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VOYAGER 2 RADIO SCIENCE

URANUS ENCOUNTER OPERATIONS PLAN

JANUARY 24, 1986

AND

ORT 4 OPERATIONS PLAN

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SECTION 1

INTRODUCTION

1.1 SCOPE

This document provides information for the conduct of

Voyager 2 Uranus Encounter Radio Science 1/24/86

and

Operational Readiness Test 4 (ORT 4) 1/11/86

It was assembled by members of the Voyager Radio Science Support Team with substantial assistance from the Radio Science Interface Working Group. Team membership and key operations personnel may be found in Appendix G.

******NOTICE******

This document is NOT a replacement for the normal DSN and Voyager documents and procedures used to operate equipment. In addition, it is NOT a source of actual event times...the Voyager ISOE is intended for that purpose and is the controlling sequence document.

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1.2 URANUS ENCOUNTER RADIO SCIENCE

A description of the Uranus Encounter Radio Science observations may be found in section 2.

1.3 OPERATIONAL READINESS TEST 4 (ORT 4)

Operational Readiness Test 4 will be the final spacecraft and GDS dress rehearsal for Uranus encounter Radio Science activities. To the extent possible, ORT 4 has been designed to mimick Uranus encounter events. For example, the spacecraft downlink power switching events will be executed; however the maneuvers will not be executed. The specific information for ORT 4 may be found in Appendix I.

1.4 OPERATIONS PLAN ROADMAP

If you want to know about:	Then go to:
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SECTION 2

SCIENCE OBSERVATIONS

2.1 RADIO SCIENCE OBSERVATIONS DESCRIPTION

There are six major Radio Science observations to be conducted during the Uranus encounter period. The sequence link names are as follows:

XCASCAL
XMMASS
XPGRAV
XPOCC
XROCC
XSCEL

The code for understanding the links is:

X	-	Distinguishes Radio Science (X-band) from other science instruments.
C	-	Target (Calibration)
M	-	Target (Miranda)
P	-	Target (Planet, in this encounter Uranus)
R	-	Target (Rings)
S	-	Target (Uranus System)
ASCAL	-	Type (Antenna and Sunsensor Calibration)
MASS	-	Type (Mass determination)
GRAV	-	Type (Gravity field determination)
OCC	-	Type (Occultation)
CEL	-	Type (Celestial Mechanics)

2.2 ANTENNA AND SUNSENSOR CALIBRATION (XCASCAL)

The purpose of this observation is to determine precisely the spacecraft's attitude for better reconstruction of the high gain antenna pointing during the ring and planetary occultations.

The spacecraft is commanded to perform gyro drift turns of + or - 0.3 degrees in a cross-hair pattern about Earth point. The spacecraft antenna pointing is determined by observing the change in the ground received signal power as the spacecraft's attitude is changed. The best ground signal SNR occurs when the spacecraft High Gain Antenna boresight is pointed directly at Earth.

The XCASCAL observation is executed twice in the Uranus Near Encounter command load B752, once immediately before the occultation events and once immediately after the occultation events.

2.3 MIRANDA MASS DETERMINATION (XMMASS)

The objective of this observation is to determine the mass and density of Miranda, a satellite of Uranus.

The frequency of the downlink carrier is precisely measured to determine the magnitude of the doppler shift caused by acceleration of the spacecraft as it passes close to Miranda (C/A = 28000 Km). Since the magnitude of the doppler shift is related to the gravitational field strength, the mass of Miranda can be determined. If the radius of Miranda is known, its density can be calculated.

The XMMASS observation will be carried out at a time near satellite closest approach, when the Miranda induced spacecraft acceleration along the line of sight to Earth is maximized, thus introducing the largest variation in the doppler signature.

During this period, the spacecraft will be in a coherent doppler tracking mode, with an uplink transmitted from DSS 14 and the downlink received at DSS 43. In the coherent tracking mode, it is possible to take advantage of the most stable frequency references, which are the hydrogen masers at the DSN complexes.

A special feature of this observation is that the spacecraft will be commanded from the ground (not onboard sequence) to switch to the coherent tracking mode (TWNC OFF). If the uplink is not detected by the spacecraft, then it will remain in the sequenced noncoherent mode (TWNC ON). This is to ensure that unique downlink telemetry is not lost in the event that the Best Lock Frequency of Voyager 2 has drifted to an extent which would preclude coherent tracking.

2.4 URANUS GRAVITY FIELD (XPGRAV)

The purpose of this observation is to determine characteristics of the gravitational field of Uranus. The downlink carrier frequency is measured precisely to determine the magnitude of the doppler shift caused by the spacecraft's close approach to Uranus. Since the magnitude of the doppler shift is related to the mass of the planet, the mass of the planet can be determined.

This observation is conducted in a coherent tracking mode (TWNC OFF), with a ground antenna transmitting an uplink which is coherently retransmitted by the spacecraft to the ground. This allows use of the most stable frequency reference standards, which reside at the DSN complexes.

The XPGRAV observation is repeated at various times during spacecraft execution of the B752 command load, in order to maximize the total amount of coherent doppler tracking.

It should be noted that this observation is complementary to additional observations performed by the Navigation team. In fact, all of the coherent doppler tracking data (and some of the non-coherent doppler) that is acquired for many days around Uranus encounter will be combined to provide the best estimate of the Uranian gravity field and also the precise location of the spacecraft. The final results of these observations are critical as input to the occultation observations, which depend on precise knowledge of the encounter geometry.

A special execution of XPGRAV is being placed immediately after the occultation period in order to acquire coherent doppler during a time interval sensitive to the masses of the other Uranian satellites. The strategy will require transmission of a real-time TWNC OFF command and modelling of the spacecraft receiver Best Lock Frequency drift (caused by the onboard occultation events) in the uplink frequency ramps, in order to maintain coherent lock.

2.5 URANUS ATMOSPHERIC OCCULTATION (XPOCC)

The objectives of this observation are:

1. to determine temperature and pressure as a function of altitude in the stratosphere and troposphere of Uranus.

2. to determine the methane abundance by locating the level of methane condensation in the Uranian troposphere.

3. to determine helium abundance in the Uranian atmosphere in conjunction with IRIS obeserations (RPOCCPT).

4. to determine the density and vertical structure of the Uranian Ionosphere.

5. to investigate turbulence and other irregularities in the neutral atmosphere and ionosphere of Uranus.

The S-band and X-band radio beams are used to probe the ionosphere and neutral atmosphere during the radio occultation by Uranus. See figures 2-1 and 2-2 for a description of the geometry of the occultation as viewed from Earth and from above the planet. Note that the units of these figures are kilometers and that spacecraft motion is from right to left. Also, figures 2-3 and 2-4 describe the expected received power and frequency profiles. These figures are displayed as a function of time.

Because the spacecraft receiver would lose lock when the spacecraft is occulted by the planet, the observation is done with the spacecraft's downlink carrier frequency referenced to the on-board Ultra-Stable Oscillator (USO, TWNC ON). To maximize the signal to noise ratio of both downlinks, telemetry and ranging modulation will be turned off. The S-band TWT is turned to high power mode to maximize the S-band signal to noise ratio and therefore the differential doppler measurement's sensitivity to ionization. The X-band TWT is turned to low power for power management reasons.

A spacecraft maneuver will be performed which is designed to point the High Gain Antenna at the virtual radio image of Earth as it is refracted around the limb of Uranus during the occultation period. It is expected that both the S-band and X-band signals will be observed throughout the entire occultation period.

Since accurate antenna pointing is critical to the success of this observation, the start of the limbtrack maneuver will be adjustable in 1 second increments. The optimum time to start the maneuver will be selected as part of the Late Stored Update (LSU) exercise which occurs only a few hours prior to the start of the occultation period.

To provide the best possible SNRs for this observation, DSS 43, DSS 42 and the Parkes Radio Observatory will be acquiring data. The signals will be added together in the post observation analysis.

2.6 RING OCCULTATION (XROCC)

The objectives of this observation are:

1. to study the radial structure of the Uranian ring system.
2. to determine ring particle size and size distribution in the decimeter to meter size range.
3. to determine the vertical structure of the rings (in order to distinguish between monolayer and cloud-like ring structure).

The radio beam from the High Gain Antenna is directed through the rings (see figures 2-1 through 2-4). From the observed effects of the interaction (i.e., complex extinction and forward scattering), characteristics of the rings may be determined. To maximize the signal to noise ratio, telemetry and ranging modulation are turned off.

In order to provide the highest sensitivity to the smallest ring particles, the X-band TWT will be in the high power mode, and the S-band TWT will be in the low power mode. The observations are conducted in the noncoherent mode (TWNC ON) with the frequency reference provided by the Ultra Stable Oscillator (USO).

To enhance signal to noise ratio, data will be acquired at DSS 43, DSS 42, and Parkes Radio Observatory. These signals will be combined in the post observation analysis.

2.7 CELESTIAL MECHANICS REDSHIFT (XSCEL)

The objectives of this experiment are:

1. the verification of a gravitational redshift. The General Theory of Relativity predicts that as the spacecraft gets closer to Uranus or any other massive body, the gravitational field will cause the frequency of the spacecraft's onboard oscillator, as observed from Earth, to appear lower than it actually is. The change is related to how strong the field is, and therefore how massive the planet it. By measuring the change in the apparant frequency of the spacecraft oscillator, a value for the planetary mass can be calculated. This value can be compared to the value obtained from two-way coherent tracking data. In this way the theory can be tested. Two-way coherent data is not used in this observation because the effect of the gravitational field on the signal going to the spacecraft is equal in magnitude, but opposite in sign to the effect on a signal leaving the spacecraft, making the net effect zero.

2. to test the Ultra-Stable Oscillator (USO). The short and long term characteristics of the USO frequency are studied and used as calibrations for the other radio science observations.

This observation has generally been conducted at regular intervals since Saturn encounter to provide a calibration baseline (they have been called USO tests). The XSCEL observations in the encounter phase occur with increasing frequency toward Uranus closest approach, as the redshift effect becomes detectable.

Data acquisition consists of two hours of non-coherent (TWNC ON) USO referenced doppler frequency measurements at the following intervals:

U	›	+- 40 days	1 per 2 weeks
U		+- 40	1 per week
U		+- 20	3 per week
U		+- 10	1 per day
U		+- 2	3 per day

FIG. 2-1

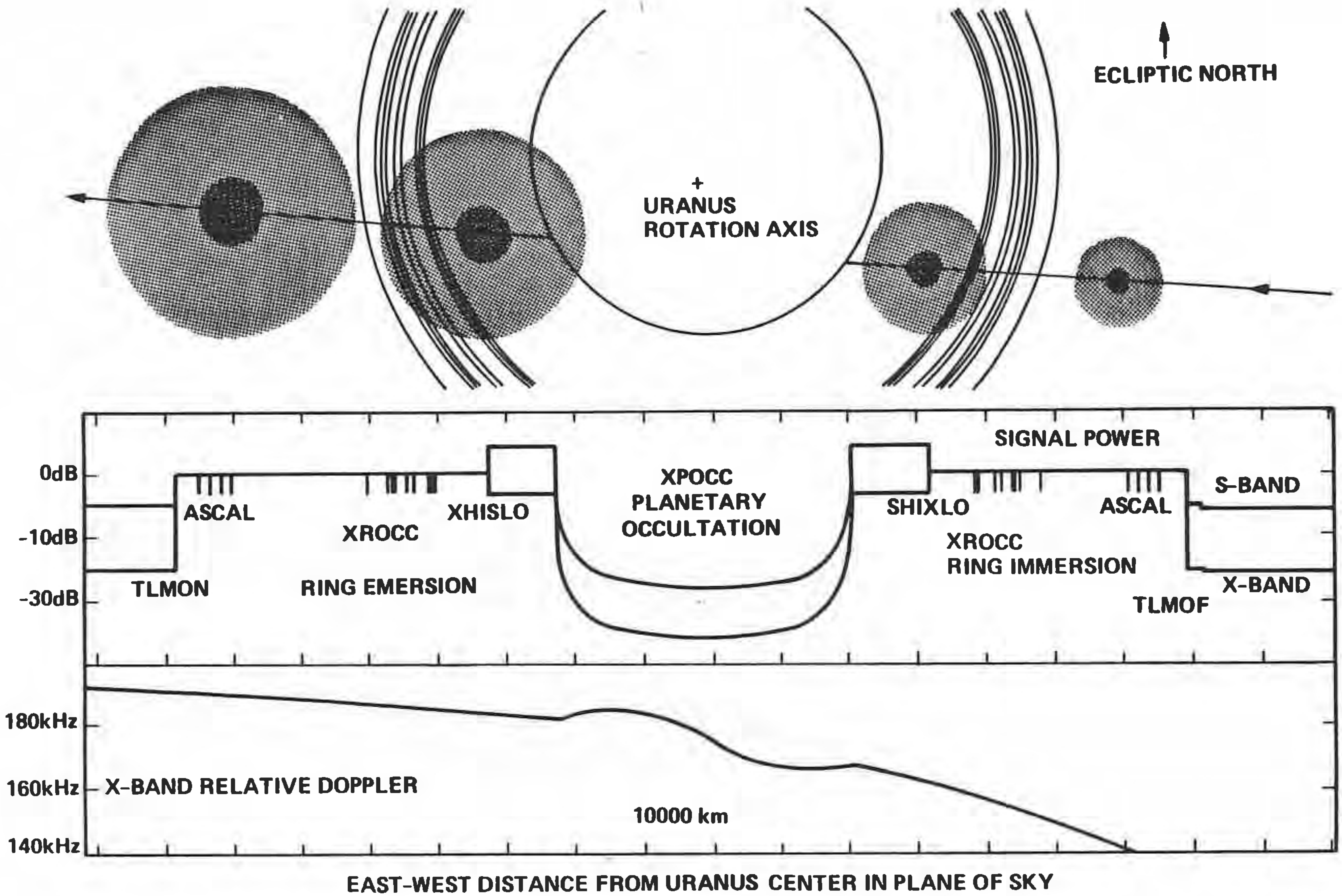

ECLIPTIC NORTH
+
URANUS
ROTATION AXIS
SIGNAL POWER
0dB
-10dB
-30dB
ASCAL
XROCC
XHISLO
XPOCC
PLANETARY
OCCULTATION
SHIXLO
ASCAL
S-BAND
TLMON
RING EMERSION
XROCC
RING IMMERSION
X-BAND
TLMOF
180kHz
160kHz
X-BAND RELATIVE DOPPLER
10000 km
140kHz
EAST-WEST DISTANCE FROM URANUS CENTER IN PLANE OF SKY

FIG. 2-2

Fig. 2-3

VOYAGER 2 at URANUS

Expected Signal Dynamics during Near Encounter

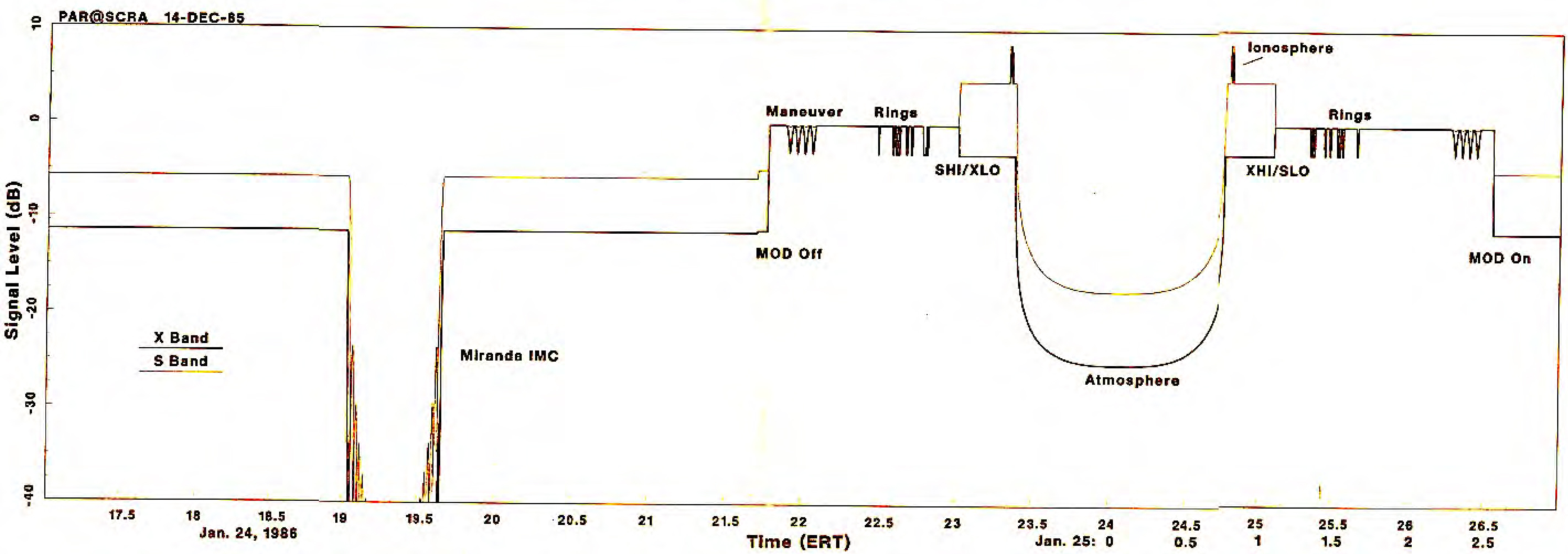
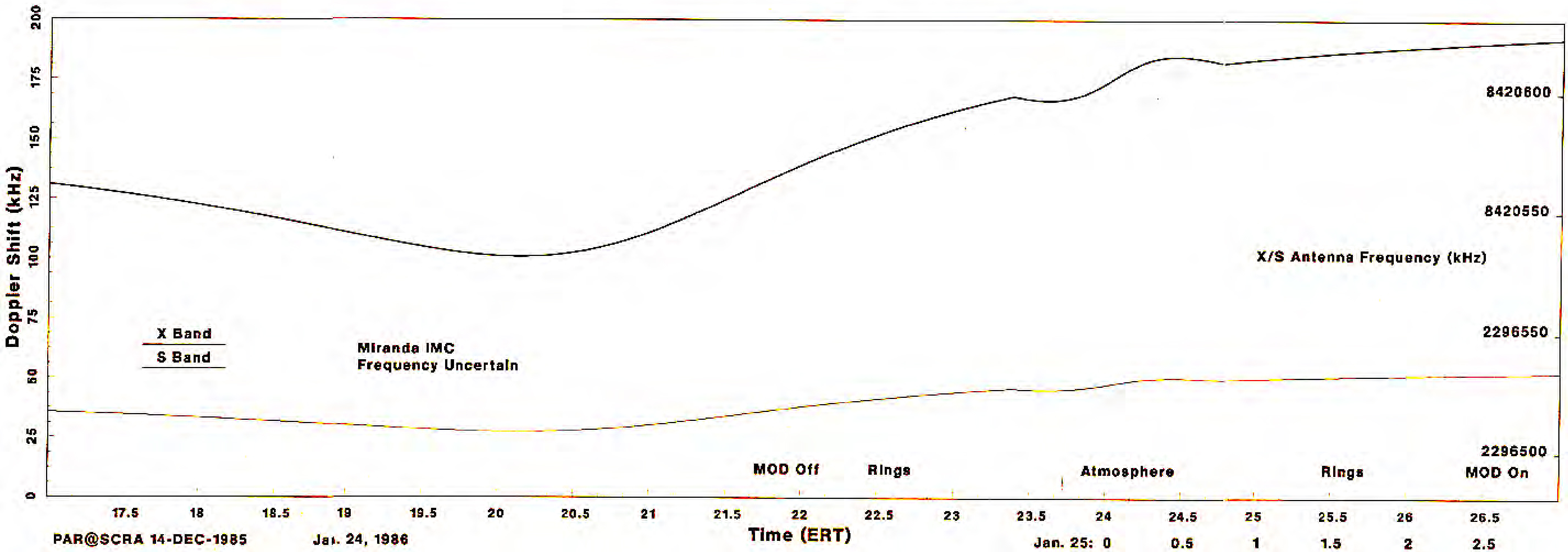


Fig 2-4

VOYAGER 2 at URANUS

Expected Signal Doppler during Near Encounter



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SECTION 3

RADIO SCIENCE GDS CONFIGURATION

3.1 INTRODUCTION

The components of the GDS and their interrelationship are depicted in the block diagram of the Mark IVA DSN end to end data flow shown in Figure 3-1. The names of the major ground data system (GDS) components to be used during the radio science events of the Voyager 2 Uranus encounter are contained in Table 3-1.

This section focuses on the instrumentation configuration and calibration requirements for the Deep Space Communication Complex 40 and the Parkes Radio Observatory in Australia. The other components of the GDS are mentioned briefly in this section. Some are discussed in more detail elsewhere in this document. Most notably, the RSST Data System and the RSST Test Support System are described in Sections 10 and 11 respectively.

******NOTE******

THE TABLES WHICH SPECIFY THE DETAILED SUBSYSTEM CONFIGURATION REQUIREMENTS ARE IN APPENDIX A.

TABLE 3-1
GDS CAPABILITIES FOR ENCOUNTER

FEA 43	FEA 42
ANTENNA MECHANICAL SUBSYSTEM	ANTENNA MECHANICAL SUBSYSTEM
MICROWAVE SUBSYSTEM	MICROWAVE SUBSYSTEM
NOISE ADDING RADIOMETER	NOISE ADDING RADIOMETER
HIGH POWER TRANSMITTER	
MMR	MMR
WIDEBAND BACKUP RECEIVER	WIDEBAND BACKUP RECEIVER
BLOCK IV RCVRs (S & X)	BLOCK III RCVRs (S & X)
BLOCK IV EXCITER	BLOCK III EXCITER
SIM SYNTHESIZER	SIM SYNTHESIZER
BLOCK IV EXTRACTORs (S & X)	BLOCK III EXTRACTORs (S & X)
SIGNAL LEVEL ESTIMATOR (S & X)	SIGNAL LEVEL ESTIMATOR (S & X)
MDA	MDA

SPC-40	LAN	Local Area Network
	APA	Antenna Pointing Assembly
	SPA	Spectrum Processing Assembly
	PPM	Precision Power Monitor
	CMC	Complex Monitor and Control Assembly
	LMC	Link Monitor and Control Assembly
	SSI	Spectral Signal Indicator
	DRA	Digital Recording Assembly
	FTS	Frequency and Timing Subsystem
	ARA	Area Routing Assembly
	ODA	Occultation Data Assembly
PARKES	ANTENNA MECHANICAL SUBSYSTEM	
	MICROWAVE SUBSYSTEM	
	RECEIVER SUBSYSTEM	
	RADIO SCIENCE RECORDING SUBSYSTEM	
	FREQUENCY AND TIMING SUBSYSTEM	
NOCC	NSS	Network Support Subsystem
	VAP	Video Assembly Processor
	NRV	NOCC Radio Science and VLBI RTM
	NTK	NOCC Tracking RTM
CTA-21	CRS	CTA-21 Radio Science Subsystem
GCF		Voice Communications
		Data Lines
	DRG	Data Records Generator
MCCC	RTDS	Real-Time Data System
MSA		RSST Real-Time Support Area
RSST	TSS	Test Support System
	DRS	Data Records System

3.2 DEEP SPACE COMMUNICATION COMPLEXES

DSCC 40, Parkes and the spacecraft are the radio science instruments. Therefore system performance of the DSCC directly determines the degree of success of the experiment, and system calibration determines the degree of uncertainty in the results of the experiment. The following paragraphs describe those functions performed by the individual subsystems depicted in Figures 3-2 and 3-3. Specific configuration and calibration requirements are addressed in Appendices A and B.

3.2.1 DSCC MONITOR AND CONTROL SUBSYSTEM

In the Mark IVA era of the DSN, the Deep Space Communications Complex (DSCC) Monitor and Control Subsystem (DMC) is in many ways the hub of activity at a DSCC. DMC receives and archives most of the information from NOCC needed by the various DSCC subsystems during their operation. Control of most of the DSCC subsystems as well as the handling and displaying of any responses to control directives and configuration and status information received from each of the subsystems is done through the DMC. The effect of this is to centralize the control, display and archiving functions necessary to operate a DSCC. Communication between the various subsystems is done using a Local Area Network (LAN) hooked up to each subsystem via a Network Interface Unit (NIU).

The DMC is broken into two fundamental parts; the complex monitor and control (CMC) and the link monitor and control (LMC). The primary purpose of CMC for radio science support is to receive and archive all predict sets transmitted from NOCC and then at a later time distribute them to the subsystems needing them. The CMC receives all the predict sets transmitted from NOCC such as radio science, doppler and uplink predicts. Upon reception these sets are archived onto a disk for storage until they are needed by a DSCC subsystem. When a subsystem requests a set of predicts, CMC transmits them to the subsystem via the LAN. Assignment and configuration of the LMC's is done through CMC and to a limited degree CMC can perform some of the functions performed by a LMC. There is only one on-line CMC with one backup at each DSCC.

LMC provides control messages entered at a LMC console to the centrally controlled DSCC subsystems, such as the DSCC Spectrum Processing Subsystem (DSP), the DSCC Tracking Subsystem (DTK) and the Precision Power Monitor Subsystem (PPM). The Spectral Signal Indicator (SSI) is one assembly which is not controlled via LMC. One critical radio science specific function the LMC performs is receipt and transmission of the system temperature and signal level information from the PPM to the DSP for recording on the ODR tapes generated by the DSP. It also displays this data at the LMC console as well as putting it in the Monitor 5-9 blocks which are sent to JPL. These blocks are recorded in monitor IDR's as well as displayed in the MCCC displays. The Monitor 5-9 blocks have become the DSS 42 PPM data deliverable to the Voyager radio science team. There are normally three LMCs at each DSCC, although at encounter the backup CMC may be available as an additional LMC.

3.2.2 DSCC ANTENNA MECHANICAL SUBSYSTEM

For the encounter both DSS 42 and 43 will provide support. These antennas function as large-aperture collectors which, by double reflection, focus incoming radio frequency (S- and X-band RCP) energy into the S- and X-band feedhorns (part of the Antenna Microwave Subsystem). Together these two antennas will function as an array with the actual combining of the data being performed in non-real-time when the data is processed in the years following the encounter.

The large collecting surface of each antenna focuses the incoming rf energy onto a hyperboloid subreflector which is adjustable in both axial and tilt positions to permit optimizing the focusing of energy into the feedhorns.

******NOTE******

THE SUBREFLECTOR IS LOCKED INTO A FIXED POSITION OR CONFIGURED IN A NON-STANDARD MODE FOR SOME RADIO SCIENCE EVENTS. THE ISOE WILL SPECIFY THE POSITIONS AND TIMES TO BE USED.

The subreflector then reflects the received energy to the dichroic plate, a device which reflects S-band energy to the S- band feedhorn and transmits X-band energy to the X-band feedhorn.

Transmitted S-band rf energy emanating from the feedhorn is focused by the same reflectors into a narrow, cylindrical beam. Since the beam is very narrow, it must be pointed with high accuracy and precision. This is accomplished by a series of drive motors and gear trains which rotate those portions of the structure which support the reflectors, position sensors, and related electronics.

Pointing angles are computed in the NOCC Support Subsystem (NSS) from an ephemeris provided by the Project. These predictions are received and archived by the CMC and made available to the Antenna Pointing Assembly (APA) of which there is one on-line at SPC 40. Using these predictions the APA can control and monitor the pointing of each antenna at the complex. The APA provides antenna position angles and residuals, antenna control mode/status information and prediction-correction parameters to the DSCC Tracking Subsystem (DTK) via the local area network (LAN) which then sends this information to JPL. Once a receiver has acquired a signal to provide feedback, a radio source can be tracked by scanning around it (CONSCAN) and computing pointing angles from signal level information supplied by the receiver.

******NOTE******

DURING PERIODS WHEN EXCESSIVE SIGNAL LEVEL DYNAMICS OR LOW RECEIVED SIGNAL LEVELS ARE EXPECTED, I.E., OCCULTATIONS AND SOME OTHER RADIO SCIENCE EXPERIMENTS, CONSCAN CANNOT BE USED AND ANGLE POINTING IS ACCOMPLISHED BY USING AN OFFSET TABLE IN THE APA TO OFFSET THE COMPUTED ANGLE PREDICT SET. SEE SECTION 8.5 FOR DETAILS.

3.2.3 DSCC ANTENNA MICROWAVE SUBSYSTEM

The Antenna Microwave Subsystem accepts the received S- and X-band RCP signals at the feedhorn from the Antenna Mechanical Subsystem. The received signals are transmitted through the polarizer plates to the orthomode transducer. The polarizer plates are adjusted so that the RCP signals are directed to the prime block I X-band TWM and prime block III S-band TWM at DSS 42 and the prime block IIA X-band TWM and prime block IVA SPD S-band TWM at DSS 43. After amplification by the traveling wave masers, the signals are routed to the Receiver-Exciter Subsystem via the microwave switching assembly.

The S-band uplink signal is transmitted via the diplexer assembly through the feedhorn to the antenna where it is focused and beamed to the spacecraft.

The noise diode assemblies, under control of the Precision Power Monitor, inject known amounts of noise power into the received signal path in front of the masers so that accurate real-time system temperature measurements may be made.

3.2.4 DSCC TRANSMITTER SUBSYSTEM

The Transmitter Subsystem accepts the S-band frequency exciter signal from the Receiver-Exciter Subsystem and amplifies it to a transmitted output level of 60 kw during normal Voyager tracking support. The amplified signal is routed via the diplexer to the antenna and then focused and beamed to the spacecraft.

3.2.5 DSCC RECEIVER-EXCITER SUBSYSTEM

The receiver assemblies (of the Receiver-Exciter Subsystem) receive, amplify, and down-convert the frequencies of spacecraft-radiated S- and X-band RCP signals. The closed-loop receivers provide doppler to the Tracking Subsystem. A dedicated four channel, narrow-band open-loop receiver provides video band signals to the DSCC Spectrum Processing Subsystem (DSP). A four channel wide bandwidth open-loop receiver provides a backup subsystem to the narrow-band open-loop receiver. The configuration of the MMR at SPC 40 is different from those of SPC 10 or 60. In order to improve the received downlink SNR it is configured such that two of the four MMR channels are from DSS 43 and the other two are from DSS 42. Specifically, the MMR channels from one to four are respectively DSS 43 SRCP, DSS 42 SRCP, DSS 43 XRCP and DSS 42 XRCP. The four channels of the wideband backup receiver are configured the same way. Figure 3-4 is a diagram of showing how the four first local oscillator (LO) frequencies of the MMR are generated and the downconversion of the X-band signal from RF to video at DSS 43. Figure 3-5 is an analogous diagram for the wideband backup open loop receiver.

The exciter generates the S-band drive signal provided to the Transmitter Subsystem for the spacecraft uplink signal. It is tuñable under the control of the DCO which in turn is controlable by the MDA. This capability is required for all periods of uplink commanding and coherent Doppler because of the damaged Voyager 2 receiver.

The Spectral Signal Indicator (SSI) provides a local display of the received signal spectra at the DSCC and routes this same data to the DSP which routes it to NOCC for remote display at JPL. These displays are used to validate Radio Science System data at the DSS, NOCC, and Mission Support Areas. It is controlled via a dedicated terminal connected to the SSI. Figure 3-6 contains a functional block diagram of the SSI with a definition of the SSI input channels.

The Precision Power Monitor (PPM) measures system temperatures (SNT) and downlink signal levels. It measures SNT by injecting known amounts of noise power into the signal path and comparing the total power with the noise injection on against the total power with the noise injection off. It measures signal level by calculating an FFT to estimate the SNR between the signal level and the receiver noise floor whose power is known from the SNT measurements. There is one PPM controller at SPC 40 which is used to control all SNT measurements and signal level estimates made by the signal level estimators (SLE) for DSS 42 and 43.

The system temperature measurements are made for each maser by utilizing the closed-loop receivers as monitoring devices. DSS 42 and DSS 43 are each equipped with two closed-loop receivers, one for S-band and one for X-band reception during Voyager support. DSS 42 is equipped with two block III receivers whereas DSS 43 is equipped with two block IV receivers. In order to monitor the S-band SNT and X-band SNT for each antenna, switching between S-band and X-band monitoring is required for each antenna. This switching is to be done automatically by PPM firmware. Figure 3-7 contains the PPM configuration at SPC 40.

3.2.6 DSCC TRACKING SUBSYSTEM

The Tracking Subsystem receives the doppler signals and ranging spectra from the Receiver-Exciter Subsystem. The doppler phase and doppler extractor reference phase are counted, formatted, and transmitted to JPL in real-time. Also contained in these blocks is the AGC information from the receiver-exciter subsystem. For ranging, the tracking subsystem generates a range code which is routed to the exciter and modulates the S-band uplink carrier. The demodulated range spectrum is compared to a model of the transmitted range code and the round-trip signal delay to the spacecraft is computed, formatted, and transmitted to JPL also in real-time. Angle information is received from the APA and is also transmitted to JPL in real-time. The GCF Data Records System at JPL produces an IDR tape upon which the doppler, ranging and angle data are delivered to the Project.

In addition, the Tracking Subsystem receives doppler frequency predictions from the CMC and computes doppler residuals and noise estimates, and uplink tuning predicts which it uses to tune the exciter. From the LMC it receives configuration and control directives as well as configuration and status information on the transmitter, microwave and frequency and timing subsystems.

3.2.7 DSCC SPECTRUM PROCESSING SUBSYSTEM (DSP)

The DSCC Spectrum Processing Subsystem at SPC 40 digitizes, and records the narrow bandwidth output from the multi-mission open-loop receiver (MMR). It receives radio science frequency predicts from the CMC, accepts configuration and control data from the LMC, provides display data to the LMC and transmits the signal spectra from the SSI as well as status information to NOCC and the Project Mission Support Area via the GCF wide-band data lines. It controls the tuning of the MMR by sending frequency control information to the programmable oscillator control assembly (POCA) which controls the frequency of the first LO of the receiver and records this information with the digitized narrow-band samples. In addition, it records the DSS 43 system temperature information received from the PPM via the LMC. The DSS 42 PPM data does not get sent to the DSP (due to a design problem) so the only source of this data is the Monitor 5-9 blocks (see 3.2.1). These recordings are made on 9 track computer compatible tape in 6250 bpi GCR format.

3.2.8 WIDEBAND BACKUP OPEN-LOOP RECORDING SUBSYSTEM

The wideband backup open-loop recording subsystem which is sometimes referred to as the Rover subsystem consists of three parts. The first is the wideband open-loop receiver which was mentioned in the receiver-exciter subsytem section. The second is the DRA recording subsystem. The third part is the CTA-21 Bandwidth Reduction Facility (BRF) described in Section 3.7. The wide-band backup open-loop receiver has one first LO and four second LO frequencies, one for each receiver channel, all of which are manually set to fixed frequencies. The four channels are frequency multiplexed into one 8 MHz wide channel which is digitized and recorded by the DRA recording subsystem on 1 inch instrumentation tape.

3.2.9 DSCC FREQUENCY AND TIMING SUBSYSTEM

The Frequency and Timing Subsystem (FTS) provides all frequencies and times required by the other DSCC subsystems. It contains four frequency standards of which one is prime and the other three are backups in case of a failure of the prime standard. Selection of the prime standard is done via CMC. Of these four standards there are two hydrogen masers and two cesium standards. These four standards all feed the Coherent Reference Generator (CRG) which provides the frequency references used by the rest of the complex. It also provides the frequency reference to the Master Clock Assembly (MCA) which in turn provides time to the Time Insertion and Distribution assembly (TID) which provides UTC and sim-time to the complex.

3.2.10 DSCC MARK III OCCULTATION DATA ASSEMBLY

The DSCC Mark III Occultation Data Assembly (ODA) is no longer used at DSCC 40, since VLBI has been transferred to the DSP. However, since the radio science recording subsystem at Parkes consists of a Mark III ODA and since there may be a need to get the Parkes data back to JPL quickly for analysis following the encounter, the capability of playback to JPL of the Parkes data via the ODA and GCF wideband subsystem at SPC 40 is being maintained through the encounter period. In addition, the ODA will be used to duplicate encounter ODA tapes from Parkes. See section 9.7.4 for more details.

3.3 PARKES RADIO OBSERVATORY

The Parkes radio observatory, also referred to as DSS 49, is part of the ground antenna array to be used during the Voyager Uranus radio science recording period. The major subsystems involved with the radio science support are the antenna, the microwave subsystem, the receiver subsystem, the recording subsystem and the frequency and timing subsystem. Figure 3-8 contains a block diagram of the Parkes Radio Science implementation.

3.3.1 PARKES ANTENNA MECHANICAL SUBSYSTEM

The Parkes antenna is a 64 meter azimuth-elevation prime focus antenna; that is, there is no subreflector as exists in the DSN antennae. The antenna is pointed using pointing predicts consisting of daily right ascension and declination estimates of the spacecraft position in the sky combined with a pointing offset table. Station operators can make manual pointing offsets to the nominal pointing. The prime focus cage can be moved to optimize its location as a function of elevation angle.

3.3.2 PARKES ANTENNA MICROWAVE SUBSYSTEM

The Parkes Antenna Microwave subsystem is made up of European Space Agency (ESA) equipment primarily consisting of two X-band polarizers and two Block-IIA type X-band masers. Since Parkes is a prime focus antenna, this equipment resides in a room at the focus of the antenna. One polarizer/maser pair is set up for RCP signals and the other pair is set up for LCP signals. The maser/polarizer configuration can be swapped in the event of failures (for example, if the RCP maser failed, the LCP maser could be switched to become the RCP maser).

This subsystem also has a Noise Adding Radiometer (NAR) assembly containing noise diodes which can inject noise into each of the two X-band masers and which are very similar to the ones used in the DSN. This allows accurate real-time system temperature measurements to be made. This is not a required radio science data type but it is a measurement which the Voyager radio science team would like to have for calibration purposes. Therefore, on a best efforts basis, this data will be measured and recorded and delivered with the rest of the Parkes data.

3.3.3 PARKES RECEIVER SUBSYSTEM

The Parkes receiver is connected to the output of one of the polarizer/maser pairs described in the previous section. For Voyager support the RCP polarizer/maser pair is used. The Parkes receiver is an open-loop receiver which consists primarily of a first LO frequency and a mixer from which an IF is generated. The first LO frequency is 8100 MHz. It is generated by multiplying a 5 MHz reference frequency received from the frequency and timing subsystem up to the LO frequency. The IF frequency generated by this mixer is approximately 320.5 MHz during periods of one-way Voyager 2 data. This IF is the input to the Parkes Radio Science Recording subsystem.

A closed-loop receiver, which is functionally a Block III type receiver, also uses the 320 MHz IF as its input frequency. This receiver is primarily for telemetry acquisition but may also be used during radio science precals to set the voltage levels into the A/D converters of the Radio Science Recording subsystem for the maximum expected signal levels specified in Appendix B.

3.3.4 PARKES RADIO SCIENCE RECORDING SUBSYSTEM

The Parkes radio science recording subsystem provides three functions, namely, receiver IF to video conversion, analog to digital conversion, and recording of the digital data onto magnetic tape. Figure 3-9 is a block diagram of this subsystem. A Mark III ODA controls these three processes. The IF to video conversion is accomplished by mixing the receiver first IF with a second LO frequency to produce a video band signal in the range from 5 to 35 KHz. The second LO is generated by multiplying the frequency from a Dana synthesizer by a factor of 7. The frequency of the Dana is controlled by a POCA which is controlled by the ODA based on a set of predicted frequencies. Since there is no Mark III GCF hookup to Parkes, the predict set must be manually typed in at the ODA. The procedure for this is in the Parkes radio science subsystem user's guide as well as the ODA Radio Science SOM.

This video signal generated by the second mixing stage is fed through an anti-aliasing filter and then sampled by four 8 bit A/D converters which produce a combined sample rate of 80 KHz. This digital data along with POCA tuning information and sample timing information is then recorded on 1600 bpi 9 track magnetic tape.

A spectrum analyzer is used to provide visibility into system performance in real-time. This analyzer can look at the video band signal from the IF to video converter as well as the output from the ODA D/A converter to check the function of the four A/D converters.

3.3.5 PARKES FREQUENCY AND TIMING SUBSYSTEM

The Parkes Frequency and Timing Subsystem provides frequency and timing information to the various Parkes subsystems. It contains two cesium atomic frequency standards, one prime and one backup, each with a crystal oscillator cleanup loop to improve the performance of the cesiums. The prime standard drives frequency and timing distribution equipment. Due to the usage of a Mark III ODA, a good part of the Mark III FTS is implemented at Parkes in order to make the ODA work. The more detailed Parkes radio science subsystem block diagram containing the FTS information is shown in Figure 3-10.

3.4 GROUND COMMUNICATIONS FACILITY

The Ground Communications Facility (GCF) provides the communication networks needed to support the communication requirements of the Radio Science System. These facilities exist at the DSCC and JPL and are briefly described in the following paragraphs.

3.4.1 GCF HIGH-SPEED DATA SUBSYSTEM

The High-Speed Data Subsystem transmits radio science open-loop tuning predictions from the NOCC to the DSS and CTA-21 and sends Radio Science, Tracking and Monitor and Control Subsystems status and configuration data from the DSCC to the NOCC.

3.4.2 GCF WIDEBAND SUBSYSTEM

In real time, the Wideband Subsystem transmits SSI data from the DSS to the NOCC. After the completion of a radio science recording period this subsystem sends radio science data from the DSCC to the NOCC.

3.4.3 GCF DATA RECORDS SUBSYSTEM

The GCF Data Records Generator (DRG) formats and provides radio science data on computer-compatible tapes called intermediate data records (IDRs) to the Project.

3.4.4 VOICE NET COMMUNICATIONS

The Ground Communications Facility voice nets provide both the means of controlling worldwide spacecraft tracking operations and for relaying information required to verify proper operation of the various DSS and spacecraft subsystems. Section 8.2 contains a more complete description of the voice net structure as it is currently planned for the encounter.

3.5 NETWORK OPERATIONS CONTROL CENTER (NOCC)

The NOCC generates and transmits information for each DSCC prior to tracking support. It also receives, displays, logs and distributes data generated at the DSCC during tracking support. A block diagram overview of NOCC is shown as part of Figure 3-1.

3.5.1 NOCC SUPPORT SUBSYSTEM

For the encounter, the NOCC Support Subsystem (NSS) generates DSCC frequency and tracking predicts using a polynominal coefficient tape (PCT) produced by the POEAS software. In addition, predicts can be generated using manual inputs or from a PCT tape generated by the more standard multi-mission program FPGP which does not model atmospheric effects. The DSN sequence of events (SOE) which is sent to the DSCC is also generated here.

3.5.2 NOCC DISPLAY SUBSYSTEM

The NOCC Display Subsystem generates DTV graphics displays and status and configuration displays. The NOCC Display Subsystem provides these displays to the Network Operations Control Area and the Project's Mission Support Area. The specific subsystems involved are the NRV RTM which generates graphic displays of SSI data and alphanumeric displays of the DSP status and tuning information, the NTK RTM which generates alphanumeric displays of closed-loop, data and the Video Assembly Processor (VAP) which generates graphic displays of selected data types in the closed-loop data received by NTK RTM.

3.6 MISSION COMPUTING AND CONTROL CENTER

3.6.1 REAL-TIME DISPLAY SYSTEM

The Mission Computing and Control Center (MCCC) Real-Time Display System (RTDS) provides displays of the data contained in the monitor 5-9 blocks which is not displayed by any of the NOCC RTM's. This data contains system temperature, AGC and signal level estimates as well as the receiver/exciter subsystem and antenna subsystem configuration information.

3.7 CTA-21 RADIO SCIENCE SUBSYSTEM

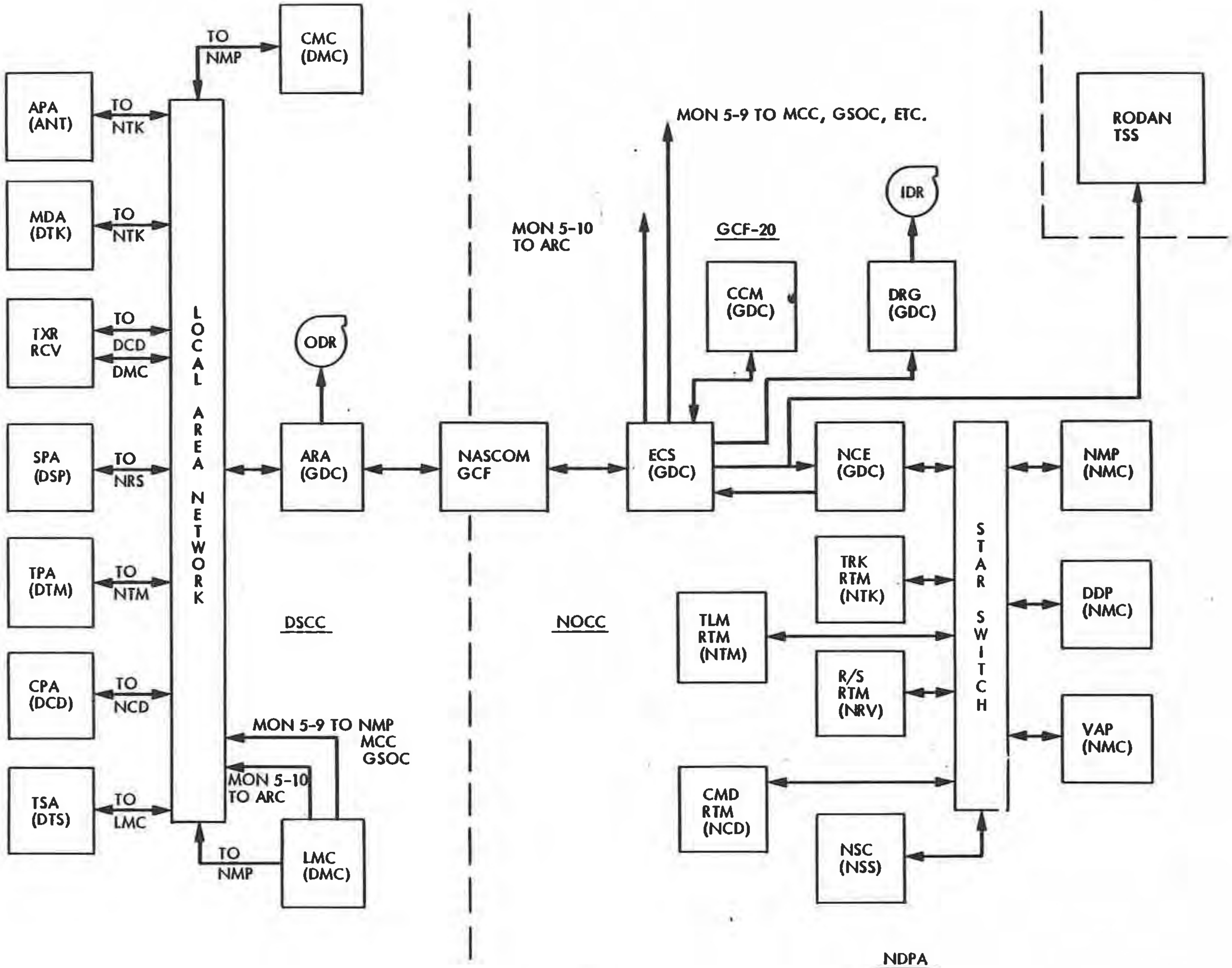
The CTA-21 Radio Science Subsystem (CRS) is located in CTA-21. It consists of the Bandwidth Reduction Facility (BRF) which bandwidth reduces the wide bandwidth radio science data recorded at DSCC 40 using Mark III style radio science predictions received from NOCC in a Mark III mode. It reads digital wide bandwidth radio science data generated by the DSCC 40 Wideband Backup Open-loop Recording Subsystem on one-inch instrumentation tapes and performs a bandwidth reduction process on the data and writes the reduced bandwidth data onto computer compatible 9 track tapes for the Voyager RSST.

3.8 MISSION SUPPORT AREA (MSA)

The Mission Support Area contains the Voyager Project's real-time control center for the Radio Science System. DTV displays and hardcopy capability are provided to the Project's real-time operations personnel to aid in operations control. See Section 6 for a more complete description.

3.9 RADIO SCIENCE SUPPORT TEAM DATA SYSTEM/TEST SUPPORT SYSTEM

This is the Project's radio science data handling system. It consists of the personnel, hardware, software, and procedures required to log, reformat, evaluate, archive, and deliver to the all data products of the Voyager Radio Science System. The RSST Test Support System is a data logging and display system designed and implemented to provide real time visibility into the performance of the radio science activities as well as to allow more detailed quick analysis in near-real time than has previously been possible. It is described in section 11. The RSST Data Production System is described in Section 10.

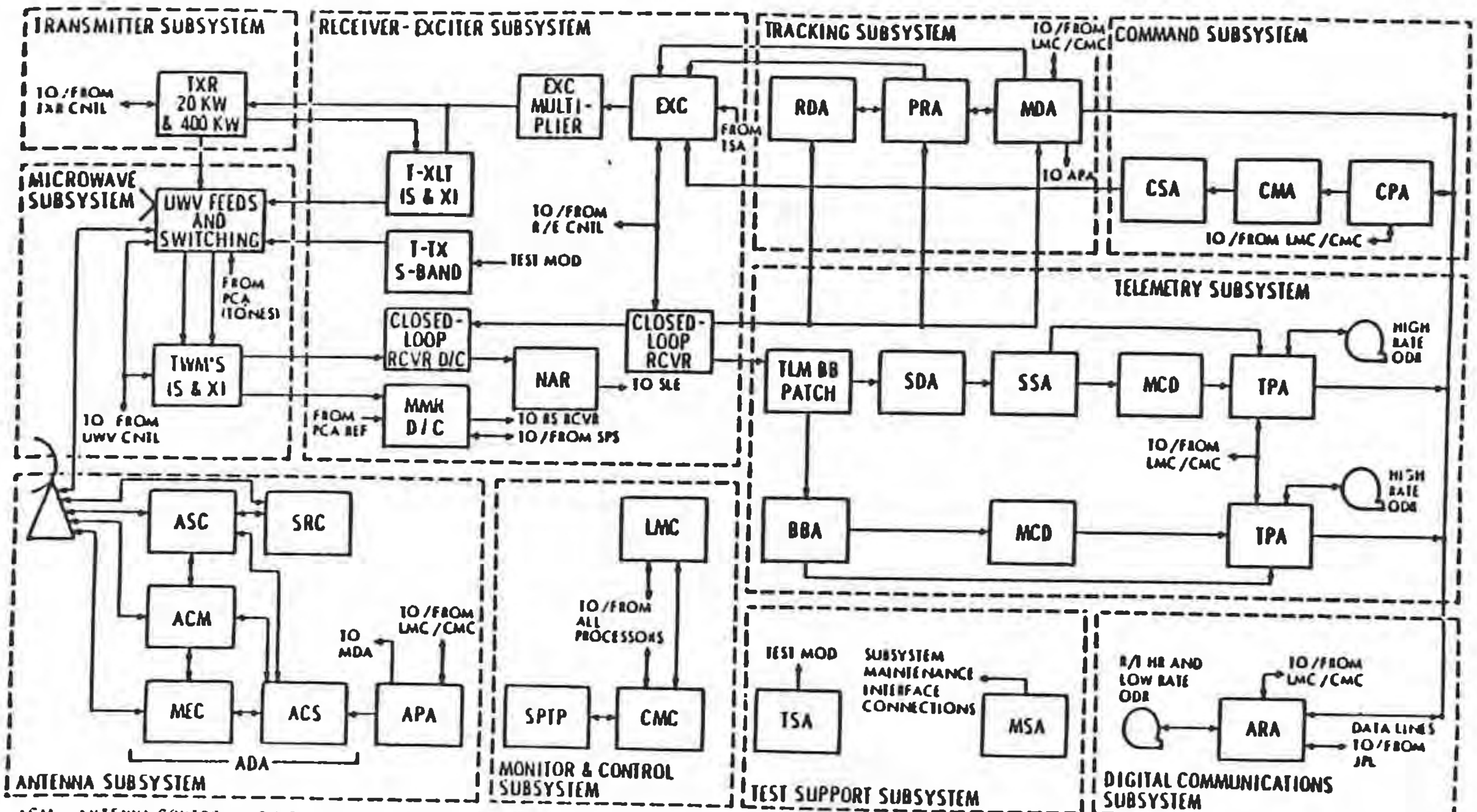


MARK IVA DSN END TO END DATA FLOW

FIGURE 3-1

MARK IVA FUNCTIONAL BLOCK DIAGRAM (WITH ACRONYM DEFINITION)

JPL

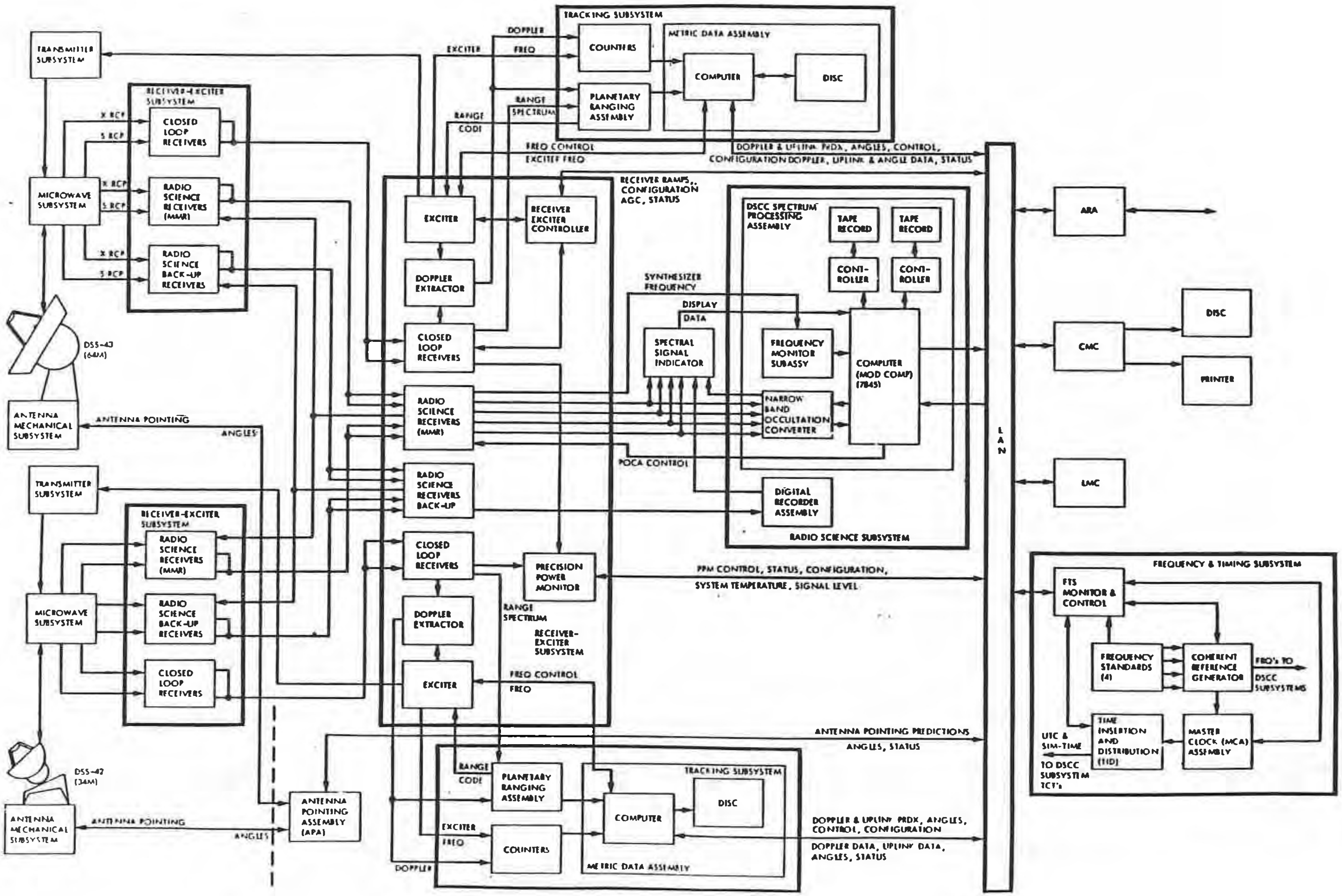


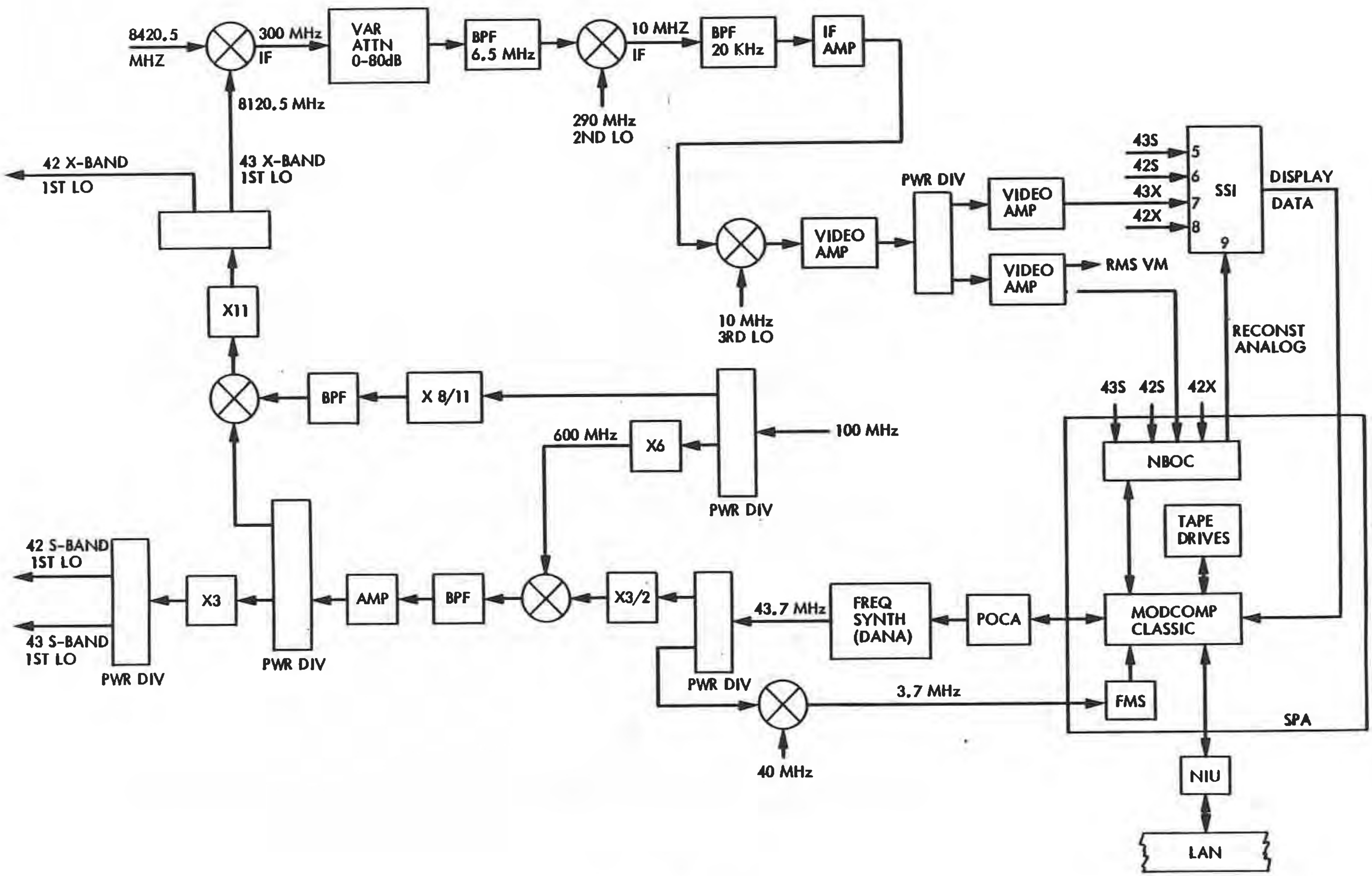
ACM - ANTENNA CONTROL AND MONITOR
ACS - ANTENNA CONTROL SUBASSEMBLY
ADA - ANTENNA DRIVE ASSEMBLY
APA - ANTENNA POINTING ASSEMBLY
ARA - AREA ROUTING ASSEMBLY
ASC - ANTENNA SERVO CONTROLLER
BB - BASEBAND
BBA - BASEBAND ASSEMBLY
CMA - COMMAND MODULATION ASSEMBLY
CMC - COMPLEX MONITOR AND CONTROL
CNTL - CONTROLLER

LMC - LINK MONITOR AND CONTROL
MCD - MAXIMUM LIKELIHOOD CONVOLUTIONAL DECODER
MDA - METRIC DATA ASSEMBLY
MEC - MASTER EQUATORIAL CONTROLLER
MMR - MULTIMISSION RECEIVER
MOD - MODULATION
MSA - MAINTENANCE SUPPORT ASSEMBLY
NAR - NOISE ADDING RADIOMETER
ODR - ORIGINAL DATA RECORD
PCA - PHASE CALIBRATION ASSEMBLY
PRA - PLANETARY RANGING ASSEMBLY

SDA - SUBCARRIER DEMODULATION ASSEMBLY
SLE - SIGNAL LEVEL ESTIMATOR
SPS - SPECTRUM PROCESSING SUBSYSTEM
SPTP - SYSTEM PERFORMANCE TEST PROCESSOR
SSA - SYMBOL SYNCHRONIZER ASSEMBLY
SRC - SUB-REFLECTOR CONTROLLER
TLM - TELEMETRY
TPA - TELEMETRY PROCESSOR ASSEMBLY
TSA - TELEMETRY SIMULATION ASSEMBLY
TWM - TRAVELING WAVE MASER

FIGURE 3-3: DSCC – 40 RADIO SCIENCE SYSTEM DETAILED PLANNING BLOCK DIAGRAM FOR VOYAGER 2 URANUS ENCOUNTER





DSCC 40 MMR/DSP

FIGURE 3-4

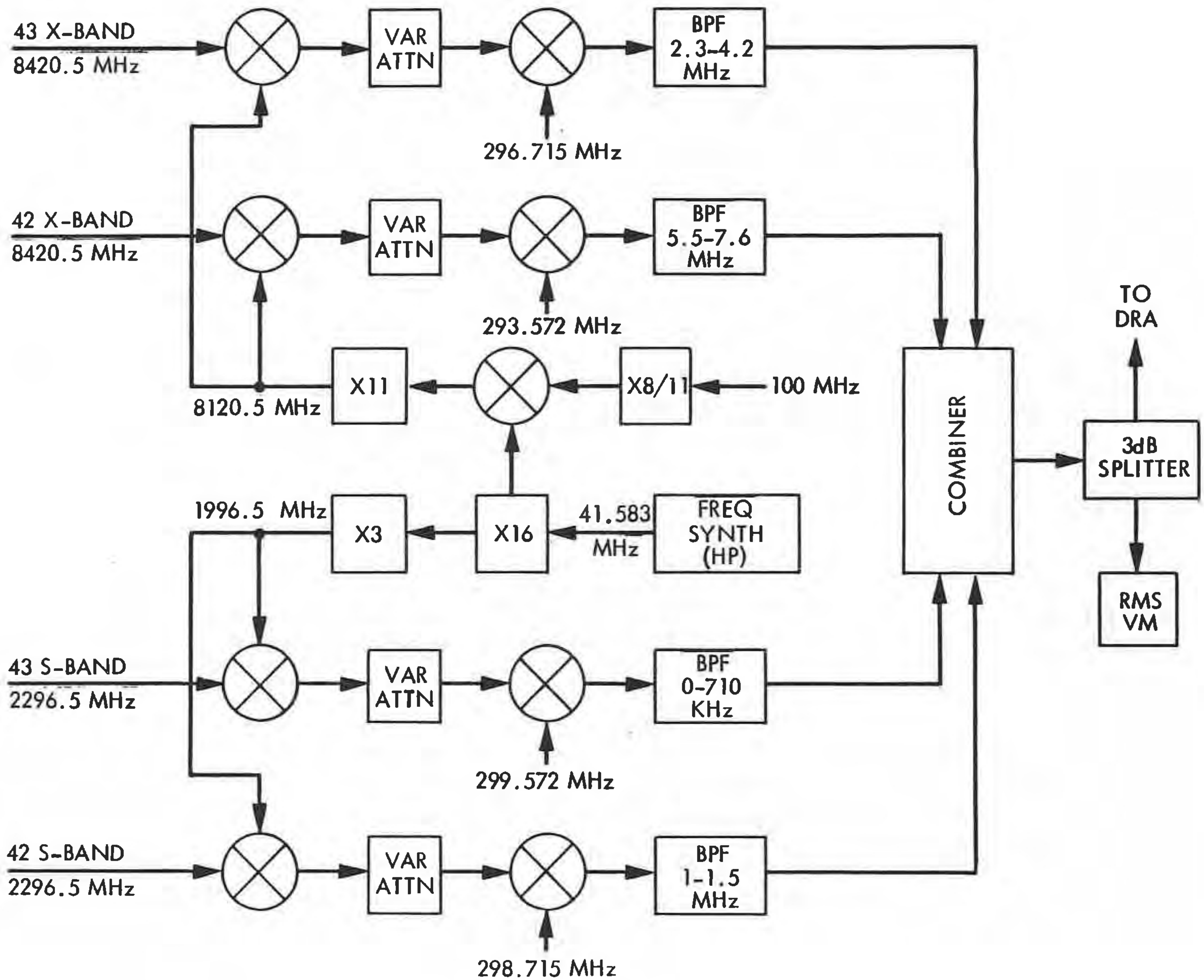


Figure 3-5. Wideband Backup OLR

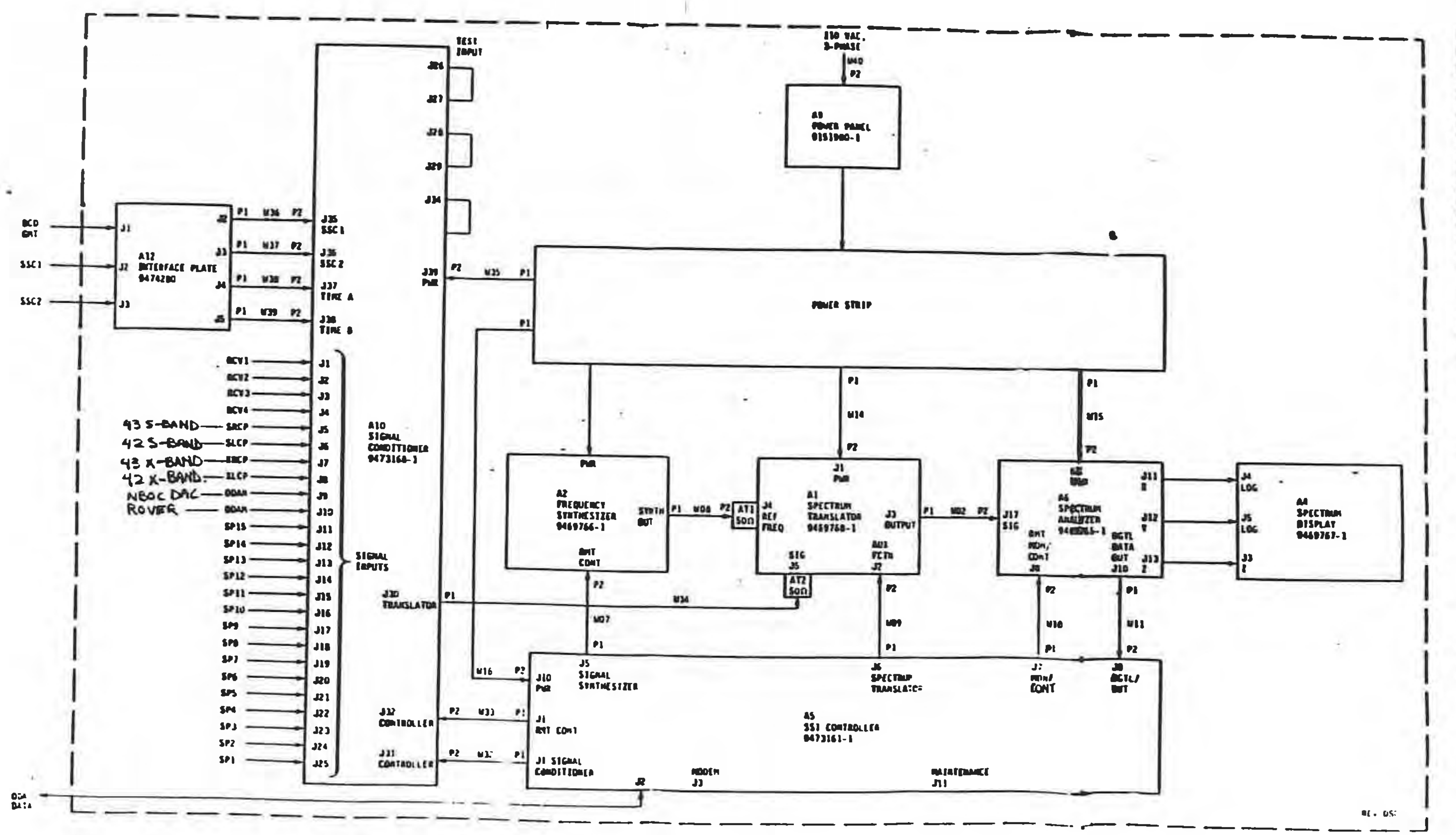
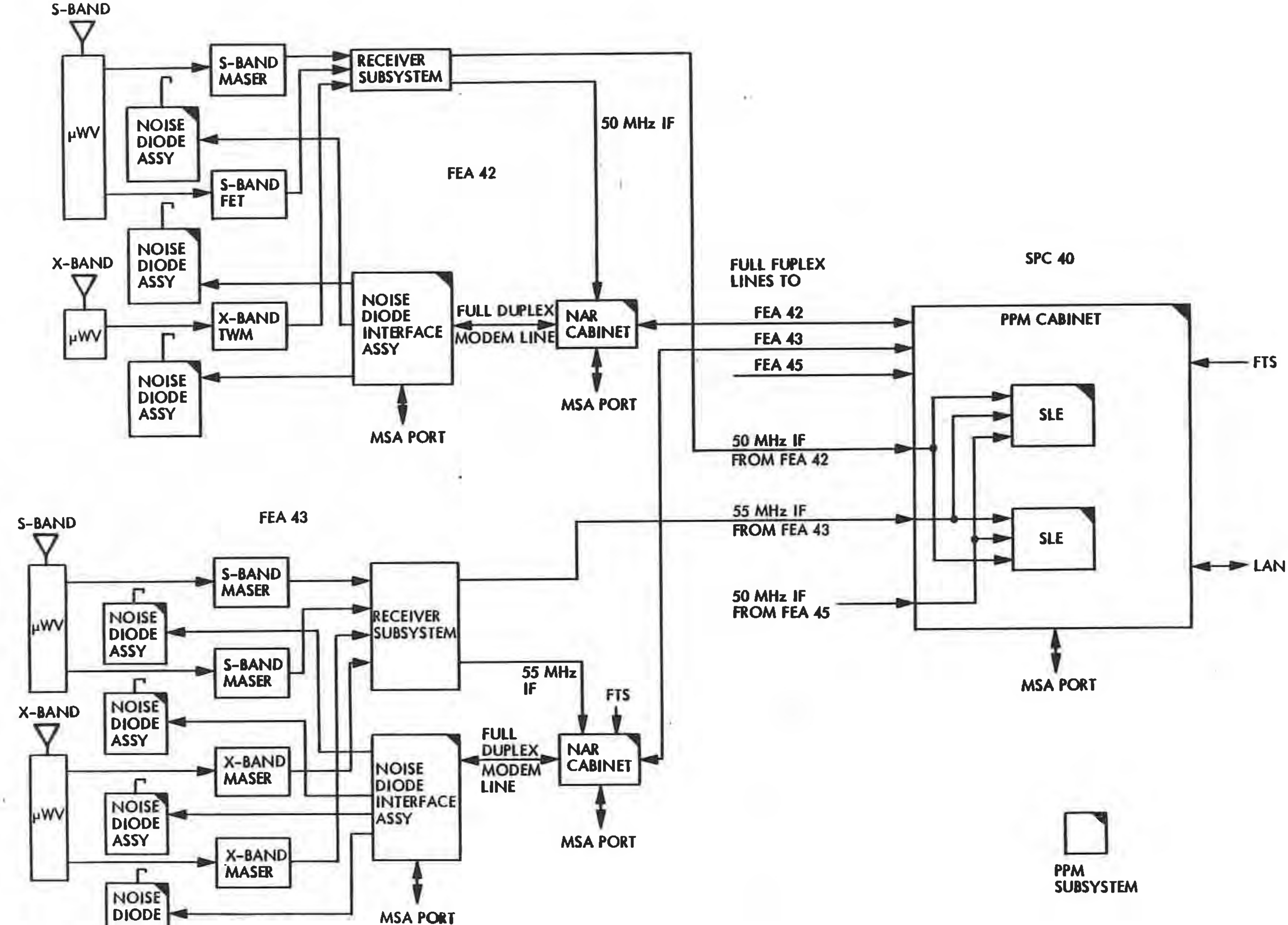


FIGURE 3-6
SSI FUNCTIONAL BLOCK DIAGRAM



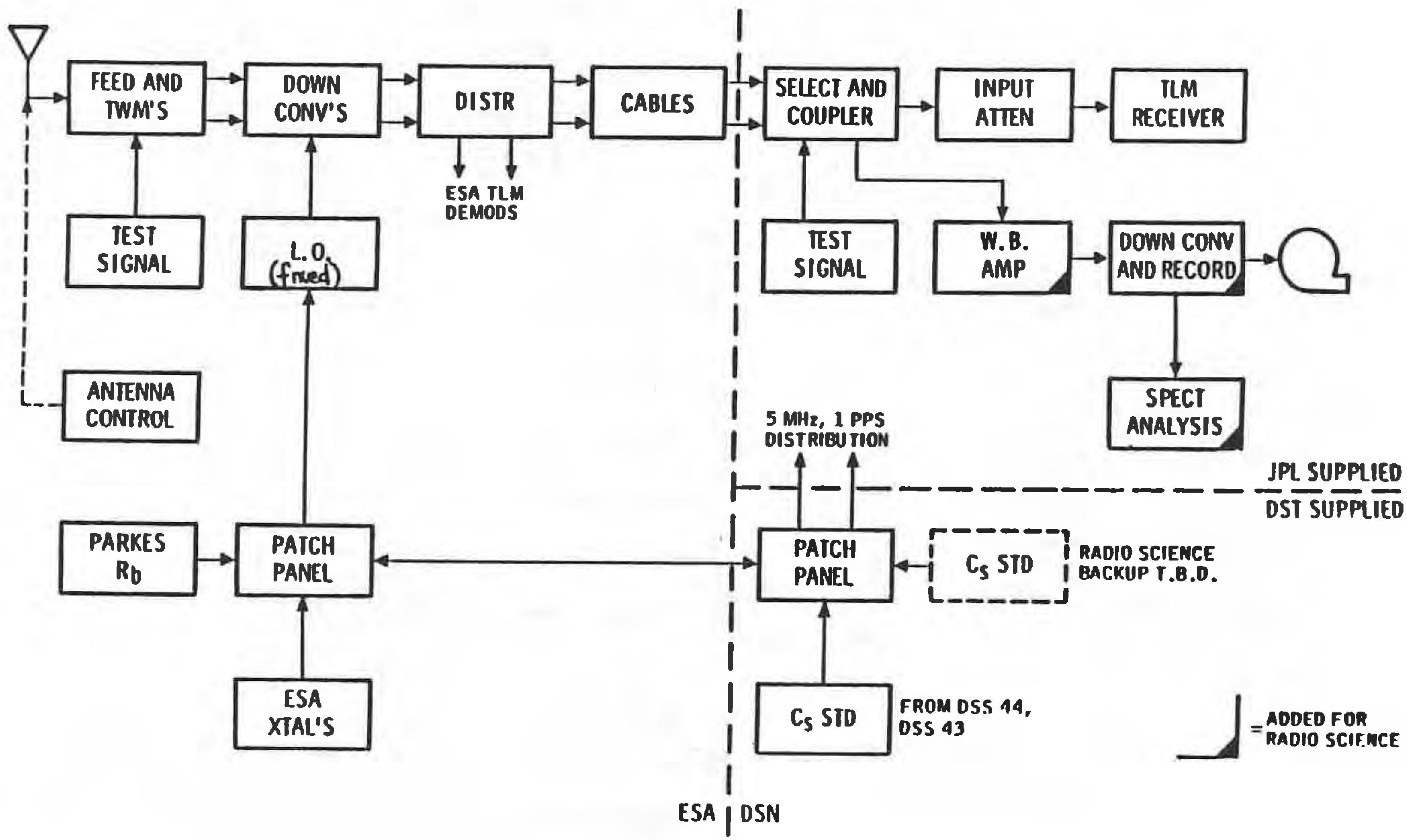
DSCC 40 PPM

FIGURE 3-7

JPL PARKES-CANBERRA RADIO SCIENCE IMPLEMENTATION

SYSTEM DESIGN

BLOCK DIAGRAM - PARKES



JPL

TECHNICAL APPROACH/DESCRIPTION
FUNCTIONAL BLOCK DIAGRAM

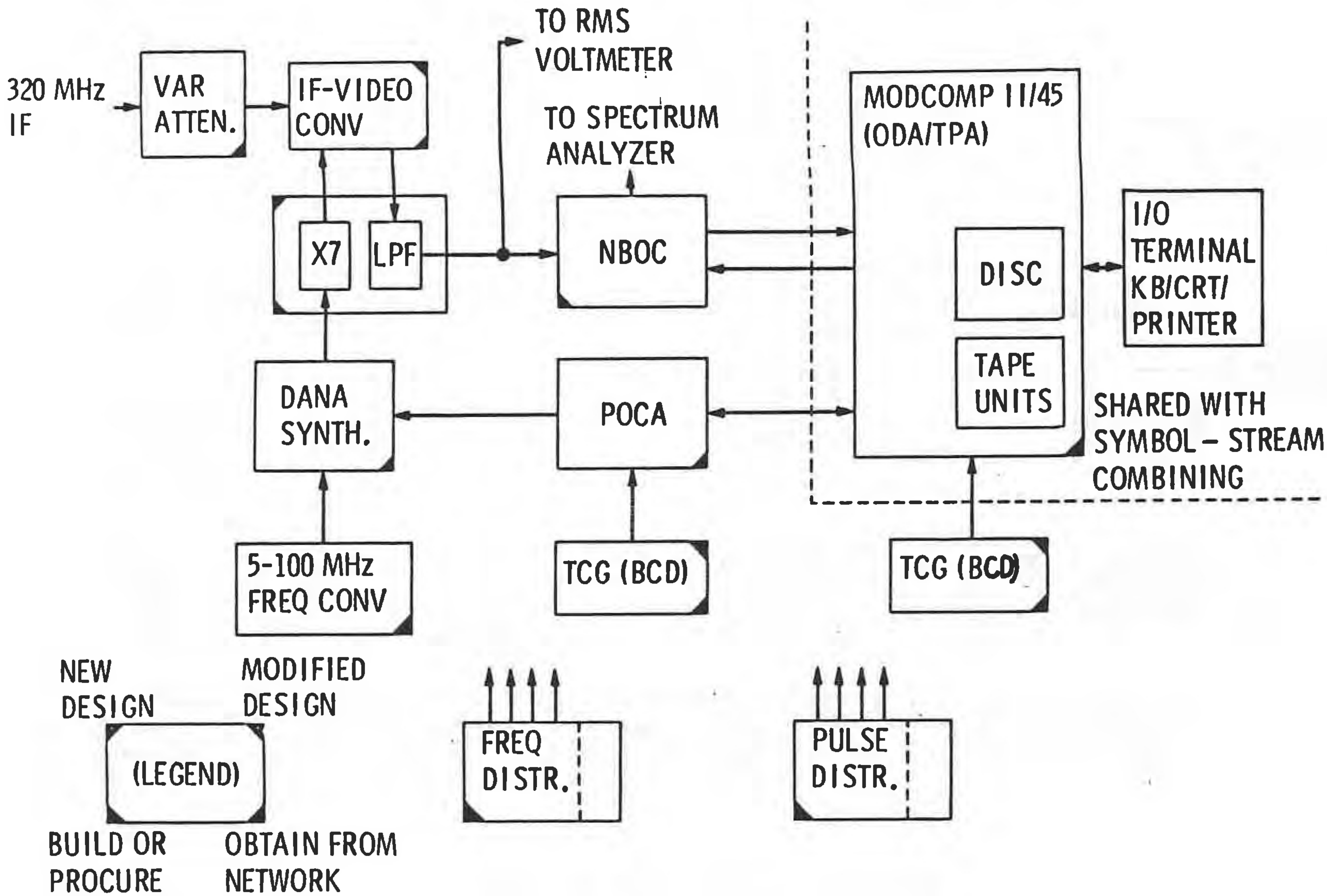
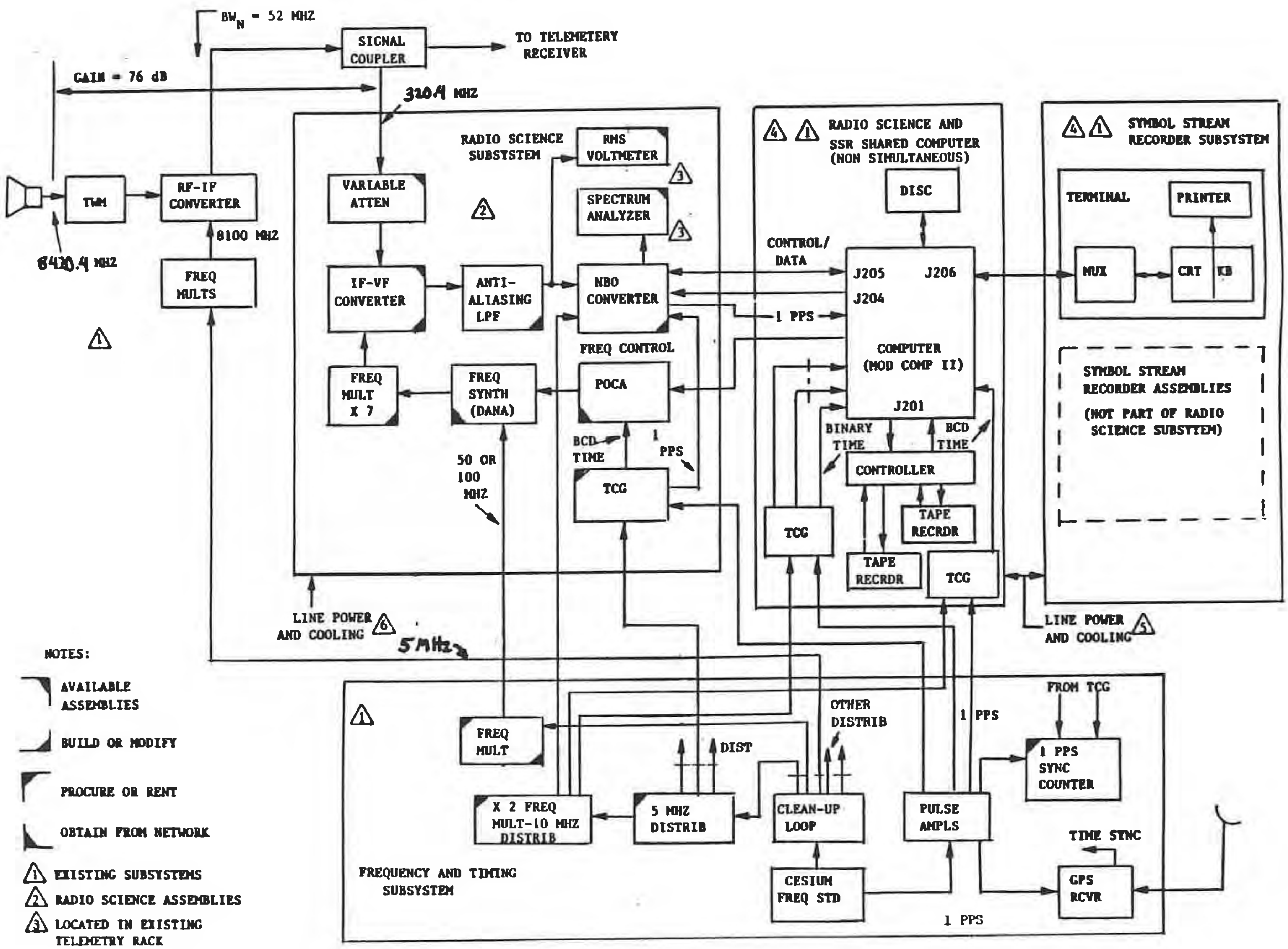


FIGURE 3-9


BW_N = 52 MHZ
SIGNAL COUPLER
TO TELEMETRY RECEIVER
GAIN = 76 dB
320.4 MHZ
TWM
RF-IF CONVERTER
8100 MHZ
8420.4 MHZ
FREQ MULTS
RADIO SCIENCE SUBSYSTEM
VARIABLE ATTEN
RMS VOLTMETER
SPECTRUM ANALYZER
IF-VF CONVERTER
ANTI-ALIASING LPF
NBO CONVERTER
FREQ CONTROL
FREQ MULT X 7
FREQ SYNTH (DANA)
POCA
BCD TIME
1 PPS
TCG
50 OR 100 MHZ
LINE POWER AND COOLING
5 MHz
RADIO SCIENCE AND SSR SHARED COMPUTER (NON SIMULTANEOUS)
DISC
CONTROL/ DATA
J205
J206
J204
1 PPS
COMPUTER (MOD COMP II)
J201
BINARY TIME
BCD TIME
CONTROLLER
TAPE RECRDR
TCG
TAPE RECRDR
TCG
SYMBOL STREAM RECORDER SUBSYSTEM
TERMINAL
PRINTER
MUX
CRT
KB
SYMBOL STREAM RECORDER ASSEMBLIES
(NOT PART OF RADIO SCIENCE SUBSYSTEM)
LINE POWER AND COOLING
FROM TCG
OTHER DISTRIB
1 PPS
DIST
FREQ MULT
1 PPS SYNC COUNTER
X 2 FREQ MULT-10 MHZ DISTRIB
5 MHZ DISTRIB
CLEAN-UP LOOP
PULSE AMPLS
TIME SYNC
CESIUM FREQ STD
GPS RCVR
1 PPS
FREQUENCY AND TIMING SUBSYSTEM
NOTES:
AVAILABLE ASSEMBLIES
BUILD OR MODIFY
PROCURE OR RENT
OBTAIN FROM NETWORK
1 EXISTING SUBSYSTEMS
2 RADIO SCIENCE ASSEMBLIES
3 LOCATED IN EXISTING TELEMETRY RACK

SECTION 4

ENCOUNTER STRATEGY OVERVIEW

This section contains an overview of the strategies that are planned to support the radio science observations described in section 2. There are two parts to this section; the first, section 4.1, describes spacecraft activity that has been implemented to acquire scientific data. The remaining sections describe the ground data system (GDS) strategy. The sections of the GDS which will be used to support the encounter are listed in Table 3-1.

4.1 SPACECRAFT EVENTS

Figure 4-1 contains a schematic of the Voyager telecommunications features utilized by Radio Science. They are described in detail below.

4.1.1 INITIAL CONFIGURATION

4.1.1.1 X-BAND TWT HIGH POWER

Objective: Maximization of the X-band signal level during the first mini-ascal and the ingress ring occultation. During the ring occultation the X-band signal is the primary source of data because it can be made stronger than the S-band signal, it is less sensitive to plasma effects, and it is more sensitive to ring features.

Description: The X-band Traveling Wave Tube (TWT) is set to high power.

4.1.1.2 S-BAND TWT LOW POWER

Objective: Due to power constraints, the S-band TWT must be turned to low power whenever the X-band TWT is on high power.

Description: The S-band TWT is set to low power.

4.1.1.3 TWNC ON

Objective: During the ring and atmospheric occultations at Uranus, an uplink to the spacecraft would be lost. For this reason TWNC is on for the radio science occultation events. During the encounter, this period of TWNC on is used to monitor the spacecraft's ultra-stable oscillator and to allow the Spacecraft Team to perform a BLF test.

Description: TWNC is an acronym for Two Way Non-coherent. When TWNC is on, the downlink carrier frequency is referenced to the spacecraft's ultra-stable oscillator even if the onboard receiver is tracking an uplink.

4.1.2 SPACECRAFT EVENTS DURING ENCOUNTER

4.1.2.1 MIRANDA MASS DETERMINATION

Objective: To determine the mass and density of the Uranian satellite Miranda from doppler data obtained just after the spacecraft's closest approach to Miranda.

Discription: A real-time TWNC off command will be sent to the spacecraft so as to execute just prior to the start of the Ariel and Miranda image motion compensation (IMC) manuevers at 16:05:00 Spacecraft Event Time on the day of Encounter. This will allow the reception of the maximum amount of coherent tracking data when the spacecraft returns to earth point after the IMC's. In order to obtain doppler data during the time before the closed-loop receivers lock-up, open-loop recordings will made.

4.1.2.2 AAI

Objective: Preparation of the spacecraft to perform the gyro-drift turns during the Mini-ascal and Limbtrack maneuvers.

Description: AAI is an acronym for All Axes Inertial. When the spacecraft is AAI, its attitude is controlled by the gyros and is not referenced to any celestial body.

4.1.2.3 X-BAND RANGING CHANNEL OFF

Objective: Maximization of the X-band carrier signal power.

Desciption: When ranging is on, some of the transmitted power is in the ranging sidebands. When ranging is off, this power is found in the carrier and telemetry sidebands. The S-band ranging channel is nominally off in cruise.

4.1.2.4 TELEMETRY MODULATION UNIT (TMU) POWER OFF

Objective: Maximization of both the S-band and X-band carrier signal powers.

Description: When the TMU power is off, the power that would have been in the telemetry sidebands is found in the carrier.

4.1.2.5 MINI-ASCAL

Objective: Determination of the spacecraft attitude for reconstruction of high gain antenna pointing during the ring and atmospheric occultations.

Description: The spacecraft performs pitch and yaw gyro-drift turns of + and - .3 degrees in a cross-hair pattern about Earth point.

4.1.2.6 X-BAND TWT LOW POWER

Objective: Due to power contraints, the X-band TWT must be turned to low power before the S-band TWT can be switched to high power.

Description: The X-band TWT is switched from high power to low power.

4.1.2.7 S-BAND TWT HIGH POWER

Objective: Maximization of the S-band signal power during the atmospheric occultation, because the radio science atmospheric occultation experiment's sensitivity is limited by the signal to noise ratio of the weakest signal - in this case S-band.

Description: The S-band traveling wave tube (TWT) is switched to high power.

4.1.2.8 LIMBTRACK MANEUVER

Objective: Tracking of the Earth's virtual image by the antenna's boresight during the atmospheric occultation.

Description: Eight pairs of pitch and yaw gyro-drift turns cause the HGA to point at the virtual image of Earth as it moves through the atmosphere around the limb of Uranus.

4.1.2.9 S-BAND TWT LOW POWER

Objective: Returning the spacecraft to the normal configuration.

Description: The S-band TWT is switched back to low power.

4.1.2.10 X-BAND TWT HIGH POWER

Objective: Returning the spacecraft to the normal configuration and preparing the spacecraft for the egress ring occultation and second mini-ascal.

Description: The X-band TWT is switched back to high power.

4.1.2.11 TMU POWER ON

Objective: Returning the spacecraft to the nominal configuration.

Description: Power to the TMU is turned back on.

4.1.2.12 SUN ACQUIRE

Objective: The transfer of the spacecraft's pitch and yaw attitude control to the sun sensor.

Description: The spacecraft's sun sensor acquires the sun and takes over control of the pitch and yaw attitude from the spacecraft's gyros.

4.1.2.13 CELESTIAL ACQUIRE

Objective: The transfer of the spacecraft's roll attitude control to Canopus Star Tracker.

Description: The Canopus star tracker takes over contol of the spacecraft's roll attitude from the spacecraft's gyros.

4.1.2.14 POST-OCCULTATION COHERENT TRACKING PERIOD

Objective: To determine the masses of Uranus and it's satellites, particularly Ariel and Umbriel, with greater precision.

Description: A real-time Twnc off command will be sent so as to execute at 0505 UTC to provide coherent tracking data to be used measure the doppler shift caused by the close approach through the Uranian system more precisely.

4.2 DSCC 40 SUPPORT

DSCC 40 will support all six radio science observations described in section 2. Both 42 and 43 will be required to support these observations. For the experiments such as XMMASS, XPGRAV and XSCEL where the closed loop data is the primary data type, DSS 43 is prime and DSS 42 is providing backup data in case there is an outage in the DSS 43 data. XMMASS will also be recorded by the open loop recording system to cover periods where it may be difficult to hold or get the closed loop receivers in lock. For the experiments, XCASCAL, XPOCC and XROCC, the primary data type is the recorded open loop data. For these experiments, DSS 42 and 43 form an S-band array and 42, 43, and Parkes form an X-band array.

4.2.1 DMC SUPPORT

The DMC is expected to provide the functions defined in Section 3.2.1. The reception of the radio science, tracking, uplink and antenna pointing predictions at CMC and then later their distribution to their respective subsystems by the CMC is the major activity required of CMC for the encounter. The CMC must also be available to assign the various subsystems to their respective links.

The LMC will be required to provide centralized control and display for the various DSCC subsystems. The particular LMC points of interest for the encounter are:

1. The ability of the LMC's to run continuously throughout the pass
2. Reception of the DSS 42 and 43 PPM data
3. Distribution of the DSS 43 PPM data to the DSP for recording on the DSP ODR's
4. Generation and transmission of the Monitor 5-9 blocks to JPL in real-time

The LMC configuration for the encounter as far as radio science observations are concerned will be one link containing DSS 43 and a separate link containing DSS 42. The DSP will be in the 43 link. This configuration will be used because it is the configuration deemed least likely to cause any of the LMC's to crash during the encounter pass. Unfortunately due to the design of the routing of the PPM data to the DSP this means none of the DSS 42 PPM data will get to the DSP. DSS 42 PPM information will be received via the Monitor 5-9 data from the 42 link.

4.2.2 ANTENNA SUBSYSTEM

The performance of the Antenna Subsystem at SPC 40 is critical to the success of radio science experiments at Uranus. As a result, the performance of the antenna pointing will be closely monitored during the encounter since the occultation experiments are expected to be SNR limited in terms of the science return from the data.

The current pointing strategy for the encounter during the radio science recording periods is in section 8.5. It is clear that CONSCAN will have to be turned off during the occultation experiments due to the signal dynamics expected during these periods. The subreflector motion in at least the Z-axis will have to be constrained since this introduces phase discontinuities in the received S-band and X-band data. Pointing offset tables are expected to be used at both DSS 42 and 43 during the CONSCAN off periods to optimize the antenna pointing. These tables will have to be developed for the subreflector positioning strategy for each antenna which will be used at the encounter.

The ultimate pointing strategy to be used during the encounter will be specified in the Radio Science consolidated TWX (see Section 7.6) and specific time critical events will be identified in the ISOE.

4.2.3 MICROWAVE SUBSYSTEM SUPPORT

The configuration of the microwave equipment is specified in the configuration tables for DSS 42 and 43 in Appendix A.

4.2.4 TRANSMITTER SUBSYSTEM SUPPORT

The transmitter subsystem will provide two very important functions for the radio science activities at the encounter. The first is that it will provide a coherent uplink frequency for use in the experiments such as XMMASS and XPGRAV which require coherent Doppler data. This is very important because the long term stability of the USO and therefore the noncoherent Doppler data is approximately three orders of magnitude less stable than that of the coherent Doppler data. The second function this subsystem provides is that it radiates any commands that are needed up to the spacecraft. Again, for the coherent Doppler radio science experiments this is critical because in many places in the Voyager sequence the only way the coherent downlink is enabled is via a real-time TWNC off command which switches the downlink from noncoherent to coherent. If this command does not get into the spacecraft, then the downlink will remain noncoherent and the experiment sensitivity will be ruined.

It should be noted that the Doppler mode for XMMASS if all goes well will be 3-way with DSS 14, providing the uplink and DSS 42 and 43 providing the signal reception. There may an attempt to go 2-way immediately following the occultation period to not only improve the mass estimate of Uranus but also the masses of the various Uranian satellites. This will require that the transmitter at DSS 43 be uplinking during the time when the radio science occultation events are being received on the ground.

The nominal transmitter power required is 60 kW. This will require use of the DSS 43 high power transmitter. The DSS 43 low power transmitter is required as a backup to the high power transmitter. The DSS 42 transmitter will act as a backup in the event both the high and low power transmitters fail at DSS 43.

4.2.5 RECEIVER/EXCITER SUBSYSTEM

4.2.5.1 CLOSED-LOOP RECEIVER/EXCITER

The DSS 43 and DSS 42 exciters are critical to radio science activities at the encounter for the same reasons the transmitter subsystem are critical (see 4.2.4). In addition, it must provide the reference frequencies to the Doppler extractors during periods of coherent Doppler data reception. Because the Doppler excursions during the encounter will be so large relative to normal cruise Doppler, the accuracy of the uplink frequency is more critical than normal. In order to get the most accurate uplink possible the uplink predicts will be updated during the 24 hour period prior to the encounter and sent to the station allowing for the most accurate predictions available.

The DSS 42 exciter should be ramped just as the DSS 43 exciter is being ramped throughout the encounter pass to provide an immediate backup to the DSS 43 uplink in case there is any problem in the DSS 43 transmitter and exciter subsystems.

The two closed-loop receivers available at DSS 42 and at 43 will be used in conjunction with the MDA at each DSS to receive downlink phase and amplitude data. The initial RF and AGC configuration for the closed loop receivers is specified in Appendix A. Any planned changes to this configuration will be identified in the ISOE. The block IV receivers at DSS 43 should be configured in the narrow RF mode to allow selection of narrower RF bandwidths during the atmospheric occultation, if it is deemed necessary to maintain receiver lock.

Ramping of the block IV receivers at DSS 43 will be required during two different periods during the encounter. The first is the Miranda mass determination experiment, XMMASS. The second is the planetary atmosphere occultation period. For XMMASS, the intent is to record on the ground as much coherent Doppler data as possible during the period of Miranda closest approach. The current plan is to have TWNC turned off throughout this period via a real-time TWNC off command. DSS 14 will be transmitting at 60 kW to the spacecraft during this period which will provide a good carrier margin at the spacecraft receiver and therefore enable the spacecraft receiver to remain in lock even when it is pointed slightly off earth line. As long as it remains in lock, the downlink will be coherent and therefore will be useful for the XMMASS experiment.

Beginning approximately 15 minutes prior to the atmospheric occultation, the block IV receivers at DSS 43 will be ramped. The specific times will be identified in the ISOE. The purpose here is to aid in maintaining receiver lock as long as possible throughout the atmospheric occultation period. These ramps will be transmitted to the station via radio science consolidated TWX.

The AGC data will be sampled once per second with an integration time of .16 seconds per sample independent of the AGC bandwidth. AGC calibration curves should be generated which cover the calibration signal levels specified in Appendix B for each of the DSS 42 and 43 closed loop receivers.

The importance of the closed loop data for atmospheric occultation lies in the fact that it will be the only data covering the Uranian atmospheric occultation period until the open loop data is processed which will take a minimum of six months to a year.

4.2.5.2 MULTI-MISSION RECEIVER USAGE

The DSS 42 and 43 MMR will be used for two different recording sessions during the encounter pass, the Miranda mass determination experiment and the ring and planetary occultations. This is discussed further in the DSP subsection, 4.2.7.

Precals will be performed on the MMR and the DSP NBOC to ready them for the peak signal levels expected when the telemetry and range modulation is turned off. The calibration signal levels as well as the rest of the radio science precal requirements are specified in Appendix B.

4.2.5.3 SSI

The prime SSI at DSCC 40 will send power spectra to the DSP which will send the data to NOCC in real-time. This data will be used to verify the configuration of the MMR and DSP prior to and during the recording periods. The SSI data is also a quick look science data type for the radio science experimenters. It is extremely important that it function properly because it will provide the only remote visibility into the operation of the MMR at JPL. A nominal set of SSI configurations will be specified in the ISOE. This set of SSI configurations is designed to contain most of the expected usage of the SSI during the encounter. The goals are to use the SSI to verify system performance at specific times and to provide the radio science investigators with a display of either the S-band or X-band downlink power spectrum during each of the experiments. Changes to this nominal set of SSI configurations may be made during real-time depending on how closely the data resembles the expected effects and on how successfully the encounter events occur. The radio science advisor present at DSCC 40 during the encounter will report back to NOCC all the SSI configuration changes made at the complex.

4.2.5.4 PPM SUPPORT

The PPM at DSCC 40 will be used primarily to make system temperature measurements during the encounter. S-band and X-band system temperature (SNT) measurements and signal level estimates from the two Signal Level Estimators (SLE) at DSCC 40 will be required from both DSS 42 and 43 for the 5 hour occultation recording period. Since the SLE data does not meet the radio science accuracy and update requirements specified in the Voyager SIRD it will be used only to calibrate the AGC data. The latest version of the PPM which is capable of automatic switching between S-band and X-band will be used during the encounter. The configuration and integration times are defined in Appendix A of this document. The SNT integration times represent the time required for a measurement of an SNT of 30 degrees Kelvin to have a one sigma uncertainty of 0.3 degrees Kelvin or 1%.

These SNT and SLE data were required to be recorded by the DSP on the narrow band ODR's. However due to design of the routing of data from the PPM to the DSP and the constraints placed on the link configuration discussed in section 4.2.1, the DSS 42 PPM data will not arrive at the DSP. Therefore the 43 PPM data will be recorded on the DSP ODR's and the 42 PPM data will be recorded in the monitor 5-9 IDR's generated at JPL. The data output by the PPM will be monitored at JPL on the MCC RTDS displays in real time since NOCC has no capability for displaying the monitor 5-9 blocks which contain the PPM data.

4.2.6 DTK SUPPORT

4.2.6.1 MDA

The Metric Data Assemblies (MDA) at DSS 42 and 43 will be used to support both the uplink and downlink activities during the encounter. The MDA will receive uplink predictions and control the uplink tuning by commanding the DCO. As mentioned in the transmitter and exciter sections, this is critical to the success of getting coherent Doppler data and of commanding the spacecraft. The uplink tuning predicts will be generated within 24 hours of the encounter in order to make them as accurate as possible. The ground work is being laid at this time to attempt to go 2-way immediately following the occultation events. This will complicate the operations during the occultation events because the MDA will have to tune the uplink frequency during the reception of the occultation data because of the approximately 5.5 hour RTLT. Since DSS 43 will be the prime uplinking station at DSCC 40, the DSS 43 MDA will be the prime exciter controller. As a backup however the DSS 42 MDA should be tuning the 42 exciter along the uplink predict profile for an immediate hand over if necessary.

On the downlink side, S-band and X-band Doppler data generated by the DSS 42 and 43 MDAs is prime for the celestial mechanics experiments, XMMASS, XPGRAV and XSCEL mentioned in section 2. In addition, as mentioned in the receiver/exciter section, the closed loop Doppler and AGC data taken and transmitted by the MDA's to JPL during the atmospheric occultation will be the only data covering the Uranian atmospheric occultation period until the open loop data is processed. The initial MDA configurations are specified in Appendix A. Changes to this configuration will be specified in the ISOE. The nominal Doppler sample rate for the 5 hour occultation recording period will be 10 samples per second with the AGC being sampled once per second. A request may be made in real-time that a time offset be entered into the MDA in order to match the time offset which is to be entered into the DSP and the ODA at Parkes (see section 4.2.7).

4.2.6.2 PRA

The Planetary Ranging Assemblies (PRA) at DSCC 40 will be used for navigation purposes throughout the encounter period. They will not be used directly in any of the radio science observations mentioned in section 2.

4.2.7 DSP

The DSP will be used to record two periods of data during the encounter. The first of the two recording periods is the recording of data during the Miranda mass determination experiment. The second and most important DSP recording period is the ring and atmospheric occultation period which will last approximately 5.5 hours.

During these two recording periods the DSP will be recording 4 channels of data in mode 1 at the 50 KHz sample rate with 8 bit quantization. At this sample rate each complete DSP tape should last 8 minutes. Because the trajectory of the spacecraft is not well constrained in terms of arrival time it is expected that a time offset will have to be used to make the MMR tuning predicts sufficiently accurate. Any time offset will be relayed from the Voyager RSST to the radio science advisor via the radio science voice net prior to the beginning of the two DSP recording periods. This time offset must be entered into the DSP while it is in IDLE mode.

The current plan is for the Miranda open loop recording period to last 40 minutes which will generate 5 tapes. Since the spacecraft will be TWNC off for approximately 80 minutes during this period there is the possibility that this recording period will be requested to be extended to the full 80 minutes. The 40 minute recording period is centered at about 19:40 UTC and will cover the end of the Miranda IMC. The length of this recording period is partially due to the uncertainty in the spacecraft arrival time at Uranus. The purpose is to receive and record coherent Doppler data any time during this period when the spacecraft is close enough to earth-line to lock up to the uplink signal from DSS 14. The period immediately following the Miranda IMC is the most sensitive part of the Miranda Doppler signature where a few extra seconds of data can significantly improve the experiment's sensitivity.

Items such as verification of the configuration of the prime open-loop recording subsystem, the reception of the required predict sets and proper system performance prior to the prime recording periods will be checked in real-time at JPL via the NOCC displays primarily using the remote SSI display at NOCC and the NRV displays. Because of this, the request will be made to keep the DSP in the run mode for the bulk of the pass. The specific run times and tape recording times will be identified in the ISOE.

The DSP will be used to duplicate the NBODR's generated during the precal period and during the pass. It may also be used to play back a certain section of the recorded data after the conclusion of the recording periods. The current plan is to fly two of the NBODR duplicates covering the ring occultation period directly to Stanford University within 36 hours of the end of the pass. The purpose is to process some of the data very quickly and present scientific results at a press conference within a few days of encounter. If any data is to be played back, the specific periods to be played back will be identified during the post observation debriefing identified in the ISOE.

The specifics of the delivery of the DSP NBODR's are defined in section 9.

4.2.8 WIDEBAND BACKUP OPEN LOOP RECORDING SUBSYSTEM

The wideband backup open loop recording subsystem or Rover will be required to provide continuous backup support of the DSP during the occultation recording period. This will require precals to set the receiver levels at the maximum expected signal levels during the pass which are specified in Appendix B. The configuration of the rover is specified in Appendix A. The visibility at JPL into the Rover operation will be provided via voice communication and the SSI. The S-band channels recorded by the Rover will be examined in real-time using the SSI. This is because the SSI can only handle a spectrum from DC to 2 MHz and the X-band channels are above that.

The Rover tapes will last 15 minutes each when the 120 ips rate is used. The current plan is to overlap tapes by 5 minutes. This will leave 5 minutes at the conclusion of each tape before the next tape must start recording. During this time the finished tape can be fast forwarded to the end of the reel in about 1 minute, dismounted, and then the tape heads can be cleaned prior the mounting of the next tape.

The tapes generated on the Rover DRAs will be shipped with the DSP ODR tapes to JPL for reduction at the BRF at CTA-21. The specifics of the delivery process are in section 9.

4.2.9 FTS

The FTS at DSCC 40 is critical to the success of the radio science events during Uranus encounter. It is very important that the same hydrogen maser be used as the frequency reference for both DSS 42 and 43. The FTS performance will be monitored to the extent possible prior to and during the encounter. The real-time monitoring capabilities of the DSCC 40 FTS at JPL are basically limited to the MDA calculated doppler pseudo-residuals, the doppler noise and the SSI.

The FTS NOA will provide a report to the RSST on the status and configuration of the FTS at each complex every two weeks throughout the encounter period.

4.3 PARKES SUPPORT

The Parkes radio science system will record open loop receiver data during the occultation recording period during the encounter. The purpose of using Parkes is to form a three station array along with DSS 42 and 43 to maximize the SNR of the received X-band downlink. The goal at Parkes is to continuously and accurately point the Parkes antenna, downconvert the Voyager 2 X-band downlink signal and to digitize and record the downconverted signal on magnetic tape for the approximately 5 hour period. The Parkes radio science data will be combined with the DSS 42 and 43 data in the data processing following the encounter.

The performance of the Parkes radio science system will be monitored as closely as possible in real-time. The prime device for real-time visibility at Parkes is the spectrum analyzer on site. The only real-time visibility at JPL into the Parkes activities and operations is the voice net. This obviously makes the voice net configuration and operation vital to the success of the Parkes operations for the encounter. Items will be placed in the ISOE at a minimum interval of once per hour requesting a statement from Parkes to JPL concerning the signal and recording status at Parkes.

4.3.1 PARKES ANTENNA MECHANICAL SUBSYSTEM

Accurate antenna pointing for a continuous 5 hour recording period will be required. The real time visibility at JPL into the accuracy of the pointing will be via the voice nets. The real-time visibility at Parkes will be via the antenna pointing subsystem and the AGC from the closed-loop telemetry receiver. The current plan for the positioning of the prime focus cage during the recording period is to position it once prior to the start of recording and then reposition it once during the recording period after the atmospheric occultation and before the second ring occultation. The cage should not be moved more often than this because each repositioning of the cage results in phase discontinuities in the recorded data. The specific times and elevation angles for the repositioning of the cage will be specified in the ISOE and/or the consolidated radio science TWX.

4.3.2 PARKES ANTENNA MICROWAVE SUBSYSTEM

The Parkes microwave subsystem will provide the X-band signal to the receiver subsystem during the encounter. The LCP maser should be available to be switched in as the RCP maser in the events the RCP maser fails. The real-time visibility into the performance of this subsystem will be provided by the Parkes spectrum analyzer.

The Parkes NAR will be used on a best efforts basis to make measurements of system temperature for calibration purposes during the radio science recording period. The details of the NAR configuration are specified in Appendix A.

4.3.3 PARKES RECEIVER SUBSYSTEM

The Parkes receiver subsystem will downconvert the X-band Voyager downlink frequency to a first IF of approximately 320 MHz. This will require that the 5 MHz reference frequency from the Frequency and Timing subsystem be present at the input to the Parkes receiver 1st LO. The real-time visibility into the performance of the receiver will be via the spectrum analyzer. The second LO of the receiver will be controlled by the ODA via a POCA. The backup POCA should be available in the event of failure of the prime POCA.

4.3.4 PARKES RADIO SCIENCE RECORDING SUBSYSTEM

If all goes well, data will be continuously recorded by this subsystem for the duration of the radio science occultation period. Due to the large arrival time uncertatinty at Uranus, entry of a time offset into the ODA is expected to be required prior to start of recording. This time offset will be passed via the radio science voice net to the Parkes radio science representative. It should be identical in magnitude but opposite in sign to the time offset entered at the DSP due to the different implementation of time offset algorithms in the ODA and DSP. Parkes will receive two sets of radio science predictions in the consolidated radio science TWX for one-way and three-way periods respectively. The recording period will be in the one-way mode.

The required ODA and open loop receiver precals are specified in Appendix B. Real-time visibility at Parkes will be provided by the spectrum analyzer and the ODA terminal. Visibility at JPL will be via the voice net.

A section of the Parkes tapes may be requested to be played back to JPL following the encounter if it is deemed necessary. However at the current time it appears this will not be requested. The delivery of the tapes to JPL is specified in section 9.

4.3.5 PARKES FREQUENCY AND TIMING SUBSYSTEM

The Frequency and Timing subsystem (FTS) is required to provide stable frequencies, times and timing pulses to the receiver and recording subsystems. The FTS NOA will provide a report on the status and configuration of the Parkes FTS every two weeks throughout the encounter period. This report will contain the measured time offsets between Parkes and DSCC 40.

4.4 GCF SUPPORT

4.4.1 PREDICT TRANSMISSION

GCF lines will be required prior to the encounter on which to transmit the necessary predicts and SOE's to DSCC 40 from NOCC.

4.4.2 DATA LINES DURING THE ENCOUNTER

Sufficient GCF data lines will be required between NOCC and DSCC 40 to transmit SSI data, tracking data and monitor data to NOCC from DSCC 40 during the encounter.

4.4.3 VOICE NETS

The voice net configuration defined in Section 8.2 will be required for the encounter.

4.4.4 DATA PLAYBACK TO NOCC

After the prime recording period wideband lines must be available for possible playback of a selected portion of the DSP recordings. Some time after the completion of the encounter, the data tapes generated at Parkes will be moved to DSCC 40. At this time a playback of a selected portion of the Parkes ODA tapes may be requested. IDRs of the DSP and ODA playback data will be generated at JPL and delivered to the RSST. The estimated ratio of the original recording sample rate to playback rate is approximately 40 to 1 so a playback of 1 minute of data will take 40 minutes, although this will also depend on the playback rate. The playback data segment is expected to consist of a minute or two of original recorded data.

4.5 NOCC SUPPORT

4.5.1 NSS

The NOCC Support Subsystem (NSS) generates the predictions for the DSN. Seven types of predictions will be generated to support the encounter. They are:

1. DSCC 40 radio science predicts
2. Parkes radio science predicts
3. Closed-loop receiver tuning predicts
4. Doppler predicts
5. Wide-band backup receiver 1st LO frequencies
6. Uplink predicts
7. Antenna pointing predicts

The details of the predicts are discussed in Section 7.1.

4.5.2 DISPLAY SUBSYSTEM AT NOCC

The display subsystem at NOCC will provide the bulk of the real-time visibility at JPL during the encounter. The NRV remote SSI display, the NRV DSP status displays, the VAP closed-loop radio science graphics displays, the NTK tracking alphanumeric displays and the NMP monitor alphanumeric displays are all expected to be used to support this encounter. The specific NOCC displays requested by the RSST for remote viewing in the Voyager radio science areas are defined in Appendix F.

4.6 MISSION COMPUTING AND CONTROL CENTER

4.6.1 REAL-TIME DISPLAY SYSTEM

The MCCC RTDS will be used during the encounter to provide visibility into receiver/exciter and antenna configuration and into the PPM data and status.

4.7 CTA-21 SUPPORT

4.7.1 BRF SUPPORT

The tapes generated on the Rover subsystem at DSCC 40 will be shipped to NDC at JPL. From there the tapes will be delivered to CTA-21 where they will be reduced to computer compatible 1600 bpi IDRs. This will require transmission of radio science predicts in the Mark III format to the BRF for the bandwidth reduction processing. The IDRs generated by the BRF will be delivered to the RSST.

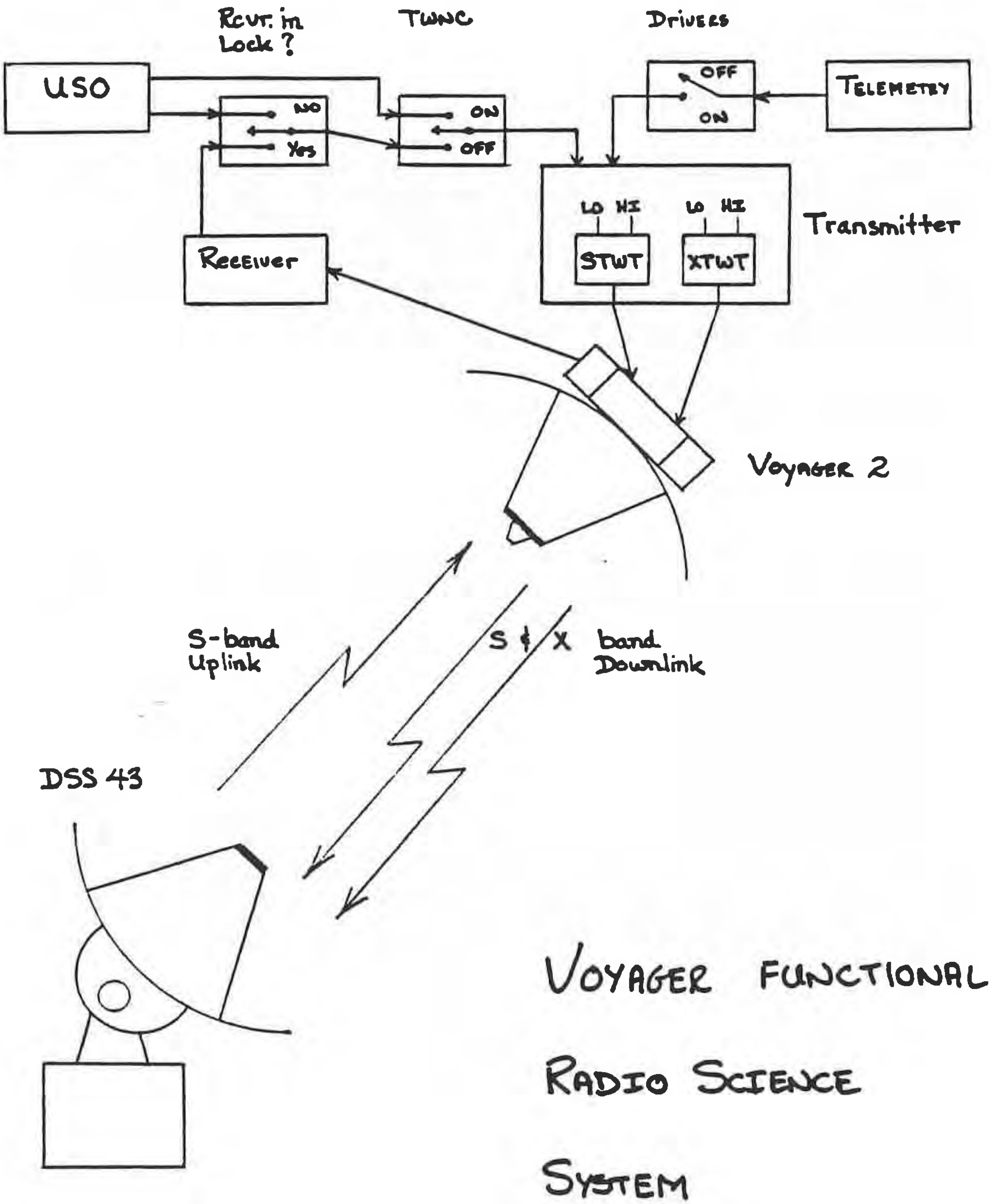

Rcvr. in Lock?
TWNC
Drivers
USO
NO
Yes
ON
OFF
OFF
ON
Telemetry
LO HI
LO HI
Transmitter
Receiver
STWT
XTWT
Voyager 2
S-band Uplink
S & X band Downlink
DSS 43
VOYAGER FUNCTIONAL
RADIO SCIENCE
SYSTEM

Fig 4-1

SECTION 5

EVENT TIME-ORDERED LISTING AND TIMELINE

5.1 SPACECRAFT EVENTS TIME-ORDERED LISTING

Table 5-1 is the time-ordered listing of the events onboard Voyager 2 that will be executed as a part of the Radio Science experiment set in the B752 command load. Section 4 contains a detailed discussion of the meaning of these events.

Most of these spacecraft events will move in time as a result of the Late Stored Update (LSU) process which will optimize the time of the start of the limbtrack maneuver. The potential time shift is on the order of +- 10 minutes.

5.2 GROUND EVENTS TIME-ORDERED LISTING

Table 5-2 contains the approximate ground events that will be expected to occur in support of the Uranus encounter Radio Science experiment set. Sections 3 and 4 contain detailed discussions of the meaning of these events.

A number of these items will move in time as a result of the Late Stored Update (LSU) process. The potential time shift is on the order of +- 10 minutes.

5.3 TIMELINE

Figure 5-1 is an approximate timeline for the Uranus encounter DSCC40 pass.

****

WARNING

DO NOT USE THESE TABLES AS AN ACTUAL
SEQUENCE OF EVENTS

THE ISOE IS THE CONTROLLING
DOCUMENT FOR ACTUAL EVENT TIMES

****

TABLE 5-1

VOYAGER 2 URANUS ENCOUNTER RADIO SCIENCE
SPACECRAFT EVENTS TIME-ORDERED LISTING

Date: January 24, and January 25, 1986 (DOY 024 and 025)
Time: 20:45 to 03:10 (UTC) Earth received time
18:00 to 00:25 spacecraft event time

SPACECRAFT ACTIVITY		S/C EVENT TIME	EARTH RECEIVED TIME
TWNC ON		18:43:12	21:27:59
AAI		18:56:48	21:41:37
X-BAND RANGE CHANNEL OFF		18:57:36	21:42:27
TELEMETRY MOD UNIT OFF		19:01:36	21:46:26
RADIO SCIENCE MINI-ASCAL			
pitch rate	+12.85 deg/hr	19:08:00	21:52:49
pitch rate	-12.85 deg/hr	19:09:24	21:54:13
pitch rate	+12.85 deg/hr	19:12:12	21:57:02
pitch rate	0.00 deg/hr	19:13:36	21:58:26
yaw rate	+12.85 deg/hr	19:14:24	21:59:12
yaw rate	-12.85 deg/hr	19:15:48	22:00:36
yaw rate	+12.85 deg/hr	19:18:36	22:03:25
yaw rate	0.00 deg/hr	19:20:00	22:04:49
X-BAND TWT LOW POWER		20:11:12	22:56:02
S-BAND TWT HIGH POWER		20:12:00	22:56:48
RSS LIMBTRACK MANEUVER			
pitch rate	+7.341 deg/hr	20:37:37	23:22:24
yaw rate	+0.424 deg/hr	20:37:37	23:22:24
pitch rate	-5.379 deg/hr	20:49:19	23:34:07
yaw rate	-2.792 deg/hr	20:49:19	23:34:07
pitch rate	-1.768 deg/hr	21:00:13	23:45:01
yaw rate	-5.679 deg/hr	21:00:13	23:41:01
pitch rate	+3.203 deg/hr	21:09:43	23:54:31
yaw rate	-6.043 deg/hr	21:09:43	23:54:31
pitch rate	+6.509 deg/hr	21:18:43	00:03:32
yaw rate	-2.453 deg/hr	21:18:43	00:03:32
pitch rate	+5.687 deg/hr	21:27:31	00:12:20
yaw rate	-2.354 deg/hr	21:27:31	00:12:20
pitch rate	-2.395 deg/hr	21:37:07	00:21:56
yaw rate	+5.274 deg/hr	21:37:07	00:21:56
pitch rate	-0.663 deg/hr	21:49:01	00:33:50
yaw rate	+5.900 deg/hr	21:49:01	00:33:50
pitch rate	0.000 deg/hr	22:00:37	00:45:26
yaw rate	0.000 deg/hr	22:00:37	00:45:26

S-BAND TWT LOW POWER	22:19:12	01:04:00
X-BAND TWT HIGH POWER	22:20:00	01:04:48
RADIO SCIENCE MINI-ASCAL		
pitch rate +12.85 deg/hr	23:31:12	02:16:01
pitch rate -12.85 deg/hr	23:32:36	02:17:25
pitch rate +12.85 deg/hr	23:35:24	02:20:14
pitch rate 0.00 deg/hr	23:36:48	02:21:38
yaw rate +12.85 deg/hr	23:37:36	02:22:24
yaw rate -12.85 deg/hr	23:39:00	02:23:48
yaw rate +12.85 deg/hr	23:41:48	02:26:37
yaw rate 0.00 deg/hr	23:43:13	02:28:01
TELEMETRY MOD UNIT ON	23:48:00	02:32:50
SUN ACQUIRE	00:09:55	02:54:45
STAR ACQUIRE	00:12:40	02:57:30

END OF RADIO SCIENCE SPACECRAFT SEQUENCE

TABLE 5-2

VOYAGER 2 URANUS ENCOUNTER RADIO SCIENCE GROUND EVENTS TIME-ORDERED LISTING

*** - EVENTS MARKED BY ASTERISKS ARE EVENTS, THE TIMING OF WHICH WILL BE AFFECTED BY THE SHIFTING OF THE MOVABLE BLOCK AND ARE THEREFORE SUBJECT TO CHANGE AS A RESULT OF THE VOYAGER LATE EPHEMERIS AND LATE STORED UPDATES.

+++ - EVENTS MARKED BY PLUSES ARE TIED TO GEOMETRIC EVENTS AND ARE THEREFORE ONLY "BEST ESTIMATES" OF THOSE TIMES.

PREPASS

024/10:45:00 BEGIN DSCC 40 PRECAL PERIOD

RADIO SCIENCE PRECALS:
- MMR PRECALS
- MMR FILTER = #8 (S AND X BAND)
- NBOC PRECALS
- ROVER/WB BACKUP RCVR PRECALS

DSS-43:

CLOSED LOOP RECEIVER CONFIGURATION:
- S-BAND RECEIVER BW = 10 HZ
- X-BAND RECEIVER BW = 30 HZ
- USE NARROW MODE

PPM CONFIGURATION:
- NAR AUTO SWITCHING ENABLED
- NAR INTEGRATION TIME = 15 SEC
- NOISE DIODE = 0.25 DEGREES
- SLE AUTO SWITCHING ENABLED
- SLE RCVR 1 INTEG TIME = 120 SEC
- SLE RCVR 2 INTEG TIME = 120 SEC

DSS-42:

CLOSED LOOP RECEIVER CONFIGURATION:
- S-BAND RECEIVER BW = 12 HZ
- X-BAND RECEIVER BW = 48 HZ

PPM CONFIGURATION:
- NAR AUTO SWITCHING ENABLED
- NAR INTEGRATION TIME = 60 SEC
- NOISE DIODE = 0.25 DEGREES
- SLE AUTO SWITCHING ENABLED
- SLE RCVR 3 INTEG TIME = 120 SEC
- SLE RCVR 4 INTEG TIME = 120 SEC

10:45:00	BEGIN PARKES PRECALS RADIO SCIENCE PRECALS: ODA PRECALS RUN ODA/POCA SELF DIAGNOSTICS
15:00:00	COMCHIEF: VERIFY VOICE NET CONFIGURATION DESCRIBED IN RADIO SCIENCE OPS PLAN SECTION 8.2
15:30:00	COMCHIEF: RELOAD VAP, DDP, NTK, NRV
15:45:00	CONFIGURE NOCC DISPLAYS PER RADIO SCIENCE OPERATIONS PLAN
	====================== BEGIN ENCOUNTER PASS ======================
16:45:00	AOS DSS-43: START 1/SEC DOPPLER RATE
16:45:00	AOS DSS-42 START 1/SEC DOPPLER RATE
16:47:12	START 115 DEGREE ROLL TURN
16:55:59	END ROLL TURN
16:56:02	X-BAND MODULATION INDEX CHANGE TO 72 DEG EXPECT 1.5 DB INCREASE X-BAND SIGNAL LEVEL
16:59:12	START VTBEST IMC: 0.85 DEG OFF EARTH POINT
16:59:12	END XPGRAV
16:59:12	TWNC ON
16:59:12	START XSCEL
17:00:00	DSS-43: CONFIRM PPM CONFIGURATION
17:00:00	DSS-42: CONFIRM PPM CONFIGURATION
17:04:01	END VTBEST IMC
17:05:00	DSS-14 TRANSFER TO DSS-43

	17:10:00	CONFIRM DSP CONFIGURATION CHN A = 1 B = 2 C = 3 D = 4 MOD MODE = 1 RATE = 8 RESOL = 8 PRD = (USE APPLICABLE PREDICT SET) FRO = +333 HZ - DSP TAPE RECORDERS SET TO 6250 BPI RECORDING DENSITY - ALL TAPES HAVE WRITE RINGS - DSP TRANSMISSION TO NOCC ENABLED RTM INTERVAL = 5 SEC SSI INTERVAL = 20 SEC
	17:15:00	- VERIFY MMR IF/VF CONVERTER SELECTED FOR RADIO SCIENCE (OCI: CFG R64M) AT LOCAL TERMINAL - VERIFY MMR INPUT SWITCH (RACK 4159/RCV 112/A5) IS IN NORMAL POSITION - REPORT MMR/ROVER ATTENUATOR SETTINGS
	17:19:15	START VACOLOR IMC: 2.39 DEG OFF EARTH POINT
	17:27:00	CONFIRM SSI AND NRV DATA DISPLAYED AT NOCC
	17:28:02	END VACOLOR IMC
	17:29:37	START ROLL OF 180 DEGREES
	17:30:00	BRIEFING BETWEEN RSST AND ON-SITE ADVISOR
9:35	17:35:00	CONFIRM SSI CONFIGURATION PORT = 5 B/W = 50 KHZ XFORM = 1024 CF = 37.5 KHZ NAVG = 512 (VERIFY SIGNAL PRESENCE IN MMR'S DSS-43 20 KHZ S-BAND FILTER)
	17:40:00	ENTER INTO DSP TIME OFFSET PROVIDED DURING BRIEFING PUT DSP IN RUN MODE WITH DELAYED TAPE RECORDIN START TIME: 19:20:00 STOP TIME: 20:00:00
	17:41:38	END ROLL
	17:44:02	START VMCOLOR IMC: 1.48 DEG OFF EARTH POINT
	17:52:00	END IMC
	17:56:48	END XSCEL
	17:56:48	TWNC OFF
	17:56:48	START XPGRAV

17:56:48 X-BAND MODULATION INDEX CHANGE TO 75 DEG
EXPECT 1.5 DB DECREASE IN X-BAND SIGNAL LEVEL

18:00:00 CONFIRM SSI CONFIGURATION
PORT = 6
B/W = 50 KHZ XFORM = 1024
CF = 37.5 KHZ NAVG = 512
(VERIFY SIGNAL PRESENCE IN MMR'S
DSS-42 20 KHZ S-BAND FILTER)

18:~~10~~ 02:00 CONFIRM SSI CONFIGURATION
PORT = 7
B/W = 50 KHZ XFORM = 1024
CF = 137.5 KHZ NAVG = 512
(VERIFY SIGNAL PRESENCE IN MMR'S
DSS-43 20 KHZ X-BAND FILTER)

18:08 9 A
18:11 9 B
18:14 9 D
18:17 9 C
CF = 0
BW = 50

18:~~20~~ 04:00 CONFIRM SSI CONFIGURATION
PORT = 8
B/W = 50 KHZ XFORM = 1024
CF = 137.5 KHZ NAVG = 512
(VERIFY SIGNAL PRESENCE IN MMR'S
DSS-42 20 KHZ X-BAND FILTER)

18:24:03 END XPGRAV

18:24:48 TWNC ON ONE WAY

18:24:48 START XSCEL

18:25:00 CONFIRM WB BACKUP RCVR FIRST LO SYNTHESIZER
SET TO NONCOHERENT FREQUENCY

18:28:02 START MOVABLE BLOCK

18:30:00 CONFIRM SSI CONFIGURATION
PORT = 10
B/W = 10 KHZ XFORM = 1024
CF = 428 KHZ NAVG = 512
(VERIFY SIGNAL PRESENCE IN ROVER'S
DSS-43 S-BAND FILTER)

18:35:00 PARKES: CONFIRM ODA CONFIGURATION
CHN 1
MOD 2 7 8
DSS 43
SCN 32
PRD (USE COHERENT SET)
TMO = (TBD)
RUN NB 024 2115 025 0245
REPORT OPEN LOOP RECEIVER ATTENUATOR
SETTINGS

18:40:00	CONFIRM SSI CONFIGURATION PORT = 10 B/W = 10 KHZ XFORM = 1024 CF = 1285 KHZ NAVG = 512 (VERIFY SIGNAL PRESENCE IN ROVER'S DSS-42 S-BAND FILTER)
18:45:00	AOS DSS-49 (PARKES OBSERVATORY)
18:50:00	REAL-TIME TWNC OFF — 2 WAY FOR MIRANDA!
18:50:00	CONFIRM SSI CONFIGURATION PORT = 9 SSS = A B/W = 10 KHZ XFORM = 1024 CF = 12.5 KHZ NAVG = 512 (VERIFY SIGNAL PRESENCE IN DSP'S DSS 43 S-BAND FILTER) ? BW = 1 KHz CF = 12.5-FRO(?)
18:52:00	*** START VABEST IMC: *** ** 2.83 DEG OFF EARTH POINT ** SSS = C BW=1KHz CF = 12.5-4 FRO ?
18:52:00	*** X-BAND MODULATION INDEX CHANGE *** *** TO 72 DEG EXPECT 1.5 DB *** *** INCREASE X-BAND SIGNAL LEVEL ***
19:00:00	PARKES: CONFIRM SIGNAL PRESENCE IN OPEN LOOP RCVR BANDPASS
19:19:15	*** END VABEST IMC ***
19:20:00	CONFIRM DSP RECORDING STARTED ← MIRANDA MASS
19:20:00	*** START VMBEST IMC: *** *** 28 DEG OFF EARTH POINT ***
19:39:13	*** END VMBEST IMC ***
19:39:13	*** START XMMASS ***
20:00:00	CONFIRM DSP RECORDING ENDED AND DSP IS IN IDLE MODE
20:00:00	PARKES: CONFIRM SIGNAL PRESENCE IN OPEN LOOP RCVR BANDPASS
20:15:00	== === BEGIN CRITICAL RADIO SCIENCE EVENTS === === RSST HAS NOCC DISPLAY PRIORITY === ==
20:15:00	PUT DSP IN RUN MODE WITH DELAYED TAPE RECORDIN START TIME: 024/21:15:00 STOP TIME: 025/02:45:00

```
20:20:00        CONFIRM SSI CONFIGURATION
                     PORT = 9              SSS = A
                     B/W  = 10 KHZ       XFORM = 1024
                     CF   = 12.5 KHZ      NAVG = 512
                    (VERIFY SIGNAL PRESENCE IN DSP'S
                     DSS-43 S-BAND FILTER)

20:30:00 (25)   CONFIRM SSI CONFIGURATION
                     PORT = 9              SSS = B
                     B/W  = 10 KHZ       XFORM = 1024
                     CF   = 12.5 KHZ      NAVG = 512
                    (VERIFY SIGNAL PRESENCE IN DSP'S
                     DSS-42 S-BAND FILTER)

20:40:00 (30)   CONFIRM SSI CONFIGURATION
                     PORT = 9            SSS = C (D)
                     B/W  = 10 KHZ     XFORM = 1024
                     CF   = 12.5 KHZ    NAVG = 512
                    (VERIFY SIGNAL PRESENCE IN DSP'S
                     DSS-43 X-BAND FILTER)

(20:35 SSI SSS = C)

20:44:51        *** END XMMASS ***

20:44:51        +++ URANUS CLOSEST APPROACH +++

20:44:51        *** START XPGRAV ***

20:47:11        *** START ROLL OF 65 DEGRESS ***

20:50:00        CONFIRM SSI CONFIGURATION
                     PORT = 9            SSS = D (C)
                     B/W  = 10 KHZ     XFORM = 1024
                     CF   = 12.5 KHZ    NAVG = 512
                    (VERIFY SIGNAL PRESENCE IN DSP'S
                     DSS 42 X-BAND FILTER)

20:53:21        *** END ROLL ***

20:55:00        LOS DSCC 10

21:00:00        CONFIRM SSI CONFIGURATION
                     PORT = 9            SSS = C
                     B/W  = 5 KHZ      XFORM = 1024
                     CF   = 12.5 KHZ     NAVG = 256
                    (VERIFY SIGNAL PRESENCE IN DSP'S
                     DSS 43 X-BAND FILTER)

21:00:00        PARKES: SET ODA TO IDLE, LOAD
                        NONCOHERENT RECORDING-SPAN
                        PREDICTS, SET ODA TO RUN
                        RUN NB 024 2115 025 0245
                !!! WARNING: SIGNAL WILL NOT APPEAR !!!
                !!!   IN PASS BAND UNTIL TWNC ON    !!!
```

21:10:00	CONFIRM WB BACKUP RCVR FIRST LO SYNTHESIZER SET TO NONCOHER FREQUENCY
21:15:00	CONFIRM DSP AND ROVER RECORDINGS STARTED
21:15:00	CONFIRM PARKES RECORDING STARTED
21:20:00	DSS-43: TURN CONSCAN OFF MOVE AND FIX SUBREFLECTOR X/Y/Z AXES FOR 64 DEG ELEVATION
21:20:00	DSS-42: TURN CONSCAN OFF MOVE AND FIX SUBREFLECTOR Z AXIS FOR 64 DEGREE ELEVATION. X/Y AXES IN AUTO FOCUS MODE
21:20:00	PARKES: MOVE AND FIX PRIME FOCUS CAGE OPTIMIZE FOCUS FOR 75 DEG ELEV
21:25:00	DSS-43: START 10/SEC DOPPLER SAMPLE RATE
21:25:00	DSS-42: START 10/SEC DOPPLER SAMPLE RATE
21:27:59	*** TWNC ON ***
21:30:00	CONFIRM SSI CONFIGURATION PORT = 9 SSS = A B/W = 5 KHZ XFORM = 1024 CF = 12.5 KHZ NAVG = 256 (VERIFY SIGNAL PRESENCE IN DSP'S DSS-43 S-BAND FILTER)
21:35:00	CONFIRM SSI CONFIGURATION PORT = 9 SSS = B B/W = 5 KHZ XFORM = 1024 CF = 12.5 KHZ NAVG = 256 (VERIFY SIGNAL PRESENCE IN DSP'S DSS-42 S-BAND FILTER)
21:37:00	DSS-43: REPORT SIM SYNTHESIZER SETTING
21:37:00	DSS-42: REPORT SIM SYNTHESIZER SETTING
21:40:00	CONFIRM SSI CONFIGURATION PORT = 9 SSS = D B/W = 5 KHZ XFORM = 1024 CF = 12.5 KHZ NAVG = 256 (VERIFY SIGNAL PRESENCE IN DSP'S DSS 42 X-BAND FILTER)
21:41:54	*** SPACECRAFT GOES AAI ***

21:42:27 *** SPACECRAFT X-BAND RANGING ***
*** CHANNEL OFF ***
0.2 dB INCREASE IN
X-BAND SIGNAL LEVEL

21:45:00 PARKES: CONFIRM SIGNAL PRESENCE IN
OPEN LOOP RCVR PASSBAND

21:45:00 CONFIRM SSI CONFIGURATION
PORT = 9 SSS = C
B/W = ~~5~~ 50 KHZ XFORM = 1024
CF = ~~12.5~~ 0 KHZ NAVG = 256
(VERIFY SIGNAL PRESENCE IN DSP'S
DSS-43 X-BAND FILTER)

21:46:26 *** SPACECRAFT TELEMETRY ***
*** MODULATION UNIT OFF ***
4.8 dB INCREASE IN
S-BAND SIGNAL LEVEL
10.2 dB INCREASE IN
X-BAND SIGNAL LEVEL

21:52:52 *** SPACECRAFT BEGINS ***
*** RADIO SCIENCE MINI-ASCAL ***
EXPECT S AND X-BAND
SIGNAL LEVEL VARIATIONS

21:55:00 CONFIRM SSI CONFIGURATION
PORT = 10
B/W = 10 KHZ XFORM = 1024
CF = 428 KHZ NAVG = 512
(VERIFY SIGNAL PRESENCE IN ROVER'S
DSS-43 S-BAND FILTER)

22:00:00 CONFIRM SSI CONFIGURATION
PORT = 10
B/W = 10 KHZ XFORM = 1024
CF = 1285 KHZ NAVG = 512
(VERIFY SIGNAL PRESENCE IN ROVER'S
DSS-42 S-BAND FILTER)

22:04:49 *** SPACECRAFT ENDS ***
*** RADIO SCIENCE MINI-ASCAL ***

22:0~~5~~7:00 CONFIRM SSI CONFIGURATION
PORT = 9 SSS = C
B/W = ~~5~~ 10 KHZ XFORM = 1024
CF = 12.5 KHZ NAVG = 256
(VERIFY SIGNAL PRESENCE IN DSP'S
DSS-43 X-BAND FILTER)

22:07:00 PARKES: CONFIRM SIGNAL PRESENCE IN
OPEN LOOP RCVR BANDPASS

22:09:48 +++ RADIO SCIENCE RING +++
+++ OCCULTATION BEGINS (INGRESS) +++

22:56:02 +++ RADIO SCIENCE ATMOSPHERIC +++
+++ OCCULTATION BEGINS +++

22:56:02 *** SPACECRAFT X-BAND TWT ***
*** GOES TO LOW POWER ***
2.3 dB DECREASE IN
X-BAND SIGNAL LEVEL

22:56:50 *** SPACECRAFT S-BAND TWT ***
*** GOES TO HIGH POWER ***
4.8 dB INCREASE IN
S-BAND SIGNAL LEVEL

23:00:00 PARKES: CONFIRM SIGNAL PRESENCE IN
OPEN LOOP RCVR BANDPASS

23:02:00 CONFIRM SSI CONFIGURATION
PORT = 9 SSS = ~~B~~ A
B/W = 5 KHZ XFORM = 1024
CF = 12.5 KHZ NAVG = 256
(VERIFY SIGNAL PRESENCE IN DSP'S
DSS-42 S-BAND FILTER)

23:07:00 CONFIRM SSI CONFIGURATION
PORT = 9 SSS = ~~A~~ C
B/W = 5 KHZ XFORM = 1024
CF = 12.5 KHZ NAVG = 256
(VERIFY SIGNAL PRESENCE IN DSP'S
DSS-43 S-BAND FILTER)

23:12:00 A←SSS

23:10:00 DSS-43: BEGIN S- AND X-BAND RECEIVER RAMPING
VERIFY RCVR SPE ZEROED OUT

23:22:24 *** SPACECRAFT BEGINS ***
*** LIMBTRACK MANUEVER ***
EXPECT S AND X-BAND
SIGNAL LEVEL VARIATIONS

=========================
025/00:00:00 DAY CHANGE >>> DOY 025
=========================

23:30
SSS = C

00:05:00 PARKES: VERIFY ODA STATUS NOMINAL

00:45:26 *** SPACECRAFT ENDS ***
*** LIMBTRACK MANUEVER ***

01:00:00 PARKES: CONFIRM SIGNAL PRESENCE IN
OPEN LOOP RCVR BANDPASS

01:00:00 DSS-43: END CLOSED LOOP RECEIVER RAMPING

01:04:00	*** PARKES: MOVE AND FIX *** *** PRIME FOCUS CAGE FOR *** *** 55 DEG ELEVATION ANGLE***
01:04:00	*** SPACECRAFT S-BAND TWT *** *** GOES TO LOW POWER *** 4.8 dB DECREASE IN S-BAND SIGNAL LEVEL
01:04:49	*** SPACECRAFT X-BAND TWT *** *** GOES TO HIGH POWER *** 2.3 dB INCREASE IN X-BAND SIGNAL LEVEL
01:04:49	+++ RADIO SCIENCE ATMOSPHERIC +++ +++ OCCULTATION ENDS +++ +++ EGRESS RING OCCULTATION BEGINS +++
01:10:00	CONFIRM SSI CONFIGURATION PORT = 9 SSS = D B/W = 5 KHZ XFORM = 1024 CF = 12.5 KHZ NAVG = 256 (VERIFY SIGNAL PRESENCE IN DSP'S DSS 42 X-BAND FILTER)
01:1~~5~~2:00	CONFIRM SSI CONFIGURATION PORT = 9 SSS = C B/W = 5 KHZ XFORM = 1024 CF = 12.5 KHZ NAVG = 256 (VERIFY SIGNAL PRESENCE IN DSP'S DSS-43 X-BAND FILTER)
02:00:00	PARKES: CONFIRM SIGNAL PRESENCE IN OPEN LOOP RCVR BANDPASS
02:16:04	+++ RADIO SCIENCE RING +++ +++ OCCULTATION ENDS +++
02:16:04	*** SPACECRAFT BEGINS *** *** RADIO SCIENCE MINI-ASCAL *** EXPECT S- AND X-BAND SIGNAL LEVEL VARIATIONS
02:28:01	*** SPACECRAFT ENDS *** *** RADIO SCIENCE MINI-ASCAL ***
02:32:50	*** SPACECRAFT TELEMETRY *** *** MODULATION UNIT ON *** 4.8 dB DECREASE IN S-BAND SIGNAL LEVEL 10.2 dB DECREASE IN X-BAND SIGNAL LEVEL

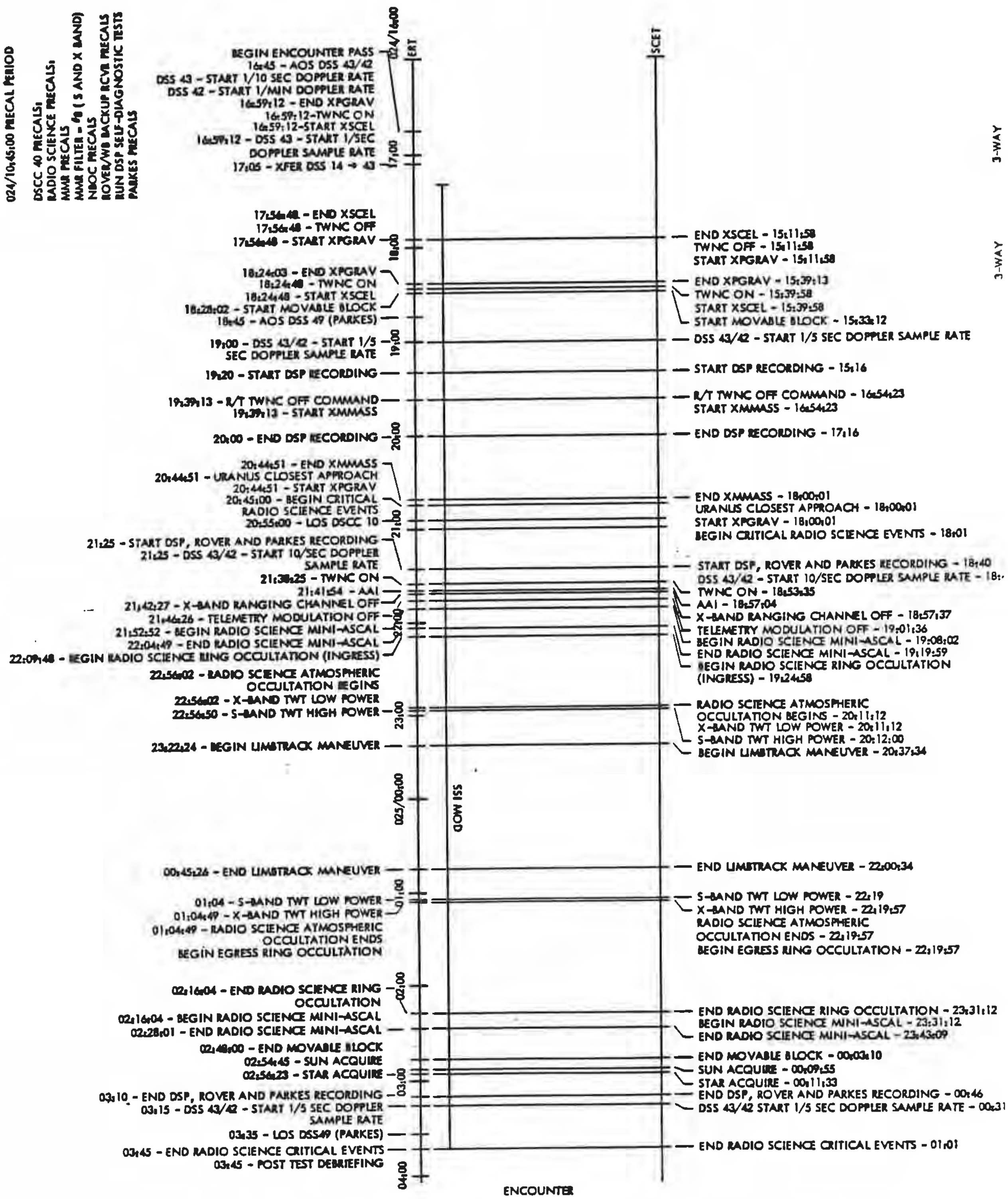
02:45:00	CONFIRM DSP AND ROVER RECORDINGS ENDED
02:45:00	CONFIRM PARKES RECORDING ENDED
02:48:00	END MOVABLE BLOCK
02:48:00	START ROLL OF 76 DEGREES
02:54:23	END ROLL
02:54:45	SPACECRAFT SUN ACQUIRE
02:56:02	X-BAND MODULATION INDEX CHANGE TO 75 DEG EXPECT 1.5 DB DECREASE X-BAND SIGNAL LEVEL
02:56:23	SPACECRAFT STAR ACQUIRE
03:00:00	DSS-43: TURN CONSCAN ON
03:00:00	DSS-42: TURN CONSCAN ON
03:05:00	DSS-43: START 1/SECOND DOPPLER SAMPLE RATE
03:05:00	DSS-42: START 1/SECOND DOPPLER SAMPLE RATE
03:35:00	LOS DSS-49 (PARKES OBSERVATORY)
03:15:00	=================================== END RADIO SCIENCE CRITICAL EVENTS ===================================
03:15:00	POST TEST DEBRIEFING (SEE RADIO SCIENCE OPS PLAN SECTION 8.10)
	PLAYBACK SELECTED PORTION OF DSP ODR'S
	=========== POST PASS ===========
	SHIP PARKES ODR'S TO DSCC-40
	GENERATE POST PASS DSP ODR CALIBRATION TAPE

SHIP EXPEDITED TO NDC:
- DSP ODR'S
- ROVER TAPES
- LMC PRINTOUT
- STRIP CHART RECORDINGS
- PREPASS COUNTDOWN LOG
- TAPE LOG

PLAYBACK PARKES DATA

SHIP EXPEDITED TO NDC:
- PARKES ODR'S

GENERATE COMPUTER COMPATIBLE BANDWIDTH REDUCED IDR'S ON THE BRF AT CTA-21 FROM THE ROVER TAPES



024/10:45:00 PRECAL PERIOD
DSCC 40 PRECALS:
RADIO SCIENCE PRECALS:
MMR PRECALS
MMR FILTER - f0 (S AND X BAND)
NBOC PRECALS
ROVER/WB BACKUP RCVR PRECALS
RUN DSP SELF-DIAGNOSTIC TESTS
PARKES PRECALS
ERT
SCET
3-WAY
3-WAY
BEGIN ENCOUNTER PASS
16:45 - AOS DSS 43/42
DSS 43 - START 1/10 SEC DOPPLER RATE
DSS 42 - START 1/MIN DOPPLER RATE
16:59:12 - END XPGRAV
16:59:12-TWNC ON
16:59:12-START XSCEL
16:59:12 - DSS 43 - START 1/SEC DOPPLER SAMPLE RATE
17:05 - XFER DSS 14 → 43
17:56:48 - END XSCEL
17:56:48 - TWNC OFF
17:56:48 - START XPGRAV
18:24:03 - END XPGRAV
18:24:48 - TWNC ON
18:24:48 - START XSCEL
18:28:02 - START MOVABLE BLOCK
18:45 - AOS DSS 49 (PARKES)
19:00 - DSS 43/42 - START 1/5 SEC DOPPLER SAMPLE RATE
19:20 - START DSP RECORDING
19:39:13 - R/T TWNC OFF COMMAND
19:39:13 - START XMMASS
20:00 - END DSP RECORDING
20:44:51 - END XMMASS
20:44:51 - URANUS CLOSEST APPROACH
20:44:51 - START XPGRAV
20:45:00 - BEGIN CRITICAL RADIO SCIENCE EVENTS
20:55:00 - LOS DSCC 10
21:25 - START DSP, ROVER AND PARKES RECORDING
21:25 - DSS 43/42 - START 10/SEC DOPPLER SAMPLE RATE
21:38:25 - TWNC ON
21:41:54 - AAI
21:42:27 - X-BAND RANGING CHANNEL OFF
21:46:26 - TELEMETRY MODULATION OFF
21:52:52 - BEGIN RADIO SCIENCE MINI-ASCAL
22:04:49 - END RADIO SCIENCE MINI-ASCAL
22:09:48 - BEGIN RADIO SCIENCE RING OCCULTATION (INGRESS)
22:56:02 - RADIO SCIENCE ATMOSPHERIC OCCULTATION BEGINS
22:56:02 - X-BAND TWT LOW POWER
22:56:50 - S-BAND TWT HIGH POWER
23:22:24 - BEGIN LIMBTRACK MANEUVER
00:45:26 - END LIMBTRACK MANEUVER
01:04 - S-BAND TWT LOW POWER
01:04:49 - X-BAND TWT HIGH POWER
01:04:49 - RADIO SCIENCE ATMOSPHERIC OCCULTATION ENDS
BEGIN EGRESS RING OCCULTATION
02:16:04 - END RADIO SCIENCE RING OCCULTATION
02:16:04 - BEGIN RADIO SCIENCE MINI-ASCAL
02:28:01 - END RADIO SCIENCE MINI-ASCAL
02:48:00 - END MOVABLE BLOCK
02:54:45 - SUN ACQUIRE
02:56:23 - STAR ACQUIRE
03:10 - END DSP, ROVER AND PARKES RECORDING
03:15 - DSS 43/42 - START 1/5 SEC DOPPLER SAMPLE RATE
03:35 - LOS DSS49 (PARKES)
03:45 - END RADIO SCIENCE CRITICAL EVENTS
03:45 - POST TEST DEBRIEFING
024/16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
025/00:00
01:00
02:00
03:00
04:00
SSI MOD
END XSCEL - 15:11:58
TWNC OFF - 15:11:58
START XPGRAV - 15:11:58
END XPGRAV - 15:39:13
TWNC ON - 15:39:58
START XSCEL - 15:39:58
START MOVABLE BLOCK - 15:33:12
DSS 43/42 - START 1/5 SEC DOPPLER SAMPLE RATE
START DSP RECORDING - 15:16
R/T TWNC OFF COMMAND - 16:54:23
START XMMASS - 16:54:23
END DSP RECORDING - 17:16
END XMMASS - 18:00:01
URANUS CLOSEST APPROACH - 18:00:01
START XPGRAV - 18:00:01
BEGIN CRITICAL RADIO SCIENCE EVENTS - 18:01
START DSP, ROVER AND PARKES RECORDING - 18:40
DSS 43/42 - START 10/SEC DOPPLER SAMPLE RATE - 18:
TWNC ON - 18:53:35
AAI - 18:57:04
X-BAND RANGING CHANNEL OFF - 18:57:37
TELEMETRY MODULATION OFF - 19:01:36
BEGIN RADIO SCIENCE MINI-ASCAL - 19:08:02
END RADIO SCIENCE MINI-ASCAL - 19:19:59
BEGIN RADIO SCIENCE RING OCCULTATION (INGRESS) - 19:24:58
RADIO SCIENCE ATMOSPHERIC OCCULTATION BEGINS - 20:11:12
X-BAND TWT LOW POWER - 20:11:12
S-BAND TWT HIGH POWER - 20:12:00
BEGIN LIMBTRACK MANEUVER - 20:37:34
END LIMBTRACK MANEUVER - 22:00:34
S-BAND TWT LOW POWER - 22:19
X-BAND TWT HIGH POWER - 22:19:57
RADIO SCIENCE ATMOSPHERIC OCCULTATION ENDS - 22:19:57
BEGIN EGRESS RING OCCULTATION - 22:19:57
END RADIO SCIENCE RING OCCULTATION - 23:31:12
BEGIN RADIO SCIENCE MINI-ASCAL - 23:31:12
END RADIO SCIENCE MINI-ASCAL - 23:43:09
END MOVABLE BLOCK - 00:03:10
SUN ACQUIRE - 00:09:55
STAR ACQUIRE - 00:11:33
END DSP, ROVER AND PARKES RECORDING - 00:46
DSS 43/42 START 1/5 SEC DOPPLER SAMPLE RATE - 00:31
END RADIO SCIENCE CRITICAL EVENTS - 01:01
ENCOUNTER

FIGURE 5-1

SECTION 6

PERSONNEL RESPONSIBILITIES

The responsibilities of the agencies supporting Uranus encounter are described in this section. Responsibilities of specific individuals are also described. For the names of the Radio Science Support Team members and the Radio Science Interface Working Group members, see Appendix G.

6.1 RADIO SCIENCE SUPPORT TEAM

During the radio science critical events period, the radio science operations desk in the Voyager Mission Support Area (MSA 264/521) will be staffed by three members of the RSST. Two other members of the RSST will provide support from RSST Headquarters (264/365). In addition, two RSST members will be supporting activities prior to the critical events period (Late Stored Updates and DSCC 40 precal period). The responsibilities of these RSST members are defined below. The names of specific individuals who will be staffing these positions are in Table 6-1.

6.1.1 OPERATIONS COORDINATOR

The Operations Coordinator is responsible for verification of the proper conduct of real-time operations for the radio science investigation, as specified in the Voyager Project ISOE. Thus, she handles all communications with the Project's mission controller (ACE) via the voice net. All requests by the RSST for actions to be taken by the MCT or DSN are communicated through the ACE by the Operations Coordinator, with the exception of the radio science control functions (see Section 8.2). Additionally, she coordinates communications and interactions among the Science Advisor, Operations Engineer, and Operations Advisor. Finally, she will be responsible for the conduct of daily pre- and post-test briefings. In general, the Operations Coordinator oversees all radio science business in the MSA.

6.1.2 OPERATIONS ENGINEER

The Operations Engineer is responsible for verification of proper operation of the Digital Spectrum Processor(DSP), Spectral Signal Indicator (SSI), Precision Power Monitor (PPM), Metric Data Assembly (MDA) and other DSCC subsystems supporting radio science observations. This is accomplished via monitoring of the real-time DTV displays at the radio science desk in the MSA. The Operations Engineer communicates via the voice net with the NOPE (Network Operations Project Engineer), NOA

(Network Operations Analyst), and ACE (Voyager Spacecraft Monitor Controller) to coordinate DTV operations. He advises the Operations Coordinator on the status of the Radio Science Ground Data System. Additionally, he communicates directly with the Radio Science Representative as required by the Science Advisor, and assists in prepass checklist verification and postpass briefings with the Representative.

6.1.3 SCIENCE ADVISOR

The Science Advisor is responsible for monitoring the progress of the experiment and for providing operational recommendations to the Operations Coordinator based upon scientific considerations. He is the principal contact for the Radio Science Representative via the Radio Science Advisor Net (RADSCI). During the radio science critical-events period, he will direct the use of the radio science control functions via this Net. The Science Advisor may request assistance from the Operations Coordinator and Operations Engineer when making control function decisions.

6.1.4 OPERATIONS ADVISOR

The Operations Advisor staffs the third floor (264/365) radio science operations room and is responsible for assisting the RSST MSA personnel in monitoring experiment progress. He communicates with the Operations Coordinator via the MISD-3 Net. The Operations Advisor is available to work on problems which may be too time-consuming for the MSA personnel, and he may delegate work to the Radio Science Team investigators or other support personnel as required. Additionally, he makes hardcopies of the real-time DTV displays when appropriate.

6.1.5 SUPPORT ENGINEER

The Support Engineer staffs the third floor radio science operations room and is responsible for ensuring proper operation of RSST equipment. He communicates with the Operations Engineer using the MISD-3 net. The primary responsibility is to operate the RODAN computer facility. Its hardware and software will be used to enhance Radio Science experiment visibility by providing real-time displays (the Test Support System - TSS) and by supporting product validation and analysis (the Data Production System - DPS). In addition, the Support Engineer will assist the Operations Advisor with DTV hardcopies.

6.1.6 LATE STORED UPDATE ADVISOR

The Late Stored Update advisor will represent the RSST at LSU activities that have radio science interactions. This will include attending Navigation results meetings to provide concurrance with movable block and limbtrack timing shifts, checking sequence products for proper implementation of such shifts, monitoring POEAS and PREDIX prediction activity, and updating Radio Science ground events to reflect timing changes. Since LSU covers a 24 hour period just prior to the Uranus encounter, it is expected that more than one person will staff this position.

The LSU advisor will also support the Late Ephemeris Update activity about 4 days prior to encounter.

6.1.7 ATR ENGINEER

The responsibilities of the ATR engineer during the Uranus encounter period will be additional support of the LSU activities in association with the LSU advisor, and support of the precal period prior to AOS on the DSCC40 occultation pass. She will provide information to the Operations Coordinator regarding non-operational equipment, calibration settings for Radio Science equipment, onsite prediction status, and general precal period status.

6.2 MISSION CONTROL TEAM SUPPORT TO THE RSST

6.2.1 ACE

The MCT will provide communications support via the ACE-to-OPCH-to-DSCC voice net link for all operational requests from the RSST with the exception of the control functions used when a radio science critical-events period is in effect. Aside from these functions (see Section 8.2) which are controlled via the Radio Science Coordination Net (RADSCI), all communications and support by the MCT will follow normal operational procedures.

6.2.2 SEQUENCE OF EVENTS

The Mission Control Team (MCT) will be responsible for supporting SOE redline activities. Redline support may be required for unexpected events affecting the radio science experiments.

6.3 DEEP SPACE NETWORK SUPPORT TO THE RSST

6.3.1 NOA

A Network Operations Analyst (NOA) will be responsible for generation of receiver tuning predicts for the DSP and Parkes ODA, the closed-loop receivers, uplink tuning predicts and the 1st lo frequency of the Rover subsystem. He, along with the NOPE will also assist the Radio Science Operations Engineer in the analysis of the displayed data and advise the RSST of the operational status of the real-time display system.

6.3.2 NOPE

In addition, a Network Operations Project Engineer (NOPE) will be required to assist in the real-time operations of the NOCC. He will also assist the Radio Science Operations Engineer in the analysis of the displayed data and advise the RSST of the real-time display system's operational status.

6.3.3 RADIO SCIENCE SCOE

The SCOE will be responsible for the design of DSN SPTs for Radio Science and will be interacting with DSCC 40 personnel to ensure that SPTs are performed as specified and that the results indicate proper DSP performance.

6.4 RADIO SCIENCE REPRESENTATIVE TO DSCC 40

The Radio Science Representative to DSCC 40 will represent the Voyager Radio Science Support Team at the DSCC. He will brief the station staff on the radio science experiment's objectives and operational requirements. He will also act as the real-time operations interface between the DSCC Shift Supervisor and the Radio Science Support Team during the radio science critical events periods in order to expedite the control functions specified in Section 8.2. Prior to the high activity period, the Radio Science Representative will participate in the briefings and information exchange between the DSCC and the Radio Science Support Team.

6.5 RADIO SCIENCE REPRESENTATIVE TO PARKES

There will be a Radio Science Representative at Parkes during the encounter period. His responsibilities will be the same as for the DSCC 40 representative.

TABLE 6-1

RSST PERSONNEL RESPONSIBILITIES FOR URANUS ENCOUNTER

OPERATIONS COORDINATOR	Susan Borutzki
OPERATIONS ENGINEER	Rob Kursinski
SCIENCE ADVISOR	Len Tyler
OPERATIONS ADVISOR	Don Sweetnam
SUPPORT ENGINEER	Hank Hotz
LSU ADVISOR	Mick Connally
ATR ENGINEER	Kathy Moyd
REPRESENTATIVE TO DSCC 40	Frank Donivan
REPRESENTATIVE TO PARKES	Dwight Holmes

SECTION 7

PREPASS ENCOUNTER OPERATIONS

This section covers the ten days preceding the encounter. This period will be occupied by final preparations for the encounter. Major preparations for radio science operations will include predict generation and transmission to DSCC 40 and Parkes, final verification of the ground data system via an SPT, and status briefings between the on-site radio science representatives at DSCC 40 and Parkes and the Radio Science Support Team via the Radio Science Advisor Net (RADSCI). The following paragraphs detail procedures and operation schedules for radio science prepass operations.

7.1 PREDICT GENERATION, TRANSMISSION AND DELIVERY

The interface agreements between the RSST, DSN, and Voyager Navigation covering the requirements for predict generation and delivery are listed in Table 7-1. The types of predicts required and the delivery dates will be specified by IOM. The general predict requirements are outlined in the following section and summarized in Appendix C.

The predicts will be generated, transmitted and delivered to the RSST for three distinct periods. The first cycle will occur as soon as possible and contain the spacecraft nominal trajectory for encounter. The second and third cycles will occur during the spacecraft Late Stored Update (LSU) sequence activity. The second cycle occurs after the first navigational update period, and the third occurs after the second navigational update. The predicts generated for the nominal trajectory are planned to be used with a time offset to adjust for the uncertainties in the spacecraft arrival time. The predicts output of the second and third cycles will only be used if there have been significant changes to the nominal trajectory.

7.1.1 POEAS PCT GENERATION

Generation of several POEAS PCTs will be required for encounter. The initial POEAS PCT will be run with the nominal encounter trajectory, with subsequent generations occuring during the spacecraft late stored update activity. The predictions which will be generated from the POEAS PCT to cover the encounter period are the radio science (DSP and ODA), tracking, and uplink sets.

7.1.2 RADIO SCIENCE PREDICTIONS (DSP-R)

The radio science predicts will be generated with a frequency tuning error of less than 100 Hz. The absolute accuracy of the noncoherent (USO) frequencies will be estimated to better than 10 Hz. The coherent frequencies do not require the same absolute accuracy, since the prime open-loop recording will occur in the noncoherent mode.

There will be three distinct radio science predict sets required for encounter. This is a change from the previous strategy where four sets were specified. The first and prime set contains all doppler mode changes expected for the pass. This will include the spacecraft execution of the real-time TNWC off command desired for Miranda mass data collection. In the event that the real-time TWNC off command is not executed, frequency offsets will be used to locate and center the signal. The second and third sets contain only one way doppler; one based on the spacecraft's ultra-stable oscillator and the other on the auxilliary oscillator.

7.1.3 TRACKING/DOPPLER PREDICTS

Tracking predicts will be generated from the POEAS PCT to cover DSS 43 and DSS 42 for the encounter. The doppler modes included in these predicts will be one way (USO frequency specified in predicts request IOM and also an AUX OSC frequency), two way and three way with all sites including DSS 61 and DSS 12.

7.1.4 UPLINK PREDICTS

Uplink predicts will be generated from the POEAS PCT for DSS 43/42, DSS 14/12, and DSS 63/61 to cover the near encounter period. These predicts will be generated with the normal uplink tuning tolerance.

7.1.5 CLOSED-LOOP RECEIVER TUNING PREDICTIONS

The block IV receiver tuning ramps for DSS 43 will be generated to cover the open-loop recording period identified in Section 5. The period during which these ramps will be used is 024/23:10 to 025/01:00 UTC. There will be approximately seven block IV ramps generated at POCA level. These predicts will be included in the radio science consolidated TWX (see Section 7.6).

7.1.6 WIDEBAND BACKUP RECEIVER LO FREQUENCIES

Two first LO frequencies for the wideband backup open-loop receiver will be generated. These values will be for the coherent and noncoherent Voyager 2 downlink frequencies. These values will be contained in the radio science consolidated TWX (see Section 7.6). The four second LO frequencies should never need to change and are contained in Appendix C.

7.1.7 PARKES RADIO SCIENCE PREDICTS

The strategy will be to generate three radio science predicts for the ODA. These will contain a one way (USO) and three way set for the entire pass, and a one way set optimized for the recording period. This strategy is meant to make full use of the fourteen predict points allowed in the ODA manual predict generation mode. The ODA will be IDLED and loaded with the appropriate set as required. These sets will be transmitted via the radio science consolidated TWX where they all will be typed in manually at the ODA at Parkes. Further details on the mechanics of the Parkes radio science predicts generation are contained in the Parkes User's Guide, Section 2.4.2.

7.1.8 PREDICTS TRANSMISSION AND IDENTIFICATION STRATEGY

The strategy will be to transmit the nominal trajectory radio science predicts to DSCC 40 and Parkes as soon as accurate sets becomes available. These sets are to be continuously available at the stations through encounter, which will require the retransmission of the DSP-R sets every three days. The identification and transmission schedule for these sets are contained in Appendix C.

The predictions generated during the LSU period will be transmitted as soon as they are generated and will be available as backup to the nominal trajectory sets.

7.1.9 DELIVERY OF PREDICTS TO THE RSST

The general strategy of the predicts delivery will be to deliver any encounter predict sets as soon as they become available. The delivery of the DSP/ODA radio science, tracking, antenna pointing, and uplink ramping will consist of both a hardcopy (SIGMA 5) and a magnetic tape (VAX generated). The wideband backup open-loop and closed-loop receiver ramping predicts will be made available in the radio science consolidated TWX (see Section 7.6). An IOM which contains further details will be provided per the interface agreements.

7.1.10 SPACECRAFT TRAJECTORY DATA

Celestial Reference Set (CRS) tapes are generated by the Navigation Team; they contain spacecraft trajectory vectors for use in data analysis by the experimenters. These tapes are delivered to the RSST by NAV via a tape interface at the IPC Library. The RSST copies the tapes at the IPC facility, archives them in the RODAN Library, and ships copies to the experimenters.

Delivery details of the CRS tape which covers the period encounter will be contained in an IOM.

7.2 OPERATIONAL VERIFICATION TESTS (OVT)

OVTs may be run during the month prior to encounter. These are DSN tests for operational training and do not officially involve the Voyager project. However, a member of the Voyager RSST may be in to observe the OVT. To facilitate communication between the test conductor and the RSST, the RSC COORD voice line should be made available. The radio science advisors net (RADSCI) should be scheduled up for these OVT to allow the RSST to monitor the conduct of the test and to answer any questions by DSCC operations personnel.

7.3 PRE-ENCOUNTER SYSTEM PERFORMANCE TEST (SPT)

Details for a pre-encounter SPT will be coordinated by the Radio Science SCOE.

7.4 ENCOUNTER STRATEGY REVIEW MEETING

A pre-encounter radio science strategy review meeting will be held as part of the Near Encounter Week Operations Strategy Review Meeting. Members of the RSST will present major topics of the planned encounter strategy to Voyager Project and DSN personnel. Suggestions for improvement will be accepted and implemented as necessary. This meeting is currently scheduled for January 15 at 1:30 PST.

7.5 DAILY BRIEFING STRATEGY

The daily briefings between the RSST and the on-site radio science representatives will begin several days prior to ORT 4 scheduled on January 11 and continue through encounter. These briefings will be conducted from the radio science desk in the Voyager Mission Support Area and will utilize the Radio Science Advisor Net (RADSCI). At least one member of the RSST encounter team will be in attendance. The general agenda is contained in Table 7-2.

7.6 RADIO SCIENCE CONSOLIDATED TWX

The radio science encounter operations will require that vast amounts of information be transmitted to the station which must be clearly understood and immediately accessable. Therefore, a TWX which contains the information formerly scattered in several TWX's will be sent as soon as the information is available but no later than two days prior to the encounter. The information which will be included in this TWX is the predicts normally sent by TWX (Parkes ODA, Rover, and closed-loop receiver ramping), predict identifications, and changes or special requests to the planned operations. Additional items may be added as necessary. The radio science NOPE will be responsible for transmitting the TWX.

7.7 STATION CONFIGURATION CONFIRMATION STRATEGY

Three tables have been devised to ensure proper station configuration for the encounter. These are contained in Appendix A as Tables A-1 through A-3, which corresponds to the DSS 42, DSS 43 and Parkes configuration respectively. The tables contain specific information for all applicable subsystems (refer to Section 3.2 for descriptions of the DSCC subsystems).

Compliance with each configuration table will be done in two ways for the encounter. The confirmation of selected items will be done during the pre-encounter briefing between the RSST and the on-site radio science representatives. In addition, the ISOE will call for configuration confirmation which will be relayed from the the DSCC to the NOCC via the standard operational network (DSCC to OPCH/TRAKON).

7.8 OPEN-LOOP RECORDING SYSTEM PRE-PASS CALIBRATION

The recorded open-loop receiver signals are the prime data type for the Uranus atmosphere and ring occultation experiments. For this reason, it is extremely important that the open-loop system be properly configured prior to the recording period, and that it be calibrated to the expected maximum signal levels. These pre-cals will also serve as a calibration of the results of the experiment. The details for the calibrations are contained in Appendix B.

7.9 NOCC PRE-PASS RADIO SCIENCE OPERATIONS

The NOCC radio science operations during the encounter pre-pass period will consist of the verification of the voice net configuration, the reload of the NOCC display system, and the assignment of these displays. The display configurations requested by the RSST are contained in Appendix F. The ISOE specifies when the various events are to occur. A member of the RSST will be available during this period to monitor this activity.

TABLE 7 - 1

PREDICTS GENERATION INTERFACE AGREEMENT LIST

PREDICT TYPE	SOURCE	USER	INTERFACE AGREEMENT
CELESTIAL REFERENCE SET (CRS)	NAV	RSST	NAV-37
RADIO SCIENCE (DSP-R)	DSN	RSST	NOCT-21
TRACKING	DSN	RSST	NOCT-31
UPLINK RAMPING	DSN	RSST	NOCT-32
WIDEBAND BACKUP OPEN-LOOP RECEIVER	DSN	RSST	NOCT-41
CLOSED-LOOP RECEIVER RAMPING	DSN	RSST	NOCT-40
ESTIMATE OF VOYAGER USO FREQUENCY	RSST	DSN	RSST-04

TABLE 7-2

DAILY RSST/DSCC BRIEFING AGENDA

A. Station Inputs

1. General Station Status and Weather Report
2. Radio Science System Status
3. Shift-Briefing Status
4. Concerns at Station
5. Information Required by Station

B. JPL Inputs

1. General Voyager Status
2. Updates to Radio Science Operations Plan
3. ISOE Updates
4. Open-Loop Predicts Set Status
5. Update to Predictions Time Offset
6. Date and Time of Next Briefing

SECTION 8

REAL-TIME OPERATIONS

This section covers those operations during the Voyager encounter pass over DSCC 40 beginning with AOS on January 24, 1986 (DOY 024) and ending with the conclusion of the radio science events on January 25 (DOY 025). Elements of the Radio Science Support Team (RSST), Mission Control Team (MCT), Deep Space Network (DSN) operations staff, and NOCC Operations Control Team (NOCT) will be deeply involved in radio science real-time operations. The encounter events are broken into three parts: those events beginning with AOS but prior to the Uranian occultation open-loop recording period, the critical events surrounding the open-loop recording period itself, and those events following the open-loop recording period but prior to LOS.

8.1 ENCOUNTER OPERATIONS PERIOD

The early part of the pass prior to the prime recording period will be used to check configurations and operation of the ground data system. This activity will also include a pre-encounter briefing between the on-site radio science representatives and the RSST. Confirmation of the voice line and NOCC DTV configurations will be done prior to AOS to reduce the amount of activity during this critical period.

There will be two open-loop recording periods during the encounter. The first period is currently scheduled from 024/1920 until 024/2000 UTC and corresponds to the Miranda mass determination recording period. The second, critical open-loop recording period will capture the Uranian ring and atmosphere occultations and extends from 024/2115 until 025/0245 UTC. The start of the critical events period for the encounter will be 20:15 UTC on DOY 024. This event signifies the start of the period in which the critical radio science operations control functions may be relayed to the on-site advisors via the RADSCI voice net. The RSST also has priority access to the NOCC display system at that time.

The period following the recording session will contain a post-encounter debriefing session and a playback of the the prime open-loop data if deemed necessary. The post-encounter debriefing will be conducted between the on-site radio science representatives and the RSST and will conclude the real-time radio science encounter activities. The narrow-band ODR playback and data delivery issues are discussed in Section 9.

8.2 VOICE NET COMMUNICATIONS

8.2.1 VOICE NET IDENTIFICATION

An overview of the voice net structure which will be used is shown in Figure 8-1 and the description of these nets is in Table 8-1. In order to ensure that the voice communications during the radio science events proceed smoothly, all personnel using the radio science voice nets must properly identify themselves. Call signs have been created which will be used during radio science events. These call signs are summarized in Table 8-2.

8.2.2 RADIO SCIENCE CONTROL FUNCTIONS

Due to the dynamic nature of the Uranus radio occultation and ring-scattering experiments, it is important that communications be established which can provide for the rapid and precise control of complicated equipment at locations remote from JPL. As a means of relieving the strain on the standard operations voice nets and providing quicker response times during observations, a net has been designated to provide for a direct voice link between the RSST and radio science representatives at DSCC 40 and Parkes. This net is designated the Radio Science Advisor Net (RADSCI).

The danger exists that confusion can arise if conflicting inputs are given to the tracking station over more than one net. Thus, the RSST inputs via the Radio Science Advisor Net are carefully regulated. Six specific radio science control functions have been identified which are critical for successful radio science operations. These six control function are itemized in Table 8-3 and will be exercised via the RADSCI net during the critical events period only. Specifically, the Science Advisor will be responsible for making the requests to the on-site radio science representatives who will then relay the request to the DSCC 40 or Parkes Shift Supervisor. However, the Science Advisor may transfer control to another RSST member on-line in the Mission Support Area if the need arises to do so. During other operational periods, the RSST will request needed changes through the standard Radio Science Operations Coordinator-to-ACE-to-OPCH-to-DSCC communications link.

An initial set of parameters for these control functions will be provided to the station both in the sequence of events and during the RSST/On-Site Represesentatives briefings. However, due to experimental uncertainties or system failures, the need for real-time changes may arise unpredictably.

8.3 SEQUENCE OF EVENTS CONFIRMATIONS

The Voyager Integrated Sequence of Events (ISOE) will be the controlling document for the conduct of the real-time operations during the encounter pass. A subset of this ISOE will be transmitted to the station by the DSN. This special radio science SOE should contain all spacecraft and ground data system events necessary for station support.

Due to the spacecraft Late Stored Update sequence activity, the final ISOE will not be transmitted to the station until a few hours prior to AOS. The spacecraft and ground events which have been moved by this update will be distinguished in the ISOE by a "RSS-M" in the S/C SBSYS (spacecraft subsystem) column. It is planned that the only ground system change which will be required due to the LSU movable block is the Parkes refocusing of the prime focus cage just prior to ring occultation egress.

The confirmation of the ISOE line items will be done via the standard DSCC/DSN/Voyager voice communication loops. The "action by››to" field in the ISOE indicates who is responsible for each confirmation. Due to the complexity of the critical operations during the encounter, the confirmation of ISOE items must be done as closely as possible to the time specified. These confirmations also provide visibility into the status of the ground data system at the station and will be closely monitored by the RSST.

8.4 PRE-ENCOUNTER BRIEFING

This briefing will be conducted between the on-site radio science advisors and the RSST. It is held shortly after AOS and provides an opportunity to pass along last-minute information on the status of the ground data system and to raise any questions or concerns. Of particular importance will be any change to the predicts time offset. For the encounter pass the briefing is scheduled for DOY 024, 17:30 UTC, at which time the encounter operations radio science team will be on-line in the Voyager MSA. The items to be covered during this briefing are contained in Table 8-4.

8.5 ANTENNA POINTING STRATEGY

The planned antenna pointing strategy is to turn CONSCAN off at DSS 43/42 during the critical radio science recording period. During this time, the subreflector will be moved and fixed for a 64 degree elevation for the X, Y, and Z axes at DSS 43 and the Z axis at DSS 42 (X and Y axes will remain in auto focusing mode).

This strategy will necessitate the use of the CONSCAN offset tables built for 64 degrees elevation residing in the APA. The pointing mode priority for DSS 43 is understood to be Precision 1, Precision 2 and computer, in that order.

The times for the antenna pointing activity will be specified in the SOE. If changes are required due to unforeseen circumstances, the updated strategy will be documented in the radio science consolidated TWX.

8.6 UPLINK TUNING STRATEGY

Uplink tuning predicts which have been generated from the POEAS PCT tape will be available for DSS 63/61, DSS 14, and DSS 42/43. The uplink strategy at DSS 63 will support the spacecraft late stored update sequence. The DSS 14 uplink will provide the real-time TWNC off command desired for the Miranda mass measurement. And the DSS 43 uplink will be used for the real-time TWNC off command which will be used for additional Uranian mass measurements after the occultation period.

8.7 TRACKING SYSTEM OPERATIONS

The details of the tracking system configuration are contained in Appendix A and the predicts summary is contained in Appendix C. The ISOE will specify when configuration changes are required.

8.7.1 CLOSED-LOOP RECEIVER CONFIGURATION

During the encounter beginning with the entry of atmospheric occultation, the received signal power (AGC) will drop steadily and the received frequency will be changing as fast as 3 Hz/sec at S-band. To maintain receiver lock as long as possible, it will be necessary to ramp the closed-loop receivers along the predicted frequency profile.

The static phase error (SPE) in the receivers should be zeroed out prior to the first receiver ramp. Preliminary ramps are not available at this time. The actual ramps will be sent to the station via the radio science consolidated TWX (see Section 7.6). The DSS 43 Block IV rates will be given in Hz/sec at the POCA level.

The appropriate AGC calibration curves must be loaded into the receivers to allow these values to be calculated. The AGC bandwidths will be specified in the ISOE. If a real-time change is necessary, this request will be coordinated through the standard communication link.

The Block IV receivers should be configured with 10 and 30 Hz loop bandwidths for S- and X-band respectively. The narrow mode should be selected, which will retain the option of reducing the bandwidths during the experiment. The Block III receiver loop bandwidths should be 12 and 48 Hz for S- and X-band respectively.

8.7.2 MDA OPERATIONS

The MDA at both DSS 42 and DSS 43 will be up and running with S- and X-band channels enabled. The default sample rate will be 1 per 5 seconds outside the prime open-loop recording period and 10 per second within this period. The specific times will be identified in the ISOE.

The required tracking predicts sets will include one, two and three-way doppler modes. Both DSS 42 and 43 will require these predicts during the radio science events. Since both the radio science and tracking predicts were generated from the same POEAS PCT, the tracking predicts will be adjusted by a time offset of the same magnitude as that used in the DSP. However, the sign of the time offset will be opposite in the two systems, due to the way in which the software applies these offsets to the predicts.

8.7.3 PPM OPERATIONS

The PPM at DSCC 40 will estimate the system noise temperatures and signal levels from DSS 42 and DSS 43 for both S-band and X-band. The S- and X-band system temperature data collection will require the automatic switching capability of the NAR between the two bands. The SLE configuration will have one assigned to the DSS 43 link and the other assigned to the DSS 42 link.

The integration times for the NARs and SLEs are specified in Tables A-1 and A-2 for DSS 42 and DSS 43, respectively and will also be contained in the ISOE encounter pass configuration information.

8.8 RADIO SCIENCE SYSTEM OPERATIONS

Radio science system operations during the Voyager 2 Uranus encounter will consist primarily of continuous open-loop receiver recordings. The occultation period recordings will be done with both the prime DSP-R recording system and the backup open-loop recording system (ROVER) at DSCC 40. The Parkes open-loop recording system will also be used to obtain additional X-band data during this time (see Section 8.9). The Miranda mass recordings will only be done with the DSP-R recording system.

8.8.1 MMR CONFIGURATION

The MMR at DSCC 40 will be configured with 4 input signals. These four receiver channels will contain the DSS 43 SRCP, DSS 42 SRCP, DSS 43 XRCP and DSS 42 XRCP signals. The bandpass filters which will be used are 20 KHz for both DSS 43 S- and X-band (DSS 42's filters are fixed in the Voyager configuration). The prime recording system (DSP-R) will record each channel at a sample rate of 50 KHz with 8 bit quantization.

8.8.2 MMR TUNING PREDICTS

The radio science predicts strategy currently planned for encounter is modified from that which has been used during the testing cycle. This strategy will require three distinct radio science receiver tuning predict sets instead of four. The three sets will be comprised of a mixed-mode set which includes all the expected doppler mode changes during the pass, a one-way USO set and a one-way AUX OSC set. The backup mixed-mode set requirement has been deleted.

The mixed-mode set will be used for encounter unless otherwise requested by the RSST. This set will continue to be used in the event where the backup mixed-mode set would have been used, namely the failure of the real-time TWNC off strategy surrounding Miranda recording. In the event that TWNC does not go off as planned, either due to transmitter failure or the incorrect estimation of the best lock frequency, a frequency offset will be used to locate the noncoherent signal during the coherent period assumed in the mixed-mode predicts. It is believed that using a frequency offset instead of changing the predict set will simplify the station operations in this contingency case.

It is planned to use the nominal encounter trajectory predicts for encounter, adjusted by a time offset. There will be two additional predict generation and transmission cycles, one for each navigational update during the LSU activity. These predicts will only be used if there is a significant error in the spacecraft trajectory. The prediction status and strategy will be be discussed as part of the daily briefings.

8.8.3 SPECTRUM PROCESSOR ASSEMBLY (SPA)

The recording and monitoring configuration of the SPA are determined by OCI's. The recording configuration is included in Table A-2 and the Voyager ISOE. The preliminary monitoring configuration is called out in Table A-2 and the Voyager ISOE will contain the nominal strategy. Deviations from the ISOE may be required in real-time and will be requested via the appropriate channels.

The SPA will be run with a time offset as discussed in Section 8.8.2. Since time offsets can only be entered while the DSP is in IDLE, any changes to this offset will be passed along during the pre-encounter briefing prior to the DSP RUN start time for Miranda mass recording.

8.8.4 WIDEBAND BACKUP OPEN-LOOP RECEIVER CONFIGURATION

The wideband backup recording system will be used during the five and one half hour occultation recording period. The first LO noncoherent and coherent frequencies will be contained in the radio science consolidated TWX. Appendix C contains the second LO frequencies. The noncoherent first LO frequency will be used for the entire recording period since the TWNC will go on shortly into this period. The presence of the S-band signals from both DSS 42 and DSS 43 will be checked using the SSI several times prior to and during the recording period.

8.8.5 SSI OPERATIONS

The SSI strategy is meant to closely monitor the performance of the radio science system during the radio science critical events. The SSI configuration is optimized for expected downlink frequency and amplitude changes, in addition to the periodic verification of signal presence. Nominal SSI operations are specified in the ISOE. However, it may be necessary to deviate from the ISOE instructions for real-time trouble-shooting of the open-loop system. In that situation, SSI instructions will be communicated from the Radio Science Adviser in the MSA to the on-site radio science representative at DSCC 40 via the

RADSCI voice net during the critical events period and through the standard voice channels at other times.

A summary of the input signal assignments into the SSI is included in Table 8-5.

8.8.6 ROVER PLAYBACK INTO THE SSI

Currently there are no plans to play the X-band signals recorded by the ROVER system back into the SSI. However, this may be requested in real-time and would be done shortly after the recording period ends. This would require a playback of a portion of the ROVER tape into the SSI at one-quarter speed (30 ips).

8.8.7 TAPE LABELING PROCEDURES

The prime recording system open-loop data tapes will be generated approximately every 8 minutes for a 5 hour and 30 minute period. It is important that tape labels be placed on these tapes as they are generated to minimize confusion concerning the contents of each tape. The DSP-R generates tape label information including tape start and stop times. This information is sent over to a CMC line printer at the end of each tape. This means that this printer must be on and stay on during the entire open-loop recording period to allow this information to be printed. Since this method may be unreliable for actual label generation, a hand-generated label may be used which contains the same information. A preliminary tape log which includes the start and stop times for each of these tapes will be relayed to JPL shortly after LOS, with a TWX tape log report to follow. See Section 9 for further details.

The wideband backup open-loop recording system will generate tapes approximately every 15 minutes. These tapes will be overlapped by approximately 5 minutes, which leaves 5 minutes to perform the tape rewind, tape head cleaning, new tape load and labelling of the finished tape. The tape labels must be generated by hand and should include the same information as the DSP-R tapes.

8.9 PARKES OPERATIONS

8.9.1 BRIEFING STRATEGY

Daily briefings will be held between the RSST and the on-site radio science represenatives for both DSCC 40 and Parkes, unless otherwise agreed to in advance. The agenda for these daily briefings is contained in Table 7-2. On the day of encounter, the final briefing will be held at 17:30 UTC, which is approximately one hour prior to Parkes AOS. The pre-encounter briefing agenda is contained in Table 8-4.

8.9.2 ANTENNA POINTING

The strategy at Parkes will be to move and fix the prime focus cage twice. The first time occurs at the start of critical radio science activities and will be for an elevation of 75 degrees. The second update occurs at the end of the atmospheric occulation just prior to the ring occultation egress and will be for an elevation of 55 degrees. This second prime focus cage update is the only ground data system change which will be shifted as a result of the LSU process and the final time will be included in the final ISOE transmitted to the station. The time will also be confirmed in the pre-encounter briefing.

8.9.3 ODA OPERATIONS

The predicts for the ODA will be sent via the radio science consolidated TWX. Three manually generated sets will be created: a one way set for the entire pass, a three way set for the entire pass and another one way set which will be optimized for the recording period to make full use of the 14 predict points available in the ODA. The full-pass one way and three way sets will be used to confirm the radio science system prior to the recording period. Ten minutes prior to start of recording the ODA will be taken to IDLE, the recording-span one way set loaded, and the ODA put back into RUN. Since the sequenced TWNC on command is within the LSU movable block, the signal will not be seen until this instruction takes effect. The nominal time of this event is currently 12 minutes after recording starts.

The ODA will be run with a time offset to the predicts. This offset will be of the same magnitude but of opposite sign from that which will be used in the DSP. This is due to the way the software handles these offsets in each system. This offset will be passed along in the pre-encounter briefing via the RADSCI voice net.

The ODA radio science recording parameters are contained in Table A-3.

8.9.4 REAL-TIME CONFIRMATIONS DURING RECORDING PERIODS

The ISOE will contain the station radio science recording configuration confirmation requests and the requests for periodic confirmations of signal presence in the open-loop receiver. Other requests for information may also be made in real-time. The station is requested to keep the RSST and NOCT apprised of any changes to the station equipment which may impact the progress of the data collection.

8.10 GRAPHICS DISPLAYS AND HARDCOPY DATA COLLECTION

The DTV displays available to the RSST in the MSA and on the third floor provide the principal data source for monitoring the operation of the encounter. Due to the complexity of events and the large body of data available, proper organization and coordination of the DTV data displays are essential. It will be the responsibility of the Radio Science Operations Engineer to interact with the MCT and the NOPE/NAT TRK to ensure the proper selection and display of data on the DTVs.

There will be five primary display subsystems used by the RSST during support for the encounter. They are the Project's TTS, MCCC's RTDS, and the NOCC's NRV, NTK, and VAP subsystems. The desired NOCC displays are specified in detail in the NOCC display request forms included in Appendix F.

All hardcopies of DTV displays made by the RSST will be collected and organized by the Operations Coordinator at the end of the radio science operations period. Copies will be produced and delivered to the Science Advisor, and the originals will be archived at JPL.

The requirements for real-time monitoring have been shown to push the NOCC display system to its limit. In an attempt to alleviate some of the problems seen during previous radio science supports, it has been suggested that the display system be reloaded prior to the critical events. This will be done prior to AOS for encounter and is specified in the ISOE. The systems to be reloaded are the NTK, NRV, VAP and DDP.

8.11 POST-ENCOUNTER DEBRIEFING

A post-encounter debriefing will provide a means for wrapping up the encounter activities. This debriefing will begin approximately one half hour after the end of the open-loop recordings. At this time, the RSST will identify the desired periods of open-loop data to be played back over the wideband data lines. Any remaining open items can be resolved during this debriefing. The post-encounter debriefing agenda is given in Table 8-6.

8.12 CONTINGENCY PLANNING

In the course of real-time operations during the encounter, the potential exists for a variety of equipment failures or problems. While it is impossible to list all potential problems, major failure modes which are considered most likely to affect the radio science effort will be covered here. Each contingency plan will contain a discussion of the major steps required for recovery of the desired fall-back position if the problem is unsolvable in real time. It is anticipated that the station personnel will have inputs to the contingency plans and a revised version will be issued if necessary.

The RSST must be apprised of any failures in any equipment affecting the radio science experiment. During critical events, the Radio Science Advisor on-line in the Voyager MSA must have the information available to evaluate the impact to the science return. The contingency chosen will depend not only on the type of failure, but when it occurs during the experiment.

In the event that there several problems during the radio science events with limited station resources, the following priorities should be followed.

SCIENCE OBSERVATION	PRIORITY DATA SYSTEM
Uranus Atmospheric Occultation (XPOCC)	Open-loop
Ring Occultation (XROCC)	Open-loop
Miranda Mass Determination (XMMASS)	Closed-loop
Uranus Gravity Field (XPGRAV)	Closed-loop
Celestial Mechanics Redshift (XSCEL)	Closed-loop

8.12.1 SOFTWARE HALTS

Any reload which may impact data collection must be coordinated through the OPS Chief, Voyager ACE, and RSST. A summary of the applicable software follows.

DSCC 40	PARKES	NOCC
APA	ODA	NRV
DSP		NTK
MDA		VAP
LMC (DSS 43/42)		
CMC		

8.12.2 HARDWARE FAILURE

It is expected that any failure of hardware will be dealt with by the appropriate engineering and maintenance personnel. Adequate spares in good condition must be available should replacement be deemed necessary or the most expedient.

8.12.3 ANTENNA

One possible failure is that of the auto collimator, which should be swapped if possible. Another is with the Precision 1 antenna pointing mode at DSS 43, whereupon Precision 2 and then computer mode should be used. The inability to the load the fixed subreflector offset table into the APA may require that the subreflector be moved and fixed at several points during the periods of least impact. Finally, if predicts are lost entirely, it may be necessary to go into the planetary predicts mode or sideral mode to continue tracking.

8.12.4 TRANSMITTER

The transmitter contingency if the high power transmitter fails at DSS 43 will be to go to the low power transmitter at DSS 43 and if that fails to go to the low power transmitter at DSS 42.

8.12.5 EXCITER

The exciter contingency will be to swap to the DSS 42 exciter if DSS 43 has an exciter problem. The DSS 42 exciter will be ramped along the uplink profile during the period the DSS 43 exciter is in use to ensure minimal switch over time if the DSS 43 exciter fails.

8.12.6 MMR

If there is a failure in any of the DSS 43 filters, the RSST may request that the filter or the inputs to the filters be swapped. This would be dependent on the period in which the failure occurred. Another possibility may be to go to the next filter size down. If it appears as though the DSP NBOC A/D converters are close to saturating, it may be expected that the MMR attenuator settings will be adjusted. A failure of the MMR POCA will require a swap to the spare POCA.

8.12.7 DSP

A halt of the DSP will be handled as other software halts at the station. If the NBOC phase-lock loop drops lock, the station is to bring it back in lock as soon as possible. Any NBOC sync alarms should be passed along to the RSST shortly after occurence. A failure of one of the tape drives during the recording period may necessitate the use of only one drive as was done during SCOT 4. However, during the atmospheric occultation period, a request may be made to swap to a narrower MMR filter and a lower sample rate in order to reduce the number of tape changes required.

8.12.8 SSI

The backup SSI at SPC 40 is requested to be brought into use if the prime SSI fails.

8.12.9 CLOSED-LOOP RECEIVERS

As in the case of a failure in the MMR, this plan would be based on when the failure occurs. During the atmospheric occultation, the receipt of the S-band signals with the closed-loop system has priority. Therefore, a failure in either of the S-band receivers would require a reconfiguration to replace the failed receiver with the receiver which had been assigned to X-band.

8.12.10 LOSS OF RADIO SCIENCE PREDICT SETS

As a last resort, the MMR POCA may be taken to manual mode and the ramps entered via the front panel. A contingency set of limited ramps will be made available in this circumstance.

8.12.11 LOSS OF SIGNAL AT PARKES

The spectrum analyzer at Parkes should be made available during the critical radio science recording period to assist in trouble-shooting the system.

NOTE: Due to an ODA anomaly, run-time frequency or time offsets are not to be entered after day change during the occultation recording period.

8.12.12 LOSS OF VOICE LINE TO STATIONS

During the period of the outage, the on-site radio science representatives will continue the encounter sequence based on the latest available information.

8.12.13 LOSS OF DATA LINE TO STATIONS

The encounter operations should continue as planned while the outage occurs. This circumstance will necessitate more reliance on verbal reporting from the stations.

8.12.14 SPACECRAFT USO FAILURE

A failure in the USO would result in the loss of a very stable signal whose frequency is known quite precisely. The RSST would request a switch to the predict sets for the auxiliary oscillator. Since the AUX OSC frequency is not well known, frequency offsets may be required to find and center the signal in the open-loop receivers at DSCC 40 and Parkes.

8.12.15 UNEXPECTED DOWNLINK MODE

If the downlink is in a different mode than was expected when the mixed-mode predicts were generated, a frequency offset will have to be entered into the DSP. The difference between the coherent and noncoherent frequencies will be included in the radio science consolidated TWX. If the discrepancy is due to a change in the planned transmitter activity, considerable advanced notice will be given. However, if it is due to unknown spacecraft response, it will have to be detected and responded to in real-time.

8.12.16 UNAVAILABILITY OF KEY RADIO SCIENCE PERSONNEL

A vacancy in the real-time operations assignments will be filled by the Radio Science Team Chief and the RSST ATR Engineer in that order. Other positions may have to be reassigned to reduce the impact to the encounter support.

SECTION 9

POST PASS OPERATIONS

Post pass operations for the Voyager 2 Uranus Encounter will span the three-month period beginning with LOS on the Encounter pass. During this period the primary radio science related activity will be data delivery to the RSST. The quick-look processing and analysis of the data for evaluation is discussed in Section 10. The following sections detail procedures and operation schedules for this period.

9.1 POST-ENCOUNTER THREE-MONTH PERIOD

As with the pre-Encounter period, the post-Encounter three month period will involve minimal real-time operations activity. The RSST may require some post-Encounter calibrations at DSCC 40 if problems arise during the Encounter. Otherwise, post-Encounter operations will be comprised primarily of data delivery (hardcopy and tapes) and preliminary processing of that data.

9.2 POST-ENCOUNTER TAPE LOGGING PROCEDURE

Due to the large number of tapes generated, and the distance between JPL and DSCC 40, it is essential to establish appropriate logging procedures for all station-generated radio science tapes.

For Encounter there will be three categories of open-loop tapes to be logged: the DSP NBODR tapes, the ROVER WBODR tapes, and the Parkes PODR tapes. During the post-pass period, all DSCC 40 tape ID numbers and start and stop times will be reported by DSCC 40 to the Track Controller via the TRACK-1 Net as standard operating procedure. It will be the responsibility of the Radio Science NOPE to monitor this report, and log all tape ID numbers and start and stop times for the RSST.

Requests will be made for duplication of NBODRs covering periods of interest immediately after the pass, to be hand-carried back to Stanford University by special courier. Also for Encounter full duplication of all of the NBODRs , WBODRs and PODRs is required. These duplicates will be shipped to JPL while the original tapes will remain at DSCC 40 until the duplicates are delivered to the RSST and have been validated. If the radio science SCOE requests a post-Encounter SPT be run on some of the data, additional duplicates should be made available to perform the SPT.

Upon completion of the recording period, a complete written report will be prepared. This report will be sent to JPL via TWX, and will contain tape ID numbers, recording times, and tape drive ID numbers. In addition to the tapes described above, the report will include ID numbers of all duplicate tapes.

9.3 DELIVERY OF QUICK-LOOK NBODRs TO STANFORD UNIVERSITY

The nominal plan for obtaining selected portions of Encounter open-loop recorded data of immediate interest is hand delivery to Stanford University of duplicates of the NBODRs by special courier within 30 hours of the end of the encounter pass. However, GCF wideband lines will be scheduled up for the period immediately following the pass, and in the case of any anomalous events the RSST may request playback of several minutes of the open-loop data after the pass.

The RSST will identify the NBODRs to be immediately duplicated for the special courier and, if necessary, the portions of the recorded open-loop data for playback to NOCC during the post-Encounter debriefing period. NBIDRs of this playback data will be generated on the DRG in NOCC and will be delivered to the RSST within 24 hours of the playback. The duplicate NBODRs will be delivered by the special courier directly to Stanford University within 30 hours .

9.4 PLAYBACK OF SELECTED PORTIONS OF THE PARKES PODRs VIA GCF

Nominally, it is not anticipated that any playback of the Parkes data will be required for Encounter. However, in the case that any anomalous events do occur, the RSST may request that several minutes of the Parkes open-loop recorded data be played-back. The RSST will identify portions of the recorded Parkes open-loop data for playback to NOCC during the post-Encounter debriefing period. All the Encounter Parkes Original Data Records (PODRs) will be transported from Parkes to DSCC 40 within 24 hours following the Encounter. There duplicates of all PODRs will be made to be shipped to JPL by expedited means. The original PODRs will be held at DSCC 40 until the duplicates arrive at JPL and have been validated by the RSST. Upon request by the RSST they will be sent with the other original tapes in the 2nd Expedited Shipment.

If necessary, GCF wideband lines will be scheduled for playback of the Parkes data following the PODRs arrival at DSCC 40. Parkes Intermediate Data Records (PIDRs) of this playback data will be generated on the DRG in NOCC and will be delivered to the RSST within 24 hours of the playback.

9.5 POST-ENCOUNTER CALIBRATIONS

It is possible that post-cals of the open-loop receiving equipment may be required for Encounter. If this procedure is required, the request will be made by the RSST over the Radio Science Advisor Net (RADSCI) during the Encounter or during the post-Encounter debriefing period.

9.6 POST-PASS SYSTEM PERFORMANCE TEST

There is no requirement for a post-Encounter SPT. However, one may be requested by the Radio Science SCOE. If this is the case the original tapes will be on hand (duplicates of all data tapes will be shipped to JPL before any originals) to make additional duplicates to perform the SPT.

9.7 TAPE DUPLICATION AND DELIVERY

The Encounter strategy will require the duplication of all NBODRs , WBODRs , and PODRs after Encounter. These duplicates will be sent to JPL, NDC attention: F. Donivan, in an expedited shipment as soon as possible. The original tapes will be kept on hand at DSCC 40 until the duplicates have arrived at JPL and have been validated. Once the arrival and validity of the duplicates has been confirmed by the RSST, the original tapes will be sent to JPL in a RSST requested, expedited shipment. This process including validation may take up to 3 months.

In addition, extra duplicates will be made of several RSST selected NBODRs during the post-Encounter debriefing to be hand-carried by special courier to Stanford University within 30 hours of Encounter. These Stanford tapes must be duplicated immediately after Encounter to ensure delivery to Stanford within 30 hours.

9.7.1 CLOSED-LOOP TRACKING DATA

A special Tracking IDR will be delivered to the RSST directly from the DSN within 1 hour of DSS 43 LOS, which covers the period 024/1645 to 025/0535. A normal Track IDR covering the same period (refer to Interface Agreement NOCT-35) will be delivered within 1 day of the Encounter. For any other periods of interest, the RSST will request copies of tracking IDRs from the DSN delivered per normal procedures.

If tracking data in the form of ATDFs is desired, the RSST will request these from the Navigation Team. Using Voyager mission-built software, IDRs can be stripped into an ATDF format onto tape(s) either at the IPC or on one of the navigation VAXs , and then verified with a routine named TDF PRINT. The output of TDF PRINT is a time-ordered listing of the tracking data over the time period of interest. These tapes would then be delivered to the RSST RODAN facility (264-365).

9.7.2 MONITOR IDR DATA

Monitor 5-9 data in the form of a Monitor IDR will be delivered to the RSST directly from the DSN covering the period from 024/1635 to 025/0535 (refer to Interface Agreement NOCT-36). The delivery schedule for the Monitor IDR is within 24 hours of Encounter.

9.7.3 NARROW-BAND OPEN-LOOP DATA

The narrow-band open-loop data is recorded at DSCC 40 on 9 track 6250 bpi tapes known as NBODRs . The tape contains the four channels of digitized receiver data from the MMR and POCA tuning information, as well as timing, configuration and status information. In the OP-B delivery of DSP-R it will also include PPM data.

All the NBODRs generated at Encounter will be duplicated as soon as possible after the pass. The duplicate tapes are to be shipped to JPL, NDC attention: F. Donivan, via expedited means. It is very important that these copies arrive at JPL ASAP because they are to be validated by the RSST before any of the original NBODRs waiting at DSCC 40 are to be shipped to JPL. Once at JPL, the tapes are delivered to the RSST where they are logged in and given RSST tape IDs . Once the arrival and validity of the duplicates has been confirmed by the RSST, the RSST will request delivery of the original NBODRs in the 2nd Expedited Shipment.

Extra duplicates of 2 NBODRs must be made immediately after being selected by the RSST during the post-Encounter debriefing period, to ensure delivery to Stanford by special courier within 30 hours of Encounter.

9.7.4 PARKES OPEN-LOOP DATA

Narrow-band open-loop data is recorded at DSS 49 (Parkes) on 1600 bpi tapes known as Parkes Original Data Records (PODRs).

The tapes contain 1 channel of digitized receiver information, each tape covering approximately a six minute and forty second time period. These tapes must be shipped to DSCC 40 within 24 hours of Encounter. At DSCC 40 duplicates of the PODRs will be made, and included in the 1st Expedited Shipment with the other duplicate tapes. Once the duplicate PODRs have arrived at JPL and have been validated, the original PODRs and other original tapes will be sent from DSCC 40 to JPL in the 2nd Expedited Shipment, only upon request by the RSST.

If any anomalous events occur during Encounter, several minutes of PODR data may be selected by the RSST for playback over wideband data lines as soon as possible after Encounter. If this should occur PIDRs would be generated at NOCC and will be delivered to the RSST within 24 hours of the playback. On delivery to the RSST the tapes are logged in and given RSST tape ID numbers.

9.7.5 ROVER DRA OPEN-LOOP ODR DATA

The Rover DRA open-loop ODR data is recorded at DSCC 40 on 1 inch instrumentation tapes known as WBODRs . The tape contains the four channels of digitized receiver data from the wideband backup receiver as well as timing information.

All the WBODRs will be duplicated at DSCC 40 as soon as possible after the pass. These duplicates are to be shipped to JPL in the 1st Expedited Shipment with the other duplicated NBODR and PODR tapes. It is very important that the tapes arrive at JPL ASAP because they must be bandwidth reduced at the BRF in CTA-21 to produce computer compatible 1600 bpi tapes which are called Wideband Intermediate Data Records (WBIDRs). Once the computer compatible WBIDRs are generated, they are delivered to the RSST where they are logged in and given RSST tape IDs .

Once the duplicate WBODRs arrival and validity have been confirmed by the RSST, the original WBODRs will be sent only when requested by the RSST in the 2nd Expedited Shipment with the other original tapes.

9.7.6 SPACECRAFT TRAJECTORY DATA

The Celestial Reference Set (CRS) tapes contain spacecraft trajectory vectors for use in data analysis by the experimenters. The format and contents of the tapes are described in Interface Agreement NAV-37.

For Encounter four CRS tapes will be required :

(1) Delivered to the RSST within 24 hours of the Navigation Results Meeting for the Late Ephemeris Update which is is 4 Days 18 Hours before Encounter.

(2) Delivered to the RSST within 12 hours of the 2nd Navigation Results Meeting for the Late Stored Update which is 18 Hours before Encounter.

(3) Delivered to the RSST within 2 weeks of Encounter using reconstructed Encounter trajectory data .

(4) Delivered to the RSST after the Encounter using the best reconstructed Encounter trajectory data, after all known sources of error have been removed.

9.7.7 SPACECRAFT ENGINEERING DATA

Radio Science System Engineering Data Record (RSSEDR) tapes contain the spacecraft engineering and necessary monitor data which are used by the RSST to evaluate overall spacecraft performance during radio science events (most notably, data are provided for the USO and RFS subsystems). A RSSEDR tape will be generated for Encounter by the Science Data Team (SDT) due to submission of a RSSEDR request form by the RSST as specified in Interface Agreement SDT-363. The requirement for delivery of the tape is within one week following the Encounter.

9.7.8 MANEUVER DESIGN AND RECONSTRUCTION DATA

Procedures for the delivery and collection of the Maneuver design Files and the Limb Track Maneuver Reconstruction have been established between the RSST and the Spacecraft Team (SCT) in Interface Agreements RSST-01 and SCT-20 respectively. The delivery schedule for the Limb Track Maneuver Reconstruction tape is nominally within 30 days of Encounter as specified in the requesting RSST IOM. However, the delivery in any case will not be made until correction is made for all the known sources of error affecting Maneuver reconstruction accuracy.

9.8 HARDCOPY DATA

9.8.1 DSCC HARDCOPY DATA

"Hardcopy data" are defined to be those data (LMC Log, notes, graphs, logs, stripcharts, etc.) which are generated by DSCC hardware and operators in support of the radio science experiments. For Encounter the hardcopy data set includes:

LMC Log	- Diagnosis of DSP subsystem problems.
Pre-Pass Countdown Log	- Establishes station configuration for data reduction purposes.
Tape Log	- Provides a primary-source listing of the data tapes.

9.8.1 DSCC HARDCOPY DATA

The hardcopy data will be shipped to JPL with the duplicate tapes in the 1st Expedited Shipment.

9.8.2 PARKES HARDCOPY DATA

"Hardcopy data" are defined to be those data which are generated by the DSS 49 hardware and operators in support of the Radio Science events. For Encounter the hardcopy set includes:

Parkes Log	- Post Encounter evaluations
Parkes PCTA Strip Chart Recording	- Analysis of the received Signal strength during Encounter
Parkes Noise Adding Radiometer (NAR) Hardcopy & Floppy Disk	- Calibration of the Gain and Noise Fluctuations in Ground Data System

The hardcopy data will be sent to DSCC 40 with the PODRs and shipped to JPL with the 1st Expedited shipment of the duplicated tapes.

9.8.3 NOCC HARDCOPY DATA

The NOCC Hardcopy Data of interest is the (Network Operations) Controller's Logs and the Tracking System Pass Summaries (NAT TRK Logs). This hardcopy data shall be made available to the RSST within 24 hours of the Encounter.

TABLE 9-1

DATA PRODUCT DELIVERY STRATEGY AND SCHEDULE

DATA TYPE	DELIVERY STRATEGY	DELIVERY SCHEDULE
TRK IDR	Tape delivery from NDC to RSST RODAN Facility (Bldg. 264, Rm. 365). Tape IDs communicated to the RSST via the NOPE. Delivery from DSN by Special pick-up by a RSST member.	A Normal IDR delivered within one day following LOS at 025/05:35 UTC A special IDR is required covering DSS 42/43 encntr pass, and must be delivered within 1 hour of LOS
MON IDR	Tape delivery from NDC to RSST RODAN Facility (Bldg. 264, Rm. 365).	All IDRs to be delivered within one day following LOS at 025/05:35 UTC
Quick-look Wideband Playback NBIDR	Contingency basis only Tape delivery from NDC to RSST RODAN Facility, Bldg. 264, Rm. 365.	Only if necessary, Start NBIDR wideband playback procedure after LOS at 025/05:35 UTC Delivery to RSST within 24 Hours
NOCC Hard-Copy -Controller's Logs -NAT TRK Logs	Hardcopy delivery from NDC to RSST RODAN Facility, Bldg. 264, Rm. 365	Delivery to RSST will be within 1 day following LOS at 025/05:35 UTC
CRS Tape (4 tapes)	Delivery from NAV to RSST via tape interface at IPC.	(1) Predict tape delivered to RSST by 020/22:00 UTC (2) Predict tape delivered to RSST by 023/23:00 UTC (3) Reconstn tape delivered to RSST by 039/05:35 UTC (4) Reconstn tape of final OD soln

TABLE 9-1 (continued)

DATA TYPE	DELIVERY STRATEGY	DELIVERY SCHEDULE
RSSEDR	Delivery from GSDT by pickup by RSST member.	EDR delivered in 1 week of Encounter
NBODRs	(1) Duplicate 2-3 Extra NBODRs at LOS, Delivery by Special Courier to Stanford	(1) Extra NBODR Duplicates arrive Stanford 30 hours of Encounter
	(2) Duplicate all NBODRs immediately after Encounter Send in the 1st Expedited Shipment expedited to NDC, JPL, attn: F. Donivan, for final delivery to the RSST	(2) NBODR Duplicates in the 1st Expedited Shipment delivered to the RSST within 2 weeks of the Encounter
	(3) Original NBODRs sent only on RSST request after arrival & validation of the Duplicates by the RSST, in the 2nd Expedited Shipment	(3) NBODR Originals in the 2nd Expedited Shipment on request by the RSST
Parkes Narrowband PODRs	After the Critical Events Period, the Parkes PODRs ID numbers will be relayed to the RSST via the Radio Science Net (RADSCI).	All PODRs delivered to DSCC 40 within 24 hours of the Encounter
	(1) Duplicate all PODRs at DSCC 40, Send Duplicates in 1st Expedited Shipment with the other Duplicates	(1) PODR Duplicates in the 1st Expedited Shipment within 2 weeks of the Encounter
	(2) Ship Original PODRs in 2nd Expedited Shipment with the other Original tapes	(2) PODR Originals in 2nd Expedited Shipment on RSST request
Parkes Wideband Playback PIDRs	On Contingency basis only, Tape delivery from NDC to RSST RODAN facility Bldg. 264, Rm. 365.	If necessary, Playback ASAP when PODRs reach DSSC 40, Deliver PIDRs in 1 day of Playback

TABLE 9-1 (continued)

DATA TYPE	DELIVERY STRATEGY	DELIVERY SCHEDULE
ROVER Wide-band WBODRs	(1) Duplicate WBODRs after Encounter, Send Duplicates in 1st Expedited Shipment with other Duplicate tapes (2) Send Original WBODRs in 2nd Expedited Shipment with other Original tapes	(1) WBODR Duplicates in the 1st Expedited Shipment within 2 wee of the Encounter (2) WBODR Originals in 2nd Expedited Ship ment on RSST request
Limb Track Maneuver Reconstru-tion tape	Delivery from Univac 1100 Library to RSST, after notification by the SCT	Tape delivered within 30 days of Encounter
DSCC Hard-Copy Data: -LMC Log -Pre-Pass Countdown Log	Send in the 1st Expedited Shipment with all other Duplicated tapes	DSCC Hardcopy in 1st Expedited Shipment du 2 weeks after Encount
Parkes Hard-Copy Data: -Parkes Log -Parkes Strip Chart Output -Parkes NAR Hardcopy & Floppy Disk	Send in the 1st Expedited Shipment with all other Duplicated tapes	Parkes Hardcopy in 1s Expedited Shipment du 2 weeks after Encount

SECTION 10

POST ENCOUNTER DATA PROCESSING AND VALIDATION

This chapter is primarily concerned with what is done with Radio Science data after it is delivered to the RSST, but includes the validation of data that is done by the DSN's System Performance Test (SPT) Program.

As the final link in the Radio Science Ground Data System, this section will describe the RSST Data Production System, the data processing and validation, and the quick-look and final data strategies required to support radio science investigations.

10.1 DSN SYSTEM PERFORMANCE TESTS

In addition to the processing and validation done by the RSST there are a number of System Performance Tests that will be done at the station. The exact procedures to be used to run the SPT programs are described elsewhere, but it is possible that a selection of the SPTs will be run pre-pass to verify hardware readiness, and a different selection may be run post-pass on copies of the data tapes in order to inform station personnel of problems as soon as possible. SPTs will be performed at the direction of the SCOE.

10.1.1 SPT PROGRAM DESCRIPTION

The DSN Radio Science SPT Program runs on the same computer and uses the same tape drives as the DSP recording system, but it operates independently. The SPT program will be used to perform a preliminary analysis of the DSP recordings. The SPT program has four main functions available:

1. Header analysis

   Displays and lists information recorded in the header such as record number, POCA frequency, time tags, and PPM/SLE data.

2. FFT

   Uses a Fast Fourier transform to derive spectra from the recorded A/D sample data. Signal frequency, amplitude, spurious signal evaluation and noise level estimates are extracted from the derived spectra.

3. Phase

   A phase lock loop acquires the signal recorded in the A/D data and evaluates the amplitude and phase stability of the system.

4. Quantization

This function is intended to evaluate the performance of the A/D converters and requires a "clean" input signal into the DSP. Quantization phase matches an accurate estimate of the recorded signal to the recorded A/D data and sums any errors for each A/D level.

10.2 RSST DATA PRODUCTION SYSTEM

The RSST Data Production System includes the software and procedures required to ensure that the data collected in support of radio science observations is usable by the science investigation team. Figure 10-1 is a block diagram of this system. The figure is arranged such that the data sources are to the left, the final data destinations are to the right, and the required processing and library facilities are in between. The following subsections describe those elements of the RSST Data Production System.

10.2.1 DATA SOURCES

The radio science data sources shown in Figure 10-1 are DSCC 40, Parkes, the NOCC, the Voyager Navigation Team (NAV Team), the Voyager Spacecraft Team (SCT), and the General Science Data Team (GSDT). The data types generated by each of these entities are shown on the figure and are described in detail in Section 10.3 below.

10.2.2 DATA PROCESSING AND LIBRARY FACILITIES

The facilities required to transport and process the various radio science data types are scattered throughout the JPL organization. These facilities include the DSN Network Data Center (NDC) in Building 230 through which all DSN data must be released to the Project, the IBM 360 library in Building 230, the Information Processing Center (IPC) 1100/81 computer and library which are located off-Lab, the DSNs VTF/CTA-21 facility in Building 125, and the Radio Occultation Data Analysis (RODAN) Facilitys Prime computer and library in Building 264. The role of each of these processing and library facilities in the collection, processing, validation, and delivery of each of the radio science data types is described in Section 10.3.

10.2.3 DATA DESTINATIONS

After completion of all data preparation processes, the data products must be archived at JPL and shipped to the Voyager Radio Science Team (RST) investigators who are located at Stanford University, and JPL. The details of the validation and delivery procedure for each of the radio science data types is described in Section 10.3.

10.3 DATA PROCESSING, VALIDATION AND DELIVERY

The following subsections describe the flow of each radio science data type through the RSST Data Records System. This flow of data products from collection, through processing and validation, to delivery is shown in a left-to-right sense in Figure 10-1.

10.3.1 CLOSED-LOOP TRACKING DATA

Procedures for the collection and delivery of Tracking Intermediate Data Records (IDRs) have been established in Interface Agreement NOCT-35 between the DSN and the RSST. The NOCT will provide for the delivery of the Tracking IDRs for the purpose of obtaining a permanent record of the downlink frequency and signal level(s). Delivery of the Tracking IDRs will be at the request of the RSST. The DRS will process the IDRs and make them available for pickup by a MCCC library representative within one hour. The MCCC library will have the tapes available for pickup by the RSST Staff Assistant. The RSST Staff Assistant will process the documentation for the IDR tapes transfer through NDC (Bldg.230 Room 109).

Procedures for collection and delivery of the Archival Tracking Data Files (ATDFs) to the RSST have been established in Interface Agreement NAV-25 between NAV and the RSST. If tracking data in the form of ATDFs is desired, the RSST will request these from the Navigation Team. Using Voyager mission-built software, IDRs can be stripped into an ATDF format onto tape(s) either at IPC or on one of the Navigation VAXs , and then verified with a routine called "TDFPRINT". The output of TDFPRINT is a time-ordered listing of the tracking data over the time period of interest. These ATDF tapes would then be delivered to the RSST RODAN facility in Bldg. 264-365.

Validation processing for the Closed-loop Tracking data is also done using the "TRKPRINT" program, which extracts data from

2-14 or 2-15 format Tracking IDRs or ATDFs for storage on a RODAN Disk File. The data stored takes the form of Doppler Counts, Residuals and Noise, Angular Residuals, Derived Power to Noise Ratios, Differenced Range vs. Integrated Doppler Data, Range Data and Radio Metric Validation data (2-14 format only). For a detailed description of the data types and formats of the Tracking IDRs, refer to the DSN Interface Change Authorization 820-13 Module TRK-2-14 and TRK-2-15 documents. For similar details on the ATDFs refer to the IDR Stripper Program Set Users Manual Rev. 4 (4/26/1984).

10.3.2 NARROW-BAND OPEN-LOOP DATA

Procedures for the delivery and collection of the Narrow Band Original Data Records (NBODRs) and the Narrow Band Intermediate Data Records (NBIDRs) have been established between the DSN and the RSST in Interface Agreements NOCT-13 and NOCT-33, respectively.

Validation processing of both the Mark IV NBODRs and NBIDRs is accomplished under five programs:

1. Header Analysis

   Program "NBHDR" reads tape record header data such as A/D Converter Mode, Sample Rate, and Time Tags, POCA Time Tags Frequency, and Status for storage in a RODAN disk File for analysis.

2. A/D Converter Channel Samples Plots

   Program "NBSMPLS" plots graphs of A/D Converter Sample Voltages vs. Sample Numbers, with Mean and Sigma values from any of four A/D Converter channels as CRT Displays or hardcopies for analysis.

3. Received Signal Power Spectra Plots

   Program "NBFFT" performs a Fast Fourier Transform (FFT) on any of four A/D Converter Sample values to produce a Power Spectrum of the received signal strength, averages a requested number of spectra, then plots a graph of the averaged Power Spectra as a CRT Display or Hardcopy.

4. Precision Power Monitor Analysis

   Program "NBPPM" reads tape record Precision Power Monitor (PPM) data such as Receiver ID, Antenna ID, Integration Time, A/D Converter and PPM Time Tags, System Noise Temperature and Sigma, for storage in a RODAN disk File.

5. POCA Data Analysis

Program "NBPOCDMP" reads tape record Programed Oscillator Control Assemply (POCA) data such as tape record number, POCA Time Tags, POCA Frequency, POCA Rate, as well tape header data, for storage in a RODAN disk File.

10.3.3 PARKES OPEN-LOOP DATA

Procedures for the delivery and the collection of the Parkes open-loop Original Data Records (PODRs) and the Parkes Intermediate Data Records (PIDRs) have been established in Interface Agreement NOCT-42 between the DSN and the RSST.

Validation processing of both the Mark III PODRs and PIDRs is accomplished under three programs:

1. Header Analysis

   Program "PHDR" reads tape record header data such as A/D Converter Mode, Sample Rate, and Time Tags, POCA Time Tags, Rate, Frequency, and Status for storage in a RODAN disk File for analysis.

2. A/D Converter Channel Samples Plots

   Program "PFFT" plots graphs of A/D Converter Sample Voltages vs. Sample Numbers, with Mean and Sigma values from any of two A/D Converter channels as CRT Displays or hardcopies for analysis.

3. Received Signal Power Spectra Plots

   Program "PFFT" performs a Fast Fourier Transform (FFT) on any of two A/D Converter Sample values to produce a Power Spectrum of the received signal strength, averages a requested number of spectra, then plots a graph of the averaged Power Spectra as a CRT Display or Hardcopy.

4. POCA Data Analysis

   Program "PPOCPLT" reads tape record Programed Oscillator Control Assemply (POCA) data such as tape record number, POCA Time Tags, POCA Frequency, POCA Rate, as well tape header data, for storage in a RODAN disk File. It then plots a graph of POCA Frequency vs Time as a CRT display or Hardcopy.

10.3.4 WIDEBAND BACKUP ROVER DATA

Procedures for the delivery and collection of the Wideband "ROVER" Original Data Records (WBODRs) and the CTA-21 Wideband Intermediate Data Records (WBIDRs) have been established in Interface Agreement NOCT-30 between the DSN and the RSST. The format of the tapes is described in sub-section IDR 12-2 of the 820-13 document. The tapes will be delivered to CTA-21 Room B-17 in Bldg. 125, Monday through Friday between 08:00 and 16:00 hours PST. The RSST will supply a hand receipt system to determine the location of the tapes. Accompanying the tapes will be instructions indicating what portion of the recorded data are to be processed and what resultant products are to be returned to the RSST. The timing requirement for delivery of these services and products is as soon as possble following Encounter.

Validation of the WBODRs is done indirectly by validation of the reduced WBIDRs constructed from them.

Validation processing of the WBIDRs is accomplished under one program:

1. Header Analysis

   Program "WBFFT" reads tape record header data such as Bandwidth Reduction Filter (BRF) Status, DSS Number, Time Tags, Sample Rate and Frequencies, for storage in a RODAN disk File for analysis.

2. Power Spectra Plots

   Program "WBFFT" performs a Fast Fourier Transform (FFT) to produce a Power Spectrum of the received signal strength, averages a requested number of spectra, then plots a graph of the averaged Power Spectral Density vs Frequency as a CRT Display or Hardcopy.

10.3.5 SPACECRAFT TRAJECTORY DATA

Procedures for the delivery and collection of the Celestial Reference Set (CRS) tapes have been established between the Navigation (NAV) team and the RSST in Interface Agreement NAV-37. The data format required is defined by SIS 4-60003-4, Rev. A. The CRS tapes will be validated by comparison with the trajectory print from TWIST. Formal statistics will be provided on request by the RSST.

10.3.6 SPACECRAFT ENGINEERING DATA

Procedures for the delivery and collection of the Radio Science Engineering Data Record (RSSEDR) tapes have been established between the General Science Data Team (GSDT) and the RSST in Interface Agreement SDT-363. The format of the RSSEDRs is defined in SIS 4-7009-01. The delivery of the tape is within one week following Encounter as specified in the requesting IOM submitted by the RSST.

10.3.7 MANEUVER DESIGN AND RECONSTRUCTION DATA

Procedures for delivery and collection of the Maneuver Design Files and the Maneuver Reconstruction tapes have been established between the Spacecraft Team (SCT) and the RSST in Interface Agreements RSST-01 and SCT-20 respectively. The format of the Pointing Vector Design File is described in Software Interface Specification (SIS) # 4-8003-22. The format of the delivered Limb Track Maneuver Reconstruction tape is described in SIS # 4-8003-19. The nominal delivery schedule for the tape will be within 30 days of Encounter, as requested by the RSST in the IOM. In any case delivery will not be made before correction of all known error sources affecting Maneuver execution accuracies.

10.3.8 HARDCOPY DATA

Procedures for the delivery and collection of hardcopy data from DSSC 40 have been established between the Deep Space Network (DSN) and the RSST in Interface Agreement NOCT-13. Procedures for the delivery and collection of Network Operations Control Center (NOCC) hardcopy data have been established between the NOCC and the RSST in Interface Agreement NOCT-39. Delivery of the Parkes hardcopy to DSCC 40 will occur with the PODRs within 24 hours of Encounter. The Parkes Hardcopy will be sent in the 1st Expedited Shipment with all the duplicate tapes. A new Interface Agreement NOCT-42 between the DSN and and the RSST to cover the Parkes hardcopy delivery procedure is in effect.

10.3.9 MONITOR IDR DATA

Procedures for the delivery and collection of Monitor Intermediate Data Record (IDR) tapes have been established between the DSN and the RSST in Interface Agreement NOCT-36. The IDR delivery will be at the request of the RSST. The DRS will process the IDR and make it available to be picked up by a MCCC Library representative within one hour. The MCCC Library will have tape(s) available for pickup by the RSST Staff Assistant (Bldg 230-Library). The RSST Staff Assistant will process the documentation for the IDRs through NDC (Bldg. 230-Room 130).

Validation and processing of the Monitor 5-9 format IDRs is accomplished using program "PPMPLOT". The program reads Time Tags and Precision Power Monitor (PPM) data in the form of System Noise Temperature values from a Monitor 5-9 IDR, and plots graphs of System Noise Temperature vs Time in ERT-UTC as a CRT display or as Hardcopy.

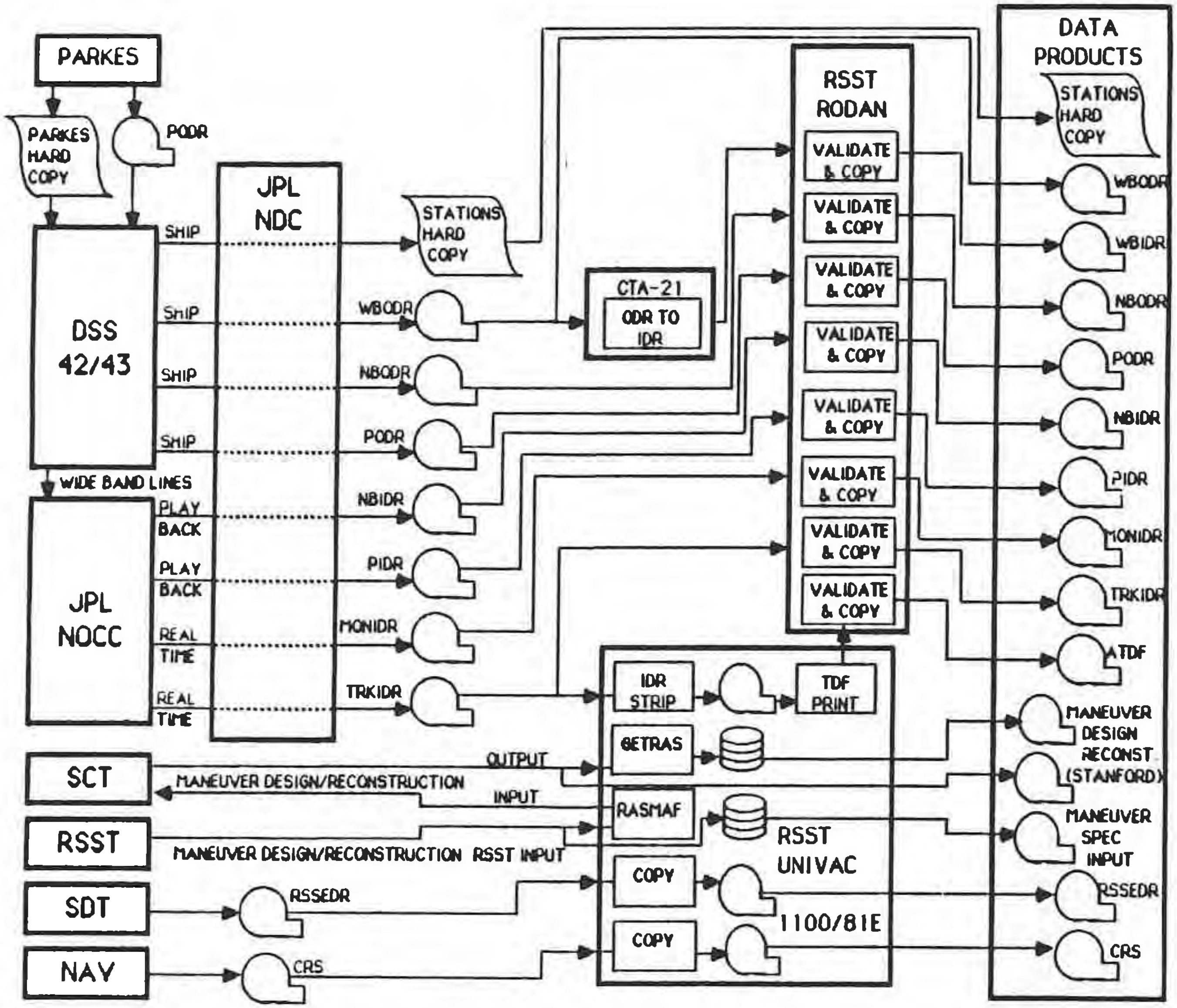

PARKES
PARKES HARD COPY
PODR
JPL NDC
STATIONS HARD COPY
SHIP
DSS 42/43
WBODR
NBODR
PODR
NBIDR
PIDR
MONIDR
TRKIDR
WIDE BAND LINES
PLAY BACK
REAL TIME
JPL NOCC
CTA-21
ODR TO IDR
RSST RODAN
VALIDATE & COPY
DATA PRODUCTS
WBIDR
ATDF
IDR STRIP
TDF PRINT
GETRAS
RASMAF
COPY
RSST UNIVAC 1100/81E
SCT
RSST
SDT
NAV
OUTPUT
INPUT
MANEUVER DESIGN/RECONSTRUCTION
MANEUVER DESIGN/RECONSTRUCTION RSST INPUT
RSSEDR
CRS
MANEUVER DESIGN RECONST (STANFORD)
MANEUVER SPEC INPUT

FIGURE 10-1

TABLE 10-1

DATA PRODUCT INTERFACE AGREEMENT LIST

DATA PRODUCT TYPE	SOURCE	USER	FORMAT	IA #
Closed-loop Tracking Data	DSN	RSST	TRK 2-15, 820-13	NOCT-35
Archival Tracking Data	NAV	RSST	Standard Format	NAV-25
Narrowband Open-Loop Data	DSN	RSST	RSC 11-9, Mark IV 820-13	NOCT-13
Narrowband Play-back Intermediate Data	DSN	RSST	RSC 11-4, Mark IV 820-13	NOCT-33
Parkes Narrowband Original Data	DSN	RSST	RSC 11-9, Mark III, 1/11/1982 820-13	NOCT-42
Parkes Narrowband Intermediate Data	DSN	RSST	RSC 11-4, Mark III, 7/1/1981 820-13	NOCT-42
Wideband Backup "ROVER" Data	DSN	RSST	RSC 11-1, 820-13, IDR 12-2	NOCT-30
Spacecraft Trajectory Data	NAV	RSST	SIS # 4-60003-4 REV A.	NAV-37
Spacecraft Engineering Data	GSDT	RSST	SIS # 4-7009-01	SDT-363

TABLE 10-1 (continued)

DATA PRODUCT TYPE	SOURCE	USER	FORMAT	IA #
Maneuver Design & Reconstruction Data	SCT	RSST	SIS #s 4-8003-21 4-8003-22	RSST-01
DSCC Hardcopy Data	DSN	RSST	Hardcopy	NOCT-13
NOCC Hardcopy Data	DSN	RSST	Hardcopy	NOCT-39
Parkes Hardcopy Data	DSN	RSST	Hardcopy	NOCT-42
Monitor IDR Data	DSN	RSST	MON 5-9, 820-13, IDR 12-1	NOCT-36

SECTION 11

TEST SUPPORT SYSTEM

The Test Support System is a real time display system that displays information of primary interest to the Radio Science Support Team on graphics terminals connected to the RODAN computer facility.

The displays provided by the TSS are different from the displays provided by the NOCC display system, although there is some overlap. Both systems will be used at Encounter.

11.1 OVERVIEW

The overall structure of the TSS is shown in figure 11-1. It is expected that there will be no further changes in the overall structure as shown, but we intend to continue to refine the details of the implementation.

11.1.1 GCF LINE TO DSN

The digital lines in the DSN's GCF are shown in figure 11-2. The line to RODAN is a receive only tap from a splitter in the link from the ECS to the NCE. There are two such splitters located in the basement of building 230.

The output of RODAN's splitter goes directly to a line driver which is connected to a line receiver in the RODAN computer room. The output of the line receiver is an RS-232 signal which is input to RODAN's front end filter computer.

11.1.2 DATA FLOW

Within RODAN, data proceeds sequentially through successive processes until it is logged on disk by the Farmer. These disk files constitute a database that is accessed as needed by the display programs. The processes that handle the data in RODAN are described below.

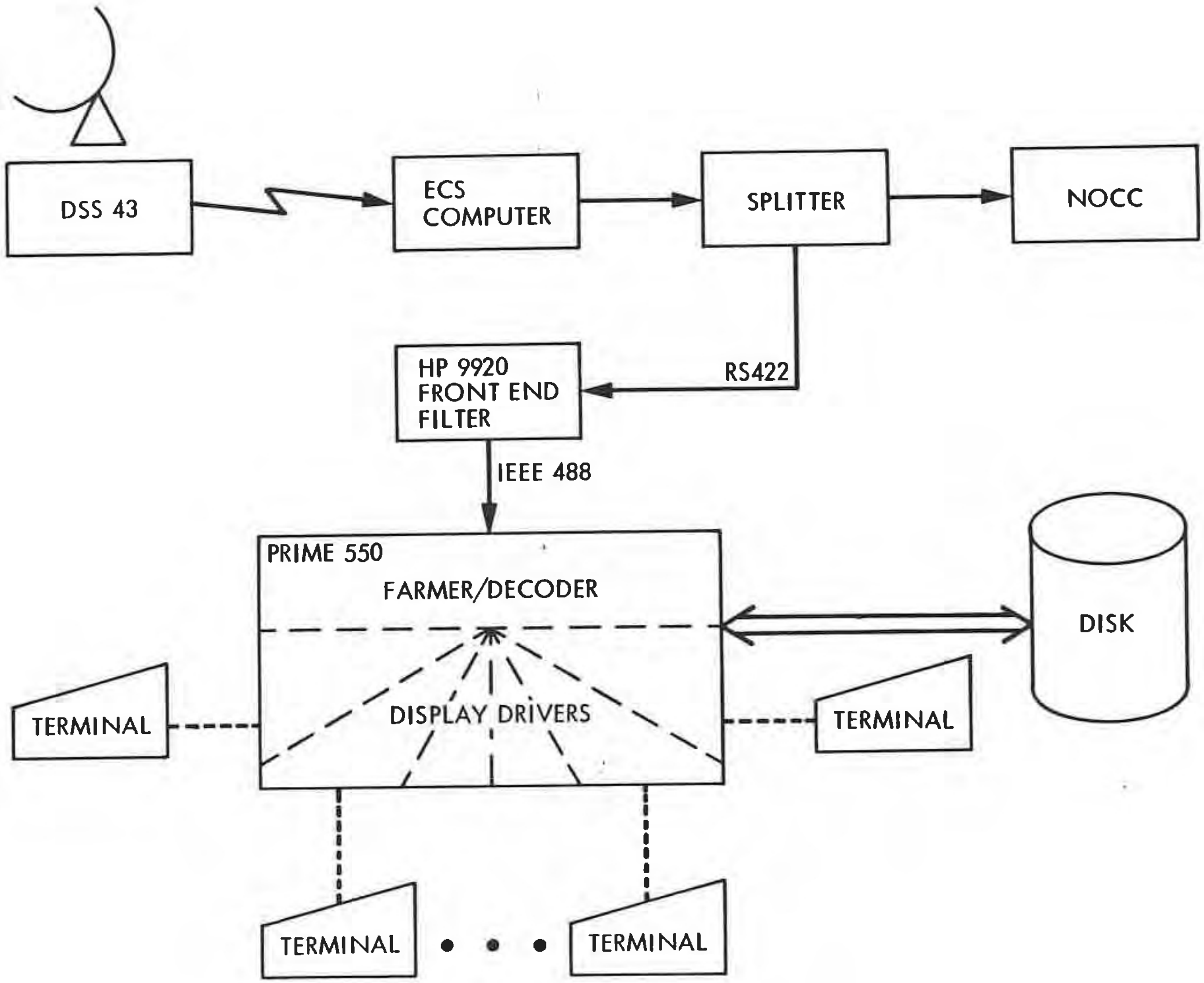
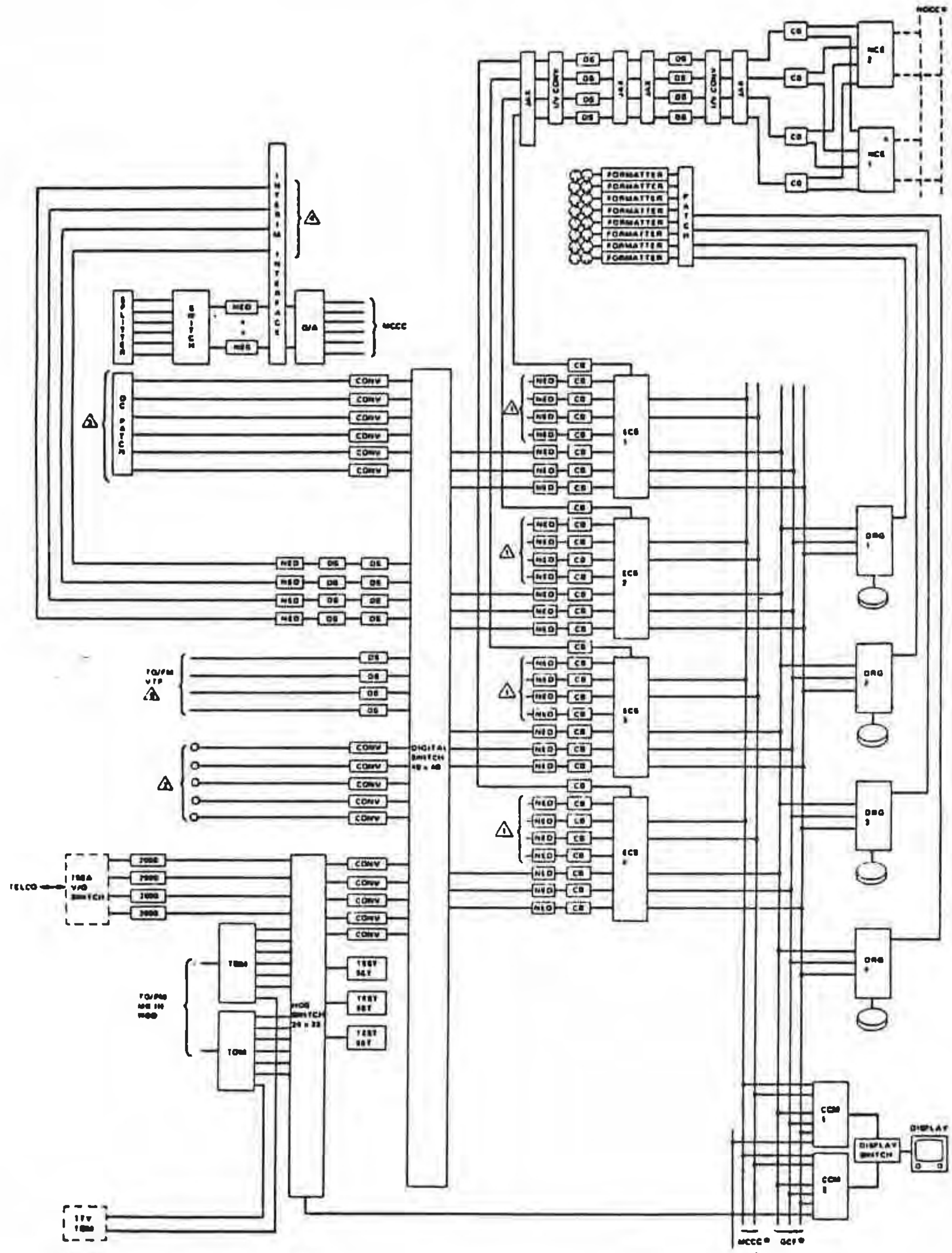


Figure 11-1: Test Support System

Figure 11-2: MK IV

CENTRAL DIGITAL COMM INTERFACES



NOTES:

1. TO/FM HSD SWITCH IN MK III CONFIGURATION
2. "PATCHABLE" TO ANY HSD CHANNEL
3. "PATCHABLE" TO ANY HSD CHANNEL DIRECT OR VIA SPLITTER AND/OR TO MCCC MK III INTERFACE
4. MK IV HSDS INTERFACES "PATCHABLE" TO MCCC
5. VTF ARA INTERFACES. MAY BE RECONFIGURED TO DEVELOPMENT AREA IN SECTION [illegible] DEVELOPMENT LAB ON A LINE-BY-LINE BASIS

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11.1.2.1 H. P. SERIAL INTERFACE

A Hewlett-Packard 98691A Programmable Serial Interface h been modified for use with the DSN's communications protocols. includes a Z80 microprocessor which manages twenty 4800-bit blo buffers.

11.1.2.2 H. P. 9000

A Hewlett-Packard 9920 computer reads data from the interfa and checks to see if the data type is one that is of interest RODAN. If so then it is sent on to the Prime via IEEE 488 parall interface.

11.1.2.3 HPIN

HPIN is a small phantom in the Prime that receives data fr the IEEE interface into a 100 block circular buffer in shar memory. It also generates warning messages if no data is receive

Further details are available in the section on intern interfaces.

11.1.2.4 FARMER

The Farmer is a process that determines what kind of data received and unpacks it into the appropriate Prime machine forma The data is then written into the appropriate disk file for th data type.

11.1.2.5 DISPLAYS

There are a number of different display programs that inspe the disk files for specific data for graphic display, and also few that display text data. These programs may be run on a appropriate graphics terminal connected to RODAN. Experience h shown that only about five such displays can be supported befo the system response time becomes unacceptably sluggish.

11.2 SETUP AND TAKEDOWN PROCEDURES FOR DATA LOGGING

This section describes how to start up the data logging portion of the Test Support System, and how to take it down at the end of the pass. If you only intend to run the display generators and are not responsible for starting and stopping the TSS then you do not need to read this section.

11.2.1 STARTUP SEQUENCING

The Prime and the HP computers can be set up in either order. If the Prime is started first then HPIN will generate DMA timeout warnings until the HP begins sending data to the Prime. (It may do that anyway if there is little data coming in.) If the HP is started first then it will hang as soon as it receives a block that it wants to send to the Prime. The hang will probably cause a receive overrun error as the H.P.'s buffers fill up, but it will resume normal operation as soon as the Prime begins accepting data.

On the Prime, HPIN, the Farmer, and any display programs must be started in that order. Each of them initializes its interface with the next process in the chain, and cannot do so if the interface is already in use. For example: the Farmer cannot set the read-write lock on a file that is already open by a display driver process, even if that file is empty.

The TSS.INITxx.COMI command file may be run either before or after HPIN is started.

If anything goes wrong during startup on the Prime (e. g. a display program is started before the Farmer) stop execution of all display programs and the Farmer. Then either logout those terminals or do a C -ALL on all those terminals before retrying the step that failed.

11.2.1.1 H.P. SETUP

The Hewlett-Packard 9920 computer used as the front end of the TSS is located in the bottom of the Array Processor rack which is the leftmost equipment rack.

11.2.1.1.1 G.C.F. LINE

Call the Comm Chief (X5800) and request "Please connect t RODAN computer line to the ECS computer handling complex XX where XX is 10, 40, or 60 according to which one you want da from. You can verify that you are connected to the proper ECS fr the Farmer display when you get that program started.

11.2.1.1.2 POWER SWITCHES

Turn on the power switches for the main box, the floppy di drives, the printer, and the monitor.

If the H.P. is already on then you may instead press SHI RST. If the H.P. does not boot properly, then try cycling powe

11.2.1.1.3 TSS: GREEN OPERATIONAL DISK

Insert the microfloppy with the green label that says "TS Stand Alone T.S.S. Operational Disk." Wait for the cold boot finish. (The screen will show "Command:...." in the top left, a the disk's activity light will go out.) The metal cover goes in the drive, and the label goes on the top.

This disk should stay in the drive or next to it at all time although the Support Engineer has backup copies. Also it shou always be write protected. (The red thingy should be pushed do so you can't see it through the hole from the top.)

11.2.1.1.4 PROGRAM STARTUP

Execute the filter program by pressing EXEC, then ty FILTER(cr), then type the select code of the interface current being used.

If you choose an unconnected interface, or if there is hardware problem you will immediately get a message "! NO RECEI CLOCK !!!!!!!!" Check that data is coming over the line, and th you used the correct select code.

You can determine whether data and clock are present on t GCF line by looking at the meter on the grey line driver on t back of the equipment rack with the H.P. in it. Set the directi switch to REC, and set the line switch to position 4. If the met reads a steady value that is not full left, then clock is bei received. Set the line switch to position 3. If the meter twitches from full left to about where the clock signal was then you are getting data blocks.

You can determine the interface select code by looking at the back of the H.P. to see which interface has the cable plugged into it. The relevant interfaces are numbered 20 through 22 and are in the left half of the backplane.

Only if the problem cannot be located locally should you call the Comm Chief (X5800) and report that the line is not working properly. The most likely source of a problem, if the H.P. is set up properly, is a cable not completely plugged back in when our line was reconnected by the Comm Chief.

If you wish you may execute the program MONITOR first to get some indication of the kind of data blocks on the line. Execute it the same way as FILTER. Programs are stopped by pressing SHIFT STOP. This returns you to the same command line you get after a cold boot.

11.2.1.2 HPIN

Login to the Prime as HPIN. While still attached to the main TSS directory type "PH HPIN". That will start a phantom called HPIN (the name you logged in as) running the file HPIN.CPL (the name you typed after the PH command).

The status of the phantom can be checked to some extent with STAT US, and STAT SEM. The former should show a phantom named HPIN with device GPO assigned. The latter should show semaphore number 1 with a value between 177634 and 0. (The number is a negative 16 bit integer displayed in octal. The value is the number of data blocks in shared memory waiting for the farmer to read them.)

Once the phantom is started you may logout.

11.2.1.3 FILE INITIALIZATION

Login to the Prime as TSS. Preferably you should do this on a character only terminal, such as the H.D.S., that will not be wanted for displays while the TSS is operating.

While still attached to the main TSS directory type one of the following:

```
CO TSS.INIT10.COM        CO TSS.INIT40.COMI
CO TSS.INIT60.COMI       CO TSS.INITALL.COMI
```

These command files delete the contents of all the relevant TSS data files. They will not work if any of these files are open.

11.2.1.4 FARMER

While still attached to the main TSS directory type "S FARMER".

The program will then ask you for a file describing what da to look for. The four files that are set up in TSS for use he are F_10, F_40, F_60, and F_ALL. The last file will accept a data from all complexes. The other three will accept data from single complex. All files will only accept data related to Voyag 2. Type the filename that you want.

11.2.2 TAKE-DOWN PROCEDURES

At the end of a pass the Farmer should be stopped by typi control-P, followed by LO to logout that terminal.

Then the HPIN phantom should be stopped. Do this by loggi back in as HPIN, then type STAT ME. Two users should be liste The first one should be your terminal, and the second one should marked as "phant" in the line number column. Then type LO -# whe # is the user number from just left of where it said "phant", th logout. It is very important to logout the HPIN phantom when t Farmer is not working.

It is not strictly necessary, but it would be nice to stop t filter program on the H.P. 9920, and start the monitor progr instead. See the H.P. Program Startup section for details.

11.3 DISPLAY GENERATORS

This section describes how to run a T.S.S. display progra

Once the data logging portion of the TSS is operating a appropriately configured NEC personal computer connected to ROI can be used to display data. Simply login to RODAN using t appropriate version of the ESC140 program and execute the displ program for the type of data you want to display.

The three primary display programs are NRVTEXT, SSIREAD, a TRK. The delivered copies of all three programs are in the t level TSS directory.

11.3.1 N.E.C. CONSIDERATIONS

The proper terminal to use with the TSS is an N.E.C. A.P.C. running a specially modified version of the ESC140 terminal emulator. Eight inch floppy disks configured to auto-load the proper version of ESC140 are kept in a beige case in the upper right cabinet above the desk on the north wall of 264-365A. (That's the cabinet in Don Sweetnam's office with all the computer manuals in it.) Labels for the special function keys on the keyboard are also in that box. These disks should be returned when you are through with them.

The NEC has internal display memory for three graphics displays (numbered from 1, not from 0) and a text display, all completely independent. The user can select any one graphics display and/or the text display without affecting the running of the display program.

Different display programs put different data in different display memories. NRVTEXT uses only the text page. SSIREAD uses graphics pages 1 and 2, but not the text page. TRK uses all three graphics pages, but not the text page.

11.3.2 BASIC PROGRAM OPERATION

To start one of the programs type "SEG progname" while attached to the top level TSS directory. All programs ask a few basic questions while they are getting started like what station or complex you want to look at. These questions are mostly self-explanatory and will not be described in detail.

The NRVTEXT display asks for start time (in 3I2 fortran format, so the / for default values will not work). That input is a cheap substitute for the graphics Realtime command described below. Generally you will enter six zeros for the start time.

Since NRVTEXT does not have the normal Quit command it must be stopped with control-P. You MUST follow the quit with a C -ALL command to close its input file. It also is useful to hit the RESET function key on the NEC terminal (above the 8).

The SSIREAD display always starts at the beginning of the file. The use of the Realtime command is recommended, but you should wait until the program has fully initialized both graphics pages 1, and 2 before the command is given. SSIREAD puts the current SSI spectrum on graphics page 1, and a summary of peak frequency and power goes on graphics page 2.

The TRK display program will draw two graphs on each of the three graphics pages. Each page refers to a single frequency at a single station. Any two of the known characteristics of that signal may be graphed on any page. The user inputs are the da type for each graph (e. g. AGC, and pseudoresiduals), and t station and frequency for each page (e. g. 43 X-band).

11.3.3 PLOT CONTROL

Once the display program has been started and configured, y can control what data in the NEC is displayed and what portion the data file is plotted. Parameters such as station numb are determined when the program is started and cannot changed later.

11.3.3.1 GENERAL

Display programs spend their time trying to update t display, rather than waiting for commands. Before a display wi accept a command from the keyboard, you must attract its attenti with the break key, or control-P. It should respond by printing menu of available commands in the top left corner of the scree Once you have the menu displayed with the cursor after it you c type any one of the commands described here, but the display wi not update while the program is waiting for a command.

Most commands are a single character followed by a carra return.

The Continue command (type C and a return, nothing else) tel the display program to continue processing data from where it w interrupted.

The Quit command tells the display program you are done. T program closes all files and exits to the operating system.

The Realtime command is a variation on the continue comma that forces the program to continue from close to the end of t input file -- that is close to the most recent data availabl Plot scales will be updated if needed. This command is especial useful if you are starting up a display well after the beginning the pass.

11.3.3.2 NEC/ESC140 DISPLAY CONTROL

There is a row of special function keys across the top of t NEC keyboard. Only three or four of them are used by the TSS.

The key labeled TEXT ON/OFF controls display of the text page. It may be needed just after starting a graphics display to avoid confusion.

The key labeled GRAPH ON/OFF operates similarly for the graphics portion of the NEC display.

The key labeled ALT GR PAGE cycles through the three graphics pages. This key is purely a local display function. It has no effect on program operation.

To control which graphics page will be operated on by a display program command, you must use the Viewpage command. The command is given after a ctl-P, and consists of the letter V, followed by a space, followed by a 1, 2, or 3, followed by a carrage return.

11.3.3.3 PLOT AXIS CONTROL, AND FILE SEARCHING

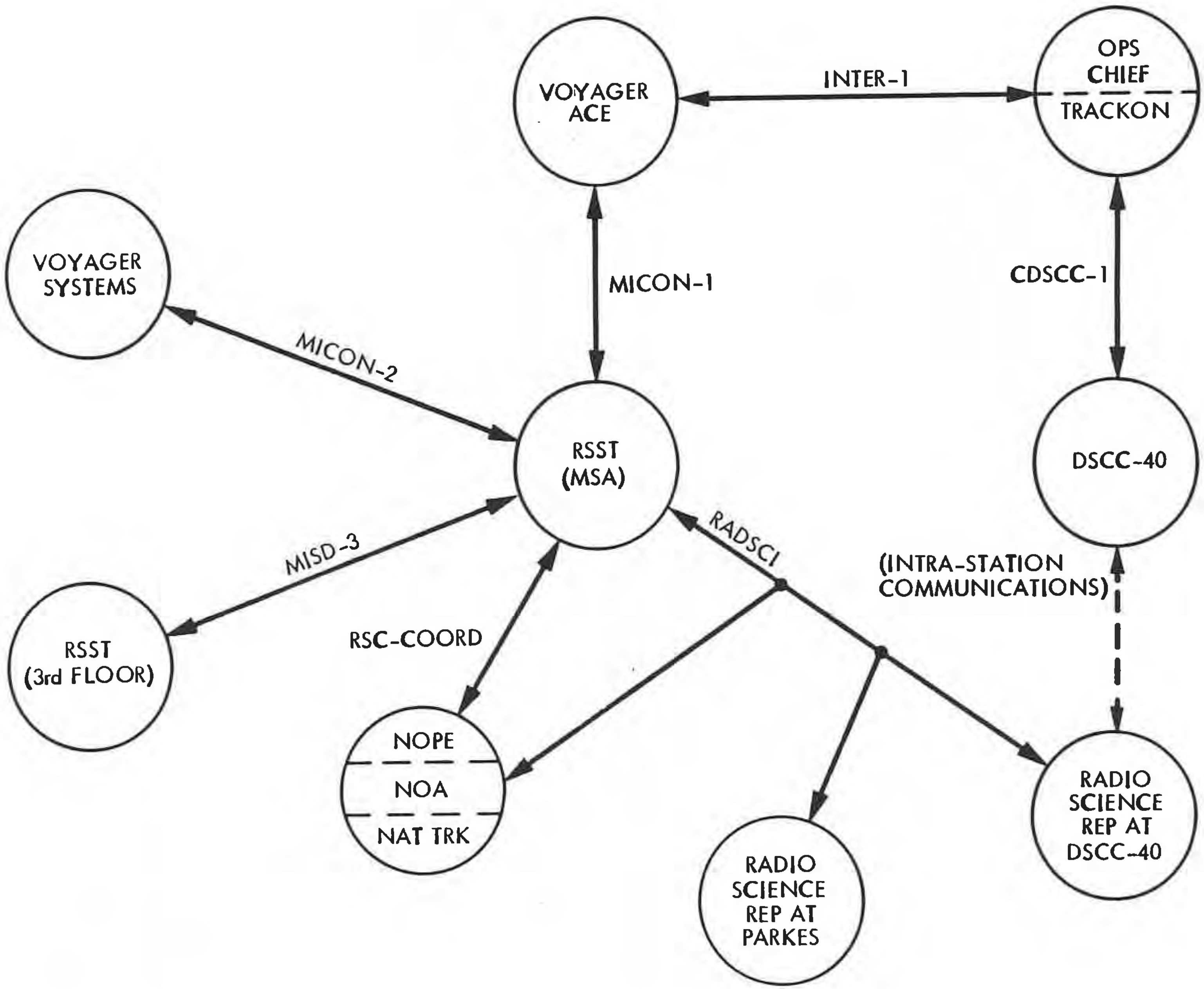
The two commands that are used to change plot axes are Frame and Limit. Both commands are implemented to act on the entire input file. You can ignore the fact that only a portion of the file is kept in memory at a time, although you may notice that certain kinds of changes are slower than others.

The Limit command erases the menu and prompts for the axis limits you want.

The Frame command enables the mouse and displays a crosshair that can be moved with the mouse. Pressing the left mouse button marks the point at the crosshairs. A box within the current display can be magnified to fill the entire display by marking the two opposite corners of that box.

If a point outside the current grid is marked, then the size of the current grid is doubled in that direction. So the Frame command can be used to pull in data from outside the current display limits. Generally the Limit command works better if you want to look at something outside the current display.

If two grids are shown on the graphics page being framed, then a box will be requested for each grid. You can bypass action on either or both grids by pressing the center mouse button for the corresponding prompt. The right mouse button returns you immediately to the main menu.



VOYAGER ACE
INTER-1
OPS CHIEF
TRACKON
VOYAGER SYSTEMS
MICON-1
CDSCC-1
MICON-2
RSST (MSA)
DSCC-40
MISD-3
RADSCI
(INTRA-STATION COMMUNICATIONS)
RSST (3rd FLOOR)
RSC-COORD
NOPE
NOA
NAT TRK
RADIO SCIENCE REP AT DSCC-40
RADIO SCIENCE REP AT PARKES

TABLE 8-1

VOICE NET COMMUNICATIONS

MICON-1:	Project's operational net for communications between MSA personnel and the ACE.
MICON-2:	MCT's internal net for communication between spacecraft subsystem analysts and the Cognizant Systems Engineer.
MISD-3:	Mission Director's net reserved for internal RSST communications during the encounter period.
RSC-COORD:	Radio Science Support Team net to NOCC for communication with the NOPE, NOA and NAT TRACK. Formerly called TRK ANAL2.
INTER-1:	Standard Project operational net to NOCC for communication between the ACE and the OPS Chief.
CDSCC-1:	Standard NOCC-to-DSN Complex control net.
CDSCC-2:	Coordination net used to exchange information not directly applicable to the ongoing tracking activities.
RADSCI:	The Radio Science Advisor Net has a special function and is described in detail in Section 8.2.2.

TABLE 8-2

VOICE NET CALL SIGNS

CALL SIGN	AGENCY	LOCATION
RADIO SCIENCE	VOYAGER PROJECT	264/MSA (JPL)
RADIO SCIENCE NOPE	DSN	230/NOCC (JPL)
VOYAGER NOPE	DSN	230/NOCC (JPL)
40 SCIENCE	DSN	DSCC 40 (AUSTRALIA)
PARKES SCIENCE	DSN	PARKES (AUSTRALIA)
SUPPORT TEAM	VOYAGER PROJECT	264/365 (JPL)

TABLE 8-3

RADIO SCIENCE CONTROL FUNCTIONS DURING CRITICAL EVENT PERIODS

1. Selection of DSP/ODA predict sets
2. Selection of DSP/ODA time offsets
3. Selection of DSP/ODA frequency offsets
4. Selection of DSP/ODA run/idle modes
5. Selection of SSI configurations
6. Selection of PPM noise diode and integration time

TABLE 8-4

PRE-ENCOUNTER BRIEFING AGENDA

1. Updates to Predicts Time Offset
2. Status of Ground Data System
3. Pre-pass Calibration Results
4. Confirmation of Station Configuration
5. Parkes Status
6. Open-loop Predicts Set ID's
7. Updates to ISOE
8. Station Questions or Concerns

TABLE 8-5

SSI SPECTRUM IDENTIFICATION

NOCC DISPLAY	SSI PORT NUMBER	SIGNAL SOURCE
SRCP	5	DSS 43 S-BAND FROM MMR
SLCP	6	DSS 42 S-BAND FROM MMR
XRCP	7	DSS 43 X-BAND FROM MMR
XLCP	8	DSS 42 X-BAND FROM MMR
ODAN/A	9	DSS 43 S-BAND FROM NBOC
ODAN/B	9	DSS 42 S-BAND FROM NBOC
ODAN/C	9	DSS 43 X-BAND FROM NBOC
ODAN/D	9	DSS 42 X-BAND FROM NBOC
ODAM	10	ROVER (SIGNAL DETERMINED BY CENTER FREQUENCY)

TABLE 8-6

POST-ENCOUNTER DEBRIEFING AGENDA

1. RSST's Data Playback Request (if applicable)
2. Operational Open Items
3. Tape-Log Report

APPENDIX A

TABLE A-1

DSS 42 STATION CONFIGURATION

1. Closed-Loop System Configuration

   a. Receivers

S-band: SRCP = RCVR 3
2BLO = 12 Hz
AGC = Narrow, unless otherwise specified in the ISOE.

X-band: XRCP = RCVR 4
2BLO = 48 Hz
AGC = Narrow, unless otherwise specified in the ISOE

** NOTE **
Generate AGC calibration curves for RCVR's 3 and 4 for the DSS 42 calibration signal levels in Appendix B

   b. MDA - TRK Predict Sets - Uplink: TBD
Coherent Downlink: TBD
Noncoherent Downlink: TBD

Doppler sample rate: 1 per 5 second, unless otherwise specified in the ISOE.

S-band and X-band channels enabled

   c. BLK III Doppler Extractors:
COH periods: referenced to BLK III exciter
NCOH periods: referenced to SIM synthesizer
Voyager 2 USO TSF in SIM synthesizer

TABLE A-1 (continued)

d. PPM - NAR: Two channel configuration monitor S-band and X-band RCP system noise temperatures for DSS 42.

Noise diode = 0.25 degrees

Integration time = 60 sec

Switching between S-band and X-band will be done automatically by the PPM every 60 seconds

SLE: Assign one SLE to DSS 42

Manually select the integration time for SLE to equal 120 seconds.

Switching between S-band and X-band will be done automatically by the SLE every 120 seconds

2. Open-Loop Subsystem

Open-loop checks for DSS 42 are specified in Table A-2, part 2.a.

3. Microwave Subsystem

Downlink signal to Maser Configuration:

Prime Block III = SRCP
Block I = XRCP

4. Antenna Subsystem

Antenna pointing strategy is defined in section 8.5.

5. Frequency and Timing Subsystem

Station frequency standard should be the same hydrogen maser used as the DSS 43 standard.

TABLE A-2

DSS 43 STATION CONFIGURATION

1. Closed-Loop System Checks

   a. Receivers - S-band:
      SRCP = RCVR 1
      2BLO = 10 Hz, in NARROW mode unless otherwise specified in the ISOE
      AGC = Narrow, unless otherwise specified in the ISOE

      X-band:
      XRCP = RCVR 2
      2BLO = 30 Hz, in NARROW mode unless otherwise specified in the ISOE
      AGC = Narrow, unless otherwise specified in the ISOE

** NOTE **
Generate AGC calibration curves for RCVR's 1 and 2 for the DSS 43 calibration signal levels in Appendix B

   b. MDA - Predict Sets - Uplink: TBD
      Coherent Downlink: TBD
      Noncoherent Downlink: TBD

      S and X-band channels enabled.

      Doppler sample rate: 1 per 5 second, unless otherwise specified in the ISOE.

TABLE A-2 (continued)

c. BLK IV Doppler Extractors:
COH periods: referenced to BLK IV exciter
NCOH periods: referenced to SIM synthesizer
Voyager 2 USO TSF in SIM synthesizer

d. PPM - NAR: Two channel configuration, monitor S-band and X-band RCP system noise temperatures for DSS 43.

Noise diode = 0.25 degrees

Integration time = 15 sec

Switching between S-band and X-band will be done automatically by the PPM every 15 seconds

SLE: Assign one SLE to DSS 43

Manually select the integration time for SLE to equal 120 seconds.

Switching between S-band and X-band will be done automatically by the SLE every 120 seconds.

2. Open-Loop System Checks

a. MMR Prime Receiver

DSS 43 S-band Filter Select = 8
DSS 43 X-band Filter Select = 8
(No filter selection capability for DSS 42)

Bandwidth: S-band = 20 kHz
X-band = 20 kHz

Frequency Reference: CRG

Ensure IF selection is set to RS position

Calibration information is in Appendix B

TABLE A-2 (continued)

b. Backup Open-loop Receiver

Calibration information is in Appendix B

Synthesizer frequencies are in Appendix C

c. SPA - Configure for narrow-band recording, pass-dependent parameters are:

CHN A = 1 B = 2 C = 3 D = 4
MOD MODE = 1 RATE = 8 RESOL = 8
PRD = TBD (see Appendix C)

Set tape recorders to 6250 bpi recording density

d. DRA wide-band recorder, IPS = 120

e. SSI - As per ISOE.

3. Microwave Subsystem

Prime Block IIA (XR01) = XRCP
Prime Block IV (SPD) = SRCP

TABLE A-2 (continued)

4. Antenna Subsystem

The antenna strategy is described in Section 8.5.

5. Transmitter Subsystem

The uplink tuning strategy is in Section 8.6.

6. Frequency and Timing Subsystem

Station frequency reference will be a hydrogen maser unless one is unavailable.

TABLE A-3

DSS 49 (PARKES) STATION CONFIGURATION

*****NOTE*****

SEE THE PARKES USER'S GUIDE FOR MORE DETAILS

1. OPEN-LOOP SUBSYSTEM

   a. Open-Loop Receiver

      Bandwidth = 35 KHz

      Calibration information is in Appendix B

   b. ODA - Recording Parameters

      CHN 1
      MOD 2 7 8
      DSS 43
      SCN 32
      PRD (manually entered one-way set)
      RUN NB 024 2115 025 0245

      Predict set information is in Appendix C

2. MICROWAVE SUBSYSTEM

   a. Prime Block IIA type = XRCP

   b. NAR configuration

      integration time = 15 seconds
      noise diode = 0.25 degrees Kelvin
      configure to record SNT data on disk

3. ANTENNA SUBSYSTEM

   Antenna pointing predicts contain the spacecraft position in Right Ascension and Declination (RA/DEC) coordinates. Section 8.9 contains Parkes antenna details.

4. FREQUENCY AND TIMING SUBSYSTEM

   Station frequency reference will be a cesium with a crystal clean-up loop (see figures in section 3).

APPENDIX B

B.1 OPEN LOOP RECORDING SYSTEM PRE-PASS CALIBRATION (GENERAL INFORMATION)

This appendix addresses the pre-pass calibration of the open loop recording systems at DSCC 40 and Parkes. There are currently three types of open loop precals needed to support the scheduled DSN support of Voyager radio science activities at Uranus encounter. They are:

1. Open loop receiver level precals to avoid saturating the analog to digital converters,
2. Open loop receiver phase, frequency and amplitude response calibrations,
3. Analog to digital converter performance precals.

The recorded open-loop receiver signals are the prime data type for the Uranus atmosphere and ring occultation experiments. For this reason, it is extremely important that the open-loop system be properly configured prior to the recording pass, and that it be calibrated to the expected maximum signal levels. The The following paragraphs describe these calibrations.

B.1.1 Open Loop Receiver Level Precals

The open-loop receiver level calibrations are performed to establish the output of the open-loop receivers at a level that will not saturate the input to the analog to digital converters. To achieve this goal, the calibration is done using a test signal generated by the exciter/translator that is set to the maximum predicted signal level for the upcoming pass. Then the output level of the receivers video band spectrum envelope is adjusted to the level determined by the equation:

$$S = L \left(\frac{SNR + 1}{2SNR + 2k\,(2SNR)^{1/2} + k*k} \right)^{1/2}$$

Where:
- S = receiver output level (volts rms)
- SNR = expected received SNR
- k = number of sigma (saturation margin)
- L = A/D converter saturation level

The value chosen for k for all of the Voyager radio science events is 5. A plot of S versus SNR is shown in Figure B-1.

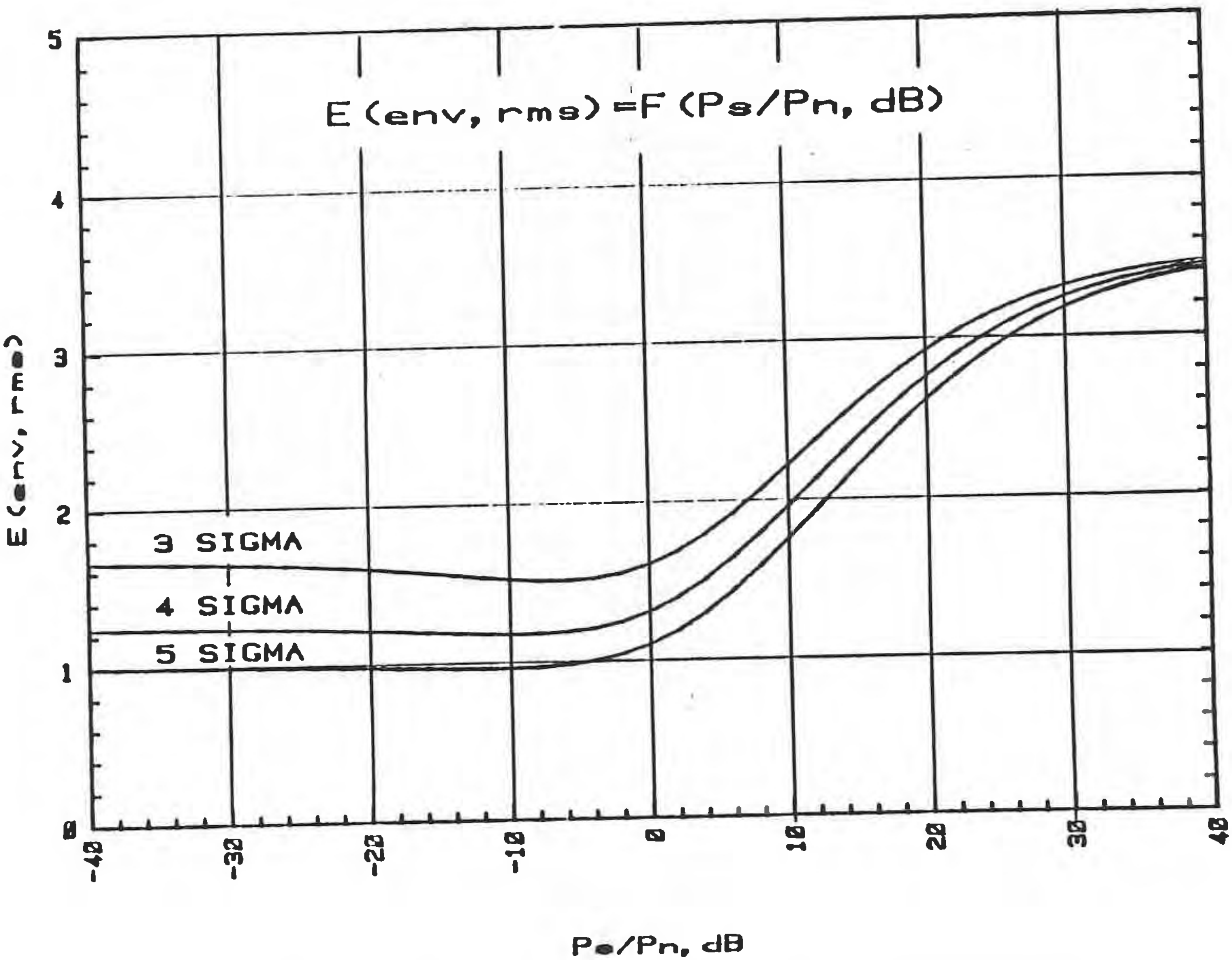


FIGURE B-1 ENVELOPE RMS VOLTAGE INTO ADC AS A FUNCTION OF INPUT POWER SIGNAL-TO-NOISE RATIO

The three bit A/D converters in the wideband backup system's DRA are companded converters designed for an optimal signal level of 1 volt rms. Due to the wide recorded bandwidth and the resulting low SNR, the receiver output signal is almost all noise and is thus directly proportional to system temperature.

Table B-1 contains the summary of the precal information needed to set the open loop receiver attenuators at each of the stations for the encounter. The following is a description of the contents of the columns in Table B-1.

COL#	COL HEADING	CONTENTS
1	DSS	This is the ID of the station scheduled to support the encounter.
2	BAND	This indicates the band, S-band or X-band, which the information in this row is applicable to.
3	MMR FILTR S & X	This is the bandwidth in Hz of the S-band and X-band MMR filters to be used during open loop recording period.
4	SIGNAL LEVEL in dBm	This column contains the maximum expected signal levels for S-band and X-band for the open loop recording period. These are the levels which are to be used to set the attenuator settings during precals.
5	SIGNAL + COLD SKY RMS VOLTS	This is the rms voltage from the OLR into the NBOC during the precal period when the antenna is looking at cold sky and the test signal level is set to the value in column 4.
6	MMR ATTN SETTING	This is a column the personel performing the precal will fill in. This column is intended to contain the S-band and X-band MMR attenuator settings resulting from performing the cold sky + calibration signal precal. It should not be necessary to add any extra attenuation to this because all the open loop recordings occur at high elevation angles.

B.1.2 Open Loop Receiver Phase Frequency and Amplitude Calibration

The purpose of this part of the calibration is to provide data that will establish baseline values for the phase, frequency, and amplitude stability and performance of the open loop systems at DSCC 40 and Parkes. The procedure basically consists of stepping a test signal across the bandpass of the open loop receiver filters and recording this data on the applicable open loop recording subsystem.

B.1.3 Analog to Digital Converter Performance Calibration

A calibration procedure has been created to allow monitoring and calibration of the particulars of the analog to digital process performed by the NBOC's at DSCC 40 and Parkes. This procedure involves basically attaching a stable external synthesizer to the NBOC, configuring the NBOC in the mode in which it will be used at the encounter and recording the digitized synthesizer frequency on a tape.

B.2 DSCC 40

B.2.1 DSCC 40 Open Loop Receiver Level Precals

The purpose of this type of precal is to adjust the receiver attenuators so as to not exceed the input range of the analog to digital converters which are digitizing the receiver output voltages. The precal information necessary to perform this task for the MMR is summarized in Table B-1. The description as to the contents of each of the columns in the table can be found in section B.1.1.

The Rover or backup open loop recording system will be used for the encounter to provide a backup recording mechanism to the MMR and DSP. Therefore level precals must be performed on this subsystem prior to its usage at the encounter. Unfortunately due to time constraints the Rover precals cannot be addressed in any detail here. The Rover calibration strategy developed by Greg Milford at DSCC 40 should be used. If possible this strategy should be adjusted to the signal levels specified in Table B-1 however updating this strategy should not be considered critical because the signal levels have only changed by about a dB.

B.2.2 DSCC 40 Open Loop Receiver Phase, Frequency and Amplitude Calibration

The purpose of this part of the calibration is to provide data that will establish baseline values for the phase, frequency, and amplitude stability and performance of the open loop system. In order to achieve this goal it is necessary to step the test signal across the bandpass of the DSCC 40 open loop receiver filters and record this data at the DSP.

Both the 42 and 43 MMR channels need to be calibrated in this manner. The S-band and X-band signal levels for this recording should be the same as the calibration signal levels specified in Table B-1. The stepping increments of the test signal are listed in Table B-2. The step sizes are due to fact that the 20 KHz S-band and X-band MMR filters are equal in bandwidth.

Each tone should be recorded for 30 seconds and then the test translator or whatever exciter source is being used to generate the tones should be stepped to the next tone. The recording or dwell time at each frequency should be approximately 30 seconds. All the predict points in the predict set used during this recording should have the same frequency. The frequency to use is the S-band frequency specified at the end of Table B-2. The DSP mode for this recording should be the Uranus encounter mode as specified in appendix A.

B.2.3 DSCC 40 NBOC Performance Calibration

In order to monitor and calibrate the particulars of the analog to digital process performed by the DSCC 40 NBOC, it is requested that the following precal procedure be performed. This procedure involves basically attaching an external synthesizer to the NBOC, configuring the NBOC in the mode in which it will be used at the encounter and recording the digitized synthesizer frequency on one tape.

1. Use as stable a synthesizer as is available and attach it to the NBOC.

2. Set the synthesizer frequency to 11100 Hz.

3. Set the peak to peak voltage into the NBOC to be in the 5 to 7 volt range.

4. Use the CHN OCI to assign the synthesizer input to all four ADC's in the NBOC such as CHN A = 2 B = 2 C = 2 D = 3 if the synthesizer were attached to J2.

5. Use a MOD OCI of MOD MODE = 1 RATE = 8 RESOL = 8 to configure the NBOC in the Uranus configuration.

6. Select any predict set which covers the current time

7. Ensure the tape recorders are set to the 6250 bpi recording density.

8. Record one tape in this configuration.

9. Disconnect the synthesizer from the NBOC and reconnect any disconnected MMR cables.

B.3 PARKES

B.3.1 PARKES Open Loop Receiver Level Precal

The purpose of this type of precal is to adjust the receiver attenuators so as to not exceed the input range of the analog to digital converters which are digitizing the receiver output voltages. The precal information necessary to perform this task is summarized in Table B-1. The description as to the contents of each of the columns in the table can be found in section B.1.1.

B.3.2 PARKES Open Loop Receiver Phase, Frequency and Amplitude Calibration

The purpose of this part of the calibration is to provide data that will establish baseline values for the phase, frequency, and amplitude stability and performance of the open loop system. In order to achieve this goal it is necessary to step the test signal across the bandpass of the Parkes open loop receiver filter and record this data at the ODA.

The stepping of the frequency of the test signal is listed in Table B-3. Each tone should be recorded for approximately 30 seconds and then the test signal should be stepped to the next tone. The X-band signal level for this recording should be the same as the calibration signal level specified in Table B-1. All the predict points in the predict set used during this recording should have the same frequency. The frequency to use is the OLR POCA frequency specified at the end of Table B-3. The algorithm for generating Parkes Radio Science predictions from X-band frequencies is specified in section 2.4.2 of the Parkes User's Guide. The ODA mode for this recording should be the Uranus encounter mode.

B.3.3 PARKES NBOC Performance Calibration

In order to monitor and calibrate the particulars of the analog to digital process performed by the Mark III type NBOC at Parkes it is requested that the following precal procedure be performed. This procedure involves basically attaching an external synthesizer to the NBOC, configuring the NBOC in the mode in which it will be used at the encounter and recording the digitized synthesizer frequency on one tape.

1. Use as stable a synthesizer as is available and attach it to the NBOC.

2. Set the synthesizer frequency to 8100 Hz.

3. Set the peak to peak voltage into the NBOC to be in the 5 to 7 volt range.

4. Use the CHN OCI to assign the synthesizer input to all four ADC's in the NBOC such as CHN 2 if the synthesizer were attached to J2.

5. Use a MOD OCI of MOD 2 7 8 to configure the NBOC in the Uranus configuration.

6. Select a station ID of 43 and a spacecraft id of 32.

7. Select any predict set which covers the current time

8. Record one tape in this configuration (06:40 length).

9. Disconnect the synthesizer from the NBOC and reconnect any disconnected receiver cables.

TABLE B-1

ENCOUNTER OL RCVR PRECAL TABLE

DSS ***	BAND ****	OLR FILTR S & X *****	SIGNAL LEVEL in dBm ******	SIGNAL + COLD SKY RMS VOLTS *********	MMR ATTN SETTING *******
42	S	20K	-155	1.0	
	X	20K	-143	1.1	
43	S	20K	-149	1.0	
	X	20K	-137	1.4	
49	X	35K	-137	1.2	

VGR TWT Power Mode Switches

SHI = SLO + 4.7 dB
XHI = XLO + 2.2 dB

Assumes the following cold sky zenith SNT's:

42 S-band = 24
42 X-band = 24
43 S-band = 22
43 X-band = 23
49 X-band = 21

TABLE B-2

DSCC 40 OPEN LOOP CALIBRATION FREQUENCY STEPS

STEP	S-BAND FREQ RELATIVE TO CENTER OF 20 KHZ S-BAND MMR FILTER
1	-10000
2	-8000
3	-6000
4	-4000
5	-2750
6	-2200
7	-1650
8	-1100
9	-550
10	0
11	550
12	1100
13	1650
14	2200
15	2750
16	4000
17	6000
18	8000
19	10000

The S-band downlink frequency to use as the 0 Hz frequency in the table is 2296465000 Hz.

TABLE B-3

PARKES OPEN LOOP CALIBRATION FREQUENCY STEPS

STEP	X-BAND FREQ RELATIVE TO CENTER OF 35 KHZ X-BAND OLR FILTER
1	-17500
2	-14000
3	-10500
4	-7000
5	-3500
6	0
7	3500
8	7000
9	10500
10	14000
11	17500

The X-band downlink frequency to use as the 0 Hz frequency in the table is 8420370000 Hz. The corresponding Parkes open loop receiver POCA frequency is 45764013.78 Hz

ENCOUNTER PREDICT SETS SUMMARY

A) PRIME RADIO SCIENCE SYSTEM (DSP-R)

SET ID	CONTENTS	USE
TBD	Mixed mode, contains all expected Doppler modes, USO reference for noncoherent mode, uplink ramps modeled in for coherent mode	Prime
TBD	One way only, USO reference	Backup
TBD	One way only, AUX OSC reference	Backup

B) WIDEBAND BACKUP OPEN-LOOP RECEIVER

FIRST LO SYNTHESIZER:

Noncoherent = 41xxxxxx.x Hz
Coherent = 41xxxxxx.x Hz

SECOND LO SYNTHESIZERS:

Channel 1 = DSS 43 SRCP, 2nd LO = 299.572 MHz
Channel 2 = DSS 42 SRCP, 2nd LO = 298.715 MHz
Channel 3 = DSS 43 XRCP, 2nd LO = 296.715 MHz
Channel 4 = DSS 42 XRCP, 2nd LO = 293.572 MHz

C) PARKES RADIO SCIENCE (ODA)

	CONTENTS	USE
1)	One way only, USO reference, spans occultation recording period	Prime
2)	One way only, USO reference, spans entire pass	System Check
3)	Three way only, spans entire pass	System Check

NOTE: See Radio Science Consolidated TWX for frequencies to be used in the generation of these predicts at Parkes.

D) TRACKING (MDA)

DOPPLER MODES:

DSS 43 One Way (USO reference)
DSS 42 One Way (USO reference)

DSS 43 One Way (AUX OSC reference)
DSS 42 One Way (AUX OSC reference)

DSS 43 Two Way (coherent)
DSS 42 Two Way (coherent)

DSS 43 Three Way with DSS 63/61/14/12/42
DSS 42 Three Way with DSS 63/61/14/12/43

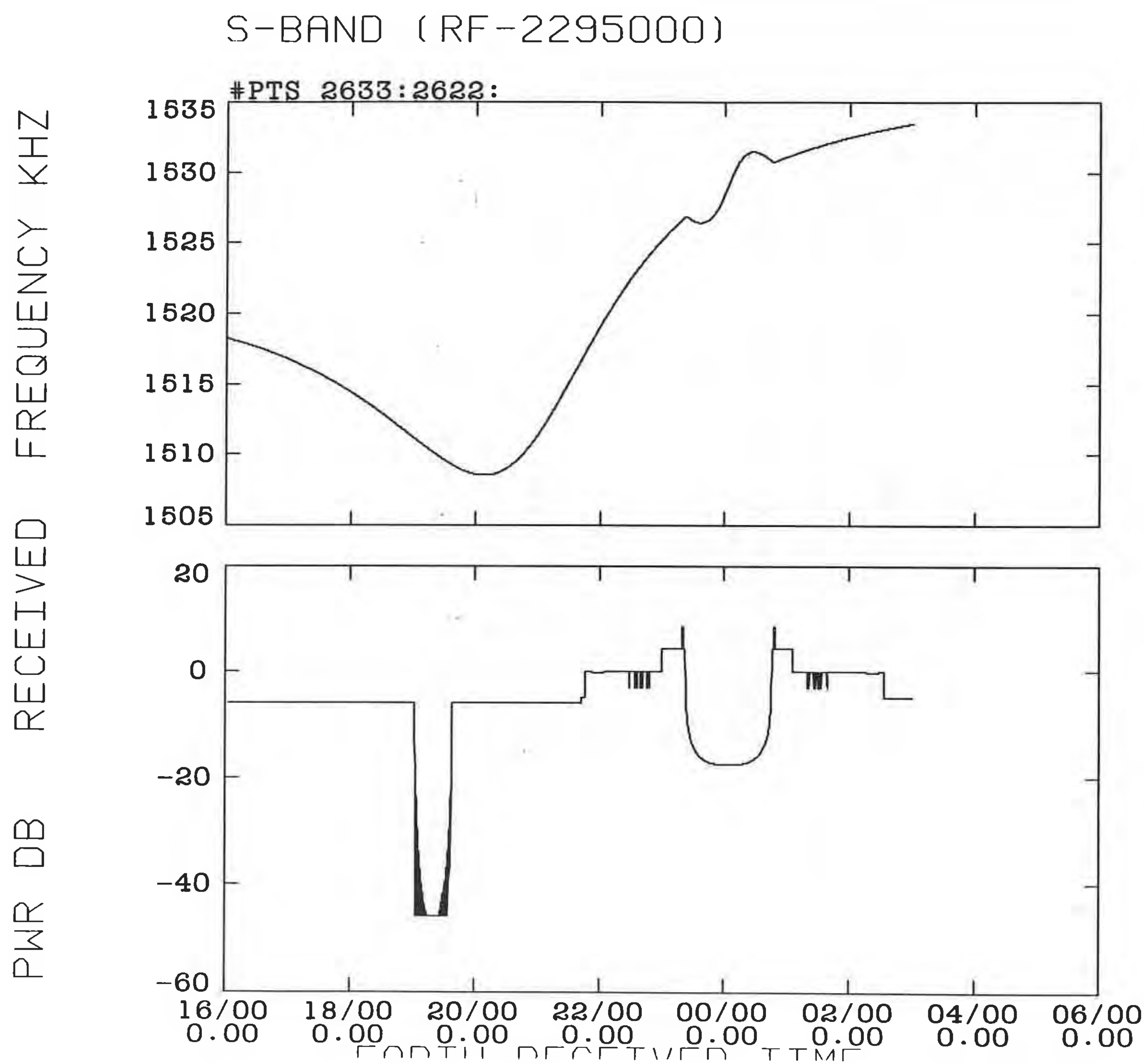
E) CLOSED-LOOP RECEIVER RAMPING

Ramping Period: 024/2310 TO 025/0100 UTC

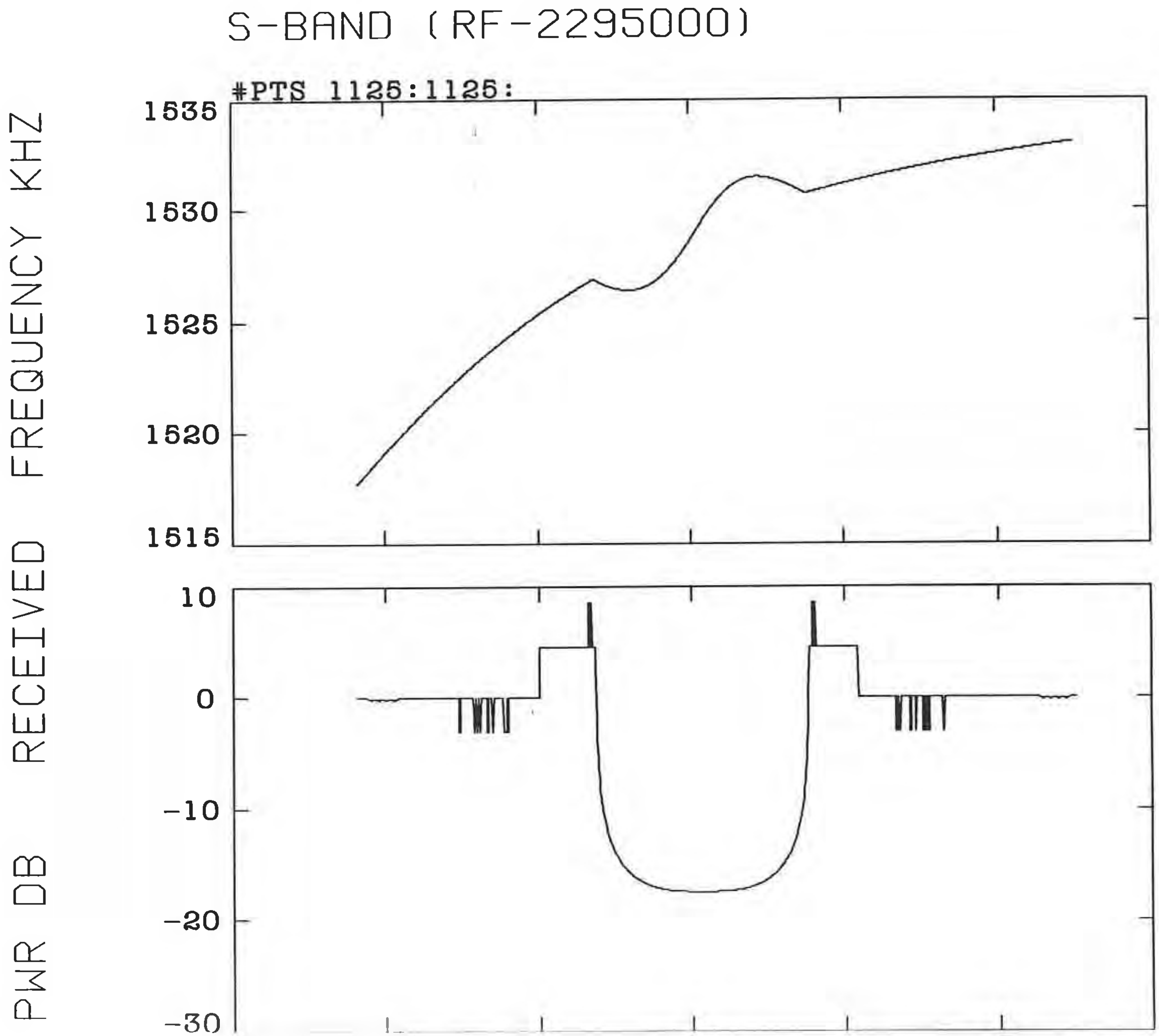
F) UPLINK RAMPING

Generated from POEAS PCT tape for DSS 43/42, DSS 63/61, and DSS 14/12.

APPENDIX D



S-BAND (RF-2295000)
#PTS 2633:2622:
FREQUENCY KHZ
1535
1530
1525
1520
1515
1510
1505
PWR DB RECEIVED
20
0
-20
-40
-60
16/00 0.00
18/00 0.00
20/00 0.00
22/00 0.00
00/00 0.00
02/00 0.00
04/00 0.00
06/00 0.00


S-BAND (RF-2295000)
#PTS 1125:1125:
FREQUENCY KHZ
1535
1530
1525
1520
1515
RECEIVED PWR DB
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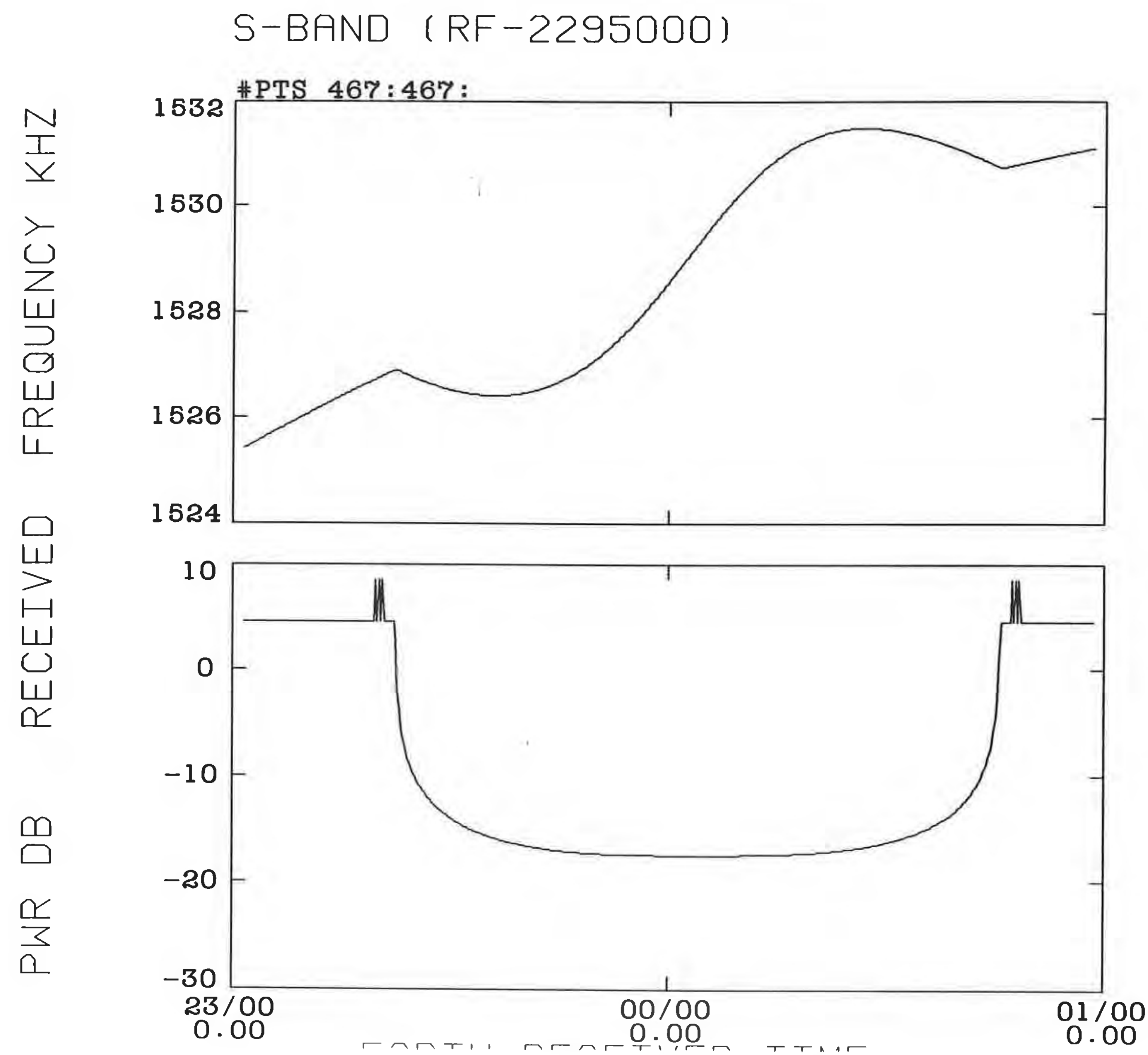
0
-10
-20
-30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#PTS 467:467:
FREQUENCY KHZ
1532
1530
1528
1526
1524
RECEIVED PWR DB
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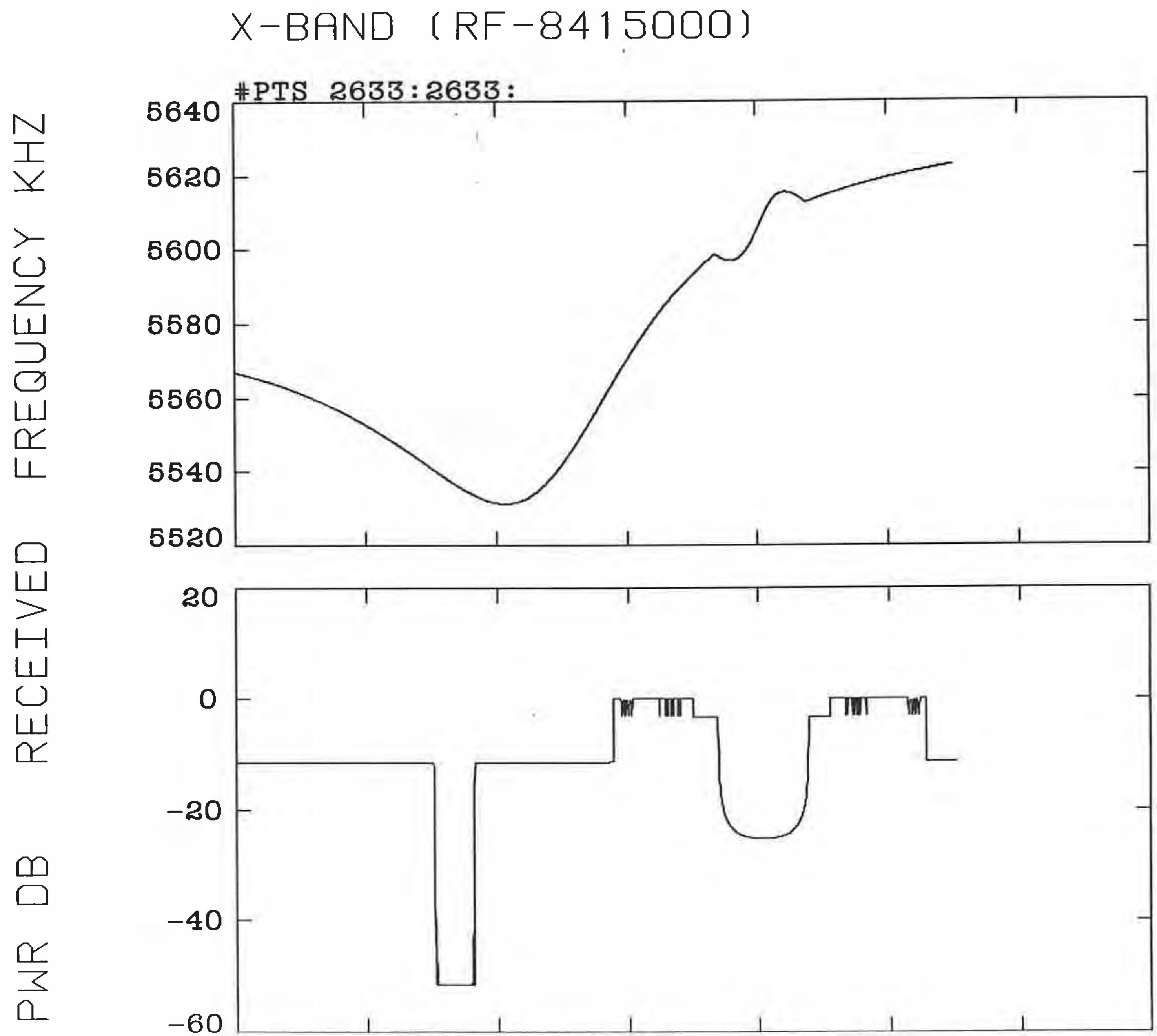
0.00
01/00
0.00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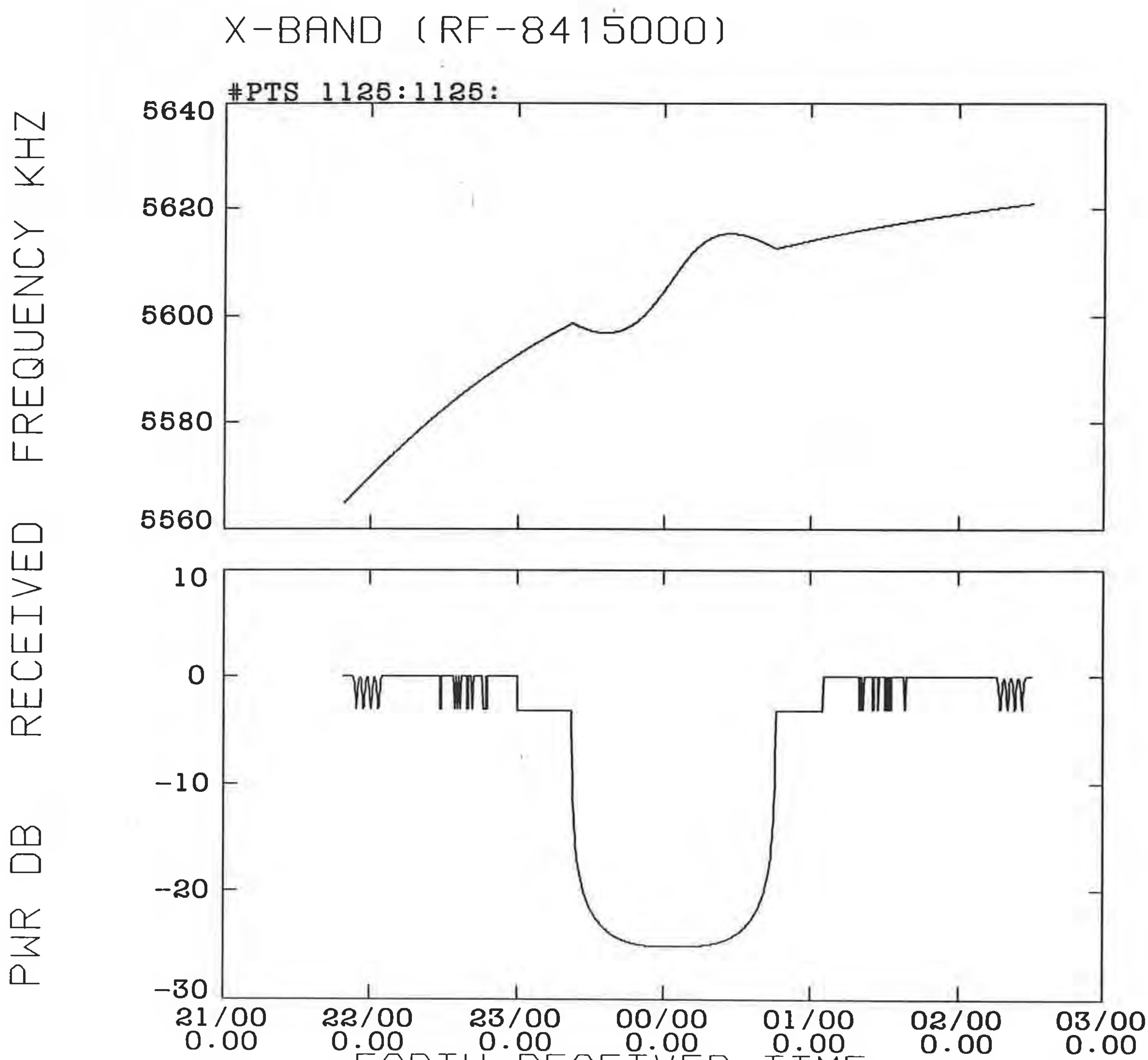
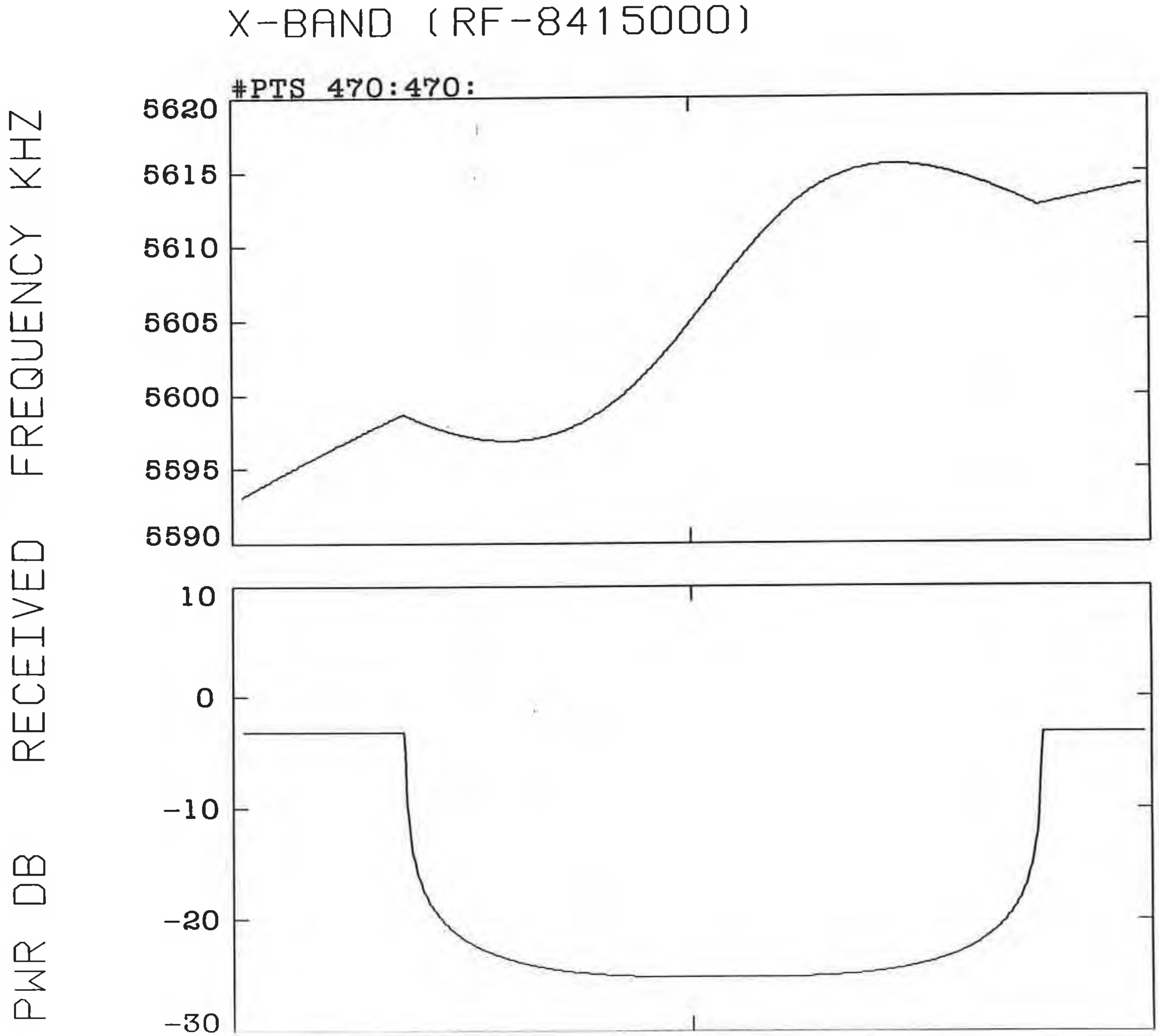
#PTS 2633:2633:
5640
5620
5600
5580
5560
5540
5520
20
0
-20
-40
-60
PWR DB RECEIVED FREQUENCY KHZ



X-BAND (RF-8415000)
#PTS 1125:1125:
FREQUENCY KHZ
5640
5620
5600
5580
5560
RECEIVED PWR DB
10
0
-10
-20
-30
21/00 0.00
22/00 0.00
23/00 0.00
00/00 0.00
01/00 0.00
02/00 0.00
03/00 0.00


X-BAND (RF-8415000)
#PTS 470:470:
FREQUENCY KHZ
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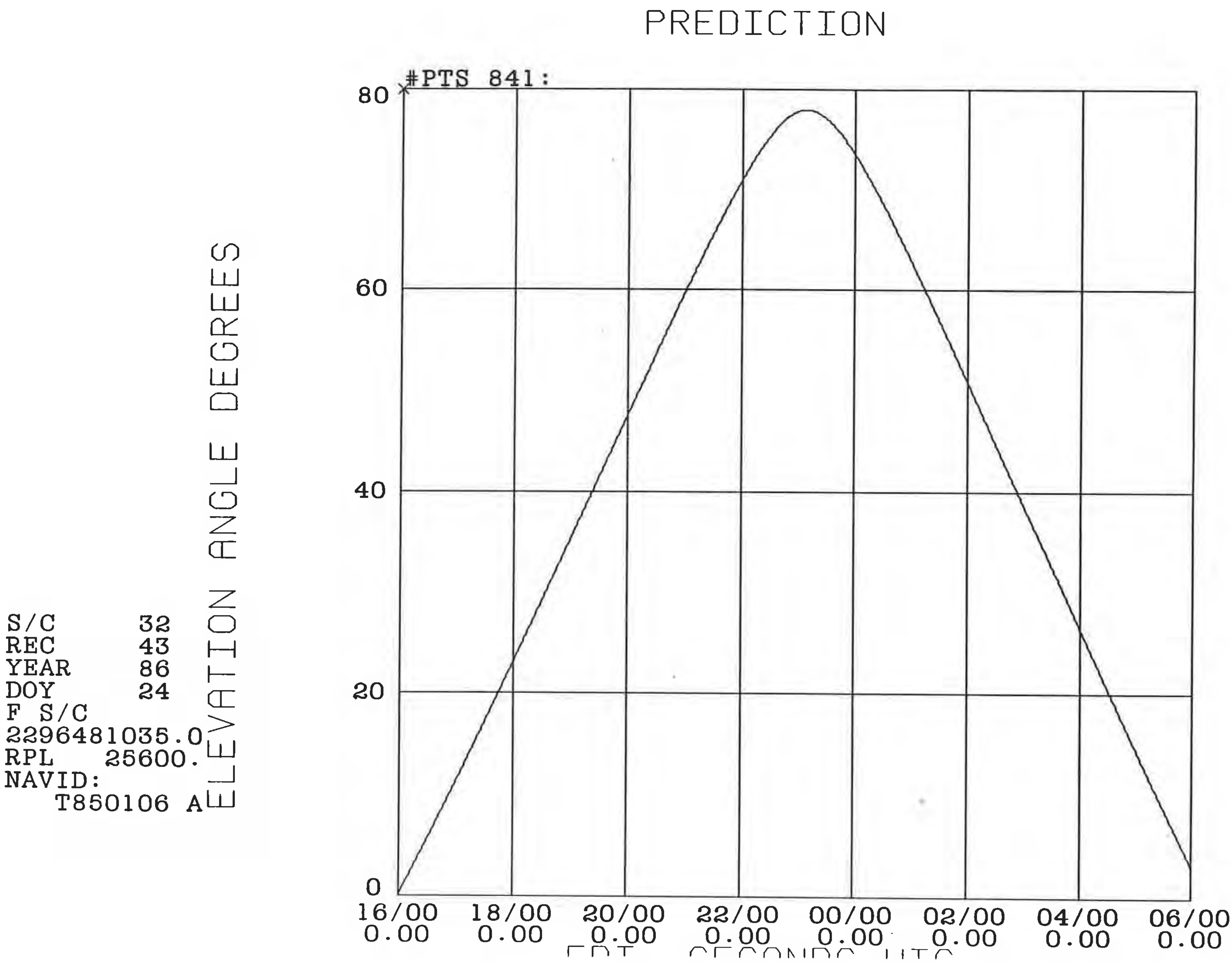
5615
5610
5605
5600
5595
5590
RECEIVED PWR DB
10
0
-10
-20
-30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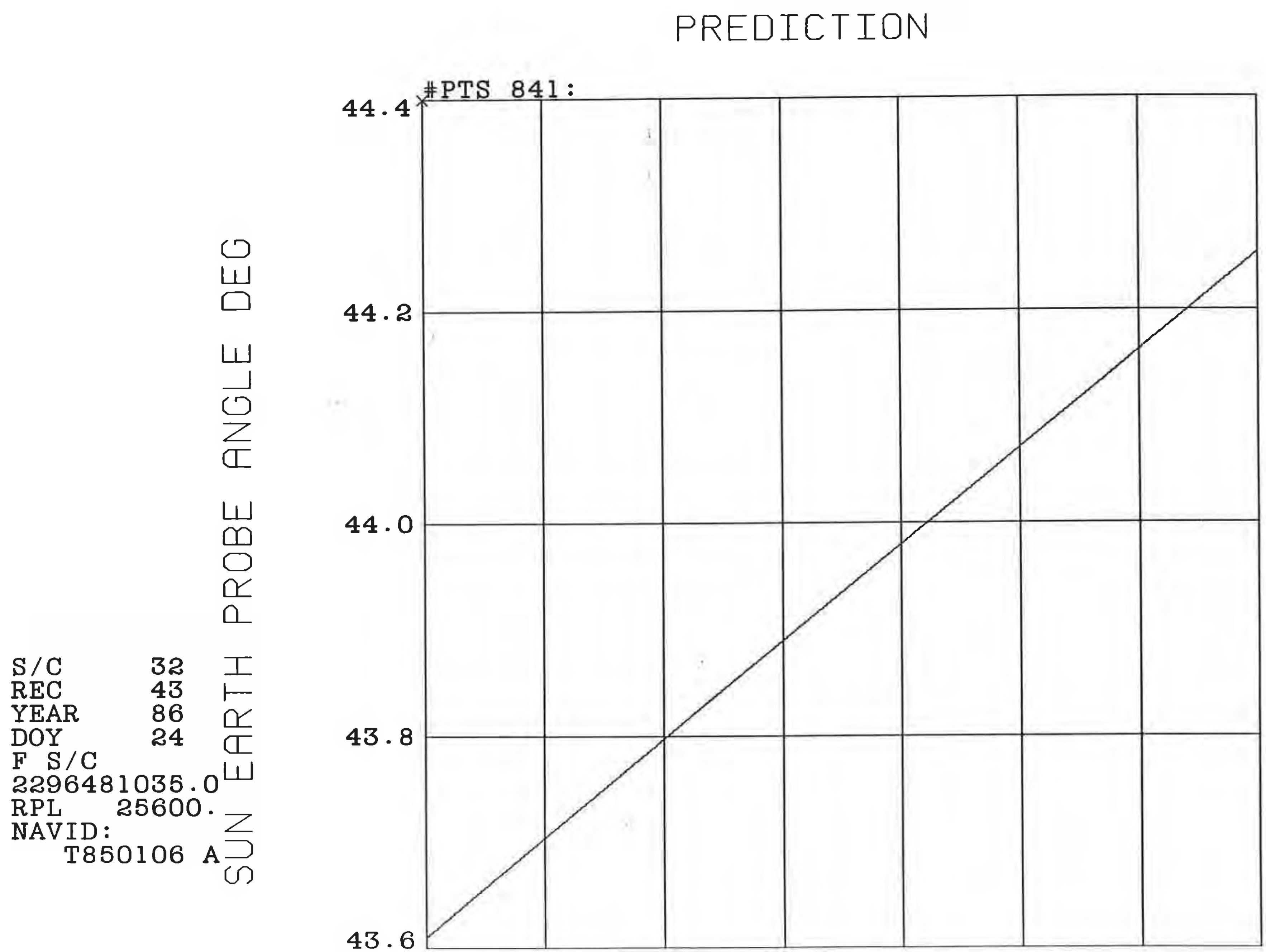
#PTS 841:
80
60
40
20
0
ELEVATION ANGLE DEGREES
S/C 32
REC 43
YEAR 86
DOY 24
F S/C
2296481035.0
RPL 25600.
NAVID:
T850106 A
16/00 0.00
18/00 0.00
20/00 0.00
22/00 0.00
00/00 0.00
02/00 0.00
04/00 0.00
06/00 0.00


PREDICTION
#PTS 841:
44.4
44.2
44.0
43.8
43.6
SUN EARTH PROBE ANGLE DEG
S/C 32
REC 43
YEAR 86
DOY 24
F S/C
2296481035.0
RPL 25600.
NAVID:
T850106 A

APPENDIX E

USEFUL FORMULAE

TABLE E-1

CALCULATION OF OPEN-LOOP ANTENNA FREQUENCY

Using the 20 KHz Narrow-Band Filters at SPC-40

fs = 4.5 * fpo + 2.1 GHz + folrs - 50 KHz

fx = 16.5 * fpo + 7.7 GHz + folrx - 150 KHz

Using the Parkes radio science subsystem

fx = 7.0 * fpo + 8.1 GHz + folrx

Where:

fs = Antenna frequency at S-band in Hertz

fx = Antenna frequency at X-band in Hertz

fpo = POCA frequency in Hertz

folrs = Signal frequency in the recorded S-band channels in Hertz

folrx = Signal frequency in the recorded X-band channels in Hertz

Note:

fpo = approximately 43.7 MHz at SPC-40

fpo = approximately 45.7 MHz at Parkes

fx/fs = 11/3 for all tracking modes

TABLE E-2

EQUATION FOR ESTIMATION OF POCA FREQUENCY

At DSCC 40:

Fpo = (S-BAND PRED - 1800 MHz)/4.5 + FLTR/4.5 + FRO/4.5

Where:

S-BAND PRED is the current predict frequency at S-band
FLTR is the filter offset at S-band
is +37.5 KHz for the 20 KHz MMR filters
FRO is the current frequency offset entered
(this entry is treated as an S-band number)

At Parkes:

Fpo = PRED - 85.2 Hz + FRO/48

Where:

PRED is the current predicted POCA frequency
85.2 is actually 4090/48 (see Parkes User's Guide, page 34, for an explanation)
FRO is the current frequency offset entered

TABLE E-3

EQUATIONS FOR CALCULATING SIGNAL POSITION IN SSI

Using channels 5 (43 S-band) or 6 (42 S-band)

Fssi = 2100 MHz + Fpo * 4.5 - SBND

Using channels 7 (43 X-band) or 8 (42 X-band)

Fssi = 7700 MHz + Fpo * 16.5 - XBND

NOTICE
POSITIVE FRO MOVES Fssi TO THE RIGHT

Using channel 9 (ODAN), SSS = A or SSS = B

Fssi = SBND - 2100 MHz - Fpo * 4.5 + 50 KHz

Using channel 9 (ODAN), SSS = C or SSS = D

Fssi = XBND - 7700 MHz - Fpo * 16.5 + 150 KHz

NOTICE
POSITIVE FRO MOVES Fssi TO THE LEFT

Where:
Fssi = Signal frequency in the SSI display
(At NOCC: MAX PWR POINT FREQ)
(At DSCC 40: SSI cursor frequency readout)
Fpo = MMR POCA frequency
SBND = Received S-band downlink frequency
XBND = Received X-band downlink frequency

TABLE E-4

EQUATION FOR SSI UPDATE INTERVAL

$$\text{UPDATE INTERVAL} = \frac{\text{XFORM} * \text{NAVG}}{5.12 * \text{BW}}$$

Where:

XFORM	is the SSI tranform size
NAVG	is the number of averages
BW	is the SSI bandwidth

NOCC DTV DISPLAY REQUEST

DATE APPLICABLE 1/24/86 RELOAD ORDER 1 OF 8

NOCC CHANNEL NUMBER 31 MCCC CAMERA NUMBER 117

DISPLAY PERIOD (UTC): START 024/1545 END 025/0315

DISPLAY AVAILABILITY: X CONTINUOUS ____ UPON REQUE

DISPLAY TYPE: ____ ALPHANUMERIC ____ GRAPHICS X S

QUADRANT(S)	ALL			
DSS	40			
BAND	N/A			
ALPHANUMERIC FORMAT *				
ALPHANUMERIC DESCRIPTION				
GRAPHICS DESCRIPTION				
LOWER VALUE				
DELTA VALUE				
START TIME				
DELTA TIME				

COMMENTS: ____

PREPARED BY S.E.B.

DATE 1/1/86

NOCC DTV DISPLAY REQUEST

DATE APPLICABLE 1/24/86 RELOAD ORDER 2 OF 8

NOCC CHANNEL NUMBER 11 * MCCC CAMERA NUMBER 113 *

DISPLAY PERIOD (UTC): START 024/1545 END 025/0315

DISPLAY AVAILABILITY: X CONTINUOUS ____ UPON REQUEST

DISPLAY TYPE: X ALPHANUMERIC ____ GRAPHICS ____ SSI

QUADRANT(S)	1	2	3	4
DSS	40	40	40	43
BAND	N/A	N/A	N/A	S
ALPHANUMERIC FORMAT #	709	706	707	607
ALPHANUMERIC DESCRIPTION	DSP STATUS	RS EVENTS	DSP FREQUENCY STATUS	DOPPLER DATA
GRAPHICS DESCRIPTION				
LOWER VALUE				
DELTA VALUE				
START TIME				
DELTA TIME				

COMMENTS: * MAY ALSO BE ASSIGNED TO NOCC SCREEN #10 (CAMERA 112) TO MINIMIZE IMPACT TO NAT-TRK

PREPARED BY S.E.B.

DATE 1/1/86

NOCC DTV DISPLAY REQUEST

DATE APPLICABLE 1/24/86 RELOAD ORDER 3 OF 8

NOCC CHANNEL NUMBER 26 MCCC CAMERA NUMBER 111

DISPLAY PERIOD (UTC): START 024/1545 END 025/0315

DISPLAY AVAILABILITY: X CONTINUOUS ____ UPON REQUE

DISPLAY TYPE: ____ ALPHANUMERIC X GRAPHICS ____ S

QUADRANT(S)	1 + 2	3 + 4		
DSS	43	42		
BAND	X	X		
ALPHANUMERIC FORMAT #				
ALPHANUMERIC DESCRIPTION				
GRAPHICS DESCRIPTION	AGC	AGC		
LOWER VALUE	-151.0	-157.0		
DELTA VALUE	+16.0	+16.0		
START TIME	1600	1600		
DELTA TIME	1 HOUR	1 HOUR		

COMMENTS: PARAMETERS MAY BE CHANGED IN REAL-TIM. BY RSST.

PREPARED BY S.E.B.

DATE 1/1/86

NOCC DTV DISPLAY REQUEST

DATE APPLICABLE 1/24/86 RELOAD ORDER 4 OF 8

NOCC CHANNEL NUMBER 12 MCCC CAMERA NUMBER 115

DISPLAY PERIOD (UTC): START 024/1545 END 025/0315

DISPLAY AVAILABILITY: ____ CONTINUOUS X UPON REQUEST

DISPLAY TYPE: X ALPHANUMERIC ____ GRAPHICS ____ SSI

QUADRANT(S)	1	2	3	4
DSS	14/43/63 (Uplinking Station)	43	42	42
BAND	N/A	X	S	X
ALPHANUMERIC FORMAT #	609	607	607	607
ALPHANUMERIC DESCRIPTION	UPLINK STATUS	DOPPLER DATA	DOPPLER DATA	DOPPLER DATA
GRAPHICS DESCRIPTION				
LOWER VALUE				
DELTA VALUE				
START TIME				
DELTA TIME				

COMMENTS: ____

PREPARED BY S. E. B.

DATE 1/1/86

NOCC DTV DISPLAY REQUEST

DATE APPLICABLE 1/24/86 RELOAD ORDER 5 OF 8

NOCC CHANNEL NUMBER 27 MCCC CAMERA NUMBER 114

DISPLAY PERIOD (UTC): START 024/1545 END 025/0315

DISPLAY AVAILABILITY: X CONTINUOUS ____ UPON REQUE

DISPLAY TYPE: ____ ALPHANUMERIC X GRAPHICS ____ S

QUADRANT(S)	1+2	3+4		
DSS	43	43		
BAND	S	S		
ALPHANUMERIC FORMAT #				
ALPHANUMERIC DESCRIPTION				
GRAPHICS DESCRIPTION	DOPPLER PSEUDO RESIDS	AGC		
LOWER VALUE	-5.0	-160.0		
DELTA VALUE	10.0	+ 7.0		
START TIME	1600	1600		
DELTA TIME	1 HOUR	1 HOUR		

COMMENTS: PARAMETERS MAY BE CHANGED IN REAL-TIME BY RSST.

PREPARED BY S. E. B.

DATE 1/1/86

NOCC DTV DISPLAY REQUEST

DATE APPLICABLE 1/24/86 RELOAD ORDER 6 OF 8

NOCC CHANNEL NUMBER 25 MCCC CAMERA NUMBER 116

DISPLAY PERIOD (UTC): START 024/1545 END 025/0315

DISPLAY AVAILABILITY: X CONTINUOUS ____ UPON REQUEST

DISPLAY TYPE: ____ ALPHANUMERIC X GRAPHICS ____ SSI

QUADRANT(S)	1 + 2	3 + 4		
DSS	43	42		
BAND	X	X		
ALPHANUMERIC FORMAT #				
ALPHANUMERIC DESCRIPTION				
GRAPHICS DESCRIPTION	DOPPLER PSEUDO RESIDS	DOPPLER PSEUDO RESIDS		
LOWER VALUE	-5.0	-5.0		
DELTA VALUE	+10.0	+10.0		
START TIME	1600	1600		
DELTA TIME	1 HOUR	1 HOUR		

COMMENTS: PARAMETERS MAY BE CHANGED IN REAL-TIME BY RSST.

PREPARED BY S.E.B.

DATE 1/1/86

NOCC DTV DISPLAY REQUEST

DATE APPLICABLE 1/24/86 RELOAD ORDER 7 OF 8

NOCC CHANNEL NUMBER 12 MCCC CAMERA NUMBER 115

DISPLAY PERIOD (UTC): START 024/1545 END 025/0315

DISPLAY AVAILABILITY: ____ CONTINUOUS X UPON REQUE

DISPLAY TYPE: X ALPHANUMERIC ____ GRAPHICS ____ S

QUADRANT(S)	1	2	3	4
DSS	43	43	42	43
BAND	N/A	N/A	N/A	X
ALPHANUMERIC FORMAT #	611	605	611	
ALPHANUMERIC DESCRIPTION	TRK ANGLE DATA	TRK EVENTS	TRK ANGLE DATA	DOPPLER DAT
GRAPHICS DESCRIPTION				
LOWER VALUE				
DELTA VALUE				
START TIME				
DELTA TIME				

COMMENTS:

PREPARED BY S. E. B.

DATE 1/1/86

NOCC DTV DISPLAY REQUEST

DATE APPLICABLE 1/24/86 RELOAD ORDER 8 OF 8

NOCC CHANNEL NUMBER 32 MCCC CAMERA NUMBER 119

DISPLAY PERIOD (UTC): START 024/1545 END 025/0315

DISPLAY AVAILABILITY: X CONTINUOUS ____ UPON REQUEST

DISPLAY TYPE: ____ ALPHANUMERIC X GRAPHICS ____ SSI

QUADRANT(S)	1 • 2	3 + 4		
DSS	42	42		
BAND	S	S		
ALPHANUMERIC FORMAT #				
ALPHANUMERIC DESCRIPTION				
GRAPHICS DESCRIPTION	DOPPLER PSEUDO RESIDS	AGC		
LOWER VALUE	-5.0	-166.0		
DELTA VALUE	+10.0	+7.0		
START TIME	1600	1600		
DELTA TIME	1 HOUR	1 HOUR		

COMMENTS: PARAMETERS MAY BE CHANGED IN REAL-TIME BY RSST.

PREPARED BY S.E.B.

DATE 1/1/86

TABLE G-1

PHONE NUMBERS OF KEY RADIO SCIENCE PERSONNEL AND OPERATIONS STATIONS

KEY RADIO SCIENCE PERSONNEL

NAME	WORK PHONE	HOME PHONE	BEEPER
B. Barclay	167-9497	(818) 335-6934	
S. Borutzki	0661	(818) 359-1282	L268
R. Caswell	167-6552/167-6566	(714) 989-4450	
M. Connally	0662	(818) 357-2850	L639
F. Donivan	5549	(818) 355-8922	
P. Eshe	0663	(818) 798-3935	
T. Fogle	167-9635	(714) 624-6003	
A. Hale	2614	(818) 352-2535	
N. Ham	4830	(818) 794-4934	
C. Hamilton	2081	(818) 798-6801	
H. Hotz	0664	(818) 957-2173	L574
B. Jolly	2614		
B. Kiazand	2170	(818) 286-6142	
S. Kinslow	0708	(714) 960-3865	
R. Kursinski	0665	(818) 249-5126	L642
K. Moyd	0707	(818) 794-7336	L549
D. Sweetnam	0227	(818) 790-6154	L589
L. Tyler (Stanford)	0629/(415)497-3535	(415) 327-7648	
J. Wisniewski	248-0890/5409/2294	(818) 897-8040	
RSST messages	0629		

OPERATIONS STATIONS

STATION	WORK PHONE
Comm Chief	5800
NATTRK	7810/7911
NOPE Console	7989
Ops Chief	7990
Ops Con	7903
PAG	7810
Radio Science/MCT	0666
Radio Science/RSST	0666
Telecom/MCT	7871
Track Controller	5858
Voyager ACE	7882
Beeper (working hours)	3430
Beeper (after hours)	3530

TABLE G-2

RADIO SCIENCE SUPPORT TEAM

Susan Borutzki, Operations Engineer

Mick Connally, Asst. Experiment Representative

Paula Eshe, Staff Assistant

Hank Hotz, Software Engineer

Scott Kinslow, Data Production Engineer

Rob Kursinski, Ground Data System Engineer

Kathy Moyd, ATR Engineer

Don Sweetnam, Team Chief

RADIO SCIENCE INTERFACE WORKING GROUP

Bill Barclay, Radio Science NOPE

Susan Borutzki, RSST

Ray Caswell, Radio Science SCOE

Mick Connally, RSST

Frank Donivan, Radio Science System Engineer(430)

Tom Fogle, Voyager NOPE

Hank Hotz, RSST

North Ham, Radio Science CDE

Scott Kinslow, RSST

Bahman Kiazand, Radio Science NOA

Rob Kursinski, RSST

Don Sweetnam, RSST

John Wisniewski, DSP CDE

ABBREVIATIONS AND ACRONYMS

A/D	Analog-to-Digital Converter
AAI	All Axes Intertial
ACE	Voyager Mission Controller
ADC	Analog to Digital Converter
AGC	Automatic Gain Control signal level
AOS	Acquisition Of Signal at a DSS
ASAP	Standard Radio Science Time Requirement
ASCAL	Antenna-Sun-Sensor calibration (spacecraft)
ATDF	Archival Tracking Data File tape
ATR	All The Rest
AUX OSC	One of two auxiliary oscillators in the spacecraft
BLF	Best-Lock Frequency (spacecraft receiver)
BLK III	Closed-loop receiver (design phase III)
BLK IV	Closed-loop receiver (design phase IV)
BPI	Bits Per Inch
BRF	Bandwidth Reduction Filter
BRP	Bandwidth Reduction Processor
C/A	Closest Approach
CBM	Cured By Magic
CDU	Command Detector Unit
CMC	Complex Monitor and Control
COH	Coherent downlink
CONSCAN	Computation of antenna pointing angles from signal-level information
CRS	CTA-21 Radio System Subsystem
CRS	Celestial Reference Set orbit determination tape
CST	Canopus Star Tracker
CTA-21	DSS mock-up at JPL
D/A	Digital-to-Analog converter
D1	Predicted one-way downlink frequency
DAC	Digital to Analog Converter
DC	Direct Current (frequency equals zero)
DCO	Digitally Controlled Oscillator
DIS	Digital Information Subsystem
DMC	DSCC Monitor and Control
DOY	Day Of Year (UTC)
DR	Discrepency Report (see CBM)
DRA	Digital Recording Assembly
DRG	Data Records Generator
DRS	Data Records Specialist
DRS	DSS Radio Science Subsystem
DSCC	Deep Space Communications Complex
DSN	Deep Space Network
DSP	Digital Spectrum Processor
DSS	Deep Space Station
DTV	Video data monitoring display device

ERT	Earth Receive Time
ESP	Extra-Sensual Perception (an RSST prerequisite)
FDS	Flight Data System
FPGP	Multi-mission tuning predict generation software
FRO	Frequency Offset
FTS	Frequency and Timing Subsystem
GCF	Ground Communications Facility
GCR	Group Coded Recording
GDS	Ground Data System
HGA	High-Gain Antenna (spacecraft)
IA	Interface Agreement
IDR	Intermediate Data Records tape
IDR	Idiotic Design Report
IMC	Image Motion Compensation (spacecraft manuever)
IPC	Information Processing Center (JPL computer facility)
IPS	Inches Per Second
ISOE	Integrated Sequence of Events
JPL	Jet Propulsion Laboratory
JST	Voyager 1
JSU	Voyager 2 (Uranus Option)
LCP	Left-handed Circularly Polarized
LMC	Link Monitor and Control
LO	Local Oscillator
LOS	Loss Of Signal at a DSS
MCCC	Mission Control Computer Center
MCT	Voyager Mission Control Team
MDA	Metric Data Assembly
MISD	Mission Director's Voice Net
MMR	Multi-Mission Receiver (open-loop)
MSA	Mission Support Area (Voyager)
MTTS	Mission Test and Telemetry Subsystem
NAR	Noise Adding Radiometer
NAV	Voyager Navigation Team
NB	Narrow-Band
NBIDR	Narrow-Band Intermediate Data Record
NBOC	Narrow-Band Occultation Converter
NBODR	Narrow-Band Original Data Record
NCOH	Non-coherent downlink
NDC	Network Data Center
NDPT	Network Data Processing Team
NDS	Network Display Subsystem
NMP	Network Monitor Processor display system
NOA	Network Operations Analyst
NOCC	Network Operations Control Center
NOCG	Network Operations Control Group
NOCT	Network Operations Control Team

NOP	Voyager Network Operations Plan (618-700)
NOPE	Network Operations Project Engineer
NOSG	Network Operations Scheduling Group
NRV	NOCC Radio Science/VLBI Display System
NRZ	Non-Return to Zero
NSP	NASA Support Plan
NTK	Network Tracking Display System
OCI	Operator Control Input
OCT	Occultation Configuration Test
OD	Orbit Determination by the Project's Navigation Team
ODA	Occultation Data Assembly
ODR	Original Data Records tape
O/L	Open-Loop
OLR	Open-Loop Receiver
OOPS	Technical term used by RSST for errors in OPS plan
OPCH	DSN Operations Chief
ORT	Operational Readiness Test
OVT	Operational Verification Test
OWLT	One-way Light Time
PCT	Polynomial Coefficient Tape
PCTA	Parkes Canberra Telemetry Array
PE	Phase Encoded
PIDR	Parkes Intermediate Data Record
POCA	Programmable Oscillator Control Assembly
PODR	Parkes Original Data Record
POEAS	Planned Orbiter Error Analysis Software Program (Software used to generate tuning predicts during atmospheric occultation)
PPM	Precision Power Monitor
PRA	Planetary Ranging Assembly
RCP	Right-handed Circularly Polarized
RF	Radio Frequency
RFS	Radio Frequency Subsystem (spacecraft)
RODAN	Radio Occultation Data Analysis Computer Facility
ROVER	Wide-band backup recording system
RSIWG	Radio Science Interface Working Group
RSS	Radio Science System
RSSEDR	Radio Science System Engineering Data Record
RSST	Radio Science Support Team
RST	Radio Science Team (investigators)
RTDS	Real-Time Display System
RTLT	Round-Trip Light-Time between Earth and the spacecraft
RTM	Real-Time Monitor (supplies data to NOCC graphics/ display systems)
SCOE	System Cognizant Operations Engineer
SCOT	Solar Conjunction Occultation Test
SCSO	Solar Conjunction Science Observation
SCT	Voyager Spacecraft Team
SDT	Voyager Science Data Team
SEP	Sun-Earth Probe
SEQGEN	VGR sequence of events program

SIRD	Support Instrumentation Requirements Documents
SLE	Signal Level Estimator
SNR	Signal-to-Noise Ratio
SNT	System Noise Temperature
SOM	Software Operations Manual
SOP	Standard Operations Procedures
SPA	Spectrum Processor Assembly
SPE	Static Phase Error
SPR	System Performance Record
SPT	System Performance Test
SSA	S-band Solid State Amplifier
SSI	Spectral Signal Indicator
STARAC	Star Acquisition
SUNAC	Sun Acquisition
TBD	To Be Determined, since we don't know the answer
TCM	Trajectory Correction Maneuver
TCT	Time Code Translator
TLC	Tracking Loop Capacitor
TMO	Time Offset
TMU	Telemetry Modulation Unit
TPAP	Telemetry Prediction and Analysis Program
TSS	Test Support System (RSST)
TTS	Test and Telemetry System
TWM	Traveling Wave Maser
TWNC	Two-Way Non-Coherent switch (spacecraft)
TWT	Traveling Wave Tube
TWTA	Traveling Wave Tube Amplifier (spacecraft)
TWX	Teletype message
TXR	DSS transmitter
USO	Ultra-stable oscillator (spacecraft)
UTC	Universal Time, Coordinated
VAP	Video Assembly Processor
VCO	Voltage Controlled Oscillator
VGR 1	Voyager 1 (JST)
VGR 2	Voyager 2 (JSU)
VTR	Video Tape Recorder
WB	Wide-Band
WBIDR	Wide-Band Intermediate Data Records tape (open-loop, computer compatible)
WBODR	Wide-band Original Data Records tape (open-loop, non-computer compatible)
XA	Doppler-compensated ground-transmitter VCO frequency for spacecraft receiver's best-lock frequency
XCASCAL	Radio science mini-ascal
XHDELAY	Radio science relativistic delay measurement
XHOCTEST	Radio science occultation-like test
XHPLASMA	Radio science sun's plasma density measurement
XMMASS	Radio science Miranda mass determination experiment
XPGRAV	Radio science Uranus mass determination experiment
XPOCC	Radio science Saturn occultation experiment

XROCC	Radio science ring-scattering experiment
XSCEL	Radio science celestial mechanics experiment

APPENDIX I

ORT 4

I-1 ORT 4 SPACECRAFT EVENTS TIME ORDERED LISTING

VOYAGER 2 RADIO SCIENCE ORT #4
SPACECRAFT EVENTS TIME-ORDERED LISTING

Date: January 11, and January 12, 1986 (DOY 011 and 012)
Time: 21:20 to 04:30 (UTC) earth received time
18:35 to 01:45 spacecraft event time

SPACECRAFT ACTIVITY	S/C EVENT TIME	EARTH RECEIVED TIME
TWNC ON	011/19:37:36	011/22:22:36
AAI	19:40:00	22:25:00
X-BAND RANGE CHANNEL OFF	19:40:48	22:25:48
TELEMETRY MODULATION UNIT OFF	19:44:48	22:29:48
X-BAND TWT LOW POWER	20:54:24	23:39:24
S-BAND TWT HIGH POWER	20:55:12	23:40:12
S-BAND TWT LOW POWER	23:02:24	012/01:47:24
X-BAND TWT HIGH POWER	23:03:12	01:48:12
TELEMETRY MODULATION UNIT ON	012/00:31:12	03:16:12
X-BAND RANGE CHANNEL ON	00:32:00	03:17:00
SUN ACQUIRE	00:35:08	03:20:08
STAR ACQUIRE	00:37:53	03:22:54

END OF RADIO SCIENCE ORT #4 SPACECRAFT SEQUENCE

I-2 ORT 4 GROUND EVENTS TIME ORDERED LISTING

VOYAGER 2 URANUS RADIO SCIENCE ORT #4
GROUND EVENTS TIME-ORDERED LISTING

*** - EVENTS MARKED BY ASTERISKS ARE SPACECRAFT EVENTS

+++ - EVENTS MARKED BY PLUSES ARE TIED TO GEOMETRIC EVENTS AS THEY WOULD OCCUR IF THIS WERE THE ACTUAL ENCOUNTER.

========================
PREPASS
========================

```
011/12:35:00        BEGIN  DSCC 40  PRECAL PERIOD
                     RADIO SCIENCE PRECALS:
                         MMR PRECALS
                         MMR FILTER = #8 (S AND X BAND)
                         NBOC PRECALS
                         ROVER/WB BACKUP RCVR PRECALS

                    DSS-43:
                    CLOSED LOOP RECEIVER CONFIGURATION:
                         S-BAND RECEIVER BW = 10 HZ
                         X-BAND RECEIVER BW = 30 HZ
                         USE NARROW MODE
                    PPM CONFIGURATION:
                         NAR AUTO SWITCHING ENABLED
                         NAR INTEGRATION TIME = 15 SEC
                         NOISE DIODE = 0.25 DEGREES
                         SLE AUTO SWITCHING ENABLED
                         SLE RCVR 1 INTEG TIME = 120 SEC
                         SLE RCVR 2 INTEG TIME = 120 SEC

                    DSS-42:
                    CLOSED LOOP RECEIVER CONFIGURATION:
                         S-BAND RECEIVER BW = 12 HZ
                         X-BAND RECEIVER BW = 48 HZ
                    PPM CONFIGURATION:
                         NAR AUTO SWITCHING ENABLED
                         NAR INTEGRATION TIME = 60 SEC
                         NOISE DIODE = 0.25 DEGREES
                         SLE AUTO SWITCHING ENABLED
                         SLE RCVR 3 INTEG TIME = 120 SEC
                         SLE RCVR 4 INTEG TIME = 120 SEC
```

12:35:00 BEGIN PARKES PRECALS
RADIO SCIENCE PRECALS:
ODA PRECALS
RUN ODA/POCA SELF DIAGNOSTICS

16:50:00 COMCHIEF: VERIFY VOICE NET CONFIGURATION
AS DESCRIBED IN RADIO SCIENCE
OPERATIONS PLAN SECTION 8.2

17:20:00 COMCHIEF: RELOAD VAP, DDP, NTK, NRV

17:35:00 CONFIGURE NOCC DISPLAYS PER RADIO SCIENCE
OPERATIONS PLAN

====================
BEGIN ORT #4 PASS
====================

18:35:00 AOS DSS-43:
START 1/SEC DOPPLER SAMPLE RATE

18:35:00 AOS DSS-42:
START 1/SEC DOPPLER SAMPLE RATE

18:50:00 DSS-43: CONFIRM PPM CONFIGURATION

18:50:00 DSS-42: CONFIRM PPM CONFIGURATION

18:55:00 DSS-14 TRANSFER TO DSS-43

19:00:00 CONFIRM DSP CONFIGURATION
CHN A = 1 B = 2 C = 3 D = 4
MOD MODE = 1 RATE = 8 RESOL = 8
FRO = +333 HZ
PRD = (USE APPLICABLE PREDICT SET)
- DSP TAPE RECORDERS SET TO 6250
BPI RECORDING DENSITY
- ALL TAPES HAVE WRITE RINGS
- DSP TRANSMISSION TO NOCC ENABLED
RTM INTERVAL = 5 SEC
SSI INTERVAL = 20 SEC

19:05:00 - VERIFY MMR IF/VF CONVERTER
SELECTED FOR RADIO SCIENCE
(OCI: CFG R64M) AT LOCAL TERMINAL
- VERIFY MMR INPUT SWITCH
(RACK 4159/RCV 112/A5)
IS IN NORMAL POSITION
- REPORT MMR/ROVER ATTENUATOR SETTINGS

19:09:00 CONFIRM SSI AND NRV DATA DISPLAYED AT NOCC

19:10:00 PRETEST BRIEFING BETWEEN RSST
AND ON-SITE ADVISORS

19:15:00 CONFIRM SSI CONFIGURATION
PORT = 5
B/W = 50 KHZ XFORM = 1024
CF = 37.5 KHZ NAVG = 512
(VERIFY SIGNAL PRESENCE IN MMR'S
DSS-43 20 KHZ S-BAND FILTER)

19:20:00 ENTER INTO DSP TIME OFFSET PROVIDED DURING BRIEFING

PUT DSP IN RUN MODE WITH DELAYED TAPE RECORDIN
START TIME: 20:10:00
STOP TIME: 20:50:00

19:25:00 PARKES: CONFIRM ODA CONFIGURATION
CHN 1
MOD 2 7 8
DSS 43
SCN 32
PRD (USE COHERENT SET)
RUN NB 011 2215 012 0330
- REPORT OPEN LOOP RECEIVER ATTENUATOR SETTINGS

19:35:00 AOS DSS-49 (PARKES OBSERVATORY)

19:35:00 CONFIRM SSI CONFIGURATION
PORT = 6
B/W = 50 KHZ XFORM = 1024
CF = 37.5 KHZ NAVG = 512
(VERIFY SIGNAL PRESENCE IN MMR'S
DSS-42 20 KHZ S-BAND FILTER)

19:40:00 CONFIRM SSI CONFIGURATION
PORT = 7
B/W = 50 KHZ XFORM = 1024
CF = 137.5 KHZ NAVG = 512
(VERIFY SIGNAL PRESENCE IN MMR'S
DSS-43 20 KHZ X-BAND FILTER)

19:45:00 CONFIRM SSI CONFIGURATION
PORT = 8
B/W = 50 KHZ XFORM = 1024
CF = 137.5 KHZ NAVG = 512
(VERIFY SIGNAL PRESENCE IN MMR'S
DSS-42 20 KHZ X-BAND FILTER)

19:47:00 CONFIRM WB BACKUP RCVR FIRST LO SYNTHESIZER SET TO COHERENT FREQUENCY

```
19:50:00        CONFIRM SSI CONFIGURATION
                    PORT = 10
                    B/W  = 10  KHZ    XFORM = 1024
                    CF   = 428 KHZ     NAVG = 512
                   (VERIFY SIGNAL PRESENCE IN ROVER'S
                    DSS-43 S-BAND FILTER)

19:55:00        CONFIRM SSI CONFIGURATION
                    PORT = 10
                    B/W  = 10 KHZ       XFORM = 1024
                    CF   = 1285 KHZ      NAVG = 512
                   (VERIFY SIGNAL PRESENCE IN ROVER'S
                    DSS-42 S-BAND FILTER)

19:57:49        ** X-BAND MODULATION INDEX CHANGE **
                **    TO 77 DEG EXPECT 1.2 DB     **
                **  DECREASE X-BAND SIGNAL LEVEL  **

20:00:00        CONFIRM SSI CONFIGURATION
                    PORT = 9             SSS = A
                    B/W  = 10 KHZ     XFORM = 1024
                    CF   = 12.5 KHZ    NAVG = 512
                   (VERIFY SIGNAL PRESENCE IN DSP'S
                    DSS 43 S-BAND FILTER)

20:05:00        PARKES: CONFIRM SIGNAL PRESENCE IN
                        OPEN LOOP RCVR PASS BAND

20:10:00        CONFIRM DSP RECORDING STARTED

20:26:19        "START XMMASS"

20:50:00        CONFIRM DSP RECORDING ENDED
                AND DSP IS IN IDLE MODE

21:00:00        LOS DSCC 10

                ===========================================
21:05:00        === BEGIN CRITICAL RADIO SCIENCE EVENTS ===
                ===     RSST HAS NOCC DISPLAY PRIORITY   ===
                ===========================================

21:05:00        PUT DSP IN RUN MODE WITH DELAYED TAPE RECORDING
                    START TIME: 011/22:05:00
                    STOP TIME:  012/03:35:00

21:10:00        CONFIRM SSI CONFIGURATION
                    PORT = 9             SSS = A
                    B/W  = 10 KHZ     XFORM = 1024
                    CF   = 12.5 KHZ    NAVG = 512
                   (VERIFY SIGNAL PRESENCE IN DSP'S
                    DSS 43 S-BAND FILTER)
```

```
21:20:00        CONFIRM SSI CONFIGURATION
                    PORT = 9            SSS = B
                    B/W  = 10 KHZ     XFORM = 1024
                    CF   = 12.5 KHZ    NAVG = 512
                   (VERIFY SIGNAL PRESENCE IN DSP'S
                    DSS 42 S-BAND FILTER)

21:30:00        CONFIRM SSI CONFIGURATION
                    PORT = 9            SSS = C
                    B/W  = 10 KHZ     XFORM = 1024
                    CF   = 12.5 KHZ    NAVG = 512
                   (VERIFY SIGNAL PRESENCE IN DSP'S
                    DSS 43 X-BAND FILTER)

21:40:00        CONFIRM SSI CONFIGURATION
                    PORT = 9            SSS = D
                    B/W  = 10 KHZ     XFORM = 1024
                    CF   = 12.5 KHZ    NAVG = 512
                   (VERIFY SIGNAL PRESENCE IN DSP'S
                    DSS 42 X-BAND FILTER)

21:50:00        CONFIRM SSI CONFIGURATION
                    PORT = 9            SSS = C
                    B/W  = 5 KHZ      XFORM = 1024
                    CF   = 12.5 KHZ     NAVG - 256
                   (VERIFY SIGNAL PRESENCE IN DSP'S
                    DSS 43 X-BAND FILTER)

21:50:00        PARKES: SET ODA TO IDLE,LOAD
                        NONCOHERENT RECORDING-SPAN
                        PREDICTS, SET ODA TO RUN.
                        (RUN NB 011 2205 012 0335)
                !!! WARNING: SIGNAL WILL NOT APPEAR  !!!
                !!!   IN PASS BAND UNTIL TWNC ON     !!!

22:00:00        CONFIRM WB BACKUP RCVR FIRST LO SYNTHESIZER
                SET TO NONCOHERENT FREQUENCY

22:05:00        CONFIRM DSP AND ROVER RECORDINGS STARTED

22:05:00        CONFIRM PARKES RECORDING STARTED

22:10:00        DSS-43: TURN CONSCAN OFF,
                        MOVE AND FIX SUBREFLECTOR X/Y/Z
                        AXES FOR 64 DEGREE ELEVATION.

22:10:00        DSS-42: TURN CONSCAN OFF,
                        MOVE AND FIX SUBREFLECTOR Z
                        AXIS FOR 64 DEGREE ELEVATION,
                        X/Y AXES IN AUTO FOCUS MODE.

22:10:00        PARKES: MOVE AND FIX PRIME FOCUS CAGE,
                        OPTIMIZE FOCUS FOR 75 DEG ELEV.
```

22:15:00	DSS-43: START 10/SEC DOPPLER SAMPLE RATE
22:15:00	DSS-42: START 10/SEC DOPPLER SAMPLE RATE
22:18:37	*** TWNC ON ***
22:20:00	CONFIRM SSI CONFIGURATION PORT = 9 SSS = A B/W = 5 KHZ XFORM = 1024 CF = 12.5 KHZ NAVG = 256 (VERIFY SIGNAL PRESENCE IN DSP'S DSS-43 S-BAND FILTER)
22:25:00	CONFIRM SSI CONFIGURATION PORT = 9 SSS = B B/W = 5 KHZ XFORM = 1024 CF = 12.5 KHZ NAVG = 256 (VERIFY SIGNAL PRESENCE IN DSP'S DSS-42 S-BAND FILTER)
22:25:01	*** SPACECRAFT GOES AAI ***
22:25:50	*** SPACECRAFT X-BAND RANGING *** *** CHANNEL OFF *** 0.2 dB INCREASE IN X-BAND SIGNAL LEVEL
22:29:50	*** SPACECRAFT TELEMETRY *** *** MODULATION UNIT OFF *** 4.8 dB INCREASE IN S-BAND SIGNAL LEVEL 10.2 dB INCREASE IN X-BAND SIGNAL LEVEL
22:30:00	CONFIRM SSI CONFIGURATION PORT = 9 SSS = D B/W = 5 KHZ XFORM = 1024 CF = 12.5 KHZ NAVG = 256 (VERIFY SIGNAL PRESENCE IN DSP'S DSS 42 X-BAND FILTER)
22:32:00	DSS-43: REPORT SIM SYNTHESIZER SETTING
22:32:00	DSS-42: REPORT SIM SYNTHESIZER SETTING
22:35:00	PARKES: CONFIRM SIGNAL PRESENCE IN OPEN LOOP RCVR PASS BAND
22:35:00	CONFIRM SSI CONFIGURATION PORT = 9 SSS = C B/W = 5 KHZ XFORM = 1024 CF = 12.5 KHZ NAVG = 256 (VERIFY SIGNAL PRESENCE IN DSP'S DSS-43 X-BAND FILTER)

22:45:00 CONFIRM SSI CONFIGURATION
PORT = 10
B/W = 10 KHZ XFORM = 1024
CF = 428 KHZ NAVG = 512
(VERIFY SIGNAL PRESENCE IN ROVER'S
DSS-43 S-BAND FILTER)

22:50:00 CONFIRM SSI CONFIGURATION
PORT = 10
B/W = 10 KHZ XFORM = 1024
CF = 1285 KHZ NAVG = 512
(VERIFY SIGNAL PRESENCE IN ROVER'S
DSS-42 S-BAND FILTER)

22:52:54 +++ RADIO SCIENCE RING +++
+++ OCCULTATION BEGINS (INGRESS) +++

22:54:00 PARKES: CONFIRM SIGNAL PRESENCE IN
OPEN LOOP RCVR BANDPASS

22:55:00 CONFIRM SSI CONFIGURATION
PORT = 9 SSS = C
B/W = 5 KHZ XFORM = 1024
CF = 12.5 KHZ NAVG = 256
(VERIFY SIGNAL PRESENCE IN DSP'S
DSS-43 X-BAND FILTER)

23:39:24 +++ RADIO SCIENCE ATMOSPHERIC +++
+++ OCCULTATION BEGINS +++

23:39:24 *** SPACECRAFT X-BAND TWT ***
*** GOES TO LOW POWER ***
2.3 dB DECREASE IN
X-BAND SIGNAL LEVEL

23:40:12 *** SPACECRAFT S-BAND TWT ***
*** GOES TO HIGH POWER ***
4.8 dB INCREASE IN
S-BAND SIGNAL LEVEL

23:45:00 PARKES: CONFIRM SIGNAL PRESENCE IN
OPEN LOOP RCVR BANDPASS

23:47:00 CONFIRM SSI CONFIGURATION
PORT = 9 SSS = B
B/W = 5 KHZ XFORM = 1024
CF = 12.5 KHZ NAVG = 256
(VERIFY SIGNAL PRESENCE IN DSP'S
DSS-42 S-BAND FILTER)

```
23:52:00       CONFIRM SSI CONFIGURATION
                   PORT = 9            SSS = A
                   B/W  = 5 KHZ      XFORM = 1024
                   CF   = 12.5 KHZ    NAVG = 256
                  (VERIFY SIGNAL PRESENCE IN DSP'S
                   DSS-43 S-BAND FILTER)

23:55:00       DSS-43: BEGIN S- AND X-BAND RECEIVER RAMPING
                       VERIFY RCVR SPE ZEROED OUT

               =========================
012/00:00:00    DAY CHANGE >>> DOY 012
               =========================

00:05:00       PARKES: VERIFY ODA STATUS NOMINAL

01:00:00       PARKES: CONFIRM SIGNAL PRESENCE IN
                       OPEN LOOP RCVR BANDPASS

01:45:00       DSS-43: END CLOSED LOOP RECEIVER RAMPING

01:46:00       PARKES: MOVE AND FIX PRIME FOCUS CAGE
                       FOR 55 DEGREE ELEVATION ANGLE

01:47:24          *** SPACECRAFT S-BAND TWT ***
                  ***   GOES TO LOW POWER   ***
                        4.8 dB DECREASE IN
                        S-BAND SIGNAL LEVEL

01:48:12          *** SPACECRAFT X-BAND TWT ***
                  ***  GOES TO HIGH POWER   ***
                       2.3 dB INCREASE IN
                       X-BAND SIGNAL LEVEL

01:48:12          +++   RADIO SCIENCE ATMOSPHERIC    +++
                  +++        OCCULTATION ENDS        +++
                  +++ EGRESS RING OCCULTATION BEGINS +++

02:00:00       PARKES: CONFIRM SIGNAL PRESENCE IN
                       OPEN LOOP RCVR BANDPASS

02:00:00       CONFIRM SSI CONFIGURATION
                   PORT = 9          SSS = D
                   B/W  = 5 KHZ    XFORM = 1024
                   CF   = 12.5 KHZ  NAVG = 256
                  (VERIFY SIGNAL PRESENCE IN DSP'S
                   DSS 42 X-BAND FILTER)

02:05:00       CONFIRM SSI CONFIGURATION
                   PORT = 9          SSS = C
                   B/W  = 5 KHZ    XFORM = 1024
                   CF   = 12.5 KHZ  NAVG = 256
                  (VERIFY SIGNAL PRESENCE IN DSP'S
                   DSS-43 X-BAND FILTER)
```

03:00:00 PARKES: CONFIRM SIGNAL PRESENCE IN
OPEN LOOP RCVR BANDPASS

03:03:24 +++ RADIO SCIENCE RING +++
+++ OCCULTATION ENDS +++

03:16:12 *** SPACECRAFT TELEMETRY ***
*** MODULATION UNIT ON ***
4.8 dB DECREASE IN
S-BAND SIGNAL LEVEL
10.2 dB DECREASE IN
X-BAND SIGNAL LEVEL

03:17:00 *** SPACECRAFT X-BAND RANGING ***
*** CHANNEL ON ***
0.2 dB DECREASE IN
X-BAND SIGNAL LEVEL

03:20:08 SPACECRAFT SUN ACQUIRE

03:21:54 SPACECRAFT STAR ACQUIRE

03:35:00 CONFIRM DSP AND ROVER RECORDINGS ENDED
(MAINTAIN DSP IN IDLE MODE FOR SSI
DATA TRANSMISSION TO NOCC)

03:35:00 PARKES: CONFIRM ODA RECORDING ENDED

03:40:00 CONFIGURE ROVER FOR PLAYBACK INTO SSI

03:50:00 DSS-43: TURN CONSCAN ON
RESUME AUTO SUBREFLECTOR FOCUSING

03:50:00 DSS-42: TURN CONSCAN ON
RESUME AUTO SUBREFLECTOR FOCUSING

03:55:00 DSS-43: START 1/ SEC DOPP SAMP RATE

03:55:00 DSS-42: START 1/ SEC DOPP SAMP RATE

04:00:00 PLAY PORTION OF ROVER DATA BACK AT 1/4 SPEED
(30 IPS) INTO THE SSI

04:01:00 CONFIRM SSI CONFIGURATION
PORT = 10
B/W = 10 KHZ XFORM = 1024
CF = 821 KHZ NAVG = 512
(VERIFY SIGNAL PRESENCE IN ROVER'S
DSS-43 X-BAND FILTER)

04:02:00 CONFIRM SIGNAL PRESENCE IN SSI AT NOCC

04:10:00 CONFIRM SSI CONFIGURATION
PORT = 10
B/W = 10 KHZ XFORM = 1024
CF = 1607 KHZ NAVG = 512
(VERIFY SIGNAL PRESENCE IN ROVER'S DSS-42 X-BAND FILTER)

04:11:00 CONFIRM SIGNAL PRESENCE IN SSI AT NOCC

04:20:00 END PLAYBACK OF ROVER DATA INTO SSI

04:25:00 LOS DSS-49 (PARKES OBSERVATORY)

04:35:00 END RADIO SCIENCE CRITICAL EVENTS

04:35:00 POST TEST DEBRIEFING
(SEE RADIO SCIENCE OPS PLAN SECTION 8.10)

PLAYBACK SELECTED PORTION OF DSP ODR'S

POST PASS

SHIP PARKES ODR'S TO DSCC-40

GENERATE POST PASS DSP ODR CALIBRATION TAPE

SHIP EXPEDITED TO NDC:
- DSP ODR'S
- ROVER TAPES
- LMC PRINTOUT
- STRIP CHART RECORDINGS
- PREPASS COUNTDOWN LOG
- TAPE LOG

PLAYBACK PARKES DATA

SHIP EXPEDITED TO NDC:
- PARKES ODR'S

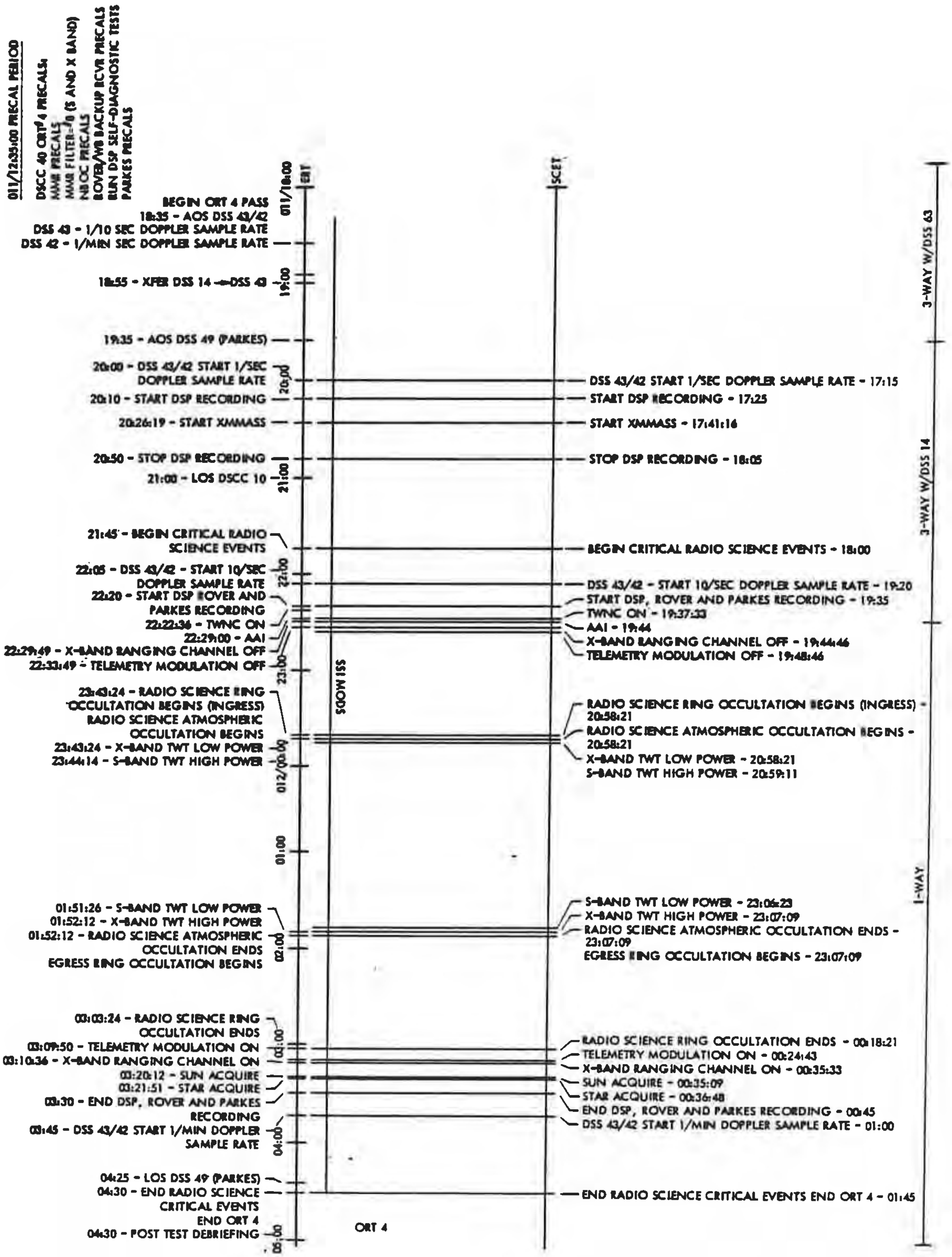
GENERATE COMPUTER COMPATIBLE BANDWIDTH REDUCED IDR'S ON THE BRF AT CTA-21 FROM THE ROVER TAPES

I-3 ORT 4 PRODUCT DELIVERY

DATA PRODUCT DELIVERY STRATEGY AND SCHEDULE

DATA TYPE	DELIVERY STRATEGY	DELIVERY SCHEDULE
TRK IDR	Tape delivery from NDC to RSST RODAN Facility (Bldg. 264, Rm. 365). Tape IDs will be communicated to the RSST at (x0663 or x5376) via the NOPE. Ref: IA # NOCT-35	All IDRs to be delivered within one day following the completion of the radio science events at 012/04:30 UTC.
Quick-Look Wideband Playback NBIDR	Tape delivery from NDC to RSST RODAN Facility, Bldg. 264, Rm. 365. Ref: IA # NOCT-33	Start NBIDR wideband playback procedure at approximately 012/03:45 UTC. Delivery to RSST will be within one day following the completion of each playback data set.
MON IDR	Tape delivery from NDC to RSST RODAN Facility (Bldg. 264, Rm. 365). Ref: IA # NOCT-36	All IDRs to be delivered within one day following the completion of the radio science events at 012/04:30 UTC.
NOCC Hard-Copy Data: -Controller's logs -NAT TRK logs	Hardcopy delivery from NDC to RSST RODAN Facility, Bldg. 264, Rm. 365 Ref: IA # NOCT-39	Delivery to RSST will be within one day following the completion of the radio science events at 012/04:30 UTC.
CRS Tape	Delivery from NAV to RSST via tape interface at IPC. Ref: IA # NAV-37.	CRS Tape - Late predict trajectory delivered to RSST by 1/4/85.
RSSEDR	Delivery from GSDT by pickup by RSST member. Ref: IA # SDT-363	All EDR's delivered within 1 week of the completion of ORT 4.

DATA TYPE	DELIVERY STRATEGY	DELIVERY SCHEDULE
NBODR's (approx. 40 tapes)	Following the Radio Science ORT events, the DSCC 40 on-site advisor relays NBODR ID numbers to the RSST via the Radio Science Net (RADSCI). The station will expedite shipment of the NBODR's to NDC, JPL, attn: T. Fogle. For final delivery to the RSST RODAN Facility, Bldg. 264, Rm. 365. Ref: IA # NOCT-13	Delivery of expedited data should be within two weeks following the ORT events. A desirable goal is to have the data at JPL within one week.
Parkes Narrowband PODR's (approx. 45 tapes)	Following the Radio Science ORT events,the Parkes Shift Supervisor relays PODR ID numbers to the RSST via the Radio Science Net (RADSCI). The PODR's will be delivered to DSCC 40 prior to playback and expedited shipment to JPL. Ref: IA # NOCT-42	Delivery from Parkes to DSCC 40 within 24 hours following the ORT. Delivery from DSCC 40 ASAP after the playback.
Parkes Wideband Playback PIDR's	Tape delivery from NDC to RSST RODAN facility Bldg. 264, Rm. 365. Ref: IA # NOCT-42	PODR delivery from Parkes to DSCC 40 within 24 hours of the ORT for playback at time TBD. Delivery of PIDR within 24 hours of playback.
Backup wideband DRA ODRs	Deliver with expedited NBODR's Ref: IA # NOCT-30	Same as NBODR's
DSCC Hard-Copy Data: -LMC Log -Pre-Pass Countdown Log	Deliver with expedited NBODR's Ref: IA # NOCT-13 "	Same as NBODR's
Parkes Hard-Copy Data: -Parkes Log -Parkes NAR -Parkes Strip Chart Output	Deliver with expedited PODR's Ref: IA # NOCT-42	Delivery to DSCC 40 within 24 hours of the ORT. Delivery to RSST with PODR's.


011/12:35:00 PRECAL PERIOD
DSCC 40 ORT 4 PRECALS:
MMR PRECALS
MMR FILTER (S AND X BAND)
NBOC PRECALS
ROVER/WB BACKUP RCVR PRECALS
RUN DSP SELF-DIAGNOSTIC TESTS
PARKES PRECALS
ERT
SCET
011/18:00
19:00
20:00
21:00
22:00
23:00
012/00:00
01:00
02:00
03:00
04:00
05:00
BEGIN ORT 4 PASS
18:35 - AOS DSS 43/42
DSS 43 - 1/10 SEC DOPPLER SAMPLE RATE
DSS 42 - 1/MIN SEC DOPPLER SAMPLE RATE
18:55 - XFER DSS 14 → DSS 43
19:35 - AOS DSS 49 (PARKES)
20:00 - DSS 43/42 START 1/SEC DOPPLER SAMPLE RATE
20:10 - START DSP RECORDING
20:26:19 - START XMMASS
20:50 - STOP DSP RECORDING
21:00 - LOS DSCC 10
21:45 - BEGIN CRITICAL RADIO SCIENCE EVENTS
22:05 - DSS 43/42 - START 10/SEC DOPPLER SAMPLE RATE
22:20 - START DSP ROVER AND PARKES RECORDING
22:22:36 - TWNC ON
22:29:00 - AAI
22:29:49 - X-BAND RANGING CHANNEL OFF
22:33:49 - TELEMETRY MODULATION OFF
23:43:24 - RADIO SCIENCE RING OCCULTATION BEGINS (INGRESS) RADIO SCIENCE ATMOSPHERIC OCCULTATION BEGINS
23:43:24 - X-BAND TWT LOW POWER
23:44:14 - S-BAND TWT HIGH POWER
01:51:26 - S-BAND TWT LOW POWER
01:52:12 - X-BAND TWT HIGH POWER
01:52:12 - RADIO SCIENCE ATMOSPHERIC OCCULTATION ENDS
EGRESS RING OCCULTATION BEGINS
03:03:24 - RADIO SCIENCE RING OCCULTATION ENDS
03:09:50 - TELEMETRY MODULATION ON
03:10:36 - X-BAND RANGING CHANNEL ON
03:20:12 - SUN ACQUIRE
03:21:51 - STAR ACQUIRE
03:30 - END DSP, ROVER AND PARKES RECORDING
03:45 - DSS 43/42 START 1/MIN DOPPLER SAMPLE RATE
04:25 - LOS DSS 49 (PARKES)
04:30 - END RADIO SCIENCE CRITICAL EVENTS
END ORT 4
04:30 - POST TEST DEBRIEFING
SOOW ISS
ORT 4
DSS 43/42 START 1/SEC DOPPLER SAMPLE RATE - 17:15
START DSP RECORDING - 17:25
START XMMASS - 17:41:16
STOP DSP RECORDING - 18:05
BEGIN CRITICAL RADIO SCIENCE EVENTS - 18:00
DSS 43/42 - START 10/SEC DOPPLER SAMPLE RATE - 19:20
START DSP, ROVER AND PARKES RECORDING - 19:35
TWNC ON - 19:37:33
AAI - 19:44
X-BAND RANGING CHANNEL OFF - 19:44:46
TELEMETRY MODULATION OFF - 19:48:46
RADIO SCIENCE RING OCCULTATION BEGINS (INGRESS) - 20:58:21
RADIO SCIENCE ATMOSPHERIC OCCULTATION BEGINS - 20:58:21
X-BAND TWT LOW POWER - 20:58:21
S-BAND TWT HIGH POWER - 20:59:11
S-BAND TWT LOW POWER - 23:06:23
X-BAND TWT HIGH POWER - 23:07:09
RADIO SCIENCE ATMOSPHERIC OCCULTATION ENDS - 23:07:09
EGRESS RING OCCULTATION BEGINS - 23:07:09
RADIO SCIENCE RING OCCULTATION ENDS - 00:18:21
TELEMETRY MODULATION ON - 00:24:43
X-BAND RANGING CHANNEL ON - 00:35:33
SUN ACQUIRE - 00:35:09
STAR ACQUIRE - 00:36:48
END DSP, ROVER AND PARKES RECORDING - 00:45
DSS 43/42 START 1/MIN DOPPLER SAMPLE RATE - 01:00
END RADIO SCIENCE CRITICAL EVENTS END ORT 4 - 01:45
3-WAY W/DSS 63
3-WAY W/DSS 14
1-WAY