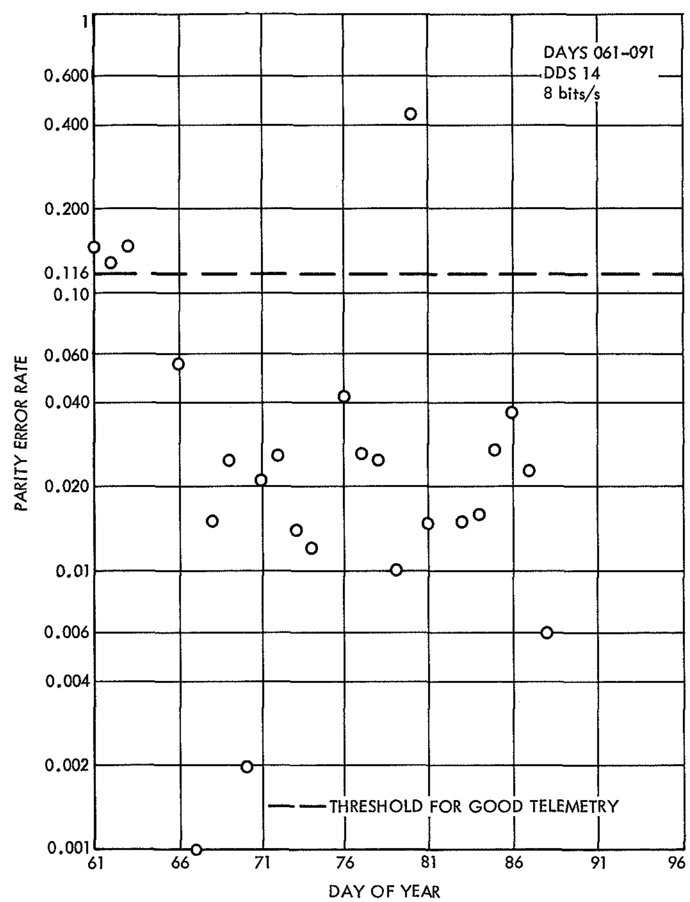

Fig. 39. Parity error rate vs day of year (March 1968)

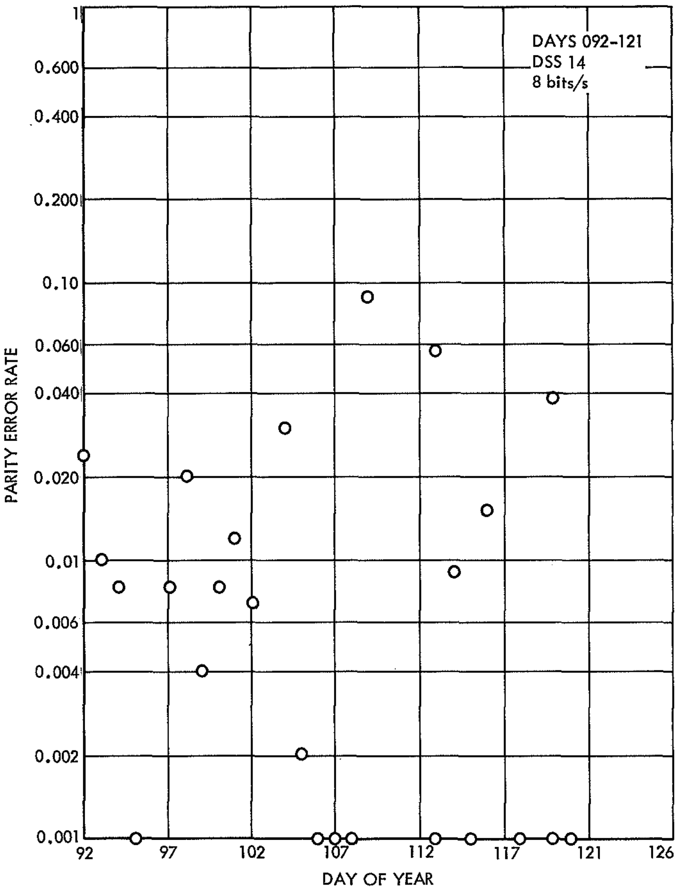

Fig. 40. Parity error rate vs day of year (April 1968)

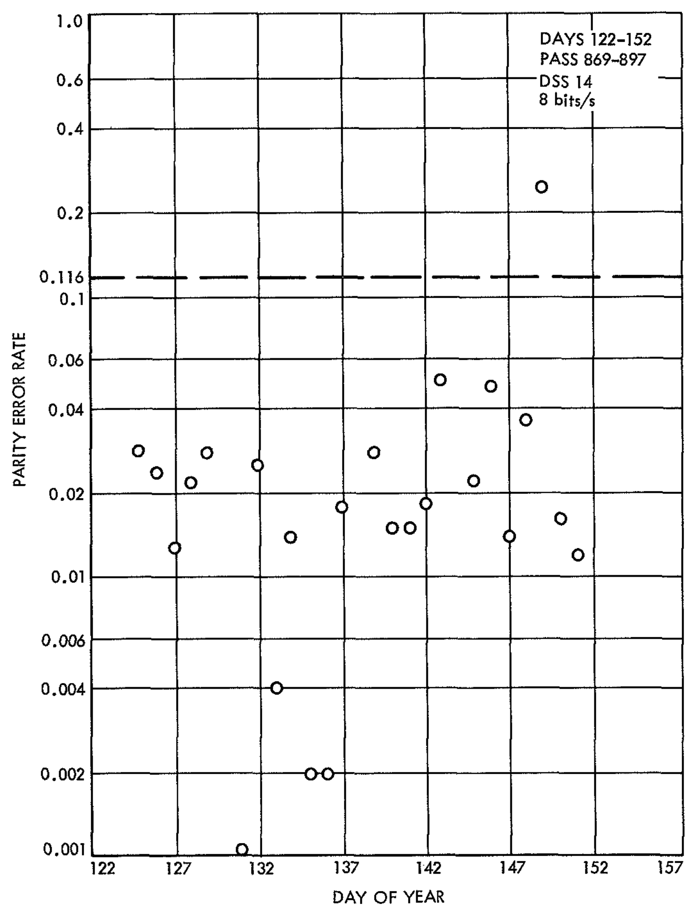

Fig. 41. Parity error rate vs day of year (May 1968)

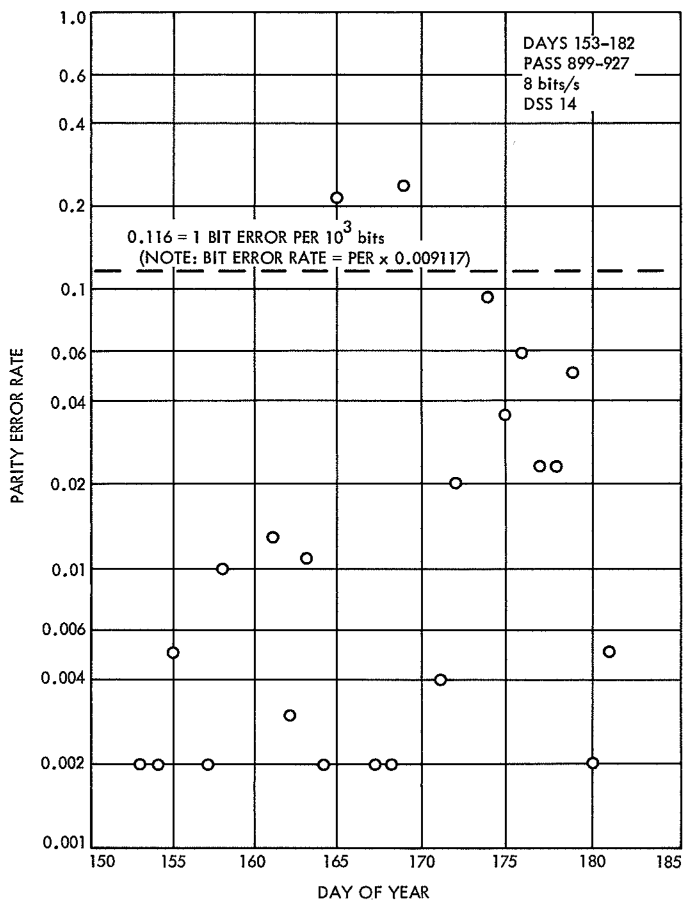

Fig. 42. Parity error rate vs day of year (June 1968)

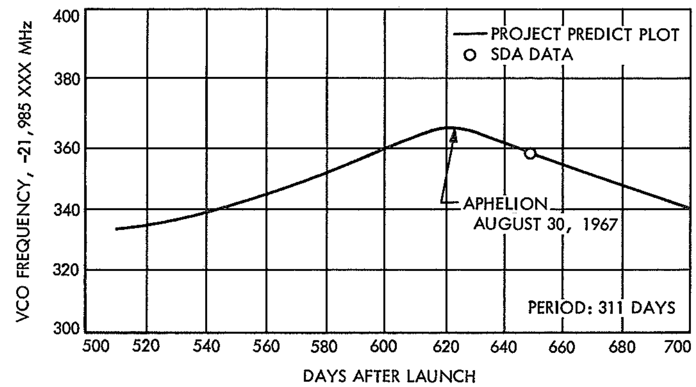

Fig. 43. Channel 6 best-lock rest frequency vs days after launch, passes 625–648

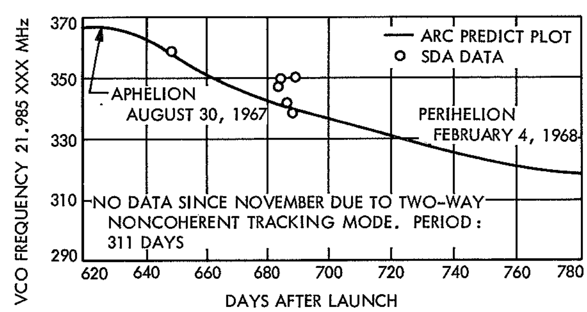

Fig. 44. Channel 6 best-lock rest frequency vs days after launch, passes 786–806

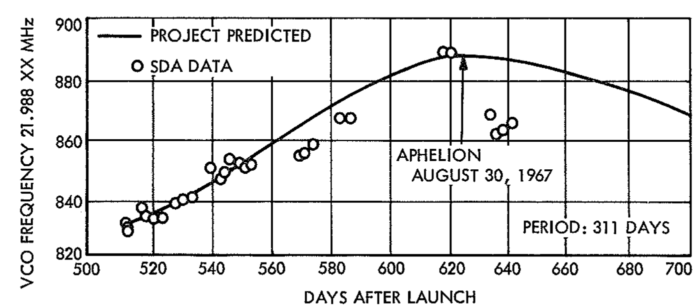

Fig. 45. Channel 7 best-lock rest frequency vs days after launch, passes 625–648

F. Predicted Frequency Performance

Pertinent information on channel 6 best-lock rest frequency is illustrated in Figs. 43 and 44. No data is presented after November 1967 because tracking was in noncoherent mode. Figures 45 and 46 present channel 7 best-lock rest frequency information, which was no longer received after October 1967. Figures 47 through 53 present auxiliary oscillator information through June 1968.

G. Interim Monitor Program Mean Residuals

Figures 54 and 55 are plots of the mean residuals printed out by the Interim Monitor Program (IMP), used to predict trajectories on a one-way mode, as a function of pass number. The data is printed out in real-time on a typewriter by the IMP at the ground station. For one-way tracking, the IMP computes the difference of the observed (*O*) one-way doppler frequency and the predicted (*P*) one-way frequency and prints out the mean for a prescribed sample interval as a function of GMT during the pass. Figure 54 shows that the auxiliary oscillator has changed from approximately +100 Hz to +400 Hz for the report period, December 1967. The slope, about +26.5 Hz per day, is an indication of the rate at which the oscillator changed frequency. Each value (Fig. 55) is an average for the pass of the mean, $\overline{X}$,

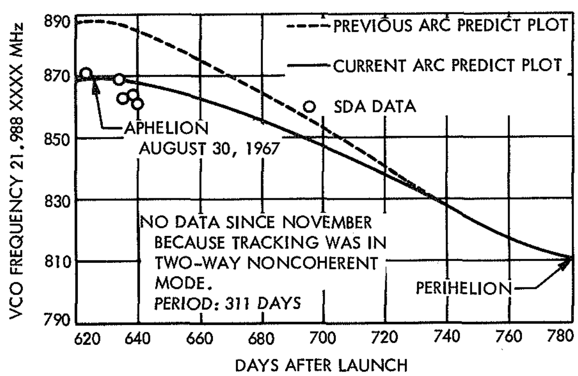

Fig. 46. Channel 7 best-lock rest frequency vs days after launch, passes 675–743

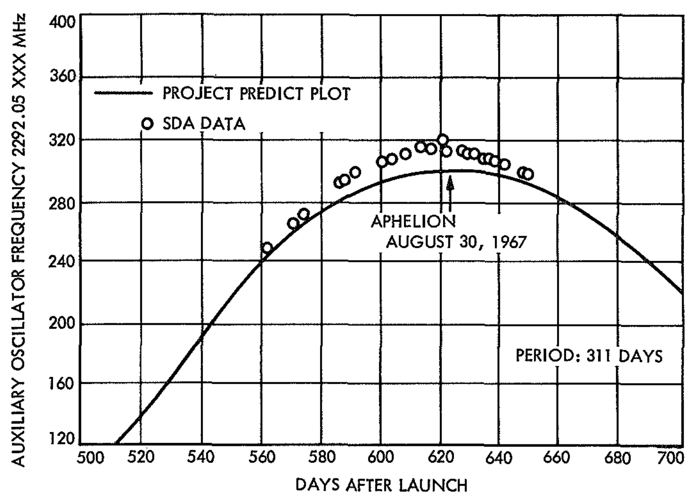

Fig. 47. Auxiliary oscillator frequency vs days after launch, passes 625–648

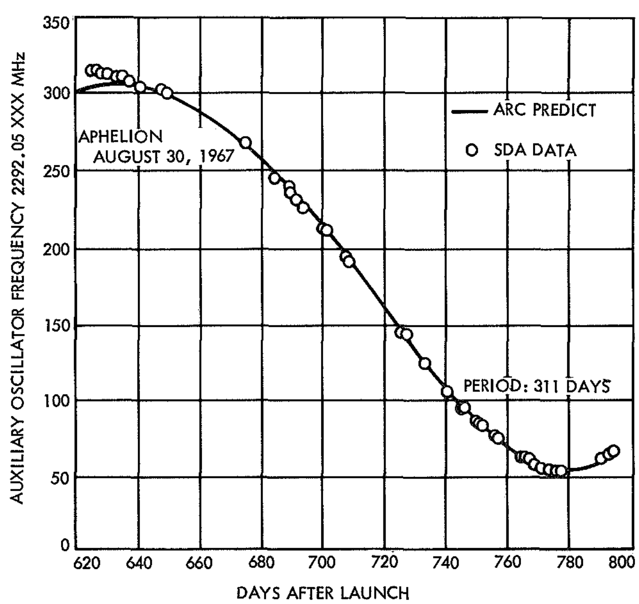

Fig. 48. Auxiliary oscillator frequency vs days after launch, passes 675–743

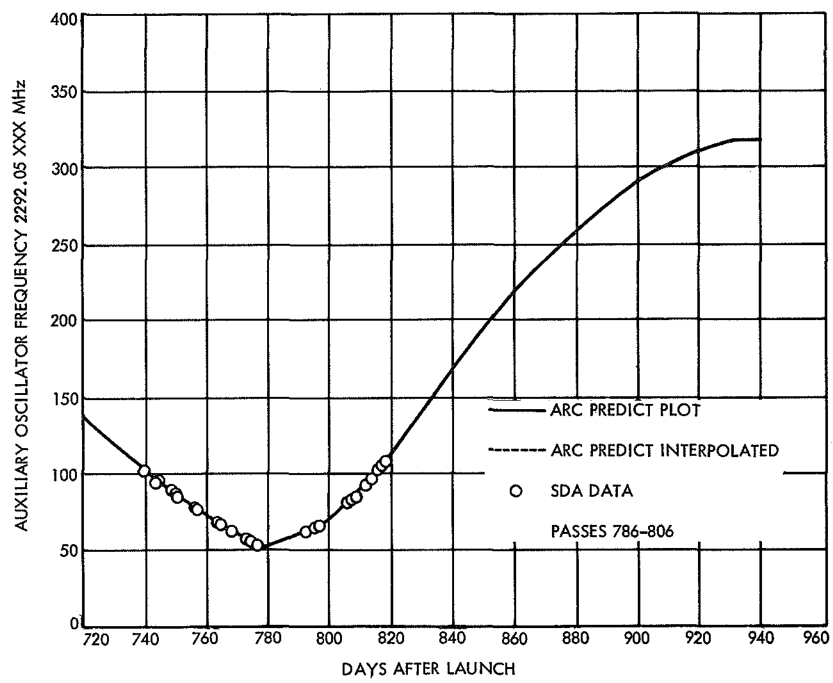

Fig. 49. Auxiliary oscillator frequency vs days after launch, passes 786–806

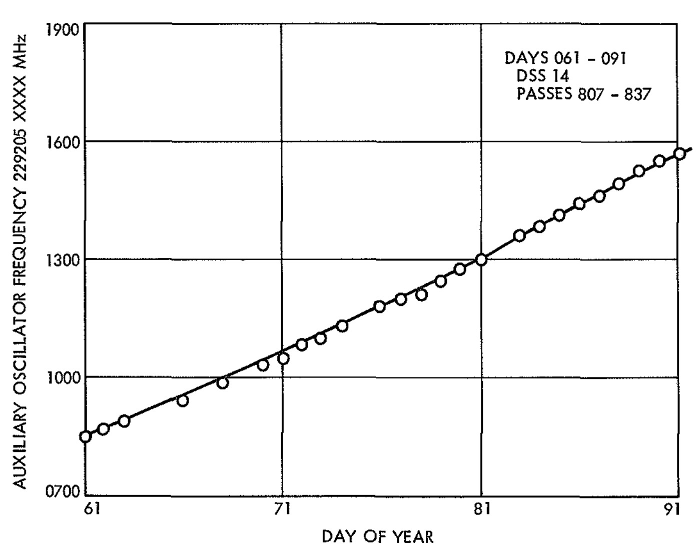

Fig. 50. Auxiliary oscillator frequency vs days of year, passes 807–837 (1968)

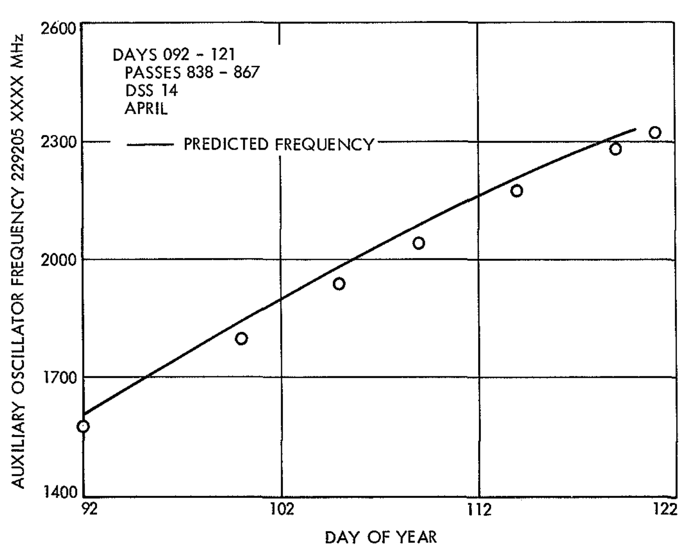

Fig. 51. Auxiliary oscillator frequency vs days of year, passes 838–867 (1968)

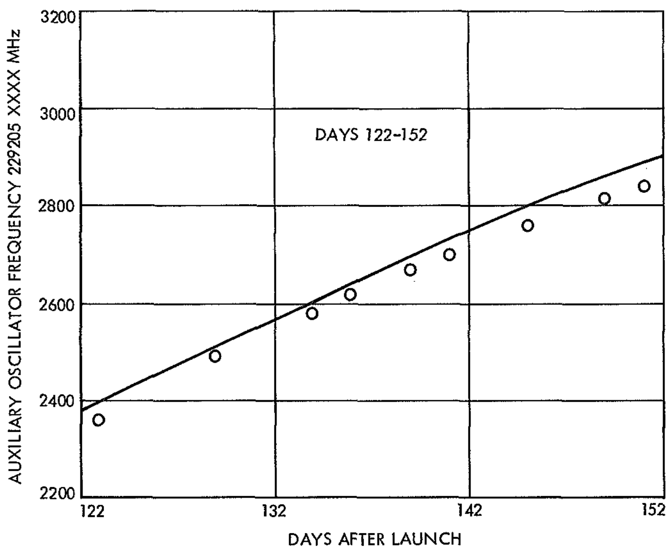

Fig. 52. Auxiliary oscillator frequency vs days after launch, passes 869–897 (May 1968)

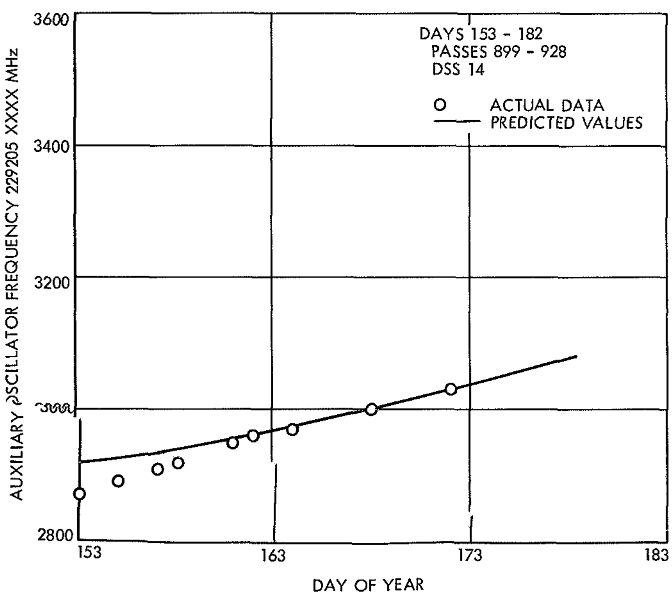

Fig. 53. Auxiliary oscillator frequency vs day of year, passes 899–928 (June 1968)

calculated by the program for each sample interval and printed out as a function of GMT, e.g.,

$$\overline{X} = \left[\sum_{i=1}^{7} (D_{oi} - D_{pi}) \right] \Big/ 7$$

where D_{oi} = observed doppler and D_{pi} = predicted doppler. The slope of the curve, +16 Hz per day, indicates the rate at which the frequency of the driver oscillator changed. The plot indicates that this value followed the predicted curve rather well in January 1968.

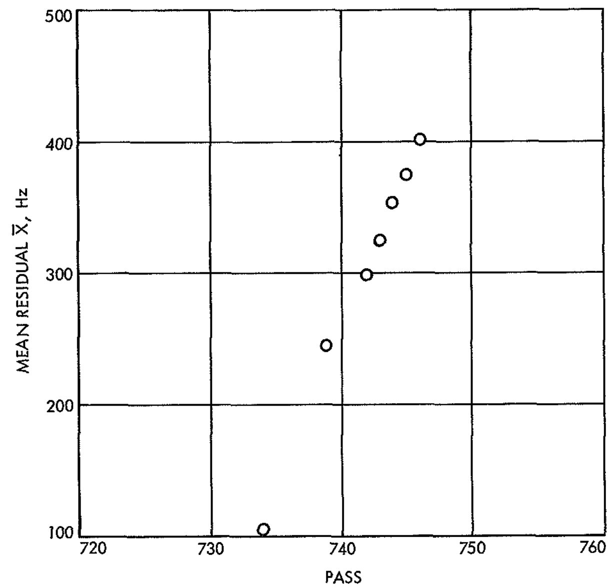

Fig. 54. IMP mean residual vs pass number, one-way mode (December 1967)

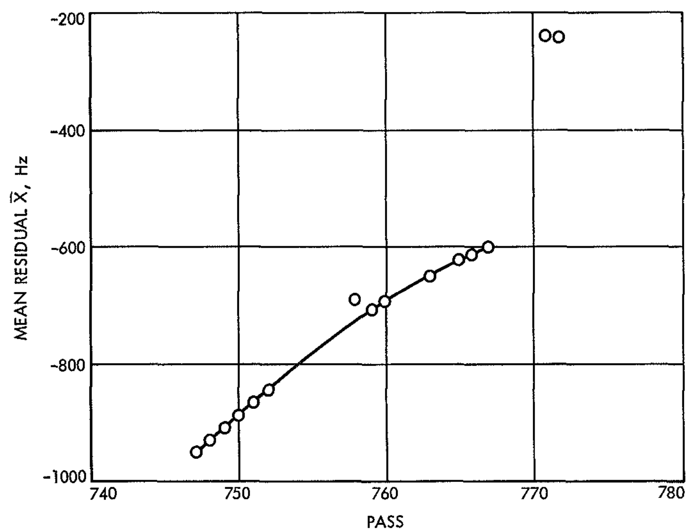

Fig. 55. IMP mean residual vs pass number, one-way mode (January 1968)

H. Predicts and Commands

Predicts generated for *Pioneer VI* to July 1, 1968, are presented in Table 32. The cumulative total of commands transmitted to *Pioneer VI* at the end of June 1968 was 5319. A total of 832 commands were transmitted

Table 32. Prediction summary, DSS 14

Predict No.[a]	Auxiliary oscillator frequency, MHz	Ground transmitter synthesizer frequency,[b] MHz	Coverage	Sample rate, s
68B	2292.052500	21.988880	7/1–8/1/67	900
69A	2292.052940	21.985360	8/8–8/18/67	600
69B	2292.053300	21.988885	8/1–9/1/67	900
70A	2292.052900	21.985362	9/1–10/1/67	900
70B	2292.052900	21.988885	9/1–10/1/67	900
71A	2292.052800	21.98535500	10/1–11/1/67	900
71B	2292.052800	21.98887000	10/1–11/1/67	900
72A	2292.052250	21.98534000	11/1–12/1/67	900
73A	2292.051336	21.98532800	12/1/67–1/1/68	900
74A	–	–	1/1–2/1/68	900
75A	2292.050680	21.98531900	2/1–3/1/68	900
75B	2292.05068000	21.98879800	2/1–3/1/68	900
76A	2292.05116000	21.98532500	3/1–4/1/68	900
76B	2292.05116000	21.98881000	3/1–4/1/68	900
77A	2292.05170000	21.98533100	4/1–5/1/68	900
77B	2292.05170000	21.98882600	4/1–5/1/68	900
78A	2292.05260000	21.98533100	5/1–6/1/68	900
78B	2292.05260000	21.98882600	5/1–6/1/68	900
79A	2292.053400	21.985331	6/1–7/1/68	900
79B	2292.053400	21.988826	6/1–7/1/68	900

[a]A = channel 6; B = channel 7.

[b]For best lock at zero doppler.

during this reporting period; attempts to transmit commands were abandoned after pass 837 at the end of March and were not resumed during the remainder of the period of this document. Previously, on pass 620 in August 1967, a total of 193 commands had been transmitted during a special orientation test (type II).

Before cessation of transmitting efforts, there were difficulties that periodically prevented command transmission. The history of these problems was given earlier. Commands by pass and day are presented in Table 26.

I. Pass Chronology

Tracking periods covered are identified by pass number, which is the number of times since launch that the spacecraft has been above the horizon of a particular station. Unless otherwise noted, the following entries refer to DSS 14.

Pass 567. Invalid hour-angle and declination readouts were caused throughout the pass by failure of the master equatorial at 1120.

Pass 573. The microwave line at DSS 12 was inadvertently disconnected, and a command did not reach the spacecraft.

Pass 575. This was a special unscheduled pass tracked by DSS 14 in addition to the regular scheduled tracking.

Pass 577. The tracking data indicated erroneous data condition code for 1 h 32 min, starting at 1038. The doppler column showed destructive count from beginning of track time until 1155 for the same pass.

Pass 580. A successful communications processor test was conducted using a new *Pioneer* operational computer program.

Pass 581. The TCP was unable to lock at 1102 at DSS 12, and 47 min of data was lost. The spacecraft was in duty cycle store.

Pass 584. The GOE at DSS 12 was unable to lock up the demodulator when the spacecraft was in one-way mode; 49 min of data was lost. The reason was not known.

Pass 585. Engineering data was missed at the beginning of the pass at DSS 12. The telemetry was transmitted upon completion of the track.

Pass 588. At 1736, a command was transmitted 1 s late.

Pass 591. At 1306, a command, transmitted just 1 min after the transmitter was turned on, was unable to reach the spacecraft. At 1400, DSS 14 reported a bit error rate greater than 1.0 at 16 bits/s. At 1350, the demodulator broke lock for 5 min and returned to help TCP lock.

Pass 592. The parity error rate recorded high; possibly this was the result of a Project delay in sending a command to lower bit rate from 64 to 16 bits/s. The parity error rate for all passes at 16 bits/s recorded high.

Pass 593. The transmitter klystron was detuned, delaying spacecraft acquisition time by approximately 7 min.

Pass 595. Recorded 2 h 40 min of extra one-way data.

Pass 601. The communications buffer failed at 1357. At 1404 the beta computer failed, and at 1440 the alpha computer was switched in. By 1550, the beta computer had been repaired; the TCP locked in at 8 bits/s at 1628.

Passes 604, 605, and 608. Special uplink power tests were held to measure the effect upon the ground station automatic gain control of 20-kW power (normally 10 kW) of the transmitter subsystem.

Pass 614. Two command numbers, 027 and 060, were not received by the spacecraft. At 1600, there was loss of telemetry as the result of a bad AIS patch cord.

Pass 616. At 1555, microwave link 10 between DSS 12 and DSS 14 failed, necessitating a switch at the communications center to line 7. A short loss of telemetry occurred. At 1713, the TCP lost W/F sync for 45 s.

Pass 620. A special test to orient the spacecraft so that the spacecraft high-gain antenna faced the earth was made. During this pass, 193 commands were transmitted to the spacecraft.

Pass 623. At 1634, the antenna lost the spacecraft signal because of pointing errors resulting from a malfunction in the azimuth channel of the autocollimator associated with the master equatorial. Tracking was intermittent.

Pass 634. The parity error rate was bad at 1157 and 1231 and was 0.022 at 1415. The bit rate went to 8 bits/s at 1245.

Passes 646 and 648. These were special communications processor test passes employing channel 6 transmitter at 20 kW. Several VCO frequencies were used.

Pioneer VI was not tracked between passes 648 and 675, September 24 through October 21, since DSS 14 was closed down for modification of equipment for support of *Mariner* Venus 67 encounter activities.

Pass 675. Word/frame sync was lost throughout the pass. This was a TCP or GOE problem, with the cause unknown. Transmitter power was increased to 15 kW for command transmission. The computer buffer was replaced to correct W/F sync. The command problem was investigated.

Pass 677. There were numerous losses of W/F sync at DSS 12 and DSS 14, a trouble-shooting problem. The transmitter power was 20 kW for command transmission. The computer buffer was replaced to correct W/F sync. The problem was investigated.

Pass 678. Although 23 commands were transmitted to the spacecraft, not all commands were effective. Network control reporting does not reflect which commands were effective. The TCP was in and out of lock many times throughout the pass.

Passes 683, 684, 686. Uplink control could not be established on channel 7. The problem was believed to be a spacecraft anomaly.

Pass 688. Frequent receiver glitches, probably the result of a spacecraft anomaly, caused bad parity error rate.

Pass 689. There was bad parity error rate in both one- and two-way coherent modes as a result of receiver glitches. Upon going noncoherent, the glitches stopped and the parity error rate was good. This was analyzed by ARC as a spacecraft problem. Systems Data Analysis (SDA) group reported that static phase error (SPE) was fluctuating from 5 to 20 kHz, indicating that receiver 2 was oscillating.

Pass 691. Two commands were not sent because of microwave line mismatch between DSS 12 and DSS 14. Project reported that none of the 13 commands were received by the spacecraft.

Pass 693. None of the commands were received by the spacecraft because of spacecraft anomaly.

Pass 695. The Systems Data Analysis group calculated that the signal appeared to be 2.5 dBmW better than theoretically predicted.

Pass 709. Stable DSIF transmitter output above 10 kW could not be obtained.

Passes 718 and 732. These were record-only passes.

Passes 724, 725, 726, 727. These passes were in the noncoherent tracking mode.

Pass 760. Receiver 2 was used as prime because automatic gain control volts for receiver 1 could not be monitored. The receiver 1 AGC amplifier and filter were replaced.

Pass 766. At 1450, there was a bad patch on the science data line through communications, but no data was lost.

Pass 768. Spacecraft uplink could not be acquired; the reason was not known.

Pass 769. Dual maser operation improved the parity error rate.

Pass 774. The dual maser was inoperative. The 400-Hz transmitter failed prior to the pass because of power fluctuations. The data was not affected.

Pass 788. Loss of commercial power delayed acquisition. There was a parity error rate of 0.000 based on one reading.

Passes 790 and 791. DSS 14 performed special tests on newly installed ground operating equipment, and the data from DSS 14 GOE was transmitted to SFOF for evaluation purposes only. The data from DSS 12 remained prime.

Pass 806. The transmitter was off at 1710 because of transmitter beam overcurrent.

Pass 812. DSS 14 was advised to track the spacecraft because of a Class III solar flare.

Pass 813. The transmitter was off because of arcing in the 400-Hz motor generator. The communication cable was cut by construction equipment, and communication was lost from 1845 to 2245. (DSS 14 had verbal instructions to peak the cone twice each hour. As part of the peaking action, the dBmW readings were dropped by a factor of 2.)

Pass 814. The 400-Hz power failed at 1300 and was off for 28 min. There were other power problems during the track. (In order to investigate the 400-Hz motor generator problem that arose during pass 813, the station was requested to turn the transmitter on at 10 kW and then increase the power slowly to 18 kW.)

Pass 818. At 1605, the demodulator would not lock up. Station 12 was brought up to support telemetry. At 1845, the power support of the 400-Hz fan was lost.

Pass 820. DSS 14 acquired the spacecraft in two-way noncoherent mode on channel 6, then switched to channel 7 at 1620. The spacecraft was acquired on channel 7 spacecraft receiver 2 at 1815 as indicated by an uplink signal strength of −144 to −140 dBmW.

Pass 822. On this pass and subsequent passes, the station acquired the spacecraft on channel 7 receiver 2 in two-way noncoherent mode.

Pass 827. The antenna was placed in brake mode at 1652:30 for 2 min because of an unauthorized crane in the area.

Pass 829. At 1619, a bad card was found in the doppler counter. From 1641, the transmitter power was unstable to the end of track because of cable arcing. The station time was found to be off by plus 2 s at 1802.

Pass 833. Doppler data was bad from 1715 to 1805. From 1719:30 through the remainder of the pass, the transmitter was off because of overbody current.

Pass 845. A communications cable to DSS 14 was inadvertently cut. This caused a loss of real-time data; however, all data was recorded on tape.

Pass 852. Approximately 1 h 50 min of real-time data was lost, and during passes 855 and 860 a smaller amount of data was lost. During these passes, the TCP program halted and had to be restarted many times in order to correct the data format. The problem appeared to be intermittent. A bad connector was replaced, but the investigation continued.

Pass 874. A commercial power failure caused 1 h 33 min of lost data. The loss of power caused an overload relay in the 400-Hz motor generator circuit to open; the problem was corrected by an electrician.

Pass 877. The real-time engineering and science data was garbled because of low line current, but all of the data was recorded on magnetic tape. The problem was corrected by readjusting the current from the communications buffer.

Pass 889. The master equatorial torquer failed. Immediately following this failure, the antenna was switched to precision mode 2, which bypassed the master equatorial torquer and enabled the antenna to be driven directly. Acquisition was delayed approximately 6 min.

Pass 895. Fifteen min of data was lost when the antenna was positioned at zenith for signal variation check. However, no problem was discovered, and the antenna was returned to spacecraft point without further incident.

Passes 920, 921, and 923. DSS 14 had intermittent warmups on masers 1 and 2; each time the masers were purged and cooled down. All problems were traced to a contaminated helium bottle.

Pass 928. DSS 14 experienced two problems: (1) Receiver 1 failed to maintain lock in the 12-Hz tracking loop bandwidth; this was corrected by rephasing the reference loop. (2) A loss of telemetry to the demodulator/synchronizer occurred; the telemetry was restored by replacing a blown fuse in the telemetry and command data rack.

Part IV. Extended Flight Phase, Third Annual Period (July 1, 1968 — July 1, 1969)

I. Introduction

A. Support Summary

The successful support of *Pioneer VI* by the DSN during the period from July 1, 1968 to July 1, 1969 included spacecraft solar occultation and full superior conjunction with the sun. Solar occultation began November 21, 1968 and ended November 25, 1968. The capabilities of the DSS 14 210-ft-diam antenna were required from October 20 to December 20 for the experiment. Support problems for the network were caused by commitment of DSS 14, which alone tracked *Pioneer VI*, to support an *Apollo* project, by rework on the antenna's main bearing checks of low-film height, and by the installation of equipment to enhance a *Mariner* 1969 occultation experiment. These occurrences were in 1969.

When the annual report period began, the *Pioneer VI* spacecraft was some 293 million km from earth, the greatest distance of separation thus far reached. At the end of the period, the spacecraft was some 283 million km from earth. Transmission of commands to the spacecraft was resumed in September 1968. Efforts to send commands had ceased in March 1968 because the high-gain antenna aboard the spacecraft could not be employed and because of the distance of the spacecraft from earth.

B. Solar Occultation

The spacecraft probe's orbit resulted in a line of sight from the probe to the earth that caused the RF signal to pass through the solar corona and to be occulted by the sun during the second half of November 1968. The polarization of the spacecraft probe was linear; it was spin-stabilized with respect to the plane of the ecliptic. Measurement was made of the plane of polarization of the signal received from the spacecraft. Faraday rotation produced by the interaction of the RF signal with the solar corona was inferred from the measurements.

1. Experiment. The modified multifrequency cone was reinstalled on the 210-ft antenna at the Mars station on September 18. These modifications permitted closed-loop tracking of the angle of the plane of polarization. The initial installation permitted manual positioning of the polarizer and the obtaining of an error signal. Initially, data was taken manually. The plane of polarization was deduced by observation of the time-of-error-signal zero crossing for a given position of the polarizer. On October 26, the polarization servo tracking loop was closed and autotracking data of the plane of polarization of the signals received from *Pioneer VI* was obtained. During this time, the effects of the diurnal variations of the earth's ionosphere were clearly observed.

On November 4, for a period of 2 h, normal polarization, which was approximately 97 deg (due to the combination of the spacecraft's orientation of 90 deg to the plane of the ecliptic and the earth's ionospheric effects of approximately 7 deg), swung dramatically to approximately 65 deg. This event occurred when the line of sight to the spacecraft was at approximately 10 solar radii from the limb of the sun. As the line of sight approached the solar limb, a steady-state rotation apparently occurred.

The last signals were obtained as the line of sight approached the sun on November 17. The solar side lobes caused large increases in system temperature at the same time the solar corona caused spectral broadening. These two effects made it impossible to track any further. From November 21 to 25, the spacecraft was physically occulted by the sun. It was not possible to reacquire the space signal until November 29. From November 29 through December 8, the spacecraft was again tracked. The experiment was terminated on December 8.

2. ***Trajectory results.*** Trajectory results for the solar occultation are summarized in Figs. 56 and 57. Figure 56 plots the sun–earth–probe angle vs time during November. The sun–earth–probe angle is given in degrees in the trajectory period, but in Fig. 56 a kind of normalized angle is shown. This angle is the ratio of the sun–earth–probe angle to the sun–earth–limb of sun angle. Occultation occurred at the times that the curve crosses the value 1.0. The solar radius and sun–earth distance used to determine the sun–earth–limb of sun angle are 0.695×10^6 and 150×10^6 km, respectively.

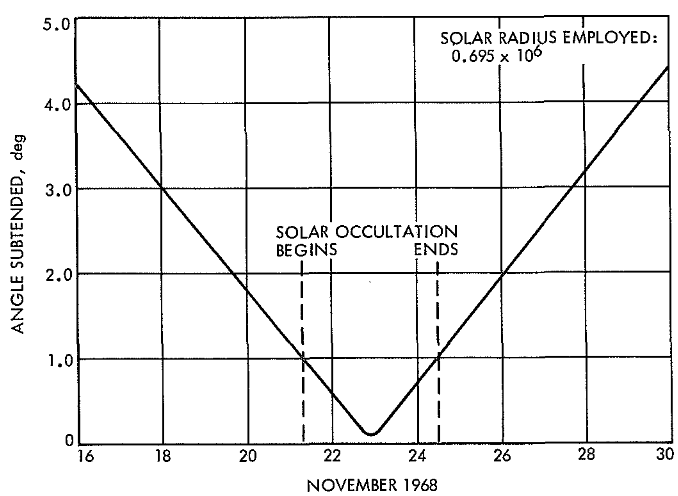

Fig. 56. Solar occultation plot

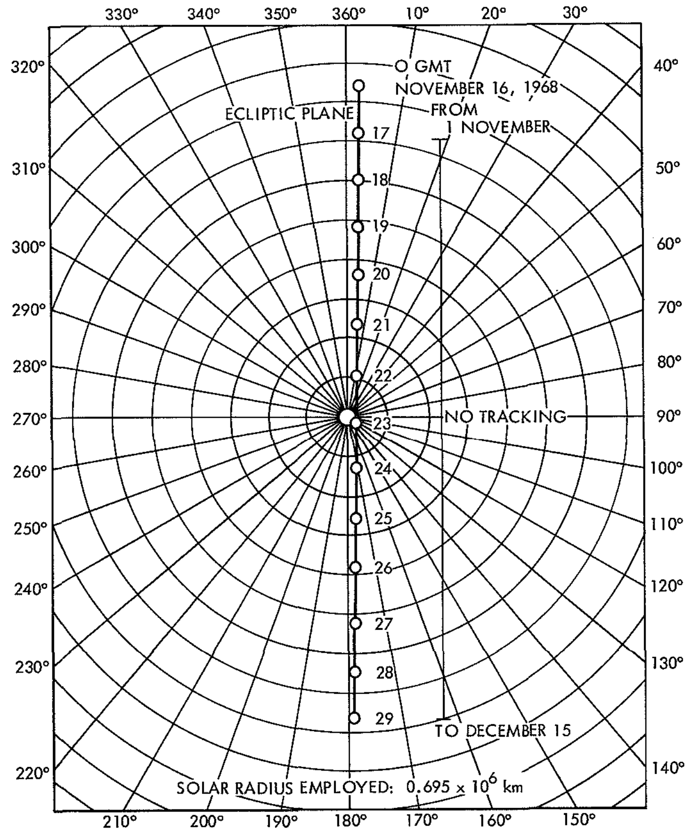

Fig. 57. Movement of *Pioneer VI* behind solar disk during November 1968

These result in a solar angular semidiameter of 0.27 deg. (Sun–earth–limb of sun angle, solar angular semidiameter at earth, and angle subtended at earth by one solar radius are the same.)

In Fig. 57, the solar occultation of the spacecraft is shown in a more geometric way. The circle represents the disc of the sun, and the line and time dots represent the progress of the spacecraft into and out of occultation. The point of view is that of an observer at earth looking toward the sun along the sun–earth line. The quantity plotted radially in Fig. 57 is essentially the sun–earth–probe angle, but again normalized by dividing by the solar angular semidiameter.

C. Solar Activity

Solar activity was at a high level during most of March 1969, with numerous small flares occurring. There were several active regions capable of producing major flares under the surveillance of satellites and observers on earth.

On March 30, after the most active of these regions had rotated behind the west limb of the sun and could no longer be observed from earth, there occurred the largest 10-cm radio burst in the corona ever recorded by terrestrial radio telescopes. Within about 2 h, cosmic-ray instruments aboard earth satellites and *Pioneers VI, VIII,* and *IX* were recording a marked increase in the intensity of low- and high-energy protons. From these measurements, it was assumed that a large solar proton flare had occurred on the backside of the sun. During this time, neutron monitors on earth showed a slight enhancement with gradual onset, so the effects at the earth's surface were slight. About a day later, cosmic-ray instruments aboard *Pioneer VII* showed increases in intensity.

The energy particle detectors aboard earth satellites and *Pioneers VIII* and *IX* began indicating reduced intensity within a few days after the March 30 event, and by April 5 the readings of those aboard *Pioneers VI* and *VII* began to subside. During the period from March 31 through April 9, solar activity on the visible side of the sun, as recorded by terrestrial observatories, was at a very low level, with only minor subflares reported.

By April 10, the active region which had produced the earlier proton flare had rotated on the far side of the sun to a position about 20 deg behind the east limb. On this date, it again erupted, producing a large proton flare. Within a half hour, cosmic-ray intensities recorded by *Pioneers VI* and *VII* jumped by more than an order of magnitude, but the instruments aboard *Pioneers VIII* and *IX* and those at earth showed essentially no change.

II. Engineering and Operations

A. Tracking

Pioneer VI was tracked by DSS 14 for a total of 1251 h 13 min during the period from July 1, 1968 to July 1, 1969 (passes 929 through 1292). The tracking time by quarter was as follows:

Tracking period	Passes	Total tracking time, h-min
Jul, Aug, Sep 1968	929–1020	375:40
Oct, Nov, Dec 1968	1021–1107	357:25
Jan, Feb, Mar 1969	1138–1202	183:55
Apr, May, Jun 1969	1204–1292	334:13

During the months of August 1968 and March 1969, tracking was in excess of the time scheduled. The percentages were: August 100.30; March 102.32; and April 103.66.

Open-loop recording began on pass 1065 during November, at the request of the *Pioneer* occultation experimenters. DSS 14 was unable to acquire the spacecraft on passes 1077 through 1079 because of the superior conjunction. Solar activity in the vicinity of *Pioneer VI* affected passes 1267, 1268, and 1269. On pass 1267, three severe jumps occurred in the doppler data; no anomaly was located at the station. On pass 1268, blunder points still appeared in the doppler data. The station equipment was rechecked, but no anomaly was found. On pass 1269, four blunder points were recorded in the doppler data. The solar activity still existed in the *Pioneer VI* area, but the intensity was low.

B. Significant Problems and Improvements

Engineering improvements during the reporting period included installation of a second autocollimator, the replacement of the S-band Cassegrain ultracone with an S-band multiple frequency (SMF) cone, and the development of a means to reduce high noise in the metric data.

Installation of the autocollimator was completed during September 1968. (The autocollimator operated in the manner of an optical tracking device by taking a beam of light and generating error signals. These error signals were fed into the antenna servoelectronics, moving the antenna to a no-error position between the antenna and master equatorial.) The SMF, also installed in September, was capable of simultaneously transmitting and receiving orthogonally cross-polarized linear signals while maintaining a low system noise temperature, approximately 22°K (Fig. 58). This capability was referred to as mode 1. When the SMF was in the matched linear polarized mode, using the diplexer, the system noise was approximately 31°K. This capability was referred to as mode 2. The SMF could use other modes, but they were not applicable to *Pioneer* support.

When the source of high noise in the metric data was diagnosed to be from a 1-MHz cleanup loop put in for the planetary ranging subsystem in June 1968, a 10-Hz signal was developed in the subsystem. This 10-Hz signal provided the same reference signals as the free-running 20-Hz oscillator with associated multipliers that had been replaced. However, the planetary ranging subsystem 10-Hz signal was referenced to the DSS atomic standard.

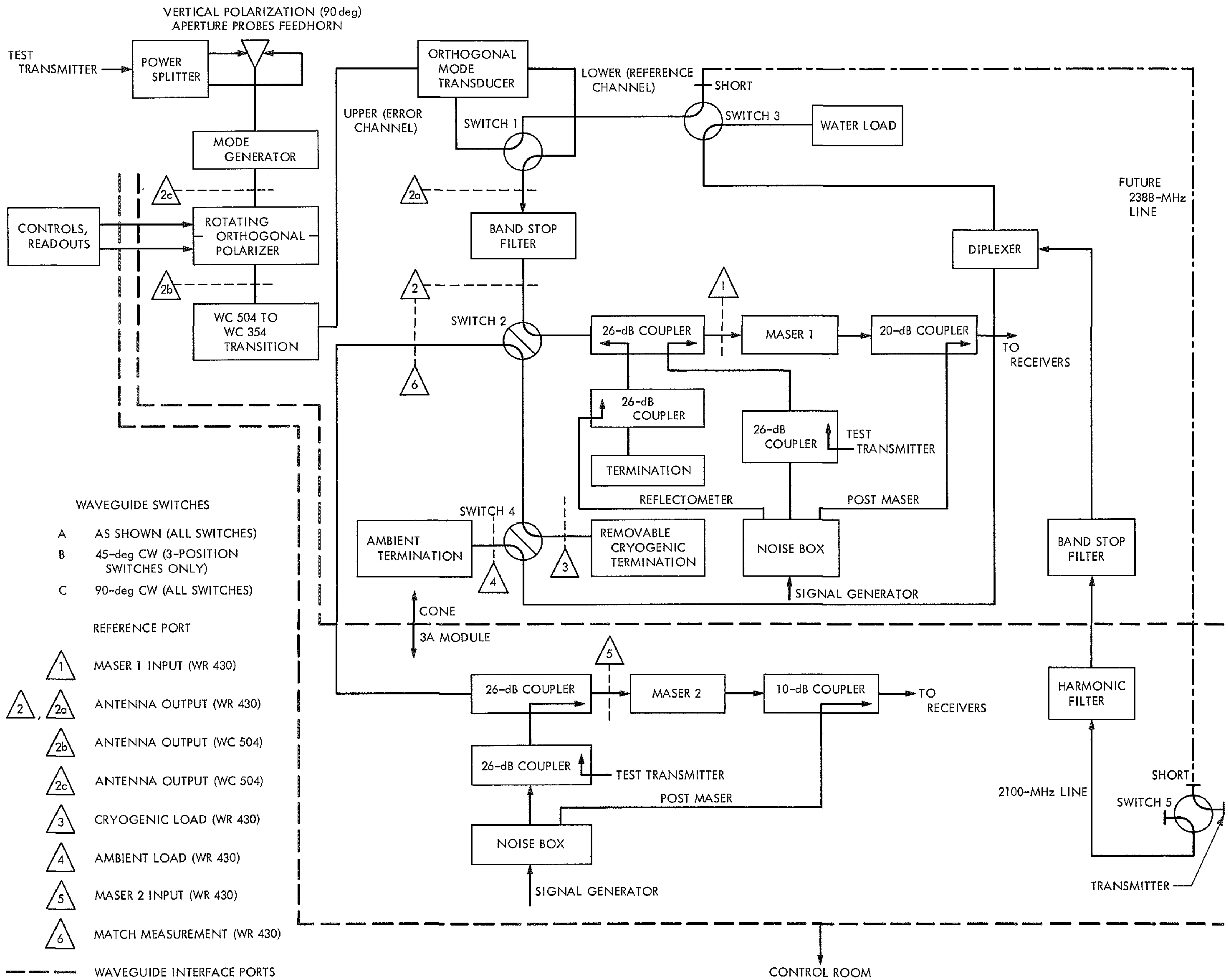

Fig. 58. SCM cone configuration

During May 1969, tests were performed on the tracking loop bandwidth ($2\ B_{LO}$) to determine optimum telemetry threshold. There had been numerous receiver glitches caused by the spacecraft signal approaching threshold. The tests, which indicated that 3 Hz was the optimum bandwidth, were performed using the *Pioneer* simulator with a $2\ B_{LO}$ of 3, 6, 9, and 12 Hz. On pass 197, at DSS 12, a test was performed using *Pioneer IX* data to confirm the previous test results (Fig. 59).

The test, commenced in the 12-Hz, $2\ B_{LO}$ position, was switched to 6 Hz for the first half of the pass, and finally switched to 3 Hz for the remainder of the pass. The bit error rates printed out every 12 min were averaged. The results showed a direct relationship of signal-to-noise-ratio to probability of error. The equivalent improvement when the $2\ B_{LO}$ was changed from 12 to 3 Hz was 1.4 dB. When changed from 12 to 6 Hz, the improvement was 0.9 dB, and the improvement from 6 to 3 Hz amounted to 0.5 dB.

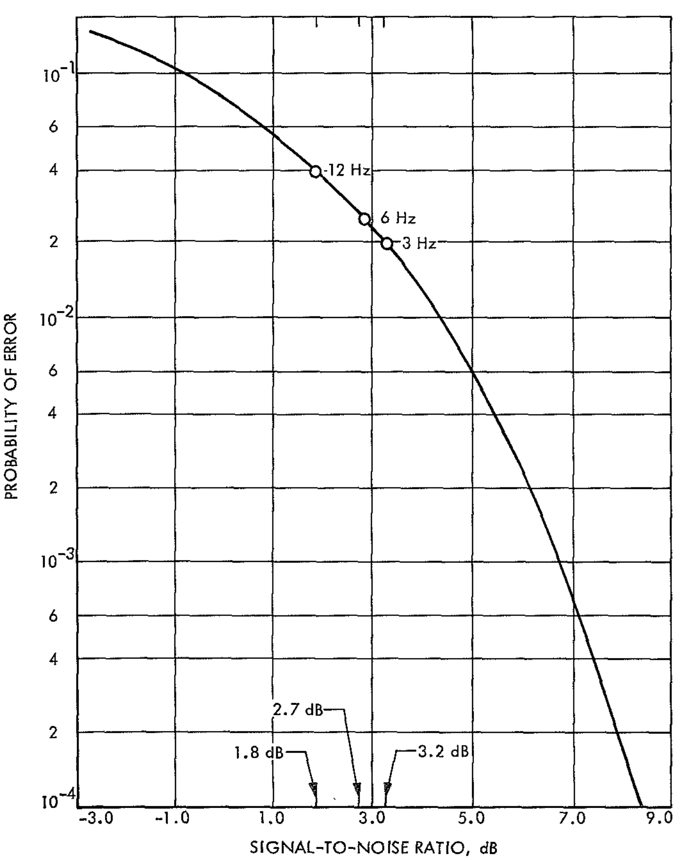

Fig. 59. *Pioneer IX* tracking loop bandwidth test results (May 1969) used to conform previous test results for all *Pioneer* spacecraft

A major irregularity during late 1968 which entailed extensive investigation was the problem of occasional spurious interrupts in the TCP that caused loss of real-time data. Because of the intermittent nature of the problem, it took more than 2 mo to isolate and correct the irregularity. Spurious word parity errors on decoded data had been caused by transients on the decoding computer paralleled input (PIN) lines. These transients generated excessive noise for the logic (one) state on the operational processing computer PIN lines.

After the problem was isolated, Ames Research Center sent to DSS 14 and all other *Pioneer* GOE-equipped stations Modification 11 for the computer buffer. Modification 11 changed the timing on the decoded data clock to the center of the data period, which triggered the interrupt to the operational processing computer. This change ensured that both computers would not address the buffer simultaneously.

C. Radio Metric Data Information

1. Good data time. Percentages of good data obtained from total actual tracking time were reported for various monthly periods during the annual period covered here (Figs. 60–64). Good data was obtained during July and

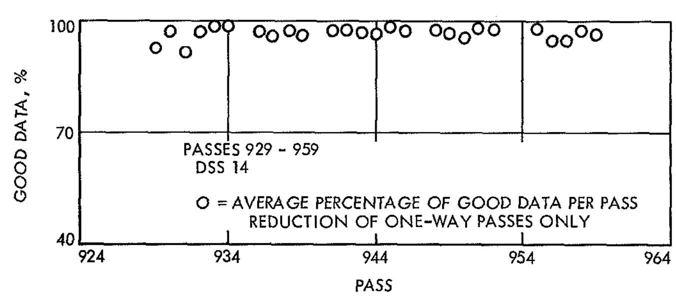

Fig. 60. Percentage of good metric data vs pass number (July 1968)

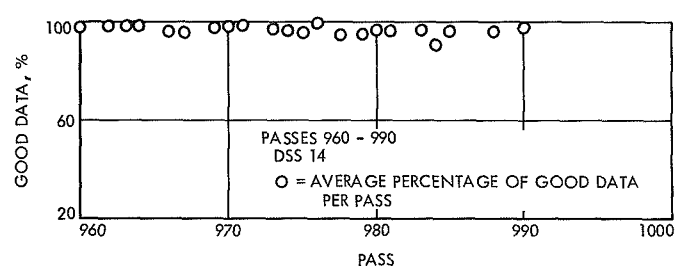

Fig. 61. Percentage of good metric data vs pass number (August 1968)

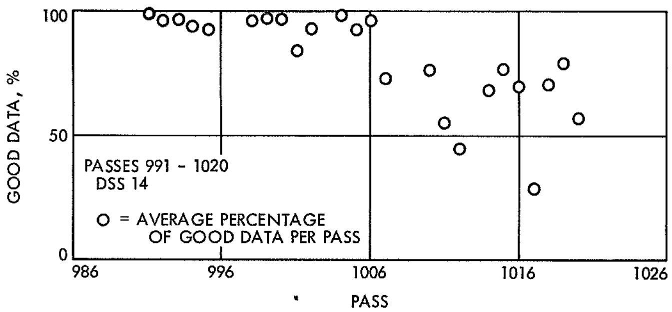

Fig. 62. Percentage of good metric data vs pass number (September 1968)

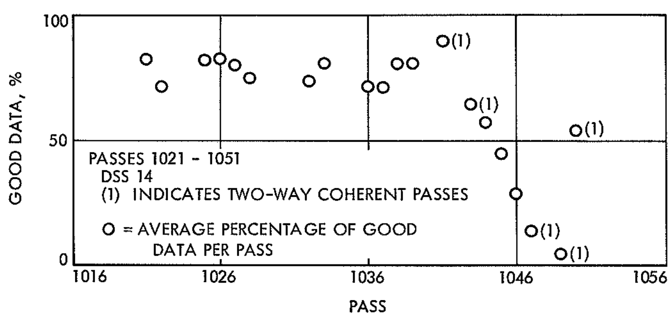

Fig. 63. Percentage of good metric data vs pass number (October 1968)

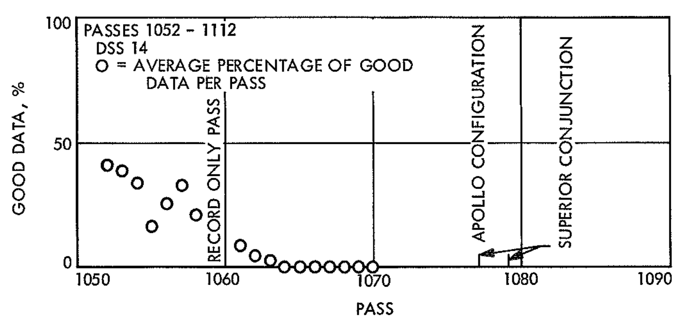

Fig. 64. Percentage of good metric data vs pass number (November and December 1968)

August 1968 for approximately 97% of the actual tracking time. The percentage was 79.84 during September, but fell to 58.79 during October. Solar occultation caused low percentages during November and December. There was no data in January 1969 because of station rework activity, and during February there was no analysis of the few tracks. Good metric data was obtained for 81.88% of the actual tracking time during March and for 85.61% of the actual tracking time during April. Percentages were not figured for May and June.

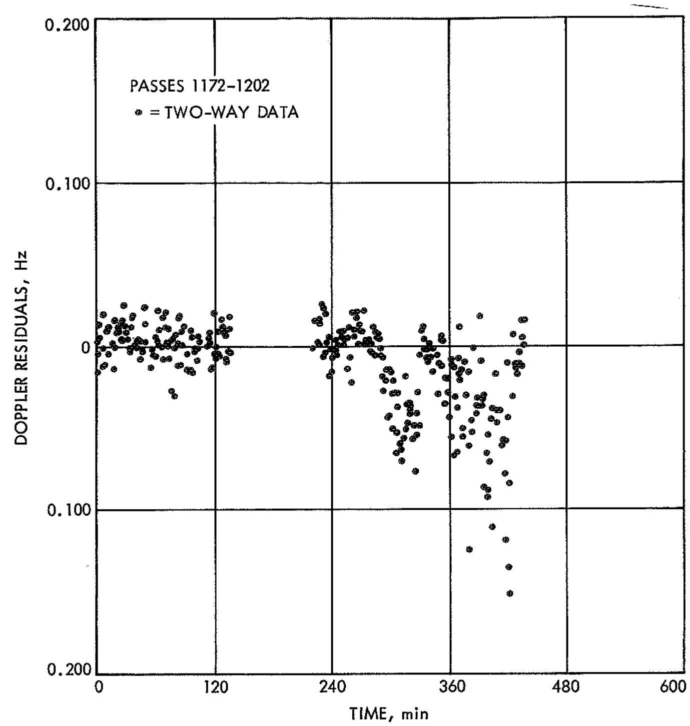

Fig. 65. High noise in doppler data believed caused by doppler counter problem (March 1969)

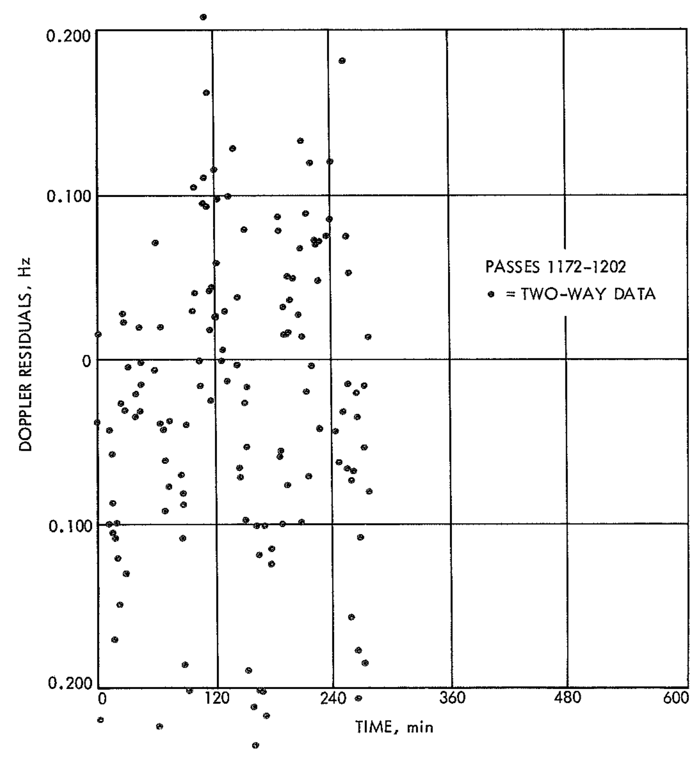

Fig. 66. Doppler counter problem causing high noise in data (March 1969)

2. Doppler information. Figures 65 and 66 illustrate a precision orbit determination program (SPODP) plot of true residuals. These residuals were the difference between actual tracking data and the calculated data from the orbit determination process. Figure 65 illustrates that the doppler problem first occurred at approximately 2243. Doppler bias and noise vs pass number are illustrated by Figs. 67–71. The changing doppler bias during April, May, and June indicated need for an updated orbit. The doppler bias changed from −275 to −375 Hz during April, from +68 to +108 Hz during May, and from +110 to +157 Hz during June.

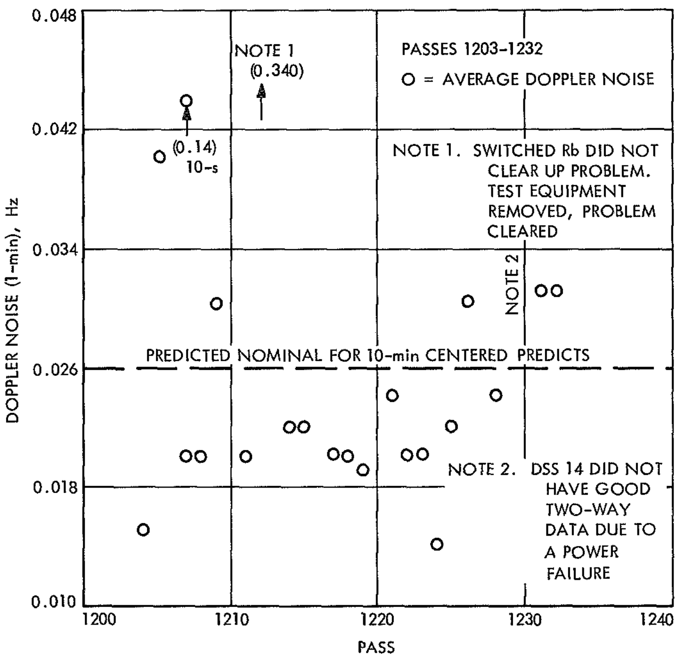

Fig. 67. Average doppler noise vs pass number (April 1969)

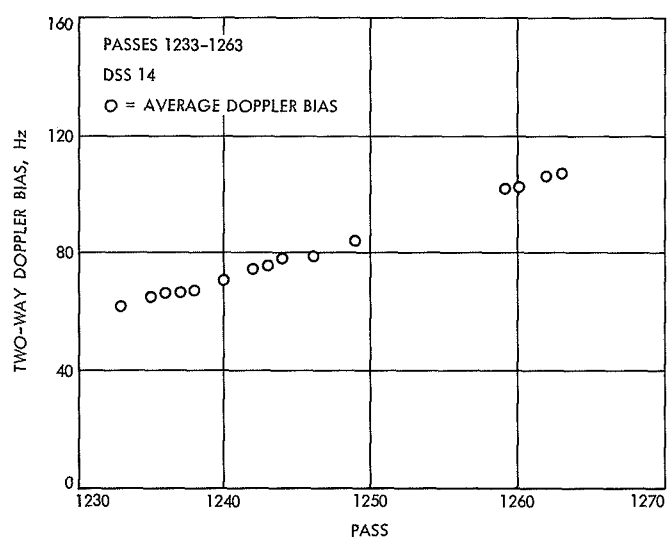

Fig. 68. Average doppler bias vs pass number (May 1969)

D. Anomalies Related to Telemetry Data Losses

Some instances of data losses and the anomalies that caused them during this report period are singled out here. The pass chronology contains additional information. Deep Space Station 14 tuned 101 min in attempts to gain two-way lock on pass 1177, having used an incorrect frequency in attempting to acquire the spacecraft in two-way mode. The antenna went to brake because of low film height on Pad 3. Two min 33 s of telemetry data

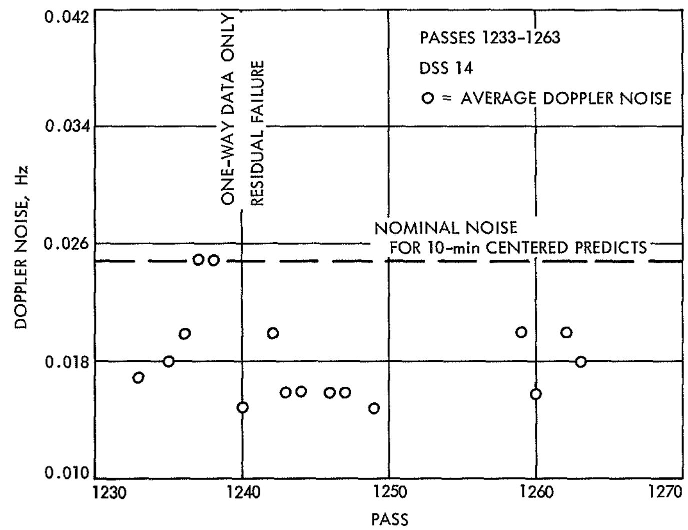

Fig. 69. Average doppler noise vs pass number (May 1969)

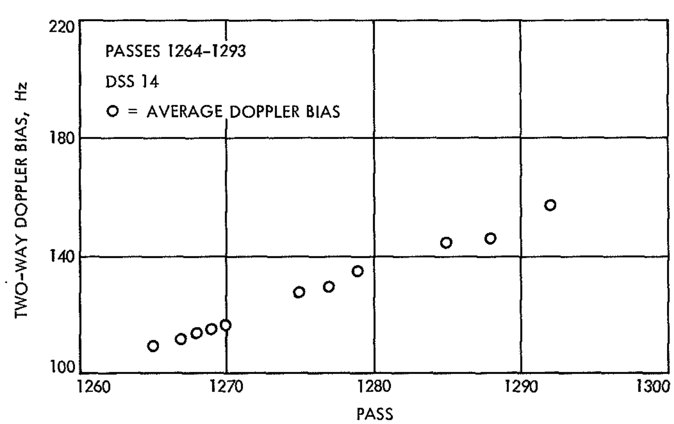

Fig. 70. Average doppler bias vs pass number (June 1969)

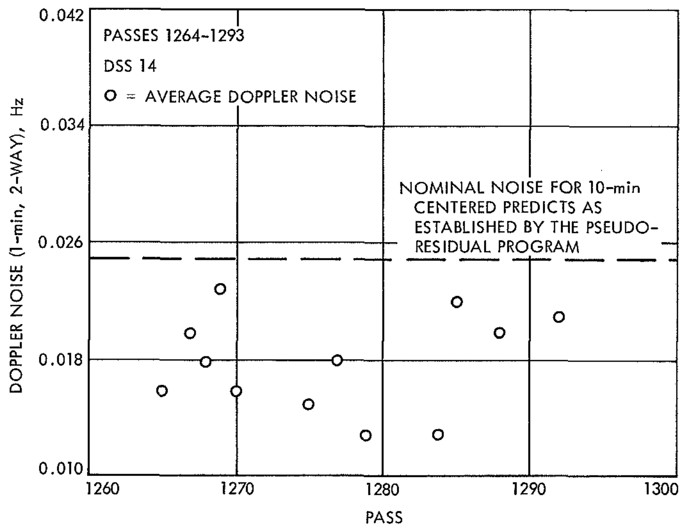

Fig. 71. Average doppler noise vs pass number (June 1969)

was lost. On pass 1178, the station had a power surge and lost binary-coded decimal time. The high noise was believed a result of a timing error caused by the power surge. The antenna went to brake and the receiver dropped lock because of low film height at 2025:56. One min 20 s of data was lost.

No anomaly was found as the cause for the high noise throughout pass 1181 as the station tracked in a two-way noncoherent mode. The received signal strength was 9.4 dBmW above threshold; the receiver was believed to be dropping cycles.

On pass 1188 at 1611:27, the station switched to S-band multiple frequency (SMF) mode 2 (a two-way matched polarized linear mode for use only on channel 7) and attempted to acquire the spacecraft on channel 6. Three h 5 min of data was lost. Channel 7 was acquired at 2010:20; it was noisy.

The station experienced high noise on pass 1212 and switched from rubidium 1 to rubidium 2, but the noise continued. Communication outage occurred from 2033 to 2039. The high noise appeared to be caused by a timing offset. Noise spikes ranged from 60 to 80 cycles. There was high noise caused by a resolver malfunction throughout pass 1232.

E. RF Performance

Table 33 presents receiver signal strengths for passes 929 through 1292. The actual downlink signal strengths have been plotted in Figs. 72–79 to illustrate characteristic trends, if any, in the station performance. The predicted downlink signal strength curves using circular and linear polarization are shown along with actual received downlink signal strength to establish the accuracy of the predictions. For January, February, and March, prediction plots are not presented because of the small number of passes.

The actual downlink signal strength was within 1 dBmW of the predicted signal strength using linear polarization during July. Consistency was maintained through August and September (1.1 dBmW). On pass 1002, the strength was degraded on both receivers, and maser 1 was replaced by maser 2. The cause of degradation on pass 1012 was not ascertained. Receiver glitching occurred throughout the month of October, causing some fluctuation of the data points, which still were within 1.2 dBmW of the predicted values.

The actual downlink signal strength values during November are plotted in Fig. 76 to graphically illustrate the characteristic trend due to a full superior conjunction with the sun. The predicted downlink signal strength curve is shown superimposed over the actual downlink signal strength values to determine the accuracy of the predictions. Figure 76 also indicates the decreasing signal strength (passes 1052–1070) as the spacecraft approached solar occultation. Passes 1095–1107 were within 1 dBmW of predictions, except for pass 1099, which had a 2.5-dBmW stronger signal level than predicted.

During November and December, the actual strength for all passes using linear polarization was within 2 dBmW of the predicted signal strength curve. The signal level was approximately 3 dBmW below the predicted curve during April. During May, the signal strength was within 1 dBmW of prediction, except for pass 1263, which was within approximately 2 dBmW of predictions. The signal level varied within 2 dBmW of predictions during June.

F. Parity Error Rate

Table 33 and Figs. 80–87 present parity error rates and plots for the reporting period. (A parity error rate of 0.116 was equivalent to 1 error in 1000 consecutive bits of information and was regarded as the limiting value for the uncoded and convolution-coded unit modes of information.) During the first quarter (July, August, September 1968), the telemetry bit rate mode was 8 bits/s.

Table 33. Summary of Operations, Passes 929–1292

Pass No.	DSS No.	Day of Year	Acq. Time	End of Track	Ground Mode Start/Stop Time 1-Way	2-Way	3-Way	Signal Strength Avg (dbm)	Configuration Loop BW (Hz)	Temp Pre/Post (°K)	Thres Pre/Post (dbm)	No. of Cmds	Average PER	Bit Rate	Comments
929	14	183	1225	1600	1225 1600			-163.5	12	17.4	-178	0	0.000	8	P0/D0/B12 from 1225 to 1239, and P1/D0/B12 from 1239 to 1600.
930	14	184	1226	1735	1226 1735			-163.3	3	18.7	-182	0	0.000	8	P1/D0/B3 from 1226 to 1735.
931	14	185	1251	1735	1251 1735			-163.9	12	17.9	-176	0	0.000	8	P1/D0/B12 from 1251 to 1735.
932	14	186	1229	1735	1229 1735			-163.6	12	17.3	-179	0	0.000	8	P1/D0/B12 during entire pass.
933	14	187	1625	2030	1625 2030			-162.9	12	16.2	-176	0	0.000	8	P1/D0/B12.
934	14	188	1606	2030	1606 2030			-163.1	12	17.5	-178	0	0.000	8	P1/D0/B12.
935	14	189	1235	1735	1235 1735			-163.0	12	18.9	-176	0	0.000	8	P1/D0/B12 from 1235 to 1735.
936	14	190	1228	1600	1228 1600			-163.3	12	16.9	-176	0	0.000	8	P1/D0/B12 from 1228 to 1600.
937	14	191	1234	1705	1234 1705			-163.0	12	18.9	-178	0	0.000	8	P1/D0/B12 from 1234 to 1705.
938	14	192	1229	1705	1229 1705			-163.9	12	18.4	-178	0	0.000	8	P1/D0/B12 from 1229 to 1705.
939	14	193	1229	1705	1229 1705			-163.4	12	17.9	-178	0	0.000	8	P1/D0/B12 from 1229 to 1705.
941	14	195	1618	2030	1618 2030			-163.0	12	18.4	-178	0	0.000	8	P1/D0/B12 from 1618 to 2030. Twenty minutes of data were lost due to three commercial power glitches.
942	14	196	1230	1707	1230 1707			-163.3	12	16.8	-179	0	0.000	8	P1/D0/B12 during entire pass.
943	14	197	1231	1600	1231 1600			-163.0	12	16.8	-179	0	0.000	8	P1/D0/B12 from 1231 to 1600.
944	14	198	1232	1740	1232 1740			-163.2	12	17.1	-179	0	0.000	8	P1/D0/B12 from 1232 to 1740.
945	14	199	1232	1740	1232 1740			-163.7	12	17.0	-179	0	0.000	8	P1/D0/B12 from 1232 to 1740.
946	14	200	1233	1740	1233 1740			-163.2	12	17.1	-178	0	0.000	8	P1/D0/B12 from 1233 to 1740.
948	14	202	1621	2030	1621 2030			-163.1	12	17.9	-178	0	0.000	8	P1/D0/B12 during entire pass.
949	14	203	1234	1740	1234 1740			-162.7	12	17.5	-178	0	0.000	8	P1/D0/B12 during entire pass.
950	14	204	1235	1830	1235 1830			-163.2	12	17.4	-179	0	0.000	8	P1/D0/B12.
951	14	205	1236	1830	1236 1830			-163.7	12	17.3	-176	0	0.000	8	P1/D0/B12.
952	14	206	1522	2100	1522 2100			-163.0	12	17.0	-179	0	0.000	8	P1/D0/B12.
955	14	209	1238	1745	1238 1745			-163.8	12	17.7	-178	0	0.000	8	P1/D0/B12.
956	14	210	1238	1745	1238 1745			-163.2	12	29.1	-178	0	0.000	8	P1/D0/B12.
957	14	211	1239	1745	1239 1745			-163.2	12	16.9	-179	0	0.000	8	P1/D0/B12. At 1353, receiver was out-of-lock for 30 seconds due to operator error.
958	14	212	1231	1745	1231 1745			-163.0	12	16.7	-179	0	0.000	8	P1/D0/B12.
959	14	213	1240	1745	1240 1745			-163.6	12	17.1	-179	0	0.000	8	P1/D0/B12.

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Table 33 (contd)

Pass No. PN 6	DSS No.	Day of Year	Acq. Time	End of Track	Ground Mode Start/Stop Time 1-Way	2-Way	3-Way	Signal Strength Avg (dbm)	Configuration Loop BW (Hz)	Temp Pre/Post (°K)	Thres Pre/Post (dbm)	No. of Cmds	Average PER	Bit Rate	Comments
960	14	214	1241	1800	1241 1800			-161.80	12	17.10	-176		0.000	8	P1/D0/B12.
962	14	216	1243	1745	1243 1745			-162.80	12	17.60	-176		0.000	8	P1/D0/B12.
963	14	217	1244	1745	1244 1745			-162.70	12	17.20	-176		0.000	8	P1/D0/B12.
964	14	218	1245	1750	1245 1750			-162.60	12	17.50	-176		0.000	8	P1/D0/B12.
965	14	219	1245	1750	1245 1750			-163.00	12	17.80	-176		0.000	8	P1/D0/B12.
966	14	220	1246	1750	1246 1750			-163.20	12	17.60	-176		0.000	8	P1/D0/B12.
967	14	221	1247	1700	1247 1700			-162.50	12	17.50	-176		0.000	8	P1/D0/B12.
969	14	223	1248	1750	1248 1750			-162.40	12	17.50	-178		0.000	8	P1/D0/B12.
970	14	224	1249	1748	1249 1748			-163.30	12	16.70	-179		0.000	8	P1/D0/B12.
971	14	225	1250	1700	1250 1700			-163.00	12	17.20	-178		0.000	8	P1/D0/B12.
973	14	227	1252	1755	1252 1755			-163.00	12	17.20	-178		0.000	8	P1/D0/B12. At 1525, Magnetic Tape 1A and 1B would not record the receiver in lock indication due to damaged patch board (TFR-125921).
974	14	228	1252	1550	1252 1550			-163.00	12	17.20	-174		0.015	8	P1/D0/B12.
975	14	229	1255	1550	1255 1550			-163.00	12	17.30	-176		0.000	8	P1/D0/B12.
976	14	230	1557	2030	1557 2030			-163.30	12	17.50	-177		0.000	8	P1/D0/B12.
977	14	231	1255	1755	1255 1755			-163.50	12	16.80	-177		0.005	8	P1/D0/B12.
979	14	233	1300	1800	1300 1800			-163.50	12	16.80	-176		0.000	8	P1/D0/B12.

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Pass No. PN 6	DSS No.	Day of Year	Acq. Time	End of Track	Ground Mode Start/Stop Time 1-Way	2-Way	3-Way	Signal Strength Avg (dbm)	Configuration Loop BW (Hz)	Temp Pre/Post (°K)	Thres Pre/Post (dbm)	No. of Cmds	Average PER	Bit Rate	Comments
980	14	234	1259	1800	1259 1800			-163.10	12	17.60	-177		0.000	8	P1/D0/B12.
981	14	235	1259	1800	1259 1800			-163.00	12	17.30	-177		0.000	8	P1/D0/B12.
983	14	237	1300	1800	1300 1800			-163.50	12	17.30	-177		0.000	8	P1/D0/B12.
984	14	238	1301	1800	1301 1800			-162.70	12	16.40	-177		0.000	8	P1/D0/B12.
985	14	239	1302	1805	1302 1805			-162.80	12	17.00	-179		0.000	8	P1/D0/B12.
986	14	240	1303	1805	1303 1805			-162.90	12	17.60	-179		0.000	8	P1/D0/B12.
987	14	241	1305	1805	1305 1805			-163.00	12	16.70	-177		0.000	8	P1/D0/B12.
988	14	242	1305	1805	1305 1805			-163.00	12	16.90	-178		0.000	8	P1/D0/B12.
990	14	244	1307	1805	1307 1805			-162.40	12	17.50	-177		0.000	8	P1/D0/B12.

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Table 33 (contd)

Pass No.	DSS No.	Day of Year	Acq. Time	End of Track	Ground Mode Start/Stop Time 1-Way	2-Way	3-Way	Signal Strength Avg (dbm)	Configuration Loop BW (Hz)	Temp Pre/Post (°K)	Thres Pre/Post (dbm)	No. of Cmds	Average PER	Bit Rate	Comments
991	14	245	1308	1805	1308 1805			-162.5	12	17.3	-177		0.000	8	Pl/D0/B12.
992	14	246	1310	1810	1310 1810			-163.6	12	17.6	-177		0.000	8	Pl/D0/B12.
993	14	247	1310	1810	1310 1810			-162.7	12	17.4	-177		0.000	8	Pl/D0/B12.
994	14	248	1318	1810	1318 1810			-162.8	12	16.6	-177		0.000	8	Pl/D0/B12.
995	14	249	1324	1810	1324 1810			-163.4	12		-178		0.000	8	Pl/D0/B12.
997	14	251	1314	1815	1314 1815			-162.8	12	17.0	-178		0.000	8	Pl/D0/B12.
998	14	252	1315	1610	1315 1610			-162.8	12	17.1	-179		0.000	8	Pl/D0/B12. Hydrostatic bearing pad recess flow failure.
999	14	253	1316	1700	1316 1700			-162.6	12	17.1	-174		0.000	8	Pl/D0/B12.
1000	14	254	1317	1820	1317 1820			-162.8	12	17.3	-176		0.000	8	Pl/D0/B12.
1001	14	255	1318	1820	1318 1820			-162.3	12	17.1	-177		0.000	8	Pl/D0/B12.
1002	14	256	1319	1820	1319 1820			-162.4	12	17.0	-178		0.000	8	Pl/D0/B12 from 131921 to 145000 and Pl/Dl/B12 from 145000 to 182000.
1004	14	258	1322	1820	1322 1820			-162.1	12	16.2	-178	0	0.000	8	Pl/D0/B12 during entire pass.
1005	14	259	1324	1820	1324 1820			-162.1	12	16.7	-179	0	0.000	8	Pl/D0/B12 during entire pass.
1006	14	260	1325	1800	1325 1820			-162.5	12	17.0	-176	0	0.000	8	Pl/D0/B12.
1007	14	261	1325	0030	1325 1527	1527* 0030		-162.5	12	16.3	-176	6	0.000	8	Pl/Dl/B12. One slight RCVR glitch at 2125. *Two-way noncoherent.

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Pass No.	DSS No.	Day of Year	Acq. Time	End of Track	Ground Mode Start/Stop Time 1-Way	2-Way	3-Way	Signal Strength Avg (dbm)	Configuration Loop BW (Hz)	Temp Pre/Post (°K)	Thres Pre/Post (dbm)	No. of Cmds	Average PER	Bit Rate	Comments
1010	14	264	1330	1825	1330 1825	NONCOHERENT		-162.9	12	31.7	-175	4	0.012	8	Pl/Dl/B12.
1011	14	265	1330	1825	1330 1825	NONCOHERENT		-163.5	12	32.0	-177	5	0.100	8	Pl/Dl/B12. Command (CMD) aborted. ANT to brake, low film height on Pad 3 dipped to 0.0015, ANT to point film height checks okay. Dirt in oven from 127.1 to 140.0° at 1800.
1012	14	266	1330	1835	1330 1835			-164.2	12	31.6	-175	4	0.000	8	Pl/Dl/B12. At 1648, low film height on Pads 1 and 3. ANT to brake.
1014	14	268	1332	1827	1332 1827	NONCOHERENT		-162.2	12	31.4	-175	4	0.020	8	Pl/Dl/B12 from 1332 to 1802 and Pl/D0/B12 from 1802 to 1827. Several RCVR glitches.
1015	14	269	1339	1828	1339 1828	NONCOHERENT		-162.3	12	31.9	-175	4	0.020	8	Pl/Dl/B12.
1016	14	270	1334	1829	1334 1829	NONCOHERENT		-162.1	12	31.7	-175	2	0.030	8	Pl/Dl/B12.
1017	14	271	1336	1831	1336 1831			-162.6	12	32.0	-174		0.000	8	Pl/Dl/B12. Overvoltage tripped transmitter.
1018	14	272	1336	1832	1336 1832	NONCOHERENT		-162.6	12	32.2	-174	2	0.040	8	Pl/Dl/B12.
1019	14	273	1338	2100	1338 2100	NONCOHERENT		-162.5	12	32.1	-174	2	0.060	8	Pl/Dl/B12.
1020	14	274	1339	1600	1339 1600	NONCOHERENT		-162.4	12	32.7	-175		0.100	8	Pl/Dl/B12.

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Table 33 (contd)

Pass No.	DSS No.	Day of Year	Acq. Time	End of Track	Ground Mode Start/Stop Time 1-Way	2-Way	3-Way	Signal Strength Avg (dbm)	Configuration Loop BW (Hz)	Temp Pre/Post (°K)	Thres Pre/Post (dbm)	No. of Cmds	Average PER	Bit Rate	Comments
1021	14	275	1340	1840	1340 1840	NONCOHERENT		-162.3	12	31.7	-174	2	0.070	8	P1/D1/B12.
1022	14	276	1357	1840	1357 1840	NONCOHERENT		-162.2	12	31.8	-174	4	0.038	8	P1/D1/B12. Polarizer failed.
1023	14	277	1343	1840	1343 1840	NONCOHERENT		-162.2	12	31.8	-174	8	0.000	8	S-Band Multiple Frequency Cone (SMF) Mode 2/B12.
1025	14	279	1346	1840	1348 1840	NONCOHERENT		-161.5	12	22.6	-175	3	0.008	8	Mode 1/B12.
1026	14	280	1347	1840	1347 1840	NONCOHERENT		-161.9	12	22.8	-175	2	0.000	8	Mode 1/B12.
1027	14	281	1348	1840	1348 1840	NONCOHERENT		-161.5	12	22.8	-175	2	0.000	8	Mode 1/B12.
1028	14	282	2029	0000	2029 0000	NONCOHERENT		-161.4	12	22.7	-175	2	0.000	8	Mode 1/B12. TXR off at 2313 due to broken coolant hose.
1032	14	286	1403	2315	1403 2315	NONCOHERENT		-161.2	12	22.7	-175	4	0.080	8	SMF Mode 1/B12. Due to a loose RCVR connector, RCVR 1 was switched to RCVR 2. TXR tripped off ac overcurrent.
1033	14	287	1357	1845	1357 1845	NONCOHERENT		-161.5	12	22.8	-175	2	0.000	8	Mode 1/B12. Power glitch - station switched to diesel power at 1757.
1035	14	289	CANCELLED												
1036	14	290	1402	1745	1402 1745	NONCOHERENT		-162.8	12	22.5	-176	2	0.010	8	Mode 1/B12.
1037	14	291	1405	1700	1405	NONCOHERENT		162.1	12	22.7	-175	2	0.000	8	Mode 1/B12.
1038	14	292	1404	1930	1404 1930	NONCOHERENT		162.7	12	23.3	-177	2	0.040	8	Mode 1/B12. Recorder 1 malfunction.
1039	14	293	1405	1850	1405 1850	NONCOHERENT		-162.3	12	22.5	-176	2	0.020	8	Mode 1/B12.
1041	14	295	1409	2300	1409 1904 2231 2300	1904 2231		-162.2	12	22.4	-176	11	0.010	8	Mode 1/B12.

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Pass No.	DSS No.	Day of Year	Acq. Time	End of Track	Ground Mode Start/Stop Time 1-Way	2-Way	3-Way	Signal Strength Avg (dbm)	Configuration Loop BW (Hz)	Temp Pre/Post (°K)	Thres Pre/Post (dbm)	No. of Cmds	Average PER	Bit Rate	Comments
1043	14	297	1412	2400	1412 1646 2301 2400	1646 2301		-162.6	12	23.3	-175	12	0.038	8	Mode 1/B12. TXR tripped twice.
1044	14	298	1750	2400	1750 2400	NONCOHERENT		-162.2	12	23.4	-175	3	0.300	8	Mode 1/B12.
1045	14	299	1415	1800	1415 1800	NONCOHERENT		-162.7	12	23.0	-175	3	0.300	8	Mode 1/B12.
1046	14	300	1802	2200	1802 2200	NONCOHERENT		-163.4	12	22.8	-176	3	BAD	16	Mode 1/B12.
1047	14	301	1418	2330	1418 1637 1707 1800	1637 1707 1800 2330		-162.5	12	22.5	-176	12	0.800 BAD	8 16	Mode 1/B12.
1049	14	303	1422	2032	1422 1847 2001 2032	1847 2001		-162.7	12	22.6	-176	7	0.600	8	Mode 1/B12 from 1422 to 1537, Mode 3/B12 from 1537 to 1624, and Mode 1/B12 from 1624 to 2032. RCVR glitching badly.
1050	14	304	1426	1930	1426 1616 1848 1930	1616 1848		-162.6	12	22.7	-175	8	0.750	8	Mode 1/B12.
1051	14	305	1427	2330	1427 2330	RECORD ONLY		-163.4	12						Mode 1/B12.

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Table 33 (contd)

Pass No.	DSS No.	Day of Year	Acq. Time	End of Track	Ground Mode Start/Stop Time 1-Way	2-Way	3-Way	Signal Strength Avg (dbm)	Configuration Loop BW (Hz)	Temp Pre/Post (°K)	Thres Pre/Post (dbm)	No. of Cmds	Average PER	Bit Rate	Comments
1052	14	306	1427	2301	1427 1521 2254 2300	1521 2254		-163.3	12	23.3	-176	21	BAD	8	Mode 1/B12. GOE failed to transmit CMD 101 at Z00000.
1053	14	307	1429	0007	1429 1631 2136 0007	1631 2136		-163.5	12	23.4	-175	15	BAD	8	Mode 1/B12. TCP not locking up.
1054	14	308	1431	2330	1431 1701 1852 2330	1701 1852		-163.6	12	22.5	-175	24	BAD	8	Mode 1/B12.
1055	14	309	1433	2300	1433 1945	1945* 2300		-163.0	12	22.6	-175	4	BAD	8	Mode 1/B12. Recorder failure. *Non-coherent.
1056	14	310	1435	2300	1435 1610	1610* 2300		-163.5	12	33.7	-175	12	BAD	8	Mode 1/B12. *Noncoherent.
1057	14	311	1436	2300	1436 1700	1700 2300		-163.5	12	22.4	-176	10	BAD	8	Mode 1/B12.
1058	14	312	1438	2300	1438	1651		-163.6	12	22.4	-178	18	BAD	8	Mode 1/B12.
1059	14	313	1447	2300	1447 2300			-165.0	12						Mode 1/B12. Record only.
1060	14	314	1441	2300	1441 2300			-164.5	12						Mode 1/B12. Record only.
1061	14	315	1443	2300	1443 2300			-165.0	12	22.5	-177				Mode 1/B12. Unable to lock TCP.
1062	14	316	1445	2400	1445 2400			-167.3	12	22.4	-177				Mode 1/B12.
1063	14	317	1449	0001	1449 0001			-170	12	23.1	-178				Mode 1/B12.**

**TCP UNABLE TO LOCK UP DUE TO SUN OCCULTATION. GROUND RECEIVER SIGNAL LEVELS FLUCTUATING OVER WIDE RANGE.

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Pass No.	DSS No.	Day of Year	Acq. Time	End of Track	Ground Mode Start/Stop Time 1-Way	2-Way	3-Way	Signal Strength Avg (dbm)	Configuration Loop BW (Hz)	Temp Pre/Post (°K)	Thres Pre/Post (dbm)	No. of Cmds	Average PER	Bit Rate	Comments
1064	14	318	1450	2300	1450 2300			-172	12	50.3	-177				Mode 1/B12.
1065	14	319	1455	2400	1455			-172	12	50.3	-177				Ground Receiver signal too erratic to measure.**
1066	14	320	1518	2400	1518 2400			-172	12	22.6	-178				Mode 1/B12.**
1067	14	321	1455	2359	1455 2359			-174	12	22.8	-177				Mode 1/B12.**
1068	14	322	1512	2400	1512 2400			-173	12	22.5	-179				Mode 1/B12.**
NOTE: FROM DAYS 323 TO 332 DSS 14 WAS ENGAGED IN TRACKING PIONEER VI USING NON-DSIF OPEN LOOP RECEIVER FOR THE FOLLOWING EXPERIMENTS: FARADAY ROTATION - G. LEVY; SPECTRUM WIDENING - R. GOLDSTEIN; RELATIVISTIC - J. ANDERSON. PIONEER DATA WAS NOT TAKEN ON THIS EXPERIMENTAL TRACKING DUE TO INABILITY TO LOCK UP ON THE EXCESSIVELY NOISY SIGNAL.															
1078	14	332	1550	2400	*			*	12	22.7	-177	NONE	*		*Uncertain as to RCVR lock. Signal evidently beyond threshold. Occultation.
1079	14	333	1519	2345					12	23.1	-177	NONE			Same as above. G. Levy on-site experimenting.
1080	14	334	1539	2315				-176	12	22.9	-177	NONE			RCVR's in and out of lock. No stable signal. Open and closed loop operations.
1081	14	335	1521	2345				-177	12	22.6	-177	NONE			Intermittent RCVR lock - approximately 30%.

**TCP UNABLE TO LOCK UP DUE TO SUN OCCULTATION. GROUND RECEIVER SIGNAL LEVELS FLUCTUATING OVER WIDE RANGE.

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Table 33 (contd)

Pass No.	DSS No.	Day of Year	Acq. Time	End of Track	Ground Mode Start/Stop Time 1-Way	2-Way	3-Way	Signal Strength Avg (dbm)	Configuration Loop BW (Hz)	Temp Pre/Post (°K)	Thres Pre/Post (dbm)	No. of Cmds	Average PER	Bit Rate	Comments
1082	14	336	1525	2313					12	22.7	-177	NONE			Intermittent lock. Station set antenna to "stow" due to high winds.
1095	14	349	2221	0013	2221 0013			-161.9	12			0	BAD	8	Mode 1/B12.
1096	14	350	1625	0014	1625 0014			-162.7	12			0	BAD	8	Mode 1/B12.
1099	14	353	1912	2142	1912 2142			-160.0	12	48.5	-173	0	0.000	8	SMF Mode 3/B12.
1100	14	354	1940	2130	1940 2130			-161.9	12	36.0	-175.5	0	0.000	8	SMF Mode 3/B12.
1101	14	355	1943	2326	1943	2047		-162.3	12	33.6	-176.5	2			SMF Mode 3/B12. At 2139, lost U bus. Generator TXR off. ANT to brake (TFR-132168). At 2152, U power up. At 2237, TCP interrupt. Reason unknown.
1107	14	361	1640	2116	1640 1931	1931* 2116		-162.5	12	23.6	-176	2	0.000	8	*Noncoherent.
1107	14	361	1640	2116	1640	1931		-162.2	12	25.6	-176	2	0.000	8	SMF Mode 3/B12. No recordings due to configuration for Apollo 8.

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Pass No.	DSS No.	Day of Year	Acq. Time	End of Track	Ground Mode Start/Stop Time 1-Way	2-Way	3-Way	Signal Strength Avg (dbm)	Configuration Loop BW (Hz)	Temp Pre/Post (°K)	Thres Pre/Post (dbm)	No. of Cmds	Average PER	Bit Rate	Comments
1138	14	026	2100	2352	2100 2206	2206* 2352		-163	12	22.2	-174	2	0.000	8	SMF Mode 1/B12. *Noncoherent mode of operation.

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Table 33 (contd)

Pass No.	DSS No.	Day of Year	Acq. Time	End of Track	Ground Mode Start/Stop Time 1-Way	2-Way	3-Way	Signal Strength Avg (dbm)	Configuration Loop BW (Hz)	Temp Pre/Post (°K)	Thres Pre/Post (dbm)	No. of Cmds	Average PER	Bit Rate	Comments
1145	14	033	1918	2223	1918 2047	2047* 2223		-163	12	49.9	-174	3	0.000	8	SMF/Mode 1/B12. *Spacecraft in two-way noncoherent mode.
1152	14	040	1924	2044	1924 2044			-164.2	12	22.6	-174	0	0.000	8	SMF/Mode 1/B12.
1159	14	047	1604	2048	1604 1753	1753 2048*		-162	12	49.2	-174	2	0.000	8	SMF/Mode 1/B12. Track voice not on magnetic tape due to communication patch not fully seated. *Noncoherent mode.

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Pass No.	DSS No.	Day of Year	Acq. Time	End of Track	Ground Mode Start/Stop Time 1-Way	2-Way	3-Way	Signal Strength Avg (dbm)	Configuration Loop BW (Hz)	Temp Pre/Post (°K)	Thres Pre/Post (dbm)	No. of Cmds	Average PER	Bit Rate	Comments
1177	14	065	1525	2157	1525 2157			-165	12	30.7	-173	0	0.500	8	SMF Mode 2/B12. Unable to acquire uplink - reason unknown.
1178	14	066	1520	2200	1520 1632	1632 2200*		-163.7	12	31.1	173	2	0.150	8	SMF Mode 2/B12. Low-film height on Pad 3 at 2025. *Noncoherent.
1179	14	067	1516	0200	1516 1639	1639 0200*		-164.8	12	21.8	-174	4	0.020	8	SMF Mode 1/B12. *Noncoherent.
1180	14	068	1516	0200	1516 1641	1641 0200*		-164.4	12	22	-175	2	0.000	8	SMF Mode 1/B12. *Noncoherent.
1181	14	069	1514	0100	1514 1632	1632 0100*		-164.3	12	22.6	-174	2	0.000	8	SMF Mode 1/B12. *Noncoherent.
1183	14	071	1554	2300	1554 1718	1718* 2300		-165	12	22.6	-173	2	0.000	8	SMF Mode 1/B12. Acquisition delayed due to missing cable connection between antenna and computer - approximately 40 minutes of tracking lost. *Noncoherent.
1184	14	072	1510	0100	1510 1642	1642* 1807 1807 0038 0038* 0100		-164.8	12	22.2	-175	6			SMF Mode 1/B12. *Noncoherent.
1186	14	074	1507	0100	1507 1728	1729* 0100		-164.5	12	22.1	-174	2	0.000	8	SMF Mode 1/B12. *Noncoherent.
1187	14	075	1517	0100	1517 1622	1622* 0100		-164.4	12	22.4	-174	2	0.000	8	SMF Mode 1/B12. *Noncoherent.
1188	14	076	1519	2300	1519 2010	2010* 2300		-164.3	12	22.4	-174	4	0.000	8	SMF Mode 1/B12. *Noncoherent.
1190	14	078	1504	2300	1504 1628 2204 2300	1628* 1729 1729 2204		-164.5	12	22.2	-175	7	0.000	8	SMF Mode 1/B12. *Noncoherent.

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Table 33 (contd)

Pass No.	DSS No.	Day of Year	Acq. Time	End of Track	Ground Mode Start/Stop Time 1-Way	2-Way	3-Way	Signal Strength Avg (dbm)	Configuration Loop BW (Hz)	Temp Pre/Post (°K)	Thres Pre/Post (dbm)	No. of Cmds	Average PER	Bit Rate	Comments
1191	14	079	1500	0100	1500 1621	1621* 1717 1717 0031 0031* 0100		-164.4	12	22.3	-174	10	0.000	8	SMF Mode 1/B12. *Noncoherent.
1193	14	081	1516	0100	1516 1638	1638* 1731 1731 0032 0032* 0100		-165.1	12	24.6	-174	8	0.450 0.000	16 8	SMF Mode 1/B12. *Noncoherent.
1194	14	082	1513	0100	1513 1635	1635* 1731 1731 0032 0032* 0100		-165	12	22.6	-174	9	0.000	16 8	SMF Mode 1/B12. *Noncoherent.
1195	14	083	1655	0100	1655 1845 2000 2103	2103* 2115 2115 0036 0036* 0100		-164.5	12	22.5	-174	8	0.000	8	SMF Mode 1/B12. At 1845, Pioneer VI tracking was stopped to transmit commands to Pioneer VIII. Pioneer VI tracking was resumed at 2000. *Noncoherent.
1198	14	086	1452	0100	1452 1614	1614* 1821 1821 0032 0032* 0100		-164.6	12	22.3	-174	8	0.040	8	SMF Mode 1/B12.
1200	14	088	1450	0100	1450 1606	1606* 1732 1732 0032 0032* 0100		-165.2	12	22.6	-174.2	8	0.000	8	SMF Mode 1/B12. *Noncoherent.

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Pass No.	DSS No.	Day of Year	Acq. Time	End of Track	Ground Mode Start/Stop Time 1-Way	2-Way	3-Way	Signal Strength Avg (dbm)	Configuration Loop BW (Hz)	Temp Pre/Post (°K)	Thres Pre/Post (dbm)	No. of Cmds	Average PER	Bit Rate	Comments
1201	14	089	1449	0100	1449 1614 1903 2034	1614* 1708 1708 1903 2034 0035 0035* 0100		-165.1	12	22.6	-174	8	0.000	16	SMF Mode 1/B12. *Noncoherent.
1202	14	090	1736	0100	1736 1905 0032 0100	1905* 1952 1952 0032		-165.1	12	22.5	-174	8	0.000	16	SMF Mode 1/B12. *Noncoherent.

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Table 33 (contd)

Pass No.	DSS No.	Day of Year	Acq. Time	End of Track	Ground Mode Start/Stop Time 1-Way	2-Way	3-Way	Signal Strength Avg (dbm)	Configuration Loop BW (Hz)	Temp Pre/Post (°K)	Thres Pre/Post (dbm)	No. of Cmds	Average PER	Bit Rate	Comments
1204	14	92	1449	2300	1449	1622* 1722 1722 2300		-165.1	12	22.7	-175	8	0.000 0.411	16* 16	SMF Mode 1/B12. * Noncoherent.
1205	14	93	1503	0100	1503 1655 2228 2250	1655* 1747 1747 2228 2250 0047* 0047 0100		-164.3	12	22.6	-175	8	0.038 0.600	8 16	SMF Mode 1/B12. FTS PC 141 jumped time causing APS failure. Reset PC 141 (TFR-13293).
1207	14	95	1505	0100	1505 1621	1621* 1702 1702 0032 0032* 1621		-164.5	12	22.6	-175	8	0.080 0.600	8 16	SMF Mode 1/B12. * Noncoherent. AT 0039, Rectifier Beam Interlock kicked XMTR off due to high voltage over-current. Reset Interlock.
1208	14	96	1501	0100	1501 1613	1613* 1702 1702 0032 0032* 0100		-164.5	12	22	-175	8	0.000 0.400	8 16	SMF Mode 1/B12. * Noncoherent.
1209	14	97	1540	0058	1540 1657	1657* 1757 1757 0032 0032* 0058		-165.2	12	22.8	-174	8	0.000 0.500	8 16	SMF Mode 1/B12. * Noncoherent.
1211	14	99	1527	2300	1527 1641	1641* 1732 1732 2242 2242* 2300		-164.9	12	23.2	-175	8	0.000	16	SMF Mode 1/B12. * Noncoherent.
1212	14	100	1526	0100	1526 1634	1634* 1747 1747 0032 0032* 0100		-165	12	22.8	-175	8	0.600 0.000	16 8	SMF Mode 1/B12. * Noncoherent.
1214	14	102	1519	0100	1519 1630	1630* 1803 1803 0032 0032* 0100		-164.3	12	25.47	-175	8	0.400	16	SMF Mode 3/B12. * Noncoherent.
1215	14	103	1519	0100	1519 1627 2047 2048	1627* 1757 1757 2047 2048 0032 0032* 0100		-164.4	12	25.05	-174	8	0.000 0.500	8 16	SMF Mode 3/B12. At 201430, XMTR off - reason unknown. * Noncoherent.
1217	14	105	1527	2300	1527 1642	1642* 1802 1802 2232 2232 2300		-164.9	12	25.9	-174	8	0.600	16	SMF Mode 3/B12. At 1528, Recorder "A" inoperative. Returned to operation at 1745. * Noncoherent.
1218	14	106	1519	2300	1519 1635	1635* 1747 1747 2248 2248* 2300		-164.7	12	27.19	-174	9	0.000 0.600	8 16	SMF Mode 3/B12. * Noncoherent.
1219	14	107	2113	0100	2113 2226	2226* 2337 2337 0032 0032* 0100		-164.5	12	28	-174	6	0.000	8	SMF Mode 3/B12. Acquisition 13 minutes late due to antenna emergency - iron stuck in front of rotating stairway. * Noncoherent.

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Table 33 (contd)

Pass No.	DSS No.	Day of Year	Acq. Time	End of Track	Ground Mode Start/Stop Time			Signal Strength Avg (dbm)	Configuration			No. of Cmds	Average PER	Bit Rate	Comments
					1-Way	2-Way	3-Way		Loop BW (Hz)	Temp Pre/Post (°K)	Thres Pre/Post (dbm)				
1221	14	109	1450	0100	1450 1615	1615* 1714 1714 0033 0033* 0100		-164.3	12	27.5	-174	9	0.500	16	SMF Mode 3/B12. XMTR tripped off at 1923. * Noncoherent.
1222	14	110	1445	0100	1445 1602	1602* 1652 1652 0033 0033* 0100		-164.5	12	26.5	-175	8	0.450	16	SMF Mode 3/B12. * Noncoherent.
1223	14	111	1455	0100	1455 1603	1603* 1657 1657 0033 0033* 0100		-164.3	12	27.1	-174	8	0.075 0.750	8 16	SMF Mode 3/B12. * Noncoherent.
1224	14	112	1925	2300	1925 2026	2026* 2142 2142 2247 2247* 2300		-163.8	12	28.02	-174	6	0.000	8	SMF Mode 3/B12. * Noncoherent.
1225	14	113	1447	2100	1447 1545	1545* 1702 1702 2053 2053* 2100		-164.2	12	26.2	-175	10	0.000 0.500	8 16	SMF Mode 3/B12. * Noncoherent.
1226	14	114	1449	0100	1449 1610	1610* 1717 1717 0032 0032* 0100		-164.7	12	26.7	-175	10	0.200	8	SMF Mode 3/B12. * Noncoherent.

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Pass No.	DSS No.	Day of Year	Acq. Time	End of Track	Ground Mode Start/Stop Time			Signal Strength Avg (dbm)	Configuration			No. of Cmds	Average PER	Bit Rate	Comments
					1-Way	2-Way	3-Way		Loop BW (Hz)	Temp Pre/Post (°K)	Thres Pre/Post (dbm)				
1228	14	116	1452	0100	1452 1603 2353 0014	1603* 1702 1702 2353 0014 0052 0052* 0100		-164.7	12	22.5	-175	10	0.200	16	SMF Mode 1/B12. At 2320, antenna to brake mode - dirt on transducer probe. * Noncoherent.
1229	14	117	1513	0100	1513 1928	1928* 0100		-165	12	22.7	-175	11	0.000 0.150	8 16	* Noncoherent. At 1515, lost all 400 cycle motor generator - went to one-motor generator set and 10 kw operation on XMTR. At 0029, XMTR off due to 400 cycle circuit braker opening. Back on XMTR at 0040.
1231	14	119	1434	2155	1434 1546	1546* 1648 1648 2155		-165	12	23.2	-174	5	0.040	8	SMF Mode 1/B12. * Noncoherent.
1232	14	120	1418	2200	1418 1518	1518 2200		-165	12	23.4	-174	7	0.300	16	SMF Mode 1/B12.

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Table 33 (contd)

Pass No.	DSS No.	Day of Year	Acq. Time	End of Track	Ground Mode Start/Stop Time 1-Way	2-Way	3-Way	Signal Strength Avg (dbm)	Configuration Loop BW (Hz)	Temp Pre/Post (°K)	Thres Pre/Post (dbm)	No. of Cmds	Average PER	Bit Rate	Comments
1233	14	121	1457	2155	1457 1602	1602 2155		-163.9	12	23.3	-175	8	0.300	16	SMF Mode 1/B12.
1235	14	123	1449	0040	1449 1556	1556 0040		-164.7	12	23	-175	7	0.300	16	SMF Mode 1/B12.
1237	14	125	1415	2025	1415 1519	1519 2025		-165.1	12	24.8	-175	6	0.000	8	SMF Mode 1/B12.
1238	14	126	1509	2055	1509 1630	1630 2055		-164.6	12	27.7	-174	4	0.350	16	SMF Mode 1/B12.
1239	14	127	1520	1600	1520 1600			-164.2	12	23.4	-175		0.250	16	SMF Mode 1/B12.
1240	14	128	1447	2054	1447 1632	1632 2054		-164.5	12	23	-175	4	0.300	16	SMF Mode 1/B12.
1241	14	129	2205	0100	2205 2327 0021 0100	2327 0021		-164.4	12	23.8	-175	3	0.058	16	SMF Mode 1/B12. At 2349 XMTR off. Cause unknown. At 2350 XMTR on at 20kw.
1242	14	130	2117	0100	2117 2230	2230 0100		-164.3	12	24	-175	2	0.274	16	SMF Mode 1/B12.
1243	14	131	2321	0256	2321 0036	0036 0256		-165.1	12	23.6	-176	4	0.880	16	SMF Mode 1/B12.
1244	14	132	2012	2329	2012 2104	2104 2329		-164.9	12	24.1	-175	5	0.350	16	SMF Mode 1/B12.
1246	14	134	1450	1900	1450 1604	1604 1900		-165	12	22.9	-176	8	0.800	16	SMF Mode 1/B12.
1247	14	135	1511	1900	1511 1610	1610 1900		-164.4	12	23.6	-174	5	0.200	16	SMF Mode 1/B12.
1249	14	137	1945	0000	1945 2050	2050 0000		-164	12	23.8	-175	5	0.333	16	SMF Mode 1/B12. Transmitter off at 2203, high voltage ac - overload tripped.
1259	14	147	1611	1928	1611 1711	1711 1928		-164.2	12	23.1	-174	5	0.250	16	SMF Mode 1/B12.

Pass No.	DSS No.	Day of Year	Acq. Time	End of Track	Ground Mode Start/Stop Time 1-Way	2-Way	3-Way	Signal Strength Avg (dbm)	Configuration Loop BW (Hz)	Temp Pre/Post (°K)	Thres Pre/Post (dbm)	No. of Cmds	Average PER	Bit Rate	Comments
1260	14	148	1410	1900	1410 1539	1539 1900		-164.6	12	22.4	-175	5	0.250	16	SMF Mode 1/B12.
1262	14	150	2110	0059	2110 2221	2221 0059		-164.1	12	23.8	-174	4	0.300	16	SMF Mode 1/B12.
1263	14	151	1608	1930	1608 1704	1704 1930		-162.7	12	24.3	-174	7	0.200	16	SMF Mode 1/B12.

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Table 33 (contd)

Pass No.	DSS No.	Day of Year	Acq Time	End of Track	Ground Mode Start/Stop Time			Avg Signal Str dbm	Configuration			No. of Cmds	Error Rate	Bit Rate	Comments
					1-Way	2-Way	3-Way		Configuration Code	System Temp °K	Receiver Thresh (dbm)				
1265	14	153	1500	2000	1500 1557	1557 2000		-163.9	SMF Mode 1/B12	23.2	-174	7	0.300	16	
1267	14	155	1453	1900	1453 1547	1547 1900		-163.8	SMF Mode 1/B12	23.2	-175	7	0.350	16	
1268	14	156	1435	1900	1435 1526	1526 1900		-163.0	SMF Mode 1/B12	23.3	-175	8	0.350	16	
1269	14	157	1411	1900	1411 1511	1511 1900		-164.4	SMF Mode 1/B12	23.6	-175	5	0.200	16	
1270	14	158	1412	1900	1412 1511	1511 1900		-164.5	SMF Mode 1/B12	22.8	-174	7	0.300	16	
1275	14	163	1275	0100	1914 2006 2250 2318	2006 2250 2318 0100		-165.0	SMF Mode 1/B12	23.4	-175	7	0.250	16	At 2217, the antenna went to brake mode due to low film height (TFR-136158). Antenna back on point at 2224.
1277	14	165	1643	2247	1643 1747 1929 2020	1747 1929 2020 2247		-164.7	SMF Mode 1/B12	22.8	-175	8	0.150	16	At 1856, antenna went to brake mode. Pedestal emergency occurred when stop button was inadvertently engaged. At 2128, TCP was out of lock - spurious interrupt, cause unknown. TCP reloaded and back in lock at 2138.
1279	14	167	1609	2200	1609 1708	1708 2200		-164.4	SMF Mode 1/B12	23.4	-175	8	0.600	16	
1285	14	173	1615	2230	1615 1723	1723 2230		-166.0	P1/D1/B12	22.8	-174	6	0.400	8	High noise in last two hours of track. A 3-db drop in signal leve was indicated - reason unknown.
1287	14	175	1606	2101	1606 1816 1827 1834 1850 1904	1816 1827 1834 1850 1904 2101		-162.4	P1/D1/B12	24.2	-173	4	0.000	16	
1288	14	176	1506	1801	1506 1604	1604 1801		-165.6	P1/D0/B12 P1/D1/B12			1	BAD	8/ 16	
1292	14	180	1644	2230	1644 1741	1741 223[illegible]		-165.0	P0/D1/B12	N/A	N/A	19	0.000	8	

In general, the parity error rate was 0.000. However, DSS 14 was required to perform boresights during most passes. The parity error rate increased on passes on which boresights were performed.

The telemetry bit rate mode was at 8 and 16 bits/s during the second quarter. The rate for passes 1053 through 1058 was bad because the spacecraft was approaching solar occultation. During January, February, and March 1969, the parity error rate was 0.000 at 8 bits/s and 0.250 at 16 bits/s. The rate was below the threshold for good telemetry at 8 bits/s during April. However, for 16 and 64 bits/s, the rate was above the good telemetry threshold. During May, the parity error rate exceeded the threshold for all good telemetry at 8 bits/s except on pass 1237. The rate for 16 and 64 bits/s was also above 0.116. During June, the parity error rate exceeded the threshold for good telemetry in all cases except on pass 1287 at a bit rate of 16 bits/s.

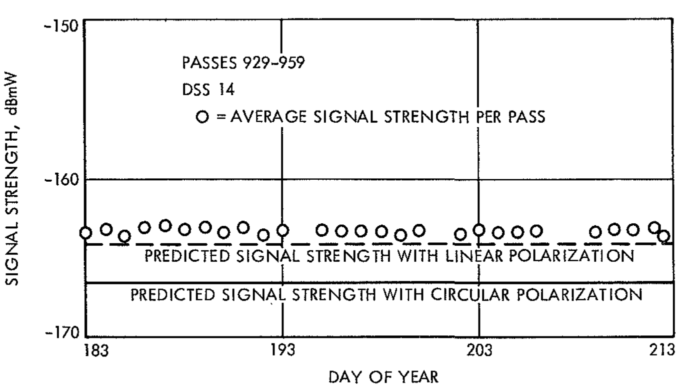

Fig. 72. Downlink signal strength vs day of year (July 1968)

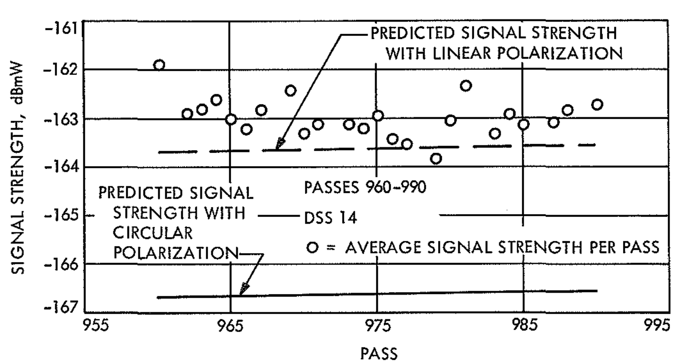

Fig. 73. Downlink signal strength vs pass number (August 1968)

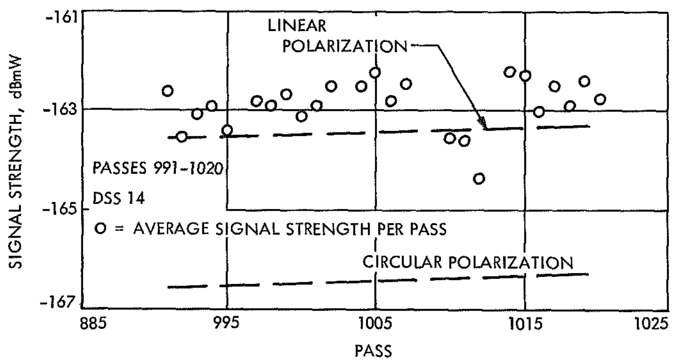

Fig. 74. Downlink signal strength vs pass number (September 1968)

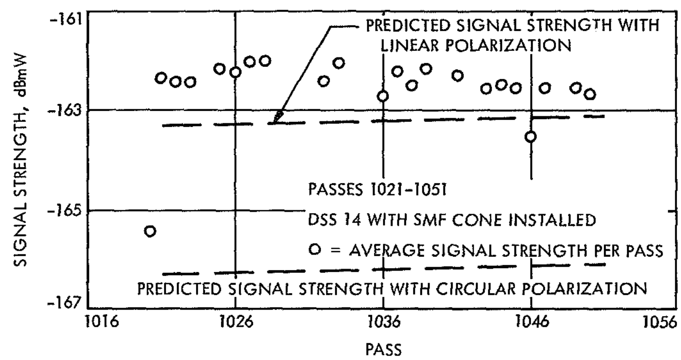

Fig. 75. Downlink signal strength vs pass number (October 1968)

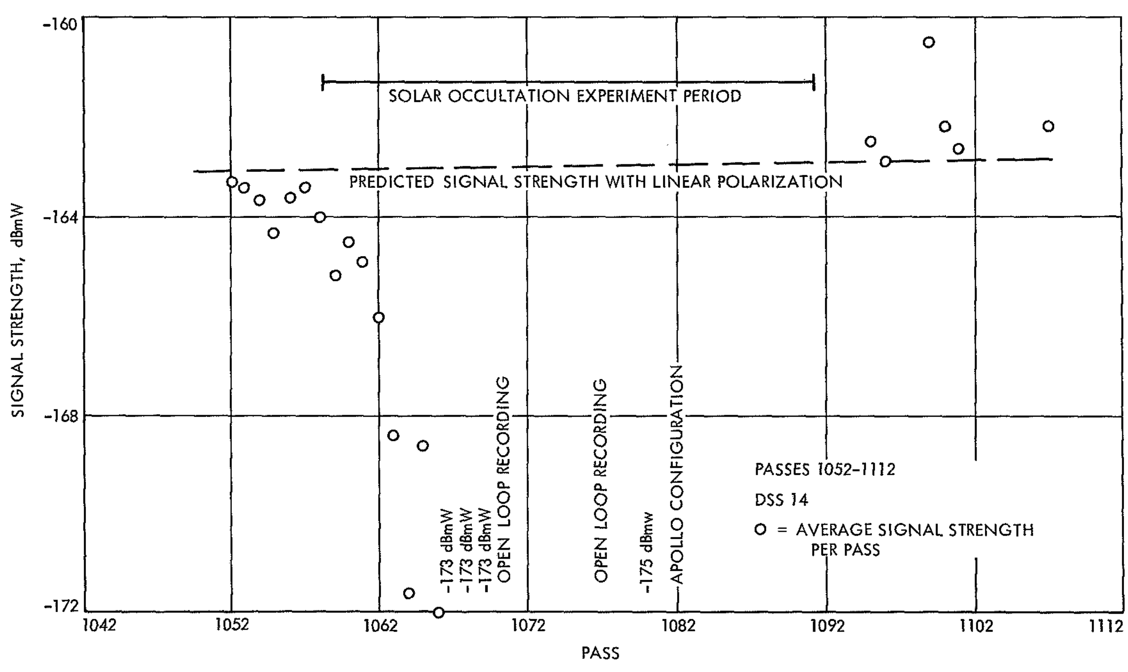

Fig. 76. Downlink signal strength vs pass number (November and December 1968)

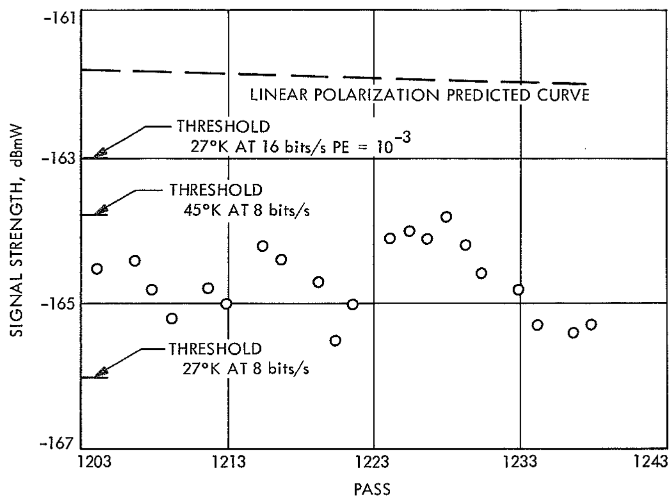

Fig. 77. Downlink signal strength vs pass number (April 1969)

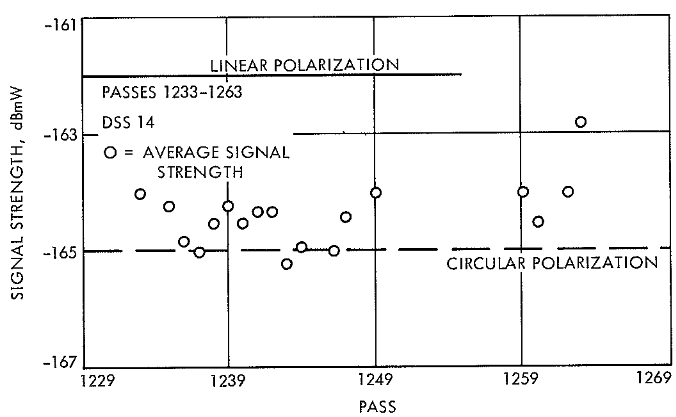

Fig. 78. Downlink signal strength vs pass number (May 1969)

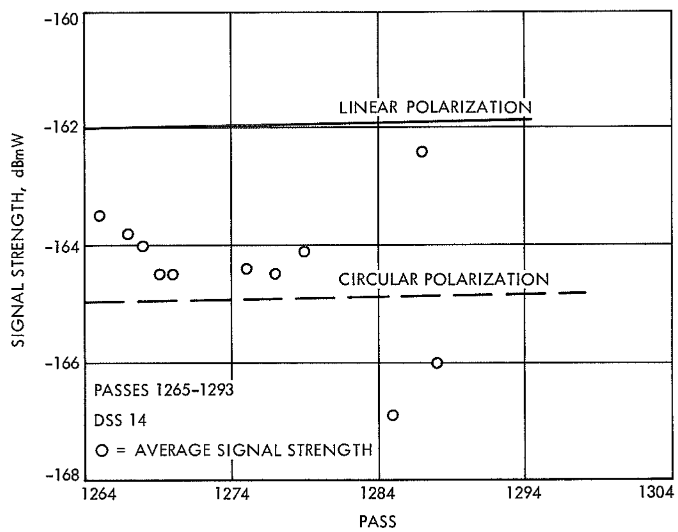

Fig. 79. Downlink signal strength vs pass number (June 1969)

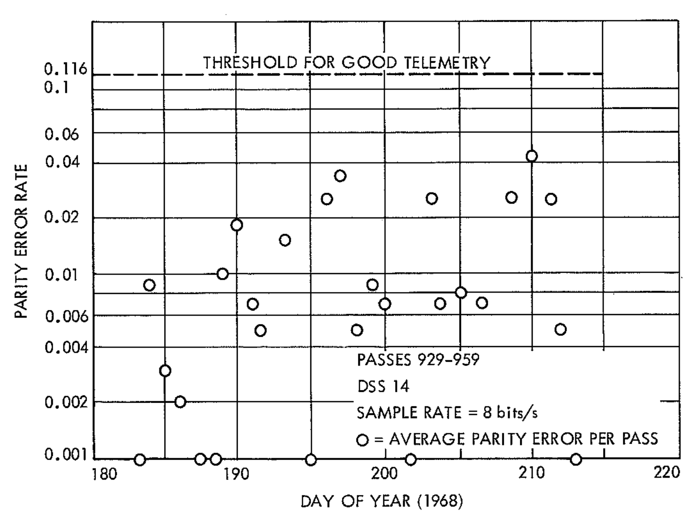

Fig. 80. Parity error rate vs day of year (July 1968)

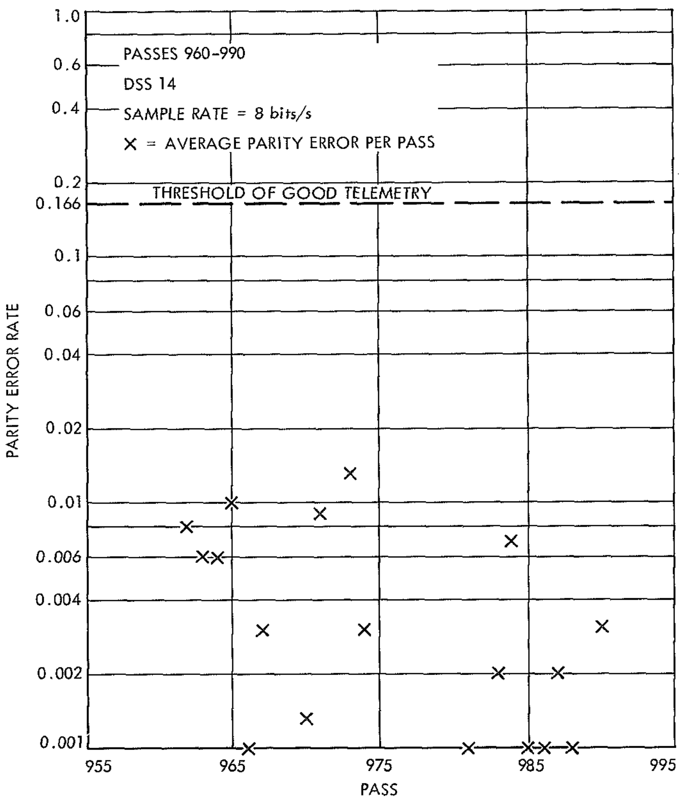

Fig. 81. Parity error rate vs pass number (August 1968)

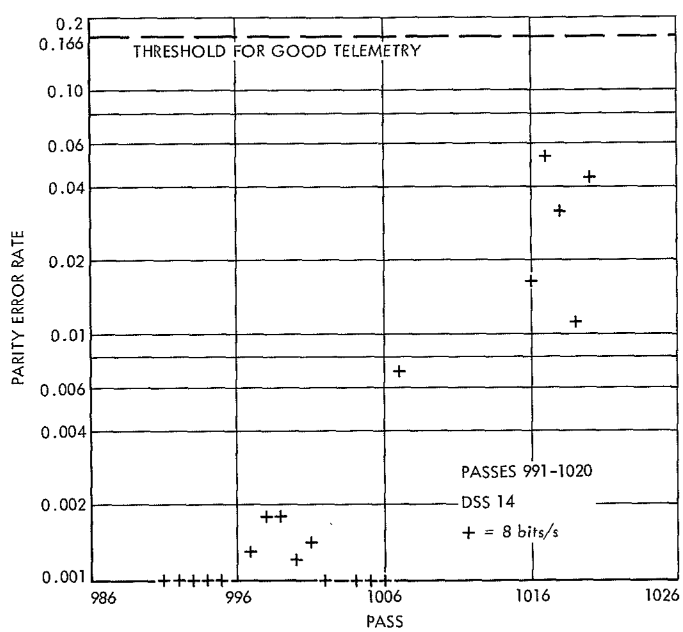

Fig. 82. Parity error rate vs pass number (September 1968)

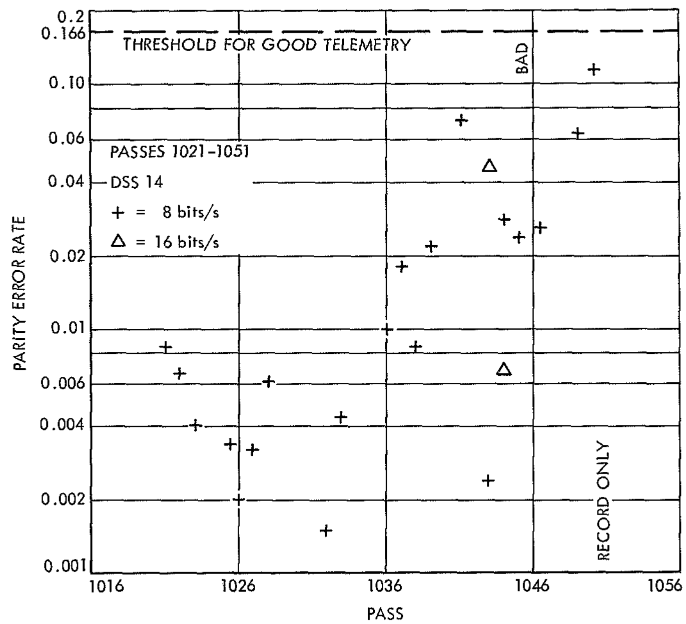

Fig. 83. Parity error rate vs pass number (October 1968)

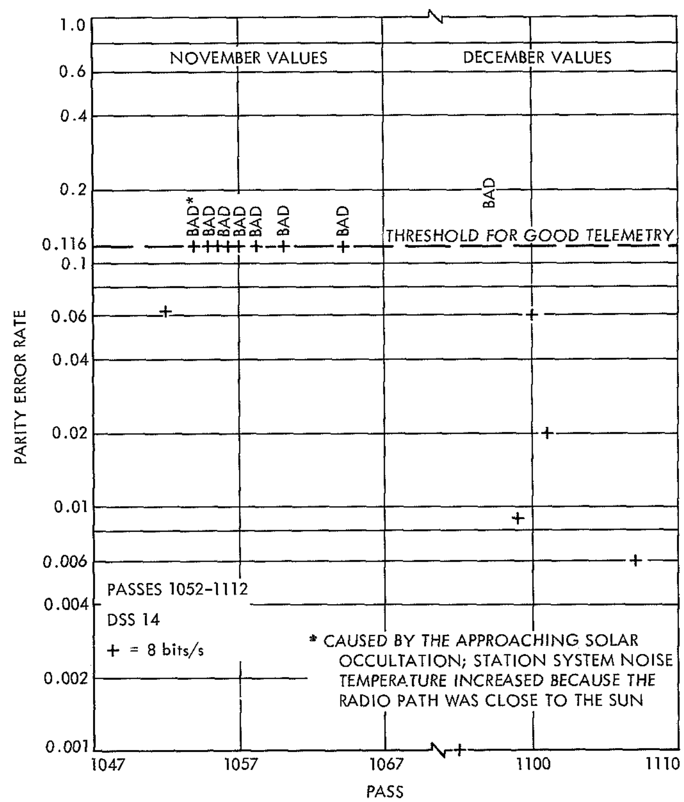

Fig. 84. Parity error rate vs pass number (November and December 1968)

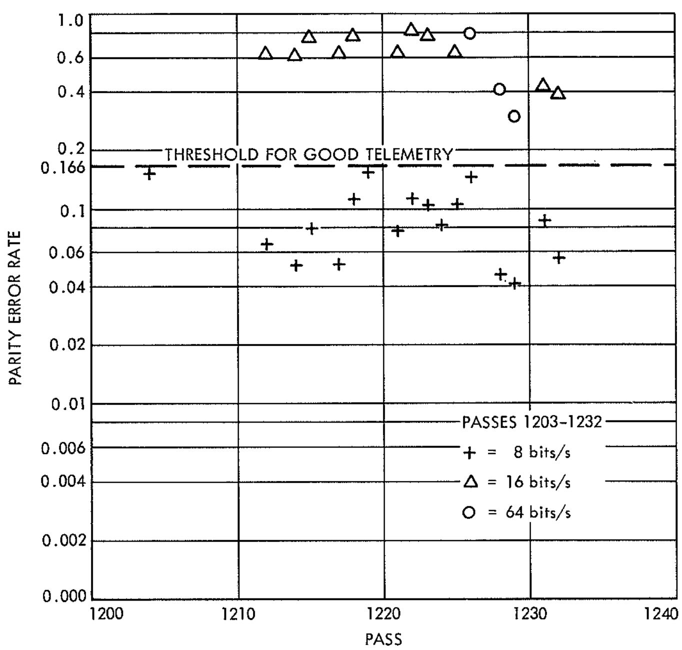

Fig. 85. Parity error rate vs pass number (April 1969)

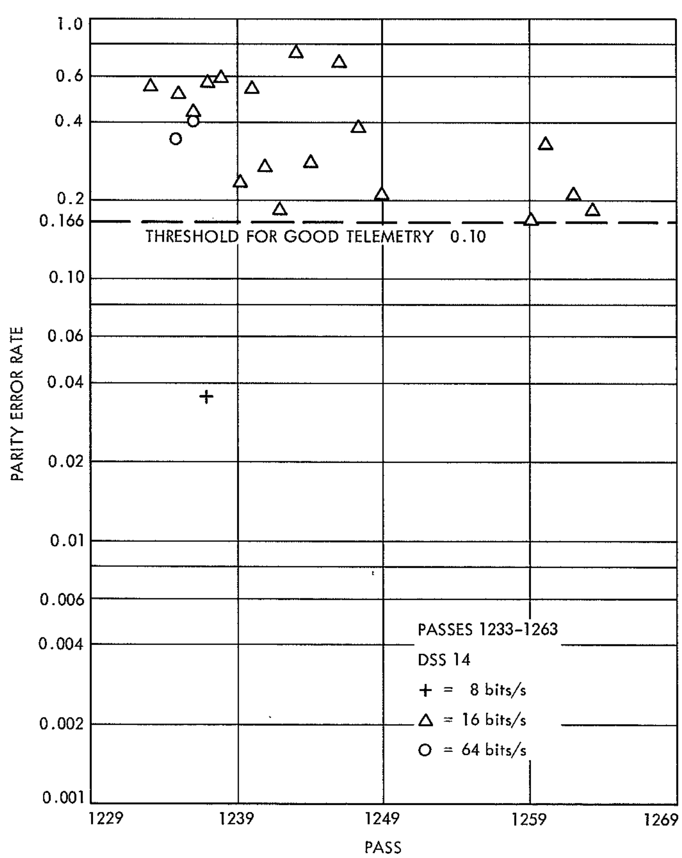

Fig. 86. Parity error rate vs pass number (May 1969)

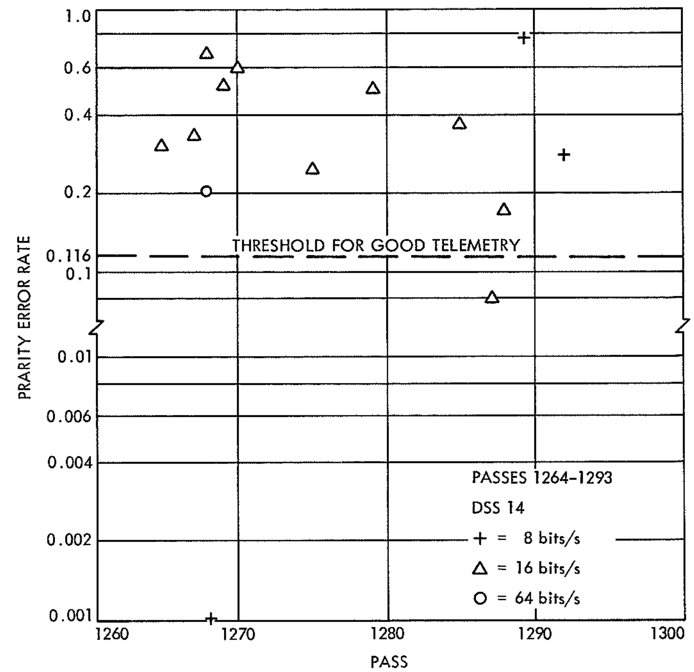

Fig. 87. Parity error rate vs pass number (June 1969)

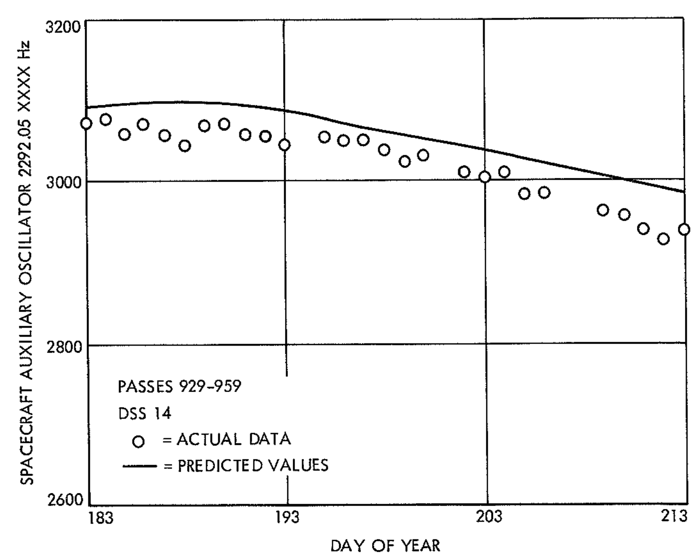

Fig. 88. Auxiliary oscillator frequency vs day of year (July 1968)

G. Predicted Frequency Performance

Plots of the measured auxiliary oscillator frequency are illustrated in Figs. 88–97 for the purpose of evaluating predictions. These plots are updated from one reporting period to another. When expected predictions differ substantially from actual values, a new predicted curve based upon the latest actual values received is illustrated. When the spacecraft was tracked in the two-way noncoherent mode, the plot only represents an estimation. At 8 bits/s, the telemetry data was recycling every 28 min. By monitoring the subcommutator identification (SCID) frames 10, 23, and 24, and word 19 for receiver-lock indication, the maximum error for receiver-lock time could be resolved down to 11 min 24 s. With the station tuning at 3 Hz, the receiver-lock time would be a maximum frequency error of 34 Hz.

No acquisitions were made on channel 6 during July, August, and September, and no acquisitions were made on channel 7 during November and December. Best-lock frequency vs pass number is presented in Figs. 98–105.

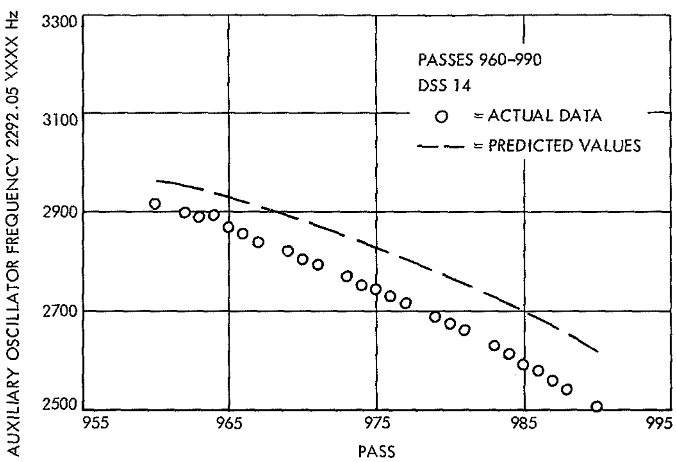

Fig. 89. Auxiliary oscillator frequency vs pass number (August 1968)

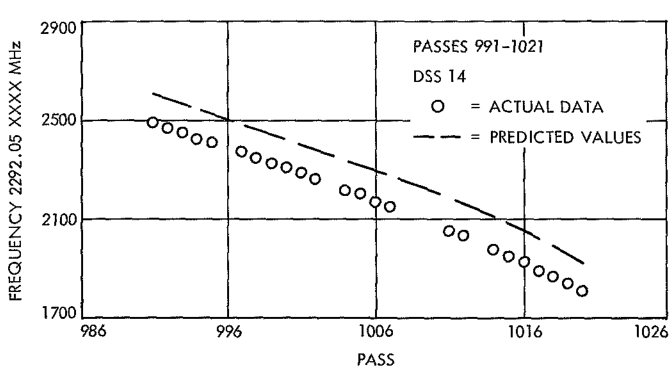

Fig. 90. Auxiliary oscillator frequency vs pass number (September 1968)

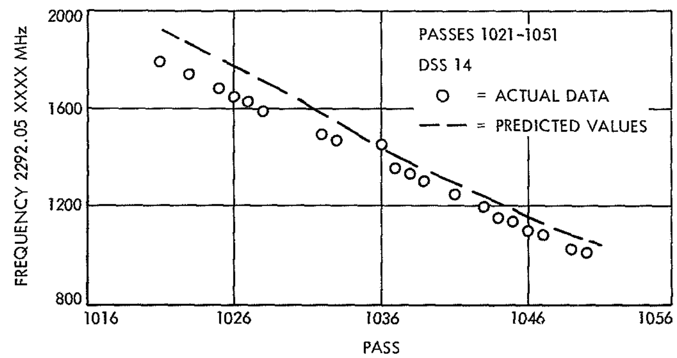

Fig. 91. Auxiliary oscillator frequency vs pass number (October 1968)

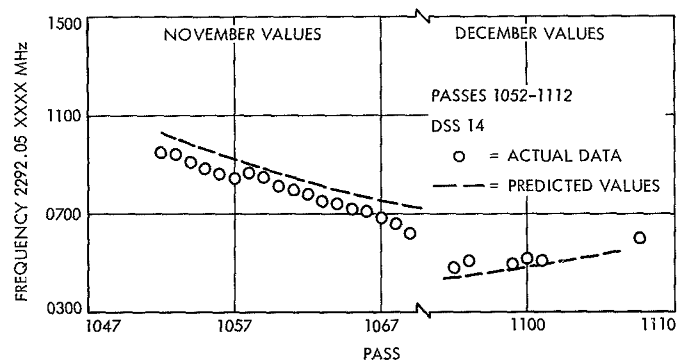

Fig. 92. Auxiliary oscillator frequency vs pass number (November and December 1968)

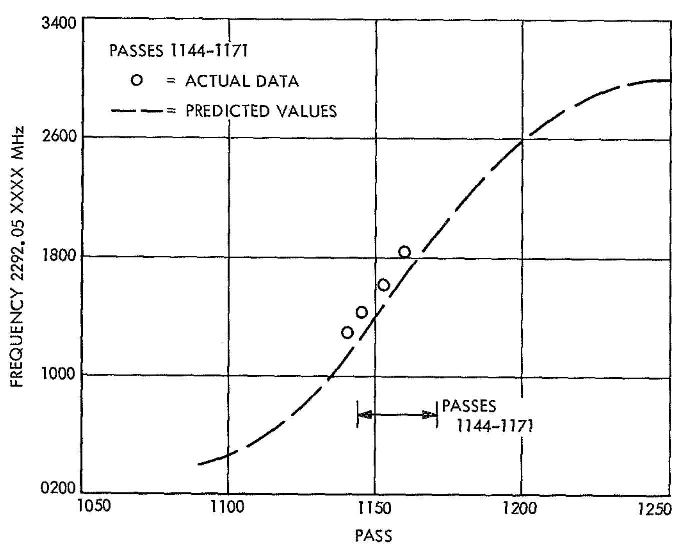

Fig. 93. Auxiliary oscillator frequency vs pass number (February 1969)

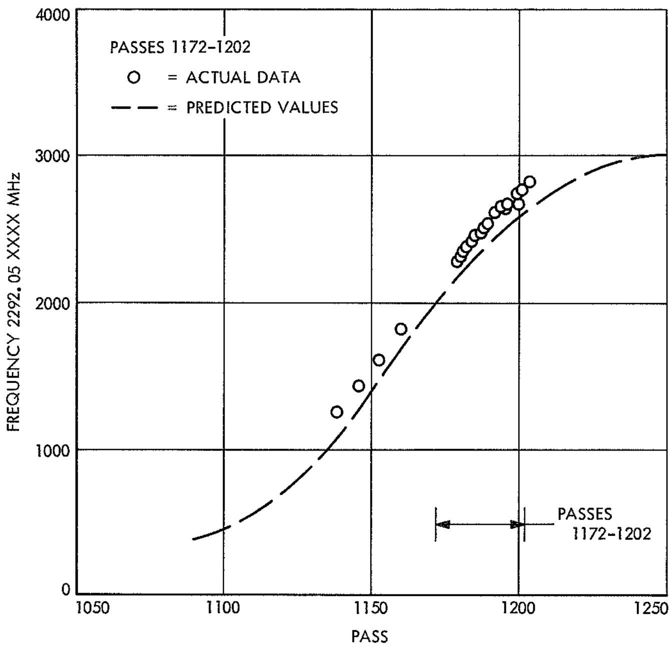

Fig. 94. Auxiliary oscillator frequency vs pass number (March 1969)

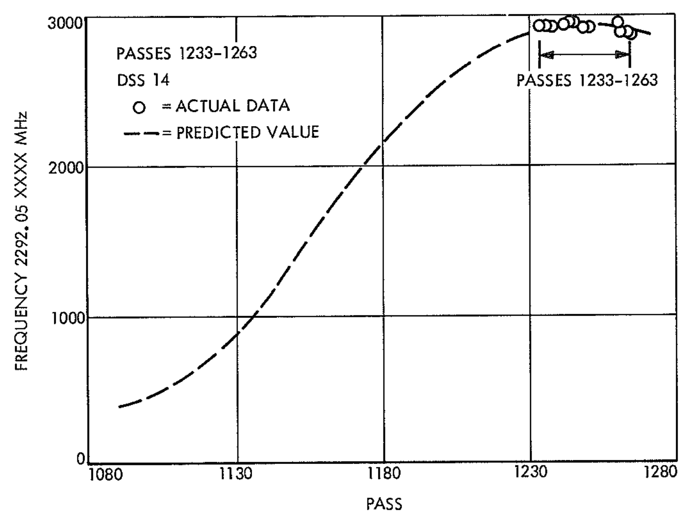

Fig. 96. Auxiliary oscillator frequency vs pass number (May 1969)

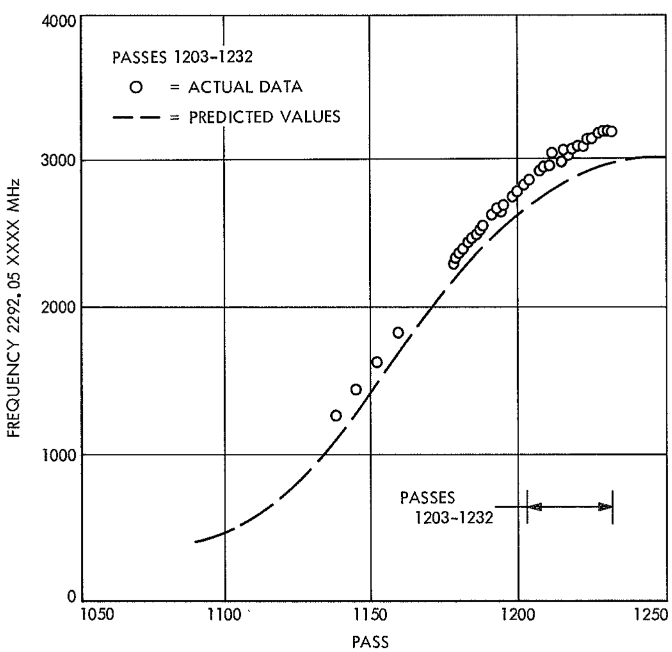

Fig. 95. Auxiliary oscillator frequency vs pass number (April 1969)

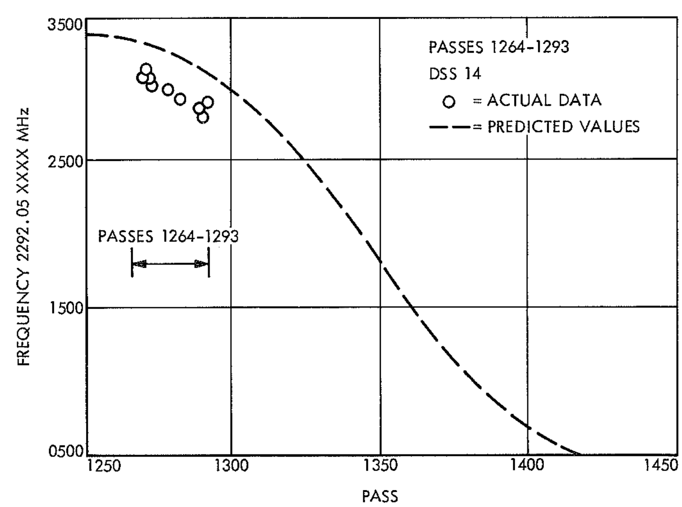

Fig. 97. Auxiliary oscillator frequency vs pass number (June 1969)

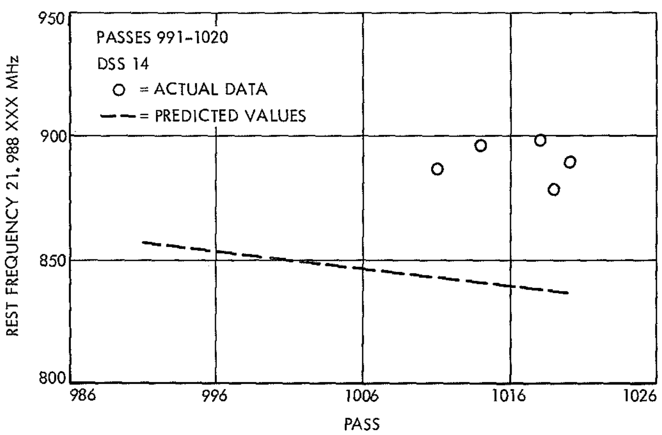

Fig. 98. Best-lock frequency vs pass number (channel 7, receiver 2, September 1968)

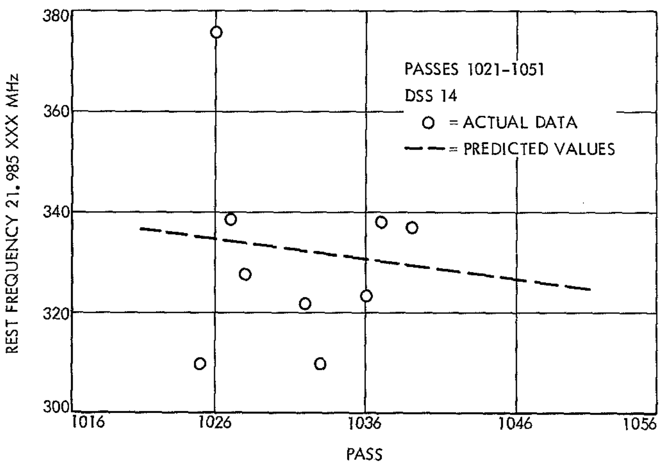

Fig. 99. Best-lock frequency vs pass number (channel 6, October 1968)

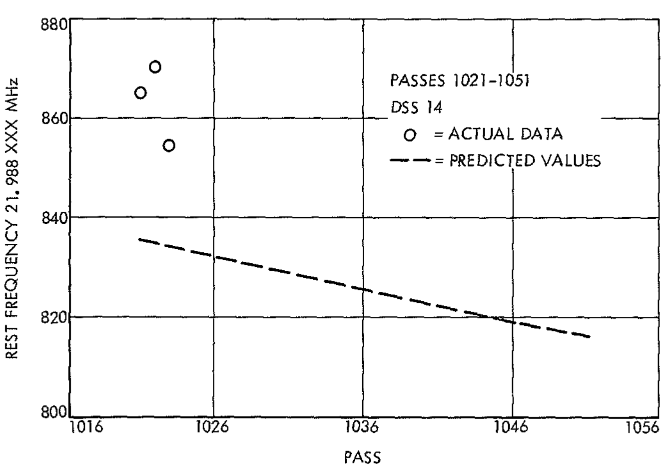

Fig. 100. Best-lock frequency vs pass number (channel 7, October 1968)

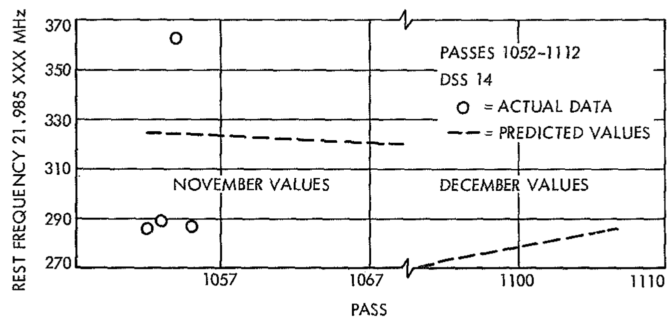

Fig. 101. Best-lock frequency vs pass number (channel 6, November and December 1968)

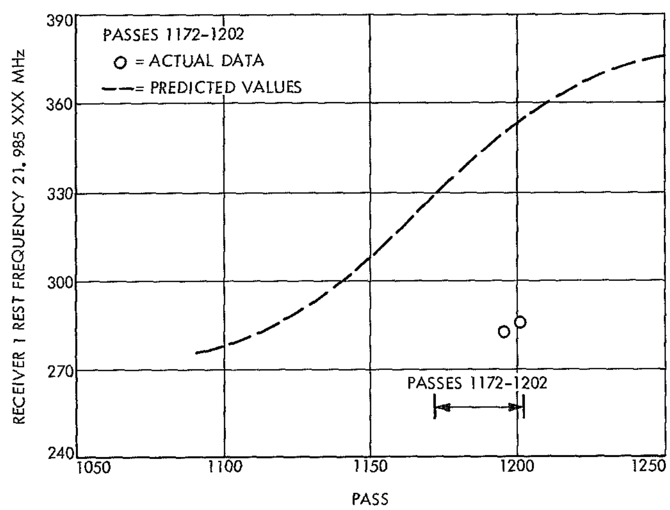

Fig. 102. Best-lock frequency vs pass number (channel 6, March 1969)

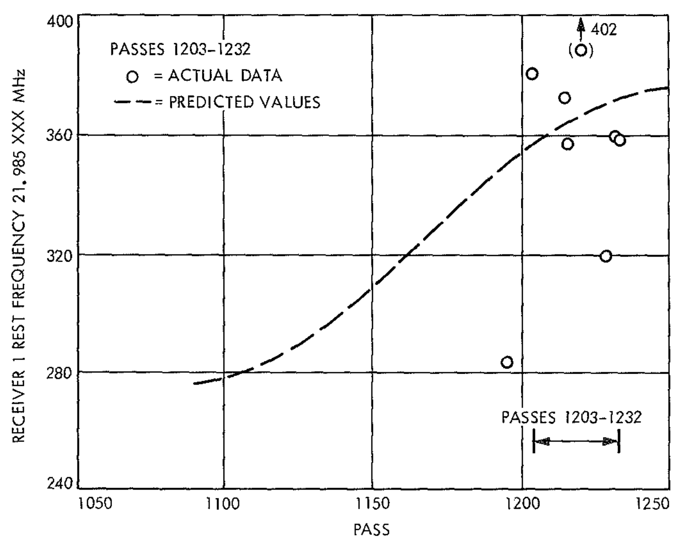

Fig. 103. Channel 6 best-lock frequency vs pass number (April 1969)

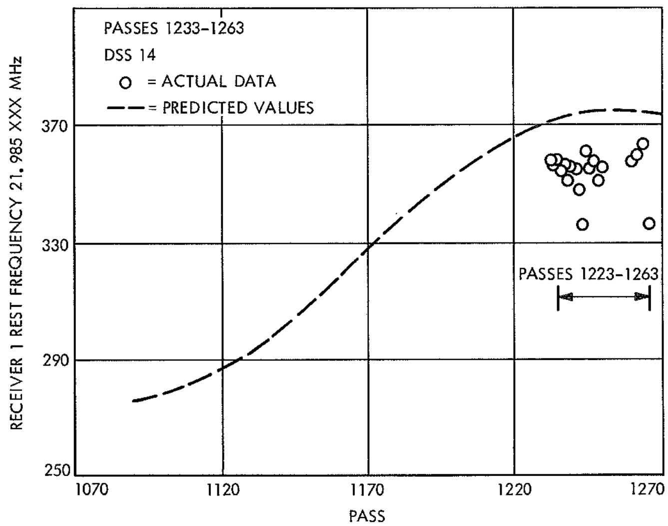

Fig. 104. Channel 6 best-lock frequency vs pass number (May 1969)

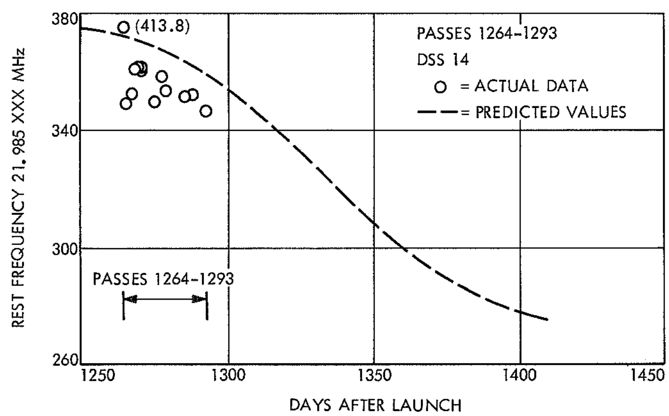

Fig. 105. Channel 6 best-lock frequency vs pass number (June 1969)

H. Predicts and Commands

Predicts generated for *Pioneer VI* to July 1, 1969, are presented in Table 34. During April, analysis indicated a bad orbit solution was being used to generate predicts. The orbit error varied from 200 Hz off at the start of the report period to 300 Hz off at the end of the period. The predicts were bad because of a lack of data points to help extend the orbit. It was decided to return to the original orbit conditions (Table 34, runs 90M and 90N).

The cumulative total of commands transmitted to *Pioneer VI* at the end of June 1969 was 6017. A total of 698 commands were transmitted during this reporting period. Transmission of commands to the spacecraft was resumed during September 1968 for the first time since the end of March 1968. The problems that caused the cessation of command transmittal were reported in the previous annual report document. Commands by pass and day for this reporting period are reported in Table 33. Command anomalies are reported in the pass chronology.

Table 34. Prediction summary

Predict No.[a]	Auxiliary oscillator frequency or driver frequency, MHz	Ground transmitter synthesizer frequency for best lock at zero doppler, MHz	Coverage	Sample rate, s
80A	2292.053000	21.98536500	6/1–8/1/68	900
80B	2292.053000	21.98886500	6/1–8/1/68	900
81A	2292.052900	21.9853500	8/1–9/1/68	900
81B	2292.05	21.98	8/1–9/1/68	900
82A	2292.052200	21.985345	9/1–10/1/68	900
82B	2292.05220	21.988845	9/1–10/1/68	900
83A	2292.051360	12.985330	10/1–11/1/68	900
83B	2292.051360	21.988828	10/1–11/1/68	900
84A	2292.050510	21.985290	11/1–12/1/68	900
84B	2292.050510	21.988830	11/1–12/1/68	900
85A	2292.050400	21.985295	12/1/68–01/1/69	900
85B	2292.050400	21.988820	12/1/68–01/1/69	900
86A	2292.050410	21.985345	01/1–2/1/69	900
86B	2292.050410	21.988790	01/1–2/1/69	900
87A	2292.051650	21.985315	2/1–3/1/69	600
87B	2292.051650	21.988902	2/1–3/1/69	600
88A	2292.052300	21.985340	3/1–4/1/69	600
88B	2292.052300	21.988920	3/1–4/1/69	600
VP5	2292.053000	21.988940	7/1–7/1/70	1800
89A	2292.053000	21.985370	4/1–5/1/69	600
89B	2292.053000	21.988940	4/1–5/1/69	600
90A	2292.053000	21.985350	5/1–6/1/69	600
90B	2292.053000	21.988890	5/1–6/1/69	600
90M	2292.053000	21.985350	5/10–6/1/69	600
90N	2292.053000	21.988890	5/10–6/1/69	600
91A	2292.053000	21.98	6/1–7/1/69	600
91B	2292.053000	21.988950	6/1–7/1/69	600

[a]A = channel 6; B = channel 7; VP = view period; M = channel 6 special run; N = channel 7 special run.

I. Pass Chronology

Tracking periods covered are identified by pass number, which is the number of times since launch that the spacecraft has been above the horizon of a particular station. Unless otherwise noted, the following entries refer to DSS 14.

Pass 931. Because the engineering support group was working on a low spot in the hydrostatic bearing, there was a short delay in spacecraft acquisition.

Pass 938. A communications patching problem developed at DSS 14 that caused the telemetry command processor science data and tracking data handling subsystem teletype data to be garbled. The normal flow of data was resumed after a 13-min delay.

Pass 941. Station computer stopped tracking three times because of commercial power transients.

Pass 957. All ground communications were lost between DSS 14 and the SFOF for nearly 2 h because the building contractor at the station inadvertently cut the main cable linking DSS 14 with the Goldstone Communication Center. Tracking was completed in the record-only mode.

Pass 973. Magnetic tapes IA and IB failed to record the receiver in-lock indication during the first half of the pass because of a damaged patch board. The problem was corrected by reseating the associated patch cord.

Pass 983. The demodulator was 17 min late in locking up because a normally unused source switch was left in the tape position.

Pass 979. Engineering data was invalid at 1331. The TCP program was reloaded at 1338. A spurious interrupt dumped the program, and reloading was necessary. At 1410, engineering telemetry data sheets indicated that values were out of limit; the program was reloaded.

Pass 998. A hydrostatic bearing pad recess flow valve failure caused the antenna to go to brake mode. Repair of the valve relieved the brake mode condition.

Pass 1000. TDH data condition code problems were experienced from 1707 to 1754. One-way doppler button was in *off* position.

Pass 1001. A second autocollimator was being installed at DSS 14; therefore, the angle data for pass 1001 was invalid. Installation of the autocollimator was completed on pass 1002.

Pass 1002. Downlink signal strength became degraded on both receivers. To resolve the problem maser 1 was replaced by maser 2.

Pass 1005. Because of incorrect printout of battery current and temperature, 1 min 45 s of data was lost. The TCP was reloaded.

Pass 1007. Spacecraft acquisition was accomplished in the two-way noncoherent mode on channel 7. All commands transmitted were successfully received by *Pioneer VI.* Subsequent acquisitions were made on channel 7.

Passes 1011 and 1012. The antenna went to brake mode because of low oil film height on pad 3; close examination revealed dirt in the area from 127 to 140 deg. This problem was resolved during regularly scheduled maintenance periods later in the year. At 1515 on pass 1011, command 101 stopped on the 19th bit; the command was retransmitted at 1517.

Pass 1014. At 1746, the receiver glitched in and out of lock, causing TCP to lose word frame sync.

Pass 1022. Tuning required 42 min (a TDH problem); 12 min of metric data was missing. Twenty-six bad data condition code points, other than tuning, were counted.

Pass 1023. Tuning took 43 min. Ten bad data condition code points, other than tuning, were counted.

Pass 1027. Servo-hydraulics pump was lost at 1558:15 due to operator error. At 1558:38, the receiver and TCP were out of lock; they were back in lock at 1604.

Pass 1028. Tuning took 48 min. At 2313, transmitter was off due to a broken coolant hose at elevation bearing. One bad data condition code point, other than tuning, was counted.

Pass 1032. Tuning took 46 min. At 1435, there was no telemetry output from receiver 1 because of loose connector; receiver 2 was switched on until return to receiver 1 at 1544. Transmitter failed because of high-voltage ac overcurrent at 1530:30. Transmitter turned on at 1532.

Pass 1033. Power glitch caused the TCP to lose program at 1715; TCP was reloaded and in lock at 1721.

Pass 1032. Tuning took 46 min. At 1435, no telemetry output was received from receiver 1 due to loose connector; switched to receiver 2. Receiver 1 was switched on at 1544. At 1530:30, the transmitter failed due to high-voltage ac overcurrent. Transmitter was turned on at 1532.

Pass 1036. Tuning took 46 min. Nine bad data condition code points, other than tuning, and 2 garbled points were counted.

Pass 1037. Tuning took 45 min. Four bad data condition code points, other than tuning, were counted.

Pass 1043. Tuning took 64 min. Ninety-three bad data condition code points, other than tuning, and 2 garbled points were counted. At 1448 and 2028:25, the transmitter failed, accounting for some of the bad data time. Twelve min of data at 1-s sample rate helped raise the good data percentage.

Pass 1044. Tuning took 38 min. Eighty-two bad data condition code points, other than tuning, and 1 garbled point were counted. The cause of the high number of bad data condition code points was not determined.

Pass 1045. Tuning took 30 min. Ninety-two bad data condition code points, other than tuning, were counted.

Pass 1046. Tuning took 37 min. Other than tuning, there were 127 bad data condition code points counted.

Pass 1047. The receiver was out of lock at 1630. The polarizer spun out of control, causing loss of uplink. As a result commands 101 at 1645 and 061 at 1700 apparently did not reach the spacecraft. Tuning took 75 min. This was a two-way coherent pass. Other than tuning, there were 399 bad data condition code points counted.

Pass 1049. Tuning took 71 min. This was a two-way coherent pass. Other than tuning, there were 282 bad data condition code points counted. The receiver glitched badly throughout the pass.

Pass 1050. Tuning took 45 min. This was a two-way coherent pass. A total of 3 h 13 min of track was taken at a 10-s sample rate. Other than tuning, there were 354 bad data condition code points counted.

Pass 1052. DSS 12 GOE failed to transmit command 101.

Pass 1177. Station tuned 101 min in attempts to gain two-way lock, having used an incorrect frequency in an attempt to acquire the spacecraft in two-way mode. The antenna went to brake because of low film height on Pad 3. Two min 33 s of telemetry data was lost.

Pass 1178. The station had a utility power surge and lost binary-coded decimal time. It was suspected the high noise was a result of a timing error caused by the power surge. The antenna went to brake and the receiver dropped lock because of low film height at 2025:56. One min 20 s of data was lost.

Pass 1181. The station tracked in a two-way noncoherent mode. No anomaly was found as a cause of high noise present throughout this pass. The received signal strength was 9.4 dB above threshold; the receiver was believed dropping cycles.

Pass 1188. At 1611:27, the station switched to SMF mode 2 and attempted to acquire the spacecraft on channel 6. Three h 5 min was lost in this unsuccessful attempt. Channel 7 was acquired at 2010:20 and was noisy.

Pass 1201. The station had numerous blunder points and receiver out-of-lock indications. Received signal strength was 9 dB above receiver threshold. The station was suspected to have an equipment malfunction. Equipment which caused the high noise and blunder points was believed to be the doppler counter. Figure 63 shows the large deviation of raw doppler data from nominal.

Pass 1202. The station had numerous blunder points and receiver-out-of-lock indications. It was determined that the doppler counter was not updating in the 10-millionth count. The station was requested to make an investigation to determine why the receiver was dropping lock so frequently. Figure 64 illustrates the complete randomness of the raw doppler data on Pass 1202.

Pass 1205. The PC 141 in the timing system jumped time and caused a failure in the antenna pointing system. This problem was corrected by resetting the PC 141.

Pass 1207. The rectifier beam interlock switch tripped because of high voltage overload and caused loss of transmitter power. The switch was reset and all indications returned to normal.

Pass 1209. The station had many blunder points. Received signal strength was 7.3 dB above receiver threshold.

Pass 1212. The station experienced high noise: a switch was made from rubidium 1 to rubidium 2, but high noise continued. Communication outage occurred from 2033 to 2039. There were many garbled lines of TDH. High noise appeared to be caused by a timing offset. Noise spikes ranged from 60 to 80 cycles.

Pass 1219. At 2050, an antenna emergency occurred because the rotating stairway was blocked; delay caused late acquisition of the spacecraft.

Pass 1221. At 1923:25, beam voltage interlock kicked the transmitter off due to air condition overcurrent. Interlock was reset; transmitter was on at 1923:35.

Pass 1223. From 2050 to 2149, station tracking data was bad; the problem was caused by a bad start (sample timing off). The TDH punches were restarted and operation was normal. All data was lost between 2050 and 2149.

Pass 1225. The PC 141 clock had an error of 200 ms from 1858 to the end of pass at 2100. Station master equatorial was out, and *Pioneer VI* was tracked in precision mode 2.

Pass 1228. The antenna went to brake mode. Dirt was found on the film height transducer probe.

Pass 1229. The transmitter was operating at 10 kW instead of 20 kW because of motor generator set outage. The problem was in the frequency regulator, which was replaced.

Pass 1235. There were 10 blunder points recorded on the data.

Pass 1237. The TCP glitched in and out of lock from 1415 until 2025, when the pass was terminated to check the problem. Receiver 2 was prime for telemetry only from 1902 to 1930. Receiver 1 was prime for telemetry from 1930 to pass termination. The station experienced high noise and four blunder points.

Pass 1238. At 1644, TCP beta was noted as glitching in and out of lock. At 1759, the master equatorial went to brake mode; PC 141 was off. At 1800, the antenna went to precision mode 1, and PC 141 was reset at 1801. At 1956, the antenna went to sidereal mode; PC 141 was again off. DSS 14 was unable to keep PC 141 set, and permission was given to change rubidiums. At 2025, the station switched from rubidium 2 to rubidium 1; PC 141 was reset at 2030.

Pass 1240. Tracking data was garbled from 1445 to 1511. The station replaced card A-25 in PC 142. The station was notified of a large blunder point occurring every 4 min. Analysis indicated a doppler counter problem. The TDH was taken off line for troubleshooting at 1710. At 1744, TDH was sampling and on line; card B-8 in doppler counter 2 was replaced. All angles were bad because the antenna was in precision mode 2 because of master equatorial update.

Pass 1241. A loss of transmitter power occurred because of low beam voltage. A readjustment was made.

Pass 1242. Because of a power supply intermittent open source, the 1-MHz reference was off from the distribution amplifier. As a result, the FTS II clock stopped at 2225. The clock was reset at 2250.

Pass 1246. The station tracked in precision mode 2. Many receiver glitches were observed during the pass. At 1635, the antenna went to brake mode; the emergency stop button was accidentally actuated. The antenna was back on the spacecraft at 1638.

Pass 1247. During troubleshooting of a declination angle readout problem, the wrong card was pulled and the antenna went to brake mode. The declination readout problem was corrected at 1744.

Pass 1249. The transmitter went off at 2203 because of a high-voltage ac overload. The transmitter went on at 2204. From 2229 to 2258, the TDH VCO counter had a trigger problem. This problem was corrected by an adjustment at 2258.

Pass 1267. Three severe jumps occurred in the doppler data received from DSS 14. No anomaly was located at the station. Solar activity was believed to be the cause.

Pass 1268. Blunder points still appeared in the doppler data. Station equipment was rechecked but no anomaly was found. Solar activity in the area of *Pioneer VI* continued.

Pass 1269. Four blunder points were recorded in the doppler data. Solar activity still existed in the *Pioneer VI* area, but the intensity was low. Station system noise temperature during this pass was high. High-voltage ac overload caused loss of transmitter power; the breaker switch was reset.

Pass 1275. The antenna at DSS 14 went to brake mode at 2217 because of low film height; the antenna was back on point at 2224.

Pass 1277. The antenna went to brake mode at 1856 because the pedestal emergency stop button was inadvertently engaged. The antenna went to precision mode 1 at 1857.

Pass 1285. The last 2 h of track in the high noise mode showed a 3-dB drop in received signal level. No apparent cause was found. This was the first *Pioneer VI* pass tracked after installation of the S-band Cassegrain ultracone.

Pass 1287. Difficulty was encountered in the acquisition of the spacecraft on channel 7. Although the spacecraft was acquired on channel 7, it was lost after a few minutes because the polarizer was rotated to set up for acquisition on channel 6. The spacecraft was then acquired and tracked on channel 6 with no further problems.

Appendix

Pioneer Calendar, June-November 1968

JUNE 1968

Calendar Date	S 1	Su 2	M 3	T 4	W 5	Th 6	F 7	S 8	Su 9	M 10	T 11	W 12	Th 13	F 14	S 15	Su 16	M 17	T 18	W 19	Th 20	F 21	S 22	Su 23	M 24	T 25	W 26	Th 27	F 28	S 29	Su 30	
Day of Year	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	
Pioneer VI Pass	899	900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924	925	926	927	928	
Pioneer VII Pass	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680	681	682	683	684	
Pioneer VIII Pass	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	

JULY 1968

Calendar Date	M 1	T 2	W 3	Th 4	F 5	S 6	Su 7	M 8	T 9	W 10	Th 11	F 12	S 13	Su 14	M 15	T 16	W 17	Th 18	F 19	S 20	Su 21	M 22	T 23	W 24	Th 25	F 26	S 27	Su 28	M 29	T 30	W 31
Day of Year	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213
Pioneer VI Pass	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949	950	951	952	953	954	955	956	957	958	959
Pioneer VII Pass	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715
Pioneer VIII Pass	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232

AUGUST 1968

Calendar Date	Th 1	F 2	S 3	Su 4	M 5	T 6	W 7	Th 8	F 9	S 10	Su 11	M 12	T 13	W 14	Th 15	F 16	S 17	Su 18	M 19	T 20	W 21	Th 22	F 23	S 24	Su 25	M 26	T 27	W 28	Th 29	F 30	S 31
Day of Year	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244
Pioneer VI Pass	960	961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986	987	988	989	990
Pioneer VII Pass	716	717	718	719	720	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746
Pioneer VIII Pass	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263

SEPTEMBER 1968

Calendar Date	Su 1	M 2	T 3	W 4	Th 5	F 6	S 7	Su 8	M 9	T 10	W 11	Th 12	F 13	S 14	Su 15	M 16	T 17	W 18	Th 19	F 20	S 21	Su 22	M 23	T 24	W 25	Th 26	F 27	S 28	Su 29	M 30	
Day of Year	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	
Pioneer VI Pass	991	992	993	994	995	996	997	998	999	1000	1001	1002	1003	1004	1005	1006	1007	1008	1009	1010	1011	1012	1013	1014	1015	1016	1017	1018	1019	1020	
Pioneer VII Pass	747	748	749	750	751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	
Pioneer VIII Pass	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	

OCTOBER 1968

Calendar Date	T 1	W 2	Th 3	F 4	S 5	Su 6	M 7	T 8	W 9	Th 10	F 11	S 12	Su 13	M 14	T 15	W 16	Th 17	F 18	S 19	Su 20	M 21	T 22	W 23	Th 24	F 25	S 26	Su 27	M 28	T 29	W 30	Th 31
Day of Year	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305
Pioneer VI Pass	1021	1022	1023	1024	1025	1026	1027	1028	1029	1030	1031	1032	1033	1034	1035	1036	1037	1038	1039	1040	1041	1042	1043	1044	1045	1046	1047	1048	1049	1050	1051
Pioneer VII Pass	777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800	801	802	803	804	805	806	807
Pioneer VIII Pass	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324

NOVEMBER 1968

Calendar Date	F 1	S 2	Su 3	M 4	T 5	W 6	Th 7	F 8	S 9	Su 10	M 11	T 12	W 13	Th 14	F 15	S 16	Su 17	M 18	T 19	W 20	Th 21	F 22	S 23	Su 24	M 25	T 26	W 27	Th 28	F 29	S 30	
Day of Year	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	
Pioneer VI Pass	1052	1053	1054	1055	1056	1057	1058	1059	1060	1061	1062	1063	1064	1065	1066	1067	1068	1069	1070	1071	1072	1073	1074	1075	1076	1077	1078	1079	1080	1081	
Pioneer VII Pass	808	809	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	
Pioneer VIII Pass	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	

NOTE: THE PASS NO. IS ASSOCIATED WITH THE CALENDAR DATE IN WHICH THE VIEW PERIOD STARTS

OCTOBER 1968

Calendar Date	T 1	W 2	Th 3	F 4	S 5	Su 6	M 7	T 8	W 9	Th 10	F 11	S 12	Su 13	M 14	T 15	W 16	Th 17	F 18	S 19	Su 20	M 21	T 22	W 23	Th 24	F 25	S 26	Su 27	M 28	T 29	W 30	Th 31
Day of Year	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305
Pioneer VI Pass	1021	1022	1023	1024	1025	1026	1027	1028	1029	1030	1031	1032	1033	1034	1035	1036	1037	1038	1039	1040	1041	1042	1043	1044	1045	1046	1047	1048	1049	1050	1051
Pioneer VII Pass	777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800	801	802	803	804	805	806	807
Pioneer VIII Pass	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324

NOVEMBER 1968

Calendar Date	F 1	S 2	Su 3	M 4	T 5	W 6	Th 7	F 8	S 9	Su 10	M 11	T 12	W 13	Th 14	F 15	S 16	Su 17	M 18	T 19	W 20	Th 21	F 22	S 23	Su 24	M 25	T 26	W 27	Th 28	F 29	S 30
Day of Year	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335
Pioneer VI Pass	1052	1053	1054	1055	1056	1057	1058	1059	1060	1061	1062	1063	1064	1065	1066	1067	1068	1069	1070	1071	1072	1073	1074	1075	1076	1077	1078	1079	1080	1081
Pioneer VII Pass	808	809	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837
Pioneer VIII Pass	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354

DECEMBER 1968

Calendar Date	Su 1	M 2	T 3	W 4	Th 5	F 6	S 7	Su 8	M 9	T 10	W 11	Th 12	F 13	S 14	Su 15	M 16	T 17	W 18	Th 19	F 20	S 21	Su 22	M 23	T 24	W 25	Th 26	F 27	S 28	Su 29	M 30	T 31
Day of Year	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366
Pioneer VI Pass	1082	1083	1084	1085	1086	1087	1088	1089	1090	1091	1092	1093	1094	1095	1096	1097	1098	1099	1100	1101	1102	1103	1104	1105	1106	1107	1108	1109	1110	1111	1112
Pioneer VII Pass	838	839	840	841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860	861	862	863	864	865	866	867	868
Pioneer VIII Pass	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385
Pioneer IX Pass	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47 *	48 *	49 *	50 *	51 *	52 *	53 54	54 55

PIONEER CALENDAR NOTES:

*Pioneer IX rises at 00:00 Z and 23:55 Z on December 24 at station 42; therefore, passes 47 and 48 both occur on *December 24*. This means that *that for DSS 42*, one (1) must be added to the pass number shown starting December 25.

JANUARY 1969

Week						2							3							4							5				
Calendar Date	W 1	Th 2	F 3	S 4	Su 5	M 6	T 7	W 8	Th 9	F 10	S 11	Su 12	M 13	T 14	W 15	Th 16	F 17	S 18	Su 19	M 20	T 21	W 22	Th 23	F 24	S 25	Su 26	M 27	T 28	W 29	Th 30	F 31
Day of Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Pioneer VI Pass	1113	1114	1115	1116	1117	1118	1119	1120	1121	1122	1123	1124	1125	1126	1127	1128	1129	1130	1131	1132	1133	1134	1135	1136	1137	1138	1139	1140	1141	1142	1143
Pioneer VII Pass	869	870	871	872	873	874	875	876	877	878	879	880	881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899
Pioneer VIII Pass	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416
Pioneer IX Pass	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85
Pn. IX DSS 41 & 42	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86

FEBRUARY 1969

Week			6							7							8							9				
Calendar Date	S 1	Su 2	M 3	T 4	W 5	Th 6	F 7	S 8	Su 9	M 10	T 11	W 12	Th 13	F 14	S 15	Su 16	M 17	T 18	W 19	Th 20	F 21	S 22	Su 23	M 24	T 25	W 26	Th 27	F 28
Day of Year	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59
Pioneer VI Pass	1144	1145	1146	1147	1148	1149	1150	1151	1152	1153	1154	1155	1156	1157	1158	1159	1160	1161	1162	1163	1164	1165	1166	1167	1168	1169	1170	1171
Pioneer VII Pass	900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924	925	926	927
Pioneer VIII Pass	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444
Pioneer IX Pass	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113
Pn. IX DSS 41 & 42	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114

MARCH 1969

Week			10							11							12							13							14
Calendar Date	S 1	Su 2	M 3	T 4	W 5	Th 6	F 7	S 8	Su 9	M 10	T 11	W 12	Th 13	F 14	S 15	Su 16	M 17	T 18	W 19	Th 20	F 21	S 22	Su 23	M 24	T 25	W 26	Th 27	F 28	S 29	Su 30	M 31
Day of Year	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
Pioneer VI Pass	1172	1173	1174	1175	1176	1177	1178	1179	1180	1181	1182	1183	1184	1185	1186	1187	1188	1189	1190	1191	1192	1193	1194	1195	1196	1197	1198	1199	1200	1201	1202
Pioneer VII Pass	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949	950	951	952	953	954	955	956	957	958
Pioneer VIII Pass	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475
Pioneer IX Pass	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144
Pn. IX DSS 41 & 42	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145

APRIL 1969

Week no.							15							16							17							18		
Calendar Date	T 1	W 2	Th 3	F 4	S 5	Su 6	M 7	T 8	W 9	Th 10	F 11	S 12	Su 13	M 14	T 15	W 16	Th 17	F 18	S 19	Su 20	M 21	T 22	W 23	Th 24	F 25	S 26	Su 27	M 28	T 29	W 30
Day of Year	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Pioneer VI Pass	1203	1204	1205	1206	1207	1208	1209	1210	1211	1212	1213	1214	1215	1216	1217	1218	1219	1220	1221	1222	1223	1224	1225	1226	1227	1228	1229	1230	1231	1232
Pioneer VII Pass	959	960	961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986	987	988
Pioneer VIII Pass	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505
Pioneer IX Pass	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174
Pn. IX DSS 41 & 42	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175

MAY 1969

Week no.	18 (week no.)				19							20							21							22					
Calendar Date	Th 1	F 2	S 3	Su 4	M 5	T 6	W 7	Th 8	F 9	S 10	Su 11	M 12	T 13	W 14	Th 15	F 16	S 17	Su 18	M 19	T 20	W 21	Th 22	F 23	S 24	Su 25	M 26	T 27	W 28	Th 29	F 30	S 31
Day of Year	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151
Pioneer VI Pass	1233	1234	1235	1236	1237	1238	1239	1240	1241	1242	1243	1244	1245	1246	1247	1248	1249	1250	1251	1252	1253	1254	1255	1256	1257	1258	1259	1260	1261	1262	1263
Pioneer VII Pass	989	990	991	992	993	994	995	996	997	998	999	1000	1001	1002	1003	1004	1005	1006	1007	1008	1009	1010	1011	1012	1013	1014	1015	1016	1017	1018	1019
Pioneer VIII Pass	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536
Pioneer IX Pass	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205
Pn. IX DSS 41 & 42	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206

JUNE 1969

Week no.		23							24							25							26							27
Calendar Date	Su 1	M 2	T 3	W 4	Th 5	F 6	S 7	Su 8	M 9	T 10	W 11	Th 12	F 13	S 14	Su 15	M 16	T 17	W 18	Th 19	F 20	S 21	Su 22	M 23	T 24	W 25	Th 26	F 27	S 28	Su 29	M 30
Day of Year	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181
Pioneer VI Pass	1264	1265	1266	1267	1268	1269	1270	1271	1272	1273	1274	1275	1276	1277	1278	1279	1280	1281	1282	1283	1284	1285	1286	1287	1288	1289	1290	1291	1292	1293
Pioneer VII Pass	1020	1021	1022	1023	1024	1025	1026	1027	1028	1029	1030	1031	1032	1033	1034	1035	1036	1037	1038	1039	1040	1041	1042	1043	1044	1045	1046	1047	1048	1049
Pioneer VIII Pass	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	566
Pioneer IX Pass	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235
Pn. IX DSS 41 & 42	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236

Glossary

ACQ	acquisition
AGC	automatic gain control
AFETR	Air Force Eastern Test Range
AOS	acquisition of signal
APC	automatic phase control
APS	antenna pointing subsystem
ARC	Ames Research Center
AZ	azimuth
AZ-EL	azimuth-elevation
B12	bandwidth 12 Hz
CDC	Command and Data Handling Console
CDU	command distribution unit
CMD	command
DEC	declination angle
Demod	demodulator
DI	diplexer in, one- and two-way operation
DIS	digital instrumentation subsystem
DO	diplexer out or bypassed; one-way operation only; reduces system noise temperature
DSIF	Deep Space Instrumentation Facility
DSN	Deep Space Network
DSS	Deep Space Station
DSU	data storage unit
DTU	data transmission unit
GCF	Ground Communications Facility
GMT	Greenwich mean time
GOE	ground operational equipment
HA-DEC	hour angle/declination
HSD	high speed data
IMP	Interim Monitor Program
IRS	infrared spectrometer
LCP	left circular polarization
MMSA	multimission support area
MSFN	Manned Space Flight Network
NASCOM	National Aeronautics and Space Administration Communications Network
OCC	operations control chief
Pass	pass number or number of times the spacecraft has passed over the station
PER	parity error rate
PI	polarizer in, eliminating 3-dB circular polarization loss
PIN	paralleled input
PO	polarizer out
RCV	Receiver-Exciter Subsystem
RCVR	receiver
RCP	right circular polarization
RTLT	round-trip light time
SDA	systems data analysis
SFOF	Space Flight Operations Facility
SMF	S-band multiple frequency
SNR	signal-to-noise ratio
SPE	static phase error
TCP	telemetry command processor
TDA	tracking and data acquisition
TDH	tracking data handling subsystem
TDP	tracking data processor
TDS	Tracking and Data System
TFR	Trouble/Failure Report
TLM	telemetry
TTY	teletype
TWT	traveling wave tube
TXR	transmitter subsystem
W/F	word/frame
XMTR ref freq	transmitter reference frequency

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