Pioneer Venus 1978 Mission Support

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The current concept for DSN support of the Pioneer Venus 1978 probe mission is described.

I. Introduction

Pioneer Venus 1978 current mission concept is for a two-spacecraft mission with both launches in the 1978 Venus opportunity. One spacecraft will consist of a bus and four probes which will all enter the Venusian atmosphere. The second spacecraft will use the same basic bus but with the probes replaced by a propulsion package sufficient for achieving an orbit around Venus with a life in orbit of seven months or one Venusian year. This article is an introduction of the current DSN concept of supporting the telemetry for the probe mission.

II. Probe Mission Characteristics

The probe mission will involve delivering an array of aerodynamic probes over the surface of Venus from a spin-stabilized bus. The probes will consist of three identical small probes and one larger probe, each carrying an assortment of instruments to measure the characteristics of the atmosphere down to the lowest atmospheric scale height above the surface. It will not be a mission objective for the probes to function after impacting the surface of the planet. The bus will carry independent scientific instruments to measure the characteristics of the atmosphere above 130 km altitude. The bus will not be designed to survive atmospheric entry. After separation of the probes from the spinning bus, some 5 to 15 days prior to entry, the bus will be retarded so as to enter the atmosphere after the probe entries have been completed. This will enable the bus to serve as a frequency reference for an interferometric tracking experiment to determine the wind drifts of the probes during their descent through the atmosphere.

The probes will have direct communication with Earth. The large probe and bus will carry coherent transponders, and the small probes will have stable oscillator-controlled transmitters (on the order of 10^{-9} stability after turn on). Since the probes will be battery powered, their radio subsystems will be turned on only a short time (on the order of an hour) prior to entry. In the current mission concept this means that the probe frequencies would not be seen on the ground from launch in August 1978 until shortly before entry in December of 1978. The descent phase will last on the order of one hour, and current mission concept has all four probes entering simultaneously during the DSS 14 and DSS 43 overlap in view period. In the interface region between 120 km and 80 km altitude, there will be a blackout of communications. Since the bus must be tracked simultaneously by the same stations as the probes for the sake of the wind drift measurements, both DSS 14 and DSS 43 must be equipped to receive all five signals simultaneously, although it may not prove necessary for bus telemetry to be received at the 64-meter stations.

III. DSN Support Plans

For the sake of redundancy there will be duplicate telemetry capability at DSS 14 and DSS 43 for each probe. The prime source of telemetry data will be through the closed-loop receivers. The current plan calls for five open-loop receivers at each station, which is one more than the Viking configuration. The fifth closed-loop receiver will give flexibility in the initial acquisition search prior to entry, or alternately allow for tracking of the bus for telemetry at a 64-meter station, if required.

Because of the higher risks associated with this multiprobe mission and to increase the data return surrounding the blackout region during entry, a predetection telemetry recovery system utilizing open-loop receivers will be provided. Four open-loop receivers, two more than the Viking configuration, will be provided at both DSS 14 and DSS 43. Telemetry data would be analog recorded for later playback. Playback of the predetection analog recordings will utilize a digital wow and flutter compensator being developed by the Jet Propulsion Laboratory. The technique involves an A to D conversion, then the digital compensation utilizing a pilot tone recorded with the data, then an A to D conversion, up conversion to S-band, and finally play-in through a standard closed-loop receiver and telemetry system. Losses associated with the predetection recording and playback compared to the real-time closed-loop system will be less than 1½ dB. The bandwidth at S-band of the predetection telemetry systems to be used for Pioneer Venus will be about 300 kHz so that tuning of the open-loop receiver should not be necessary during the descent.

The wind drift measurement will require that all five signals received from the probes and bus (if the probe entries are simultaneous) be received through a single open-loop receiver. The frequency allocations will be such that a bandwidth on the order of 1 MHz will be required. To avoid the necessity of an additional open-loop receiver, two ports on one of the open-loop receivers is being provided for telemetry. One port would be 300 kMz for telemetry, and the other port would be 1 MHz for the wind drift measurement. The details of how the differential interferometry data will be taken for the wind drift experiment have not been established; however, it appears the project will request that experimenter-provided equipment be placed at DSS 14 and DSS 43. It is against usual Office of Tracking and Data Acquisition (OTDA) policy to have project-provided equipment at the stations, so further negotiation will be required on this point.

The operation of nine receivers simultaneously at each DSS to acquire 5 separate carriers for a 90-minute primary mission will be interesting, to say the least. To make this complex operation more manageable, each receiver will be provided with manually programmed, digitally controlled oscillators so that any tuning required can be set and checked prior to the turn on of the probe transmitters. The bus will be in two-way (its transmitted signal coherent to a signal received from the ground) during the probe entries, and it is hoped that the mission design will enable the uplink to the bus to be from a 26-meter DSS to avoid this additional complexity at the 64-meter DSSs. It may also be required to maintain an uplink to the large probe prior to blackout. This uplink could be from one of the 64-meter DSSs or an additional 26-meter DSS. In any case, dual uplink from a single station will not be provided.

A block diagram of the receiver configuration discussed is shown in Fig. 1.

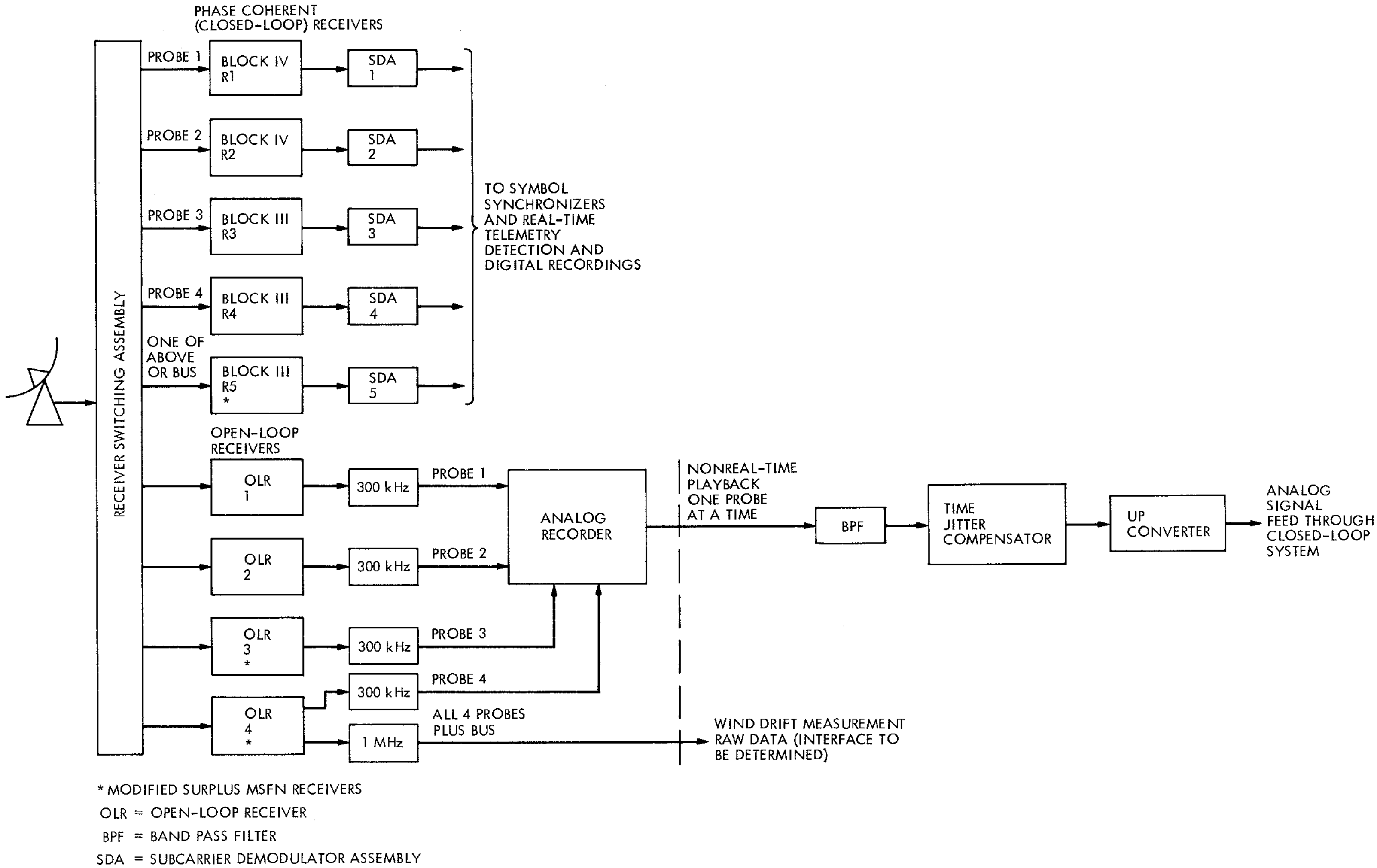

Fig. 1. Receiver configuration for telemetry data recovery and interferometry experiment