#478

VOYAGER 1 + 2

PLANETARY RADIO ASTRONOMY DATA

77-084A-10C
77-076A-10C

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1. INTRODUCTION:

The documentation for this data set was originally on paper, kept in NSSDC's Data Set Catalogs (DSCs). The paper documentation in the Data Set Catalogs have been made into digital images, and then collected into a single PDF file for each Data Set Catalog. The inventory information in these DSCs is current as of July 1, 2004. This inventory information is now no longer maintained in the DSCs, but is now managed in the inventory part of the NSSDC information system. The information existing in the DSCs is now not needed for locating the data files, but we did not remove that inventory information.

The offline tape datasets have now been migrated from the original magnetic tape to Archival Information Packages (AIP’s).

A prior restoration may have been done on data sets, if a requestor of this data set has questions; they should send an inquiry to the request office to see if additional information exists.

2. ERRATA/CHANGE LOG:

NOTE: Changes are made in a text box, and will show up that way when displayed on screen with a PDF reader.

When printing, special settings may be required to make the text box appear on the printed output.

Version	Date	Person	Page	Description of Change
01				
02				

3 LINKS TO RELEVANT INFORMATION IN THE ONLINE NSSDC INFORMATION SYSTEM:

http://nssdc.gsfc.nasa.gov/nmc/

[NOTE: This link will take you to the main page of the NSSDC Master Catalog. There you will be able to perform searches to find additional information]

4. CATALOG MATERIALS:

a. Associated Documents — To find associated documents you will need to know the document ID number and then click here.
http://nssdcftp.gsfc.nasa.gov/miscellaneous/documents/

b. Core Catalog Materials

VOYAGER 1

PLANET RADIO ASST (PRA)

77-084A-10C PSFP-00059

THIS DATA SET HAS BEEN RESTORED. THERE WERE ORIGINALLY FOUR 9-TRACK, 6250 BPI TAPES, WRITTEN IN BINARY. THERE ARE FOUR RESTORED TAPES. THE DR TAPES ARE 3480 CARTRIDGES AND THE DS TAPES ARE 9-TRACK, 6250 BPI. THE ORIGINAL TAPES WERE CREATED ON AN IBM 360 COMPUTER. THE DR AND DS NUMBERS ALONG WITH THE CORRESPONDING D NUMBERS AND TIME SPANS ARE AS FOLLOWS:

DR#	DS#	DD#	FILES	TIME SPAN
DR004181	DS004181	D043048	1	09/05/77 - 06/30/78
DR004182	DS004182	D043049	1	07/26/78 - 02/28/79
DR004183	DS004183	D043050	1	03/01/79 - 07/18/79
DR004184	DS004184	D043051	1	08/02/79 - 03/31/80

VOYAGER 2

PLANETARY RADIO ASTRONOMY DATA

77-076A-10C PSFP-00236

THIS DATA SET HAS BEEN RESTORED. ORIGINALLY IT CONTAINED FOUR 9-TRACK, 6250 BPI TAPES WRITTEN IN BINARY. THERE ARE TWO RESTORED TAPES. THE DR TAPES ARE 3480 CARTRIDGES AND THE DS TAPES ARE 9-TRACK, 6250 BPI. THE ORIGINAL TAPE WERE CREATED ON AN IBM 360 COMPUTER AND THEY WERE RESTORED ON THE MRS SYSTEM. THE DR AND DS NUMBERS ALONG WITH THE CORRESPONDING D NUMBERS AND THE TIME SPANS ARE AS FOLLOWS:

DR#	DS#	D#	FILES	TIME SPAN
DR004225	DS004225	D043052	1	08/20/77 - 06/20/78
		D043053	2	07/25/78 - 05/31/79
DR004226	DS004226	D043054	1	06/01/79 - 08/10/79
		D043055	2	08/19/79 - 04/30/80

REQ.AGENT	RAND NO.	ACQ. AGENT
BER	VOO	RWV

VOYAGER 1 & 2

PLANETARY RADIO ASTRONOMY DATA

77-084A-10C

77-076A-10C

This data set catalog consist of 4 Voyager 1 and 4 Voyager 2 data tapes covering the Jupiter encounters. The data tapes are 6250 BPI, Binary, 9-track and containing one file of data each. The tapes were created on an IBM 360 computer.

The time spans are as follows:

Voyager 1

D#	C#	TIME SPANS
D-43048	C-21295	09/05/77 - 06/30/78
D-43049	C-21296	07/26/78 - 02/28/79
D-43050	C-21297	03/01/79 - 07/26/79
D-43051	C-21298	08/02/79 - 03/31/80

Voyager 2

D#		
D-43052	C-21299	08/20/77 - 06/20/78
D-43053	C-21300	07/25/78 - 05/31/79
D-43054	C-21301	06/01/79 - 08/10/79
D-43055	C-21302	08/19/79 - 04/30/80

77-084A-10C

B35770-000A

ORI
Silver Spring, Maryland 20910

VOYAGER PLANETARY RADIO ASTRONOMY EXPERIMENT DATA DESCRIPTION

SEPTEMBER, 1980

PREPARED FOR
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND 20771

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ABSTRACT

This document is intended as an introductory manual for the use of the Voyager Planetary Radio Astromony (PRA) data stored at the Natonal Space Science Data Center (NSSDC). It includes a brief description of the PRA receiver electronics and the programmable modes in which it can operate. The frame-averaged, millibel tapes and the 24-hour dynamic spectra plots which are immediately available through the NSSDC are explained. Finally, the publications which have resulted from the PRA data through 1979 are listed.

INSTRUMENT DESCRIPTION

The following is a brief summary of the characteristics of the PRA instrumentation. A more detailed description can be found in Lang and Peltzer (1977) and Warwick et al. (1977). The salient characteristics are summarized in Table 1.

Both Voyager spacecraft carry identical radiometers consisting of two orthogonal ten meter monopoles (Figure 1) coupled to individual pre-amplifiers and mixers. The mixer outputs are then fed to a 90^{o} hybrid followed by parallel IF amplifiers (Figure 2). This allows the system to measure the left-hand (LH) and right-hand (RH) circularly polarized components of the wave, but not its linear components or the phase difference between the components. This is equivalent to measuring only two of the four Stokes parameters necessary to completely define the wave polarization state. Thus, only the total power and polarization sense of the wave, either LH or RH depending on which signal is stronger, can be determined unambiguously from a single measurement. This determination alone is invaluable in helping to specify source locations and emission modes and in distinguishing one emission source from another.

In many cases the degree of polarization can be bounded based on the polarization measurements and knowledge of the angle between the direction normal to the antenna plane and the source of emission. The antenna plane is defined by the plane of the two monopoles and is oriented relative to the rest of the spacecraft as shown in Figure 3. Table A-1 displays the antenna normal angle relative to Jupiter for the two Voyagers. The values are extracted from the Voyager ephemeris tapes. Whenever the angle changes by more than 1^{o} a new value is tabulated. Thus, in times of frequent spacecraft maneuvering a large number of entries appear. In studies of the polarization of the data, Table A-1 should be consulted since the sign of the polarizaton should not be trusted when the antenna normal angle is within 35^{o} of 90^{o}.

At low frequencies (around 3 MHz), each monopole antenna is substantially shorter than one wavelength and, in effect, has the small radiation resistance and isotropic reception pattern of a Hertzian dipole. At

TABLE 1

PRA EXPERIMENT SALIENT INFORMATION

Receiver

Low Frequency Band	70 channels
Frequency Range	1.2 kHz - 1326 kHz
Bandwidth	1 kHz
Frequency Spacing	19.2 kHz
Sensitivity	$0.3\ \mu V/\sqrt{kHz}$
High Frequency Band	128 channels
Frequency Range	1.2 MHz - 40.5 MHz
Bandwidth	200 kHz
Frequency Spacing	307.2 kHz
Sensitivity	$0.1\ \mu V/\sqrt{kHz}$
Dynamic Range (with commandable attenuators)	140 dB
Dynamic Range (for fixed attenuation)	50 dB

Operating Modes

POLLO, HARAD, LEVEL, FIXLO

Frequency Range Scan Time	6 sec
Postdetection Time Constant	25 msec
Frequency Synthesizer Settling Time	5 msec
Data Rate (Maximum)	266 2/3 bps

PHIEX

Postdetection Time Constant	0.1 ms
Data Rate	115.2 kbps

POLHI

Postdetection Time Constant	0.1 msec
Data Rate (Maximum)	266 2/3 bps

Antennas

Length	10 m
Effective Area (Low band wavelengths only (λ))	$0.119\ \lambda^2$

Principal Investigator
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J.K. Alexander, Goddard Space Flight Center, Greenbelt, MD 20771

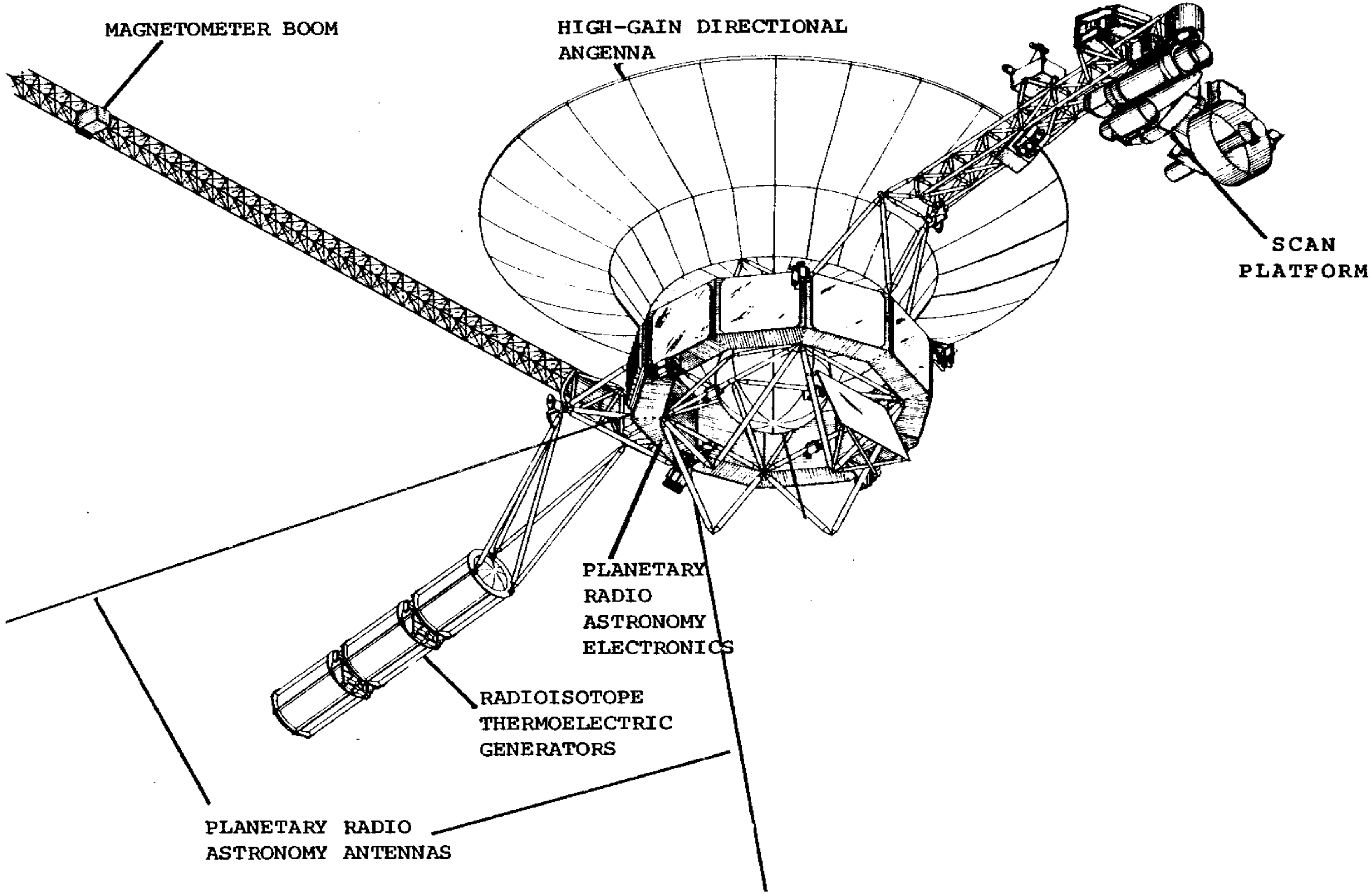

FIGURE 1. Diagram of the Voyager spacecraft showing the Planetary Radio Astronomy antennas and electronics and other spacecraft components.

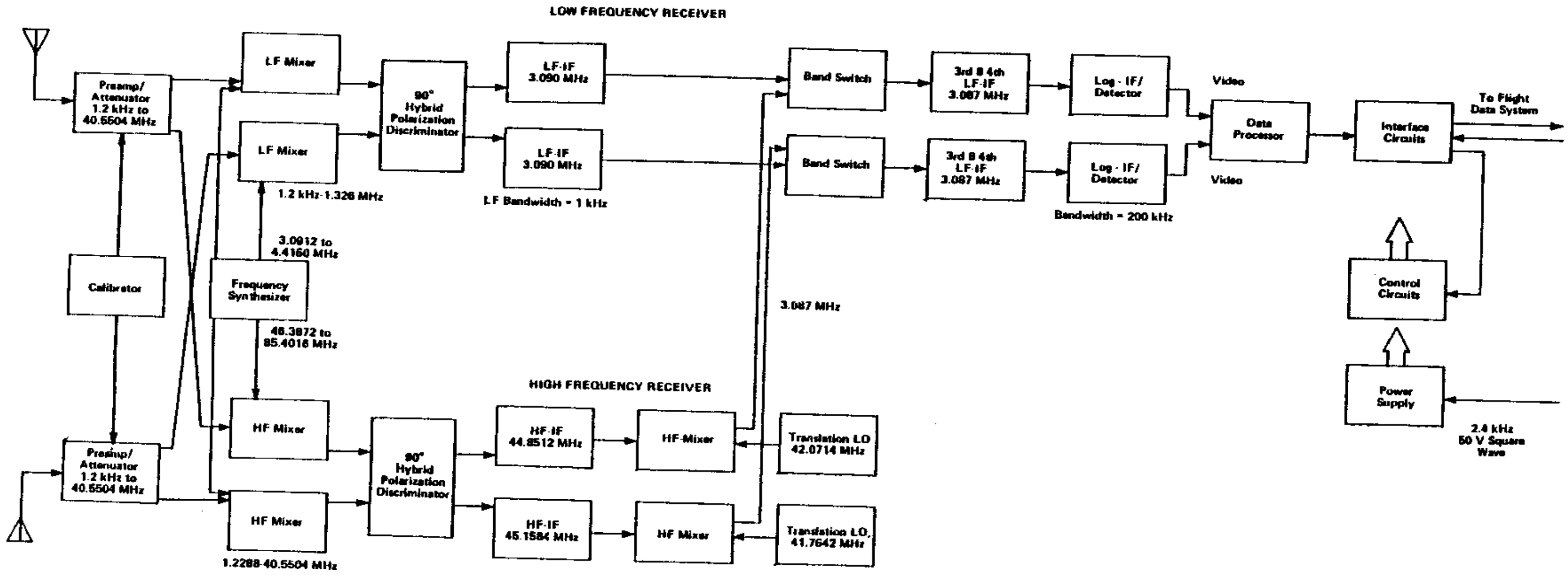

FIGURE 2. Simplified block diagram of the PRA receiver electronics.

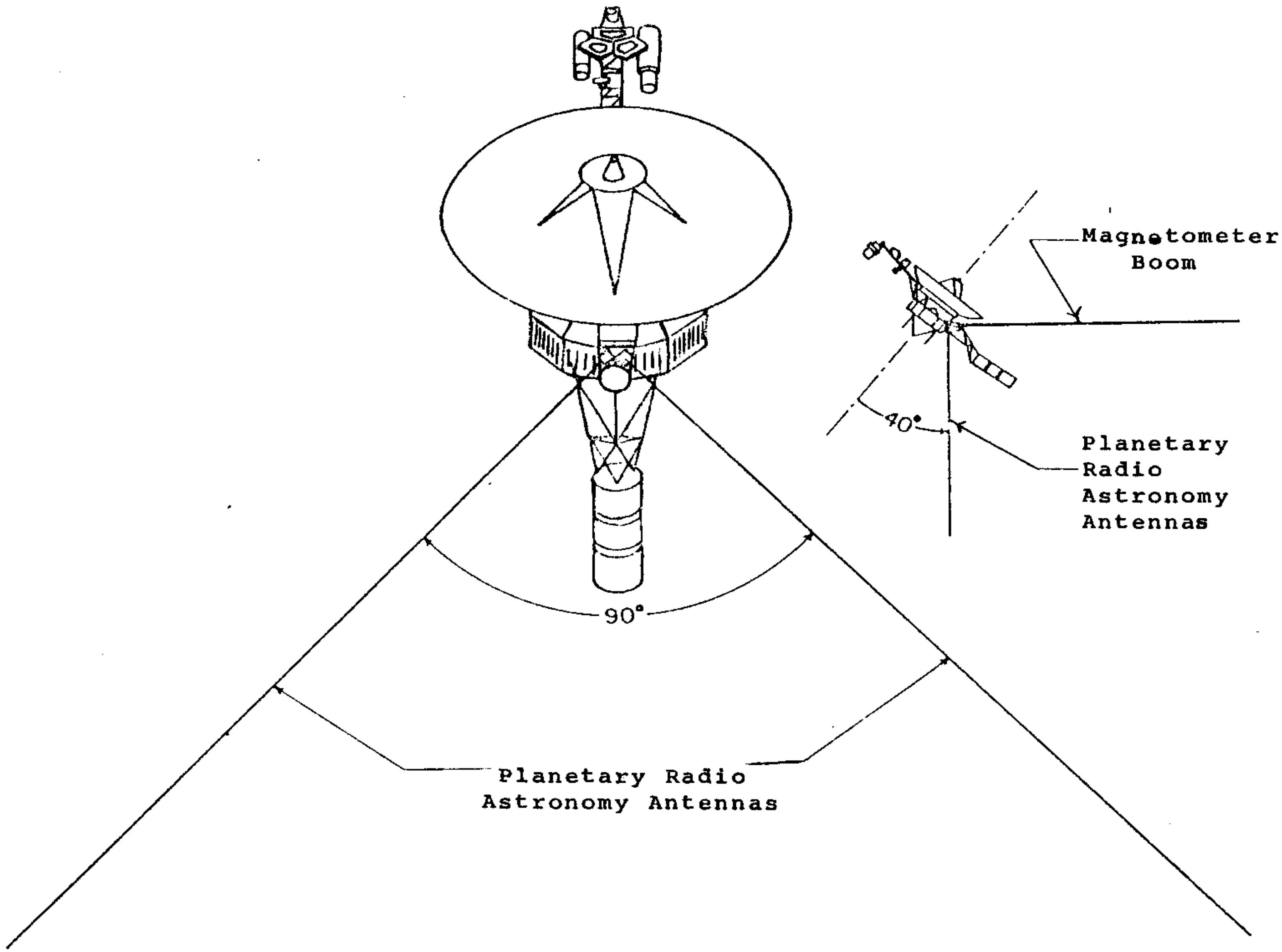

FIGURE 3. Simplified diagram of the Voyager Spacecraft showing the orientation of the PRA antennas.

higher frequencies, the pattern becomes multilobed since the antenna elements now must support a more complex current distribution. In actuality, this "utopian" behavior is altered slightly by the presence of the large conducting surfaces near the monopoles. Examples of these conducting surfaces are the 13 meter magnetometer boom and the 3.7 meter diameter high-gain telemetry antenna. Since the low frequency antenna pattern is so simple and since the other spacecraft appendages are all short compared to a wavelength, the low-frequency observations appear to have been affected the least by spacecraft perturbations to the antenna response pattern. At higher frequencies, complete reversals in the polarization sense from one frequency band to another sometimes appear which are clearly instrumental in origin. The bands of frequencies most often affected are approximately 5 MHz and 15 MHz on both spacecraft. Caution must be exercised in separating instrumental polarization reversals from the true reversals which may be evident near these frequencies.

The PRA receiver operates in two broad frequency bands whose channel bandwidths and separations are different. The 1.2 kHz to 1326 kHz low-frequency (LF) band consists of seventy 1 kHz wide channels, each separated by 19.2 kHz. The 1.2 MHz to 40.5 MHz high-frequency (HF) band consists of 129 channels, each of 200 kHz bandwidth. The separation between channels in the HF band is 307.2 kHz. A complete listing of channel numbers and corresponding frequencies is shown in Table A-2.

The receiver dynamic range expressed logarithmically is 50 dB, and by inserting attenuators in the receiver preamplifiers in anticipation of particularly intense signals, a total effective dynamic range of 140 dB can be achieved. During Voyager 1 (V1) and Voyager 2 (V2) encounters at Jupiter ghost images of intense HF band signals below 10 MHz appeared on some dynamic spectra at 25 MHz and above. These ghost images are due to spurious harmonics generated in the IF section when the high frequency receiver is near saturation. They are for the most part easily identifiable by virtue of their mirror image properties (for example, see Figure 9 around 6 and 18 hours) and are not confused with actual high-frequency decametric emissions.

Although the HF band should in principle be 14 times more sensitive than the LF band in detecting a signal against a uniform background, an extremely high level of noise in the HF band related to Voyager spacecraft high-speed switching logic greatly reduced its effective sensitivity. Thus the HF band observations of Jovian decametric emission (DAM) were limited to the period about one and a half months before and after Jupiter encounter. The excellent spacecraft noise rejection design employed in the LF band permitted detection of Jupiter emission near 1 MHz almost immediately after launch. At V1's closest approach, detection threshold in the PRA LF band was equivalent to 2×10^{-26} W m^{-2} Hz^{-1} if normalized to a distance of 4 A.U. Where the spacecraft noise was the greatest, at 10 MHz in the HF band, the minimum detectable flux from Jupiter was approximately 3×10^{-23} W m^{-2} Hz^{-1}. One point worth noting is that toward the high-frequency end of the HF band the detection thresholds are comparable to those found in the LF band. Finally, despite the fact that both V1 and V2 receivers were exposed for a noteworthy length of time to the intense radiation levels in Jupiter's magnetosphere and are approaching their projected four year design lifetimes, no permanent failures have developed and both receivers have performed to their original specifications.

OPERATING MODES

The PRA receiver can be programmed to operate in any of six operational modes. Minor variations in each of these six modes brings the actual number of useful commandable modes to 14. A mode is defined as an instrument and spacecraft Flight Data System (FDS) configuration which produces 200 8-bit words -- 2 words of instrument status followed by 198 data words. The cycle time for a mode is six seconds with one exception to be discussed later. Modes are executed in 48-second frames -- a grouping of eight 200 word records, all in the same mode. The order of execution of the modes is determined from a mode mixture table containing 30 entries, and the modes are commanded in accordance with a continuous cycling through this table. The table can be changed by ground command and has been changed many times in the mission (see Tables 2 and 3).

Although the PRA receiver is capable of being commanded into six basic modes of operation only three of these were used to any large extent in the mission through 1979. These modes are called POLLO, FIXLO, and PHIEX. The modes called POLHI, LEVEL, and HARAD have been used occasionally (see Table 3) but not often enough to warrant detailed discussion. The actual mode in use at any particular time can be determined directly from the status words embedded in each mode scan.

POLLO has been by far the most important data mode in the mission. POLLO is a stepped-frequency mode which samples 198 frequencies in a six second time interval. Sixty msec of each 6-second cycle involves housekeeping chores such as encoding the two 8-bit words describing the status of the experiment. The status words are followed by 198 words of data describing the measurements for each frequency. The signal from each frequency channel is integrated for 25 msec following a 5 msec frequency synthesizer settling time for a total of 30 msec. The receiver then steps to the next lower frequency channel. Only one type of circular polarization is measured with each channel sampling, and this changes in each step. Thus, in one sweep the left-hand polarization of the highest frequency channel is measured followed by the right-hand polarization of the next lower frequency, followed by the left-hand polarization of the channel below that, etc. An exception to this rule, however, is that the polarization measurement does not reverse in the transition from the high band to the low band frequencies. In the next cycle the polarization measurements are reversed and the sweep begins with a measurement of right-hand polarization at the highest frequency. Note that no simultaneous measurements of both polarizations are ever made in POLLO but that measurements can be obtained in opposite polarizations at two adjacent frequencies in 30 msec or at the same frequency in 6 seconds.

POLLO samples 198 frequencies, but there are a total of 199 frequency channels in high and low band which could be sampled. The channel which is not sampled will be either the highest or lowest frequency in high band, depending on the type of POLLO scan implemented. This occurs because the two local oscillator frequencies in high band are offset from each other by 307.2 kHz (see Figure 2) causing a simultaneous measurement of two adjacent frequencies, called the upper and lower channels. In a POLLO sweep all measurements are made either with the upper channel or the lower channel. If the upper channel is chosen the 128 high band frequencies from 40.5 MHz to 1.5 MHz are sampled. If the sweep uses the lower channel the span of frequencies is from 40.2 MHz to 1.2 MHz. In the data taken through 1979, the POLLO mode sampling the lower channel was used nearly all the time. In low band the two local oscillator frequencies are the same so that all 70 frequency channels are sampled in each POLLO scan.

The FIXLO mode of operation is designed to concentrate the measurements on several frequencies of interest. The output of a FIXLO cycle, like a POLLO cycle, consists of 200 8-bit words of which the first two give information on the status of the instrument. The next 198 words represent measurements made with a continuous repetition of the pattern $R_L L_L L_U R_U$. R and L are right and left-hand polarization measurements and L and U are the lower and upper channels which are the same in low band, but offset by 307.2 kHz in high band as discussed previously. The FIXLO cycle concentrates on a single frequency (or adjacent frequencies in high band), but three frequencies are sampled in each frame of FIXLO data. If F_1, F_2, and F_3 are the three frequencies, then the order in which a FIXLO frame samples them is $F_1F_2F_1F_3F_1F_2F_1F_3$. Table 2 lists the choice of the three frequencies throughout the mission. In some entries the frequencies are underlined since they are a special extension of the low band into the high frequency range. These measurements have the property of a narrow 1 kHz bandwidth, but the sensitivity of the low band receivers falls off rapidly between 2.0 and 2.5 MHz. Similarly, it is possible to extend the high band receiver beyond its normal frequency range. For example, an in-flight receiver polarization test was performed at 47 MHz.

In some instances a second set of three FIXLO frequencies have been sampled in the same mode mixture with the regular FIXLO frames. These alternate FIXLO scans are designated FIXLO' in Tables 2 and 3 and the frequencies used are listed under F_4, F_5, and F_6 in Table 2. A frame of FIXLO' data has a different pattern of frequency measurement which is $F_6F_4F_5F_4F_6F_4F_5F_4$. As shown in Table 3, FIXLO' was only used when Table indices 3, 6, 10 and 11 were in effect.

The PHIEX or POLHI "express" mode is a special extension of the POLHI mode which is designed for high time resolution, fixed-frequency studies. This mode can only be used when the spacecraft is in the GS2 imaging configuration. When the mode is executed, data can be returned at a rate of 14.4 K words per second, since the radio data are merged with the high-rate imaging data stream. Two frequencies can be chosen for study and these are listed in Table 2. Sampling of the two frequencies alternates in 24-second intervals. During the 24 seconds the readout of the measurements occurs every 69.4 microseconds alternating between the upper and lower channels and the left and right polarizations. Thus, in high band, two adjacent frequencies are being monitored, left-hand polarization from one and right-hand from the other. For low band the polarization alternates but the frequency remains the same throughout the 24-second interval.

Measurements are made in both channels simultaneously so that the integration time is 0.1 msec. Since no mode status words are contained in this data stream, the instrument status must be obtained from the POLHI data which are output in the normal PRA data stream at the same time.

Normal POLHI data scans consist of 2 mode status words followed by 198 data words taken at the same rate and in the same manner as for the PHIEX mode. Thus, useful data is taken for only 13.7 msec out of the 6 second interval. Since the amount of PHIEX data was more than originally anticipated, POLHI was very seldom implemented after the first few months of the mission.

The HARAD mode is a swept-frequency mode that is the same as POLLO in the high band but is centered on the spacecraft power supply harmonic frequencies in low band. The intent was to measure any excitation of the local plasma by the power supply wave form. This effect was never observed so HARAD has fallen into disfavor.

LEVEL is a swept-frequency calibration mode using the attenuators and an internal noise diode. It has been used several times in the mission especially for four hours before and after each encounter. In all cases the measurements showed no changes in the instrument performance.

DATA DESCRIPTION

Table 2 lists the implementation of the operating modes described in the previous section as they occurred in the mission through 1979 as well as other significant events affecting the data. The times of these events are recorded to the second where possible, but in some cases this accuracy was not available and the seconds or minutes columns have been left blank. The table index is indicative of the mode mixture which was commanded at a particular time and it is explained in Table 3. The frequencies sampled in the FIXLO mode are listed under the columns marked F_1, F_2, and F_3. The order in which these frequencies are scanned was discussed in the previous section. The alternate FIXLO mode, FIXLO', uses the frequencies marked F_4, F_5, and F_6. This mode is only used, however, when the table index is 3, 6, 10 or 11 as shown in Table 3. The same columns listing the FIXLO' frequencies have been used for the POLHI frequencies (P_1, P_2, and P_3) since the two modes were never used simultaneously. The PHIEX frequencies are listed in the columns marked P_1 and P_2 under PHIEX. The table index and frequencies are left blank when they have not changed from the previous event.

Finally, the comments column of Table 2 gives a capsule description of the reason for each entry. In most cases the entries describe data rate or mode mixture changes. Several times, however, unforseen resets of the instrument occurred, described as power up resets. Instrument resets would result in all 90 dB of commandable attenuation being in effect for short periods of time until the previous mode was reestablished. Usually, very little data was lost and, since this problem became more frequent later in the mission, not all of the resets have been listed. In some instances 15 dB of attenuation was inserted for short periods of time, and the sudden change in the Jovian signal intensity is apparent in the data. Use of the attenuators was found to be unnecessary except near encounter so that very little of the data includes a commanded attenuation.

The spacecraft turnaround times indicate when the Voyagers were reoriented such that the measured polarization sense of the radio source reverses. (Short-term spacecraft maneuvers are not counted as turnaround

TABLE 2

VOYAGER 1 EVENTS

Date			Time			Table	Frequencies (MHz) FIXLO			FIXLO'/POLHI			PHIEX		
Mon.	Day	Yr.	Hr.	Min.	Sec.	Index*	F_1	F_2	F_3	F_4/P_1	F_5/P_2	F_6/P_3	P_1	P_2	Comments
Sept.	5	77	15	22	12	1	0.19	0.31	0.25	0.06	0.21	0.25	7.99	0.56	First data received - High Rate **
Sept.	8	77	13	15	00		0.21	0.31	0.25	0.06	0.21	0.25			0.19 MHz was bad channel
Sept.	13	77	18	9	57										Cruise 6
Nov.	8	77	13	24	59										High data rate
Dec.	12	77	23	20			0.21	0.25	0.31	21.8	7.99	0.56			
Mar.	14	78	21	15		2									More POLLO scans
June	7	78	13	12	47										Cruise 3
June	22	78	18	25	35	3	$\underline{1.50}$ [+]	$\underline{2.00}$	$\underline{2.44}$	1.71	2.23	2.78	26.1	1.53	Even POLLO/FIXLO
June	30	78	19	0	49										Cruise 6
July	6	78	15	49	07	1							7.99	0.56	Power Up Reset Recovery
Aug.	3	78	00	10		3									

* The table index refers to the mode mixture in effect. It is interpreted in Table 3.

** Data rates and Cruise modes are listed in Table 4.

\+ Underlined frequencies are special extensions of the normal low band receiver frequency ranges.

TABLE 2

VOYAGER 1 EVENTS

Date			Time			Table	Frequencies (MHz) FIXLO			FIXLO'/POLHI			PHIEX		
Mon.	Day	Yr.	Hr.	Min.	Sec.	Index*	F_1	F_2	F_3	F_4/P_1	F_5/P_2	F_6/P_3	P_1	P_2	Comments
Oct.	23	78	20	37	8	3	1.54	1.54	1.54	1.54	1.00	1.19			Frequencies requested by T. D. Carr
Dec.	5	78	0	4	55										High data rate
Dec.	8	78				4									Near encounter test
Dec.	10	78													30 dB Attenuation In
Dec.	12	78													0 dB Attenuation In
Dec.	15	78				3									POLLO-FIXLO
Dec.	19	78	19	11	20	6	1.50	1.50	1.50	1.19	1.19	1.19			9/10 POLLO
Jan.	13	79	12	34	59										Power Up Reset
Jan.	13	79	19	3											Power Up Reset Recovery
Jan.	30	79	11	49	23	4									Encounter Mode Mix
Feb.	2	79	4	35	00										Pre-encounter calibration
Feb.	2	79	4	57	26	7									LEVEL In
Feb.	2	79	8	35	00										Phase Calibration
Feb.	2	79	12	35	00	4									Calibration Out
Feb.	23	79	21	36	6								9.52	26.1	

TABLE 2

VOYAGER 1 EVENTS

Date			Time			Table	Frequencies (MHz) FIXLO			FIXLO'/POLHI			PHIEX		
Mon.	Day	Yr.	Hr.	Min.	Sec.	Index*	F_1	F_2	F_3	F_4/P_1	F_5/P_2	F_6/P_3	P_1	P_2	Comments
Feb.	24	79	2	9	24	8									HARAD In
Feb.	26	79	0	11	48										15 dB Attenuation In
Mar.	8	79	19	58	20										15 dB Attenuation Out
Mar.	11	79	10	57	32	7									LEVEL In
Mar.	11	79	14	39	56										Phase Calibration
Mar.	11	79	18	39	56	8									Calibration Out
Mar.	20	79	21	45	32	9	0.10	0.08	0.12				0.10	0.12	FIXLO In
Apr.	6	79	03	06	00										Spacecraft turnaround
Apr.	13	79	13	1	32	6									Cruise 4
July	28	79				4									All POLLO
Oct.	29	79	17	21	36	9									FIXLO In GS-3
Nov.	1	79	22	33	37	4									All POLLO
Nov.	20	79	17	21	37	9									FIXLO In GS-3
Nov.	22	79	00	10	00	4									All POLLO
Dec.	11	79	14	57	38	9									FIXLO In GS-3
Dec.	18	79				4									All POLLO

TABLE 2

VOYAGER 2 EVENTS

Date Mon.	Date Day	Date Yr.	Time Hr.	Time Min.	Time Sec.	Table Index*	FIXLO F_1	FIXLO F_2	FIXLO F_3	FIXLO'/POLHI F_4/P_1	FIXLO'/POLHI F_5/P_2	FIXLO'/POLHI F_6/P_3	PHIEX P_1	PHIEX P_2	Comments
Aug.	20	77	18	38	05	1	0.19	0.31	0.25	0.06	0.21	0.27	7.99	0.56	First data received - High rate
Aug.	22	77	6	26			0.21	0.31	0.25	0.06	0.21	0.27	7.99	0.56	0.19 MHz was bad channel
Aug.	25	77													Spacecraft turnaround
Aug.	29	77	20	33											15dB Attenuation In
Sept.	8	77	23	6											15dB Attenuation Out
Dec.	5	77	23	44	24		0.21	0.25	0.31	21.8	7.99	0.56	7.99	0.56	
Mar.	2	78	16	40		2									More POLLO scans
May	24	78	23	42	16										Phase Calibration On
June	16	78	16	35	02		1.50	2.00	2.44	1.71	2.23	2.78	26.1	1.53	Phase Calibration Off
June	16	78	16	40	38	3									Even POLLO/FIXLO
June	20	78	9	29	26										Cruise 6
July	25	78	15	59	00										Power Up Reset Recovery
July	27	78	21	36											Power Up Reset Recovery
Oct.	13	78	15	6											
Oct.	24	78					1.54	1.54	1.54	1.54	2.76	2.76		1.22	Frequencies requested by T. D. Carr
Oct.	26	78	14	6	5										Cruise 4

TABLE 2

VOYAGER 2 EVENTS

Date			Time			Table	Frequencies (MHz) FIXLO			FIXLO'/POLHI			PHIEX		
Mon.	Day	Yr.	Hr.	Min.	Sec.	Index*	F_1	F_2	F_3	F_4/P_1	F_5/P_2	F_6/P_3	P_1	P_2	Comments
Nov.	7	78	17	30		3									
Nov.	18	78	16	05			1.54	1.54	1.54	1.54	2.76	2.76			Frequencies requested by T. D. Carr
Dec.	16	78	2	9	42	6	1.50	1.50	1.50	1.19	1.19	1.19			9/10 POLLO
Apr.	11	79	20	12	44	4									Near Encounter Test - High data rate
Apr.	23	79	12	29	41	6									End Near Encounter Test Cruise 3
Apr.	24	79	6	54	29	10	0.81	0.35	0.10	26.1	10.1	3.07	9.52	10.1	5/6 POLLO
May	15	79	5	5	41										High data rate
June	6	79	19	42	25	11									LEVEL In
June	7	79	3	48	49										Phase Calibration
June	8	79	4	8	49	10									LEVEL Out
July	4	79	1	37	35	4									All POLLO
July	7	79	8												Power Up Reset/90 dB Attenuation In
July	7	79	17	51	59										Power Up Reset Recovery and 15 dB Attenuation In
July	12	79	19	51	58										0 dB Attenuation - Post Encounter
July	25	79	22	6	22	10	0.75	0.77	0.77	0.25	0.15	0.31			5/6 POLLO

TABLE 2

VOYAGER 2 EVENTS

Date Mon.	Day	Yr.	Time Hr.	Min.	Sec.	Table Index*	Frequencies (MHz) FIXLO F_1	F_2	F_3	FIXLO'/POLHI F_4/P_1	F_5/P_2	F_6/P_3	PHIEX P_1	P_2	Comments
July	28	79	2	54	22	11									Post-Encounter Calibration
July	28	79	6	53	34										Phase Calibration
July	28	79	10	55	10	10									Cruise
Aug.	19	79	23	7	8										Cruise 4
Nov.	2	79	16	4	43										High data rate
Nov.	25	79	8	19	0										Cruise 4

Table 3

Table Index Mode Mix Interpretation

Table Index	Mode Mixture
1	POLLO/LEVEL/HARAD/FIXLO/POLHI/POLLO/4 FIXLO/POLLO/POLHI/3 FIXLO/POLLO/HARAD/3 FIXLO/POLLO/POLHI/3 FIXLO/POLLO/2 FIXLO/POLHI/FIXLO
2	POLLO/LEVEL/HARAD/FIXLO/POLHI/FIXLO/5 POLLO/HARAD/FIXLO/POLHI/FIXLO/5 POLLO/HARAD/FIXLO/POLHI/FIXLO/POLHI/5 POLLO
3	POLLO/FIXLO/POLLO/FIXLO'/....
4	30 POLLO
5	29 FIXLO/POLLO
6	9 POLLO/FIXLO'/9 POLLO/FIXLO/9 POLLO/FIXLO'
7	LEVEL/29 POLLO
8	HARAD/29 POLLO
9	FIXLO/29 POLLO
10	FIXLO'/5 POLLO/FIXLO/5 POLLO/...
11	LEVEL/5 POLLO/FIXLO/5 POLLO/FIXLO'/5 POLLO/FIXLO/5 POLLO/FIXLO'/5 POLLO

times.) This occurs because the emission source is then on the opposite side of the antenna plane.

In the previous section we described the modes of operation and mentioned that these are usually grouped in frames consisting of a set of eight cycles of a particular mode. The time required to transmit a frame of data to the ground varies depending on the cruise mode of the spacecraft. These times are summarized in Table 4. In the highest data rate modes the frames are produced and transmitted continuously. The length of time to transmit a frame increases gradually with the other cruise modes except for Cruise-6. In Cruise-6 the data transmission rate is so low that the PRA frames are too widely separated in time to be generally useful. Consequently, for the times corresponding to Cruise-6 the data have not yet been processed. The times when each of the cruise modes were in effect and when data are available are shown in Figure 4. Note that Cruise-5 was not used through 1979, and Cruise-6 data are not shown since they are not available.

Figure 5 shows the flow of data after it has been transmitted by the spacecraft. Telemetry from the two Voyagers is routed to the Jet Propulsion Laboratories (JPL) where it is recorded. The data are then divided according to instrument and placed on Experimenter Data Record (EDR) tapes. The EDR tapes are not, however, in perfect time sequence. If JPL encounters any problems in a segment of the data the processing of that segment may be delayed and added to a later EDR tape. Delays in the receipt of data by JPL from the scattered tracking stations may also result in a jumbled time sequence. As a result, the EDR tapes often consist of blocks of synchronous data which are asynchronous with respect to each other. The same problems can also result in duplicate data appearing in the EDR tapes.

The PRA EDR tapes are then sent to the principle investigator, J. W. Warwick, at Radiophysics Inc., in Boulder, Colorado. The EDR data records are converted in a one-to-one ratio into Decalibrated Experimenter Data Records (DEDR) tapes by a translation of the measurements from telemetry counts into signal level at the receiver terminals expressed in millibels above a fixed lower voltage of 0.07 10^{-6} V. (To convert from millibels to power flux

Table 4

Cruise Mode Data Rates

Cruise Mode	Frame Completion Time (sec.)
High Data Rate (GS3, Cruise 1, Cruise 2)	48
Cruise 3	96
Cruise 4	192
Cruise 5	240
Cruise 6	2880

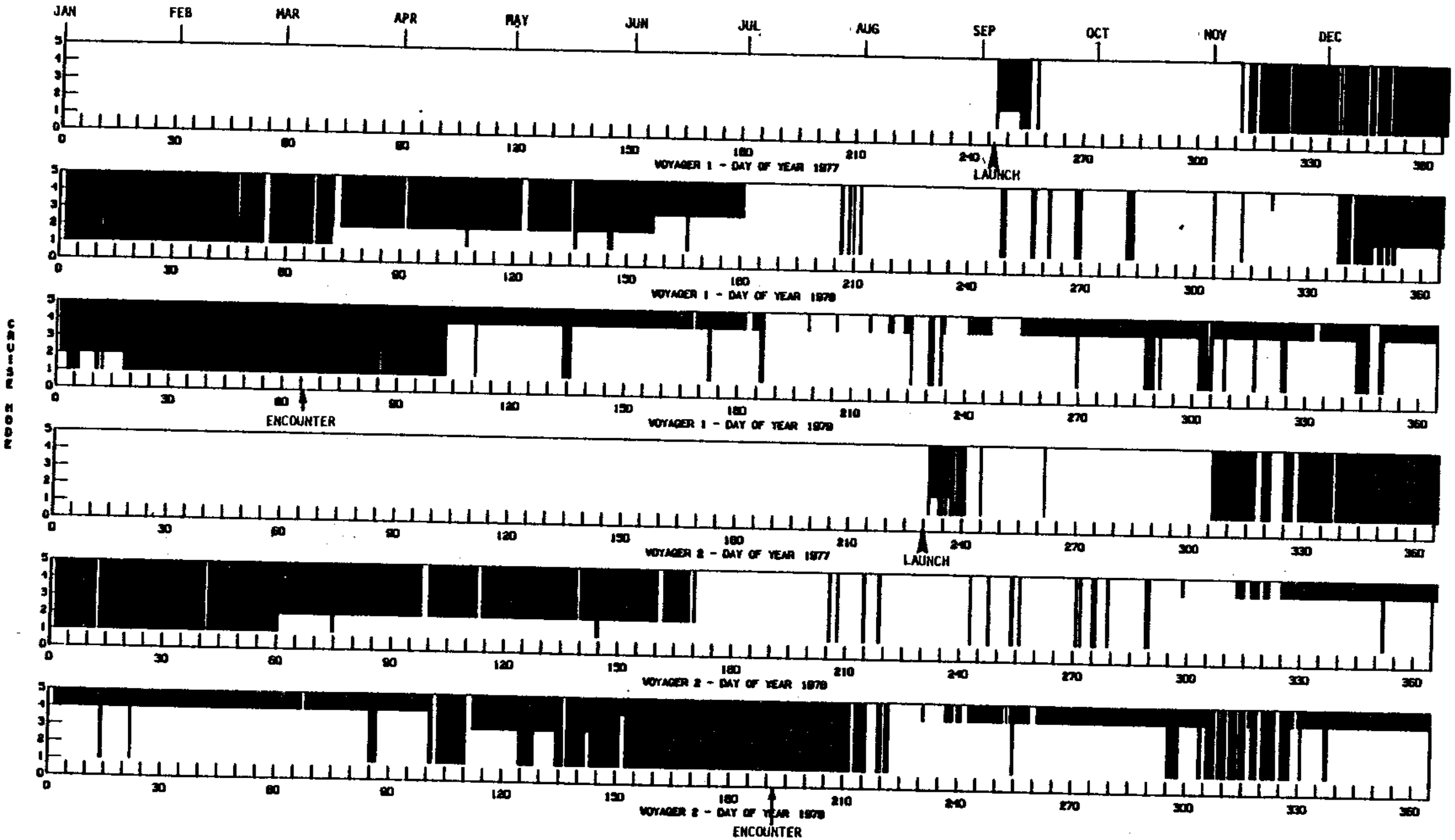

FIGURE 4. Plot of cruise mode versus time for each Voyager spacecraft. The black histogram bars extend downward from the lowest data rate, Cruise-5, to the Cruise mode in effect at the given time. The times when the GS2 and GS3 modes were in effect are grouped with Cruise 1. Cruise 5 was not used from launch through 1979. Cruise 6 times are not shown since these data are not available in the 48-second frame averages tapes.

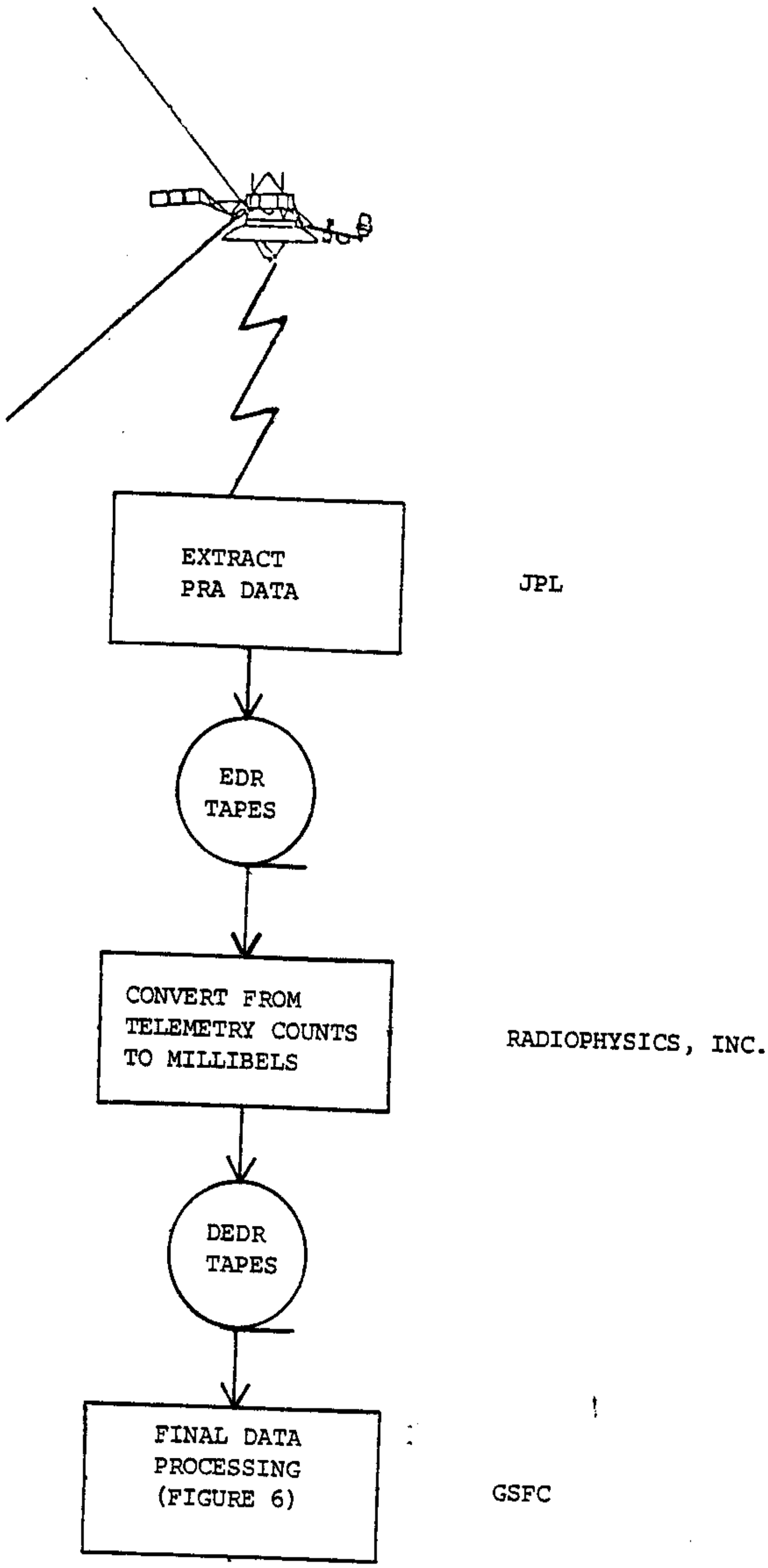

FIGURE 5. Flow of data from the spacecraft through initial processing and calibration at JPL and Radiophysics, Inc. to Goddard Space Flight Center.

densities at the antenna it should be assumed that zero millibels corresponds to 3.5 x 10^{-22} W m^{-2} Hz^{-1} in each polarization channel.) The time order of the data remains the same.

Goddard Space Flight Center (GSFC) receives copies of the DEDR tapes from Radiophysics Inc. The flow of subsequent data processing is diagrammed in Figure 6. First, the DEDR tapes are copied, but the recording density is increased from 800 bits per inch to 6250 bits per inch in the process. The tape volume and times of coverage for these data are then recorded in a data catalog for possible future reference. At this point all of the POLLO frames are extracted from the data and a new tape is created based on averages of the signal for the eight scans in each frame. The result is the average signal for left and right polarizations within each frequency for the duration of the frame. The frame duration depends on the cruise mode in effect at the time, as shown in Table 4. After the frame-averaged data are sorted by time they are merged with the old master tape and any duplicate records are eliminated. The resultant master tape format is described in detail in Table 5.

Both DEDR and frame-averaged millibel tapes are stored at GSFC. For those interested in the data from modes other than the stepped-frequency POLLO mode, it will be necessary to begin with the DEDR tapes and search the status words of each record for the code representing the mode of interest. The processed POLLO data are directly available on eight tape volumes in the GSFC Systems and Applications Computing Center (SACC) tape library. The eight volumes and their dates of coverage are listed in Table 6. If the tapes are to be used with the SACC computers or if the user has access to a computer which has the Fortran Tape Input/Output (FTIO) system then the VTAPES subroutine can be used for direct mounting of the correct volume.

The bottom of Figure 6 demonstrates that the master tape of POLLO data serves as the starting point for the dynamic spectra plots. Through intermediate processing steps a plot tape suitable for the Versatec plotter is generated. This intermediate tape is used to generate the 24-hour plots described in the next section.

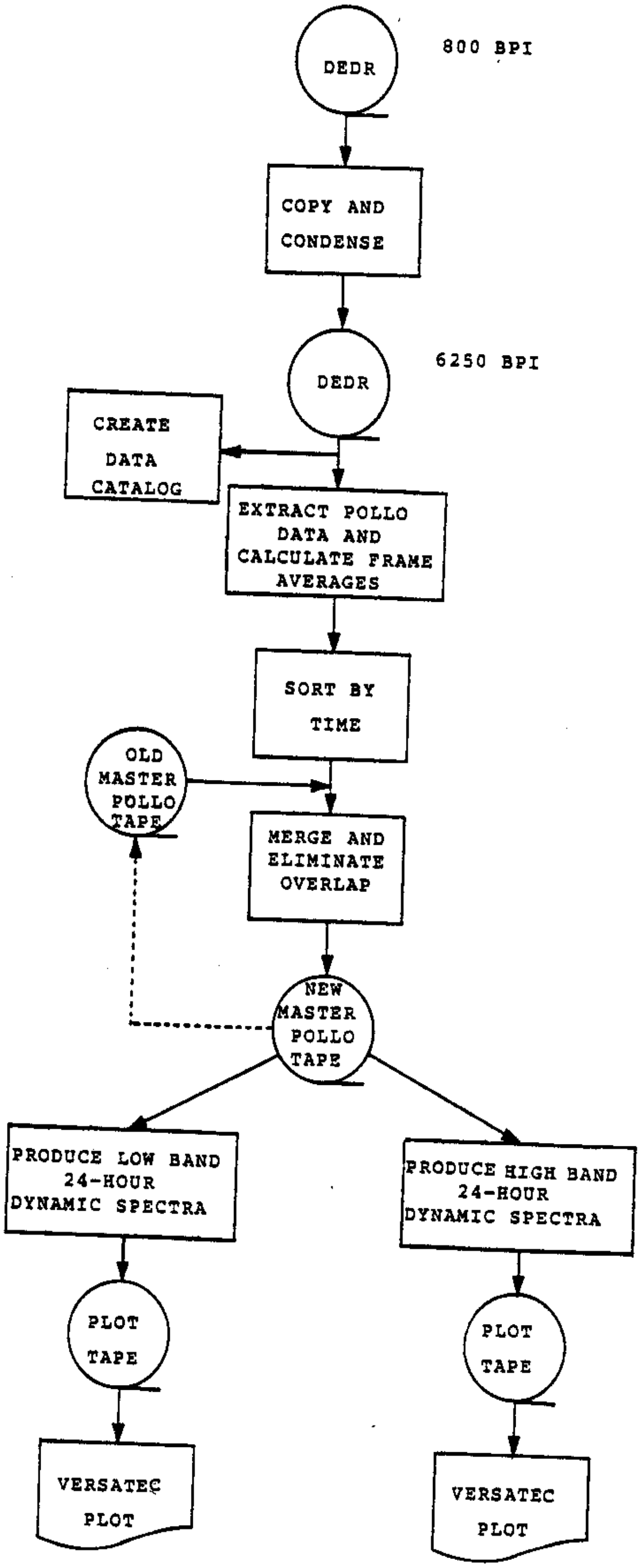

FIGURE 6. Flow of PRA data processing at Goddard Space Flight Center from receipt of the DEDR tapes from Radiophysics, Inc. to production of the dynamic spectra plots.

TABLE 5

VOYAGER FRAME AVERAGES TAPES

EACH LOGICAL RECORD CONTAINS THE AVERAGE VALUE IN MILLIBELS OF THE LH AND RH CHANNELS FOR EACH FREQUENCY FOR ONE VOYAGER POLLO FRAME (=8 SCANS, NOMINALLY 48 SECONDS). LOGICAL RECORDS ARE 808 8-BIT BYTES PLUS A 4 BYTE CONTROL WORD. PHYSICAL RECORDS ARE 32484 BYTES (40*812+4). DCB=(RECFM=VBS,LRECL=812, BLKSIZE=32484........DENSITY=6250 BPI

THE FORMAT IS AS FOLLOWS:

WORD#	TYPE	BYTES	DESCRIPTION
1	I	4	DATE IN YYMMDD FORM, E.G.(MAY 24,1978=780524)
2	I	4	SPACE-CRAFT EVENT TIME IN ELAPSED MILLISECONDS FROM 0 HOURS ON DATE(WORD 1),GIVEN AT THE START OF THE FRAME
3	I	4	TELEMETRY MODE...=7 OR 8(CR-1) =1(CR-2) =2(CR-3)) =3(CR-4) =10(GS-3)
4-202	I	2	THE AVERAGED RECEIVED POWER FOR ALL 199(*) FREQUENCIES IN DESCENDING ORDER OVER THE FRAME IN MILLIBELS FOR LH AND RH CHANNELS

THE TAPE CAN BE READ AS FOLLOWS:

```
INTEGER*4 A(202)
INTEGER*2  AVE(199,2)     (*)
EQUIVALENCE (A(1),IYMD),(A(2),MSEC),(A(3),MODE),(A(4),AVE(1)))

READ(IUNIT) A
```

* NOTE THAT AVE IS DIMENSIONED 199 INSTEAD OF 198. THIS ALLOWS FOR THE 'EXTRA' FREQUENCY CHANNEL AVAILABLE IN HIGH BAND. POSITION 1 THUS CORRESPONDS TO 40550 KHZ (AND IS USUALLY ALL ZEROS). POSITION 129 CORRESPONDS TO 1228.8 KHZ. LOW BAND IS CONTAINED IN POSITIONS 130 TO 199. ALSO, LH AVERAGES ARE STORED IN AVE(I,1), AND RH AVERAGES ARE STORED IN AVE(I,2).

TABLE 6

MILLIBEL TAPE VOLUMES

The following tapes are in the tape library in the building 1 Systems and Applications Computing Center (SACC) at Goddard Space Flight Center. The format of the tapes is described in Table 5. Copies or direct use of these tapes can be arranged through J. K. Alexander or M. L. Kaiser, Laboratory for Extraterrestrial Physics, Code 695, Goddard Space Flight Center , Greenbelt, Maryland 20771.

TAPE VOLUME	DATA SET NAME	DATES OF COVERAGE
RA0001	VOYAGER1.AVG	Sept. 5,77-June 30, 78
RA0002	VOYAGER1.AVG	July 1, 78-Feb. 28, 79
RA0003	VOYAGER1.AVG	March 1, 79-July 31, 79
RA0004	VOYAGER1.AVG	Aug. 1, 79-Dec. 31, 79
RA0010	VOYAGER2.AVG	Aug. 20, 77-June 30, 78
RA0011	VOYAGER2.AVG	July 1, 78-May 31, 79
RA0012	VOYAGER2.AVG	June 1, 79-Aug. 10, 79
RA0013	VOYAGER2.AVG	Aug. 19, 79-Dec. 31, 79

VTAPES Subroutines

A Fortran subroutine, written by P. G. Harper, is available on the SACC computer which will automatically mount the correct millibel tape given the spacecraft, the time period, and the Fortran input device unit number. This requires the use of the Fortran Tape Input/Output (FTIO) system. Thus, the data must be read in with an FREAD statement as described in the FTIO manual. The CALL statement is as follows:

```
CALL VTAPES (ID, ITYPE, IYMD, IUNIT)
```

where all four arguments are integers and

ID = 1 or 2 for Voyager 1 or 2
ITYPE = 1 for millibel tapes
IYMD = YYMMDD, six digit integer giving the year, month, and day for the data required
IUNIT = Fortran input device number corresponding to XX in the data definition card below

The IBM data definition card appears below. XX is to chosen by the user.

```
//FTXXF001 DD UNIT=(6250,,DEFER),LABEL=(,SL),DCB=RECFM=VBS
```

The subroutine is found in the library with data set name M2.U3MLK.LODMOD. Note that the subroutine need only be called with the starting date for a span of many days of data, unless the dates extend beyond the end of a tape. Consecutive calls to VTAPES will result in a tape mount request only if a new tape is required.

DYNAMIC SPECTRA PLOTS

The POLLO data have been used to generate 24-hour dynamic spectra plots. Copies of these plots extending through the end of 1979 have been stored at the NSSDC with this document. The plots are divided into high band and low band, and Figures 7, 8, and 9 are examples of these. Since the high band is considerably lower in sensitivity than low band, meaningful high frequency data were only obtained within several months of Jupiter encounters. Consequently, the stored high band records do not span the full range of time from launch to December 31, 1979, but only from Feb. 1, 1979 to Apr. 29, 1979 for Voyager 1 and May 1, 1979 to Aug. 10, 1979 for Voyager 2.

The plots exemplified by Figures 7 and 8 are produced on a 12 inch Versatec electrostatic plotter with 200 dot/inch resolution. In their original form, the only explanatory markings which appear are the large block letters on the right side of each plot. Extra annotation has been added to each figure to explain the tic marks along the axes and the meanings of the block letters. In each case the plots are composed of four panels. The vertical axis represents the high or low band frequency scale. Note that frequency increases in the downward direction. The horizontal axis represents spacecraft event time. In the lower three panels the darkness is proportional to the logarithmic intensity of the signal above a computed background. The background is calculated for each frequency in each consecutive group of 500 frame averages. It represents an iterative average of the signal level calculated after excluding the highest and lowest signals until the standard deviation is within a predetermined value. Such a variable background was found necessary so that the plot can display differences in signal strength for both weak emission far from Jupiter and the strong emission during encounter. The lower two panels represent the frame averages of right and left hand polarization measurements and the sum of these two is shown in the total power panel. Their difference gives the polarization sense displayed in the top panel, where white (black) represents a dominance of right hand (left hand) polarization.

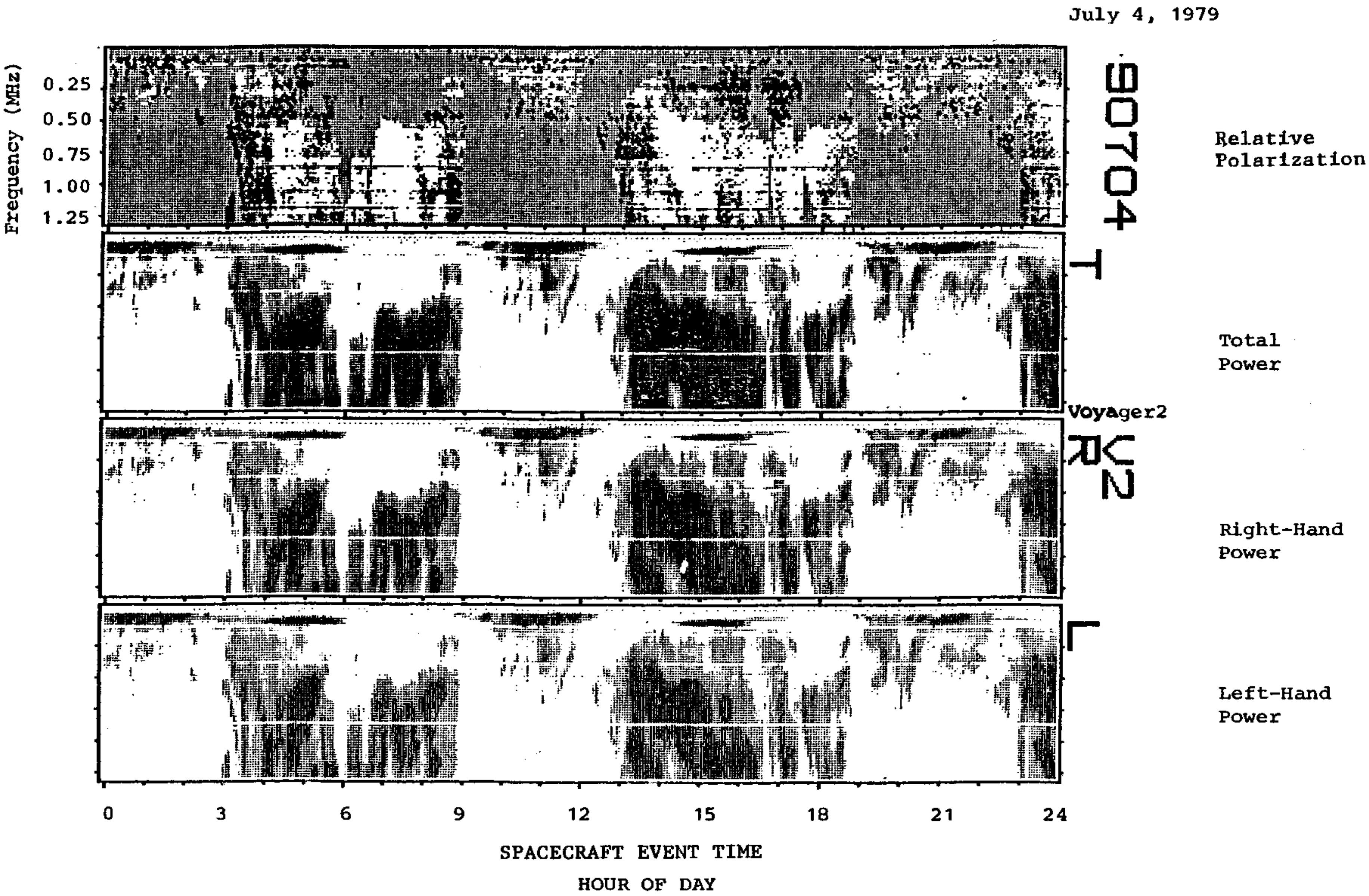

FIGURE 7. Example of 24-hour low-band dynamic spectra plot data received by Voyager 2 on July 4, 1979. The lower three panels are shaded in proportion to the logarithm of the signal strength for left-hand, right-hand, and total power (sum of left and right). The top panel is shaded in accordance with polarization, from white for right-hand dominance to black for left-hand dominance.

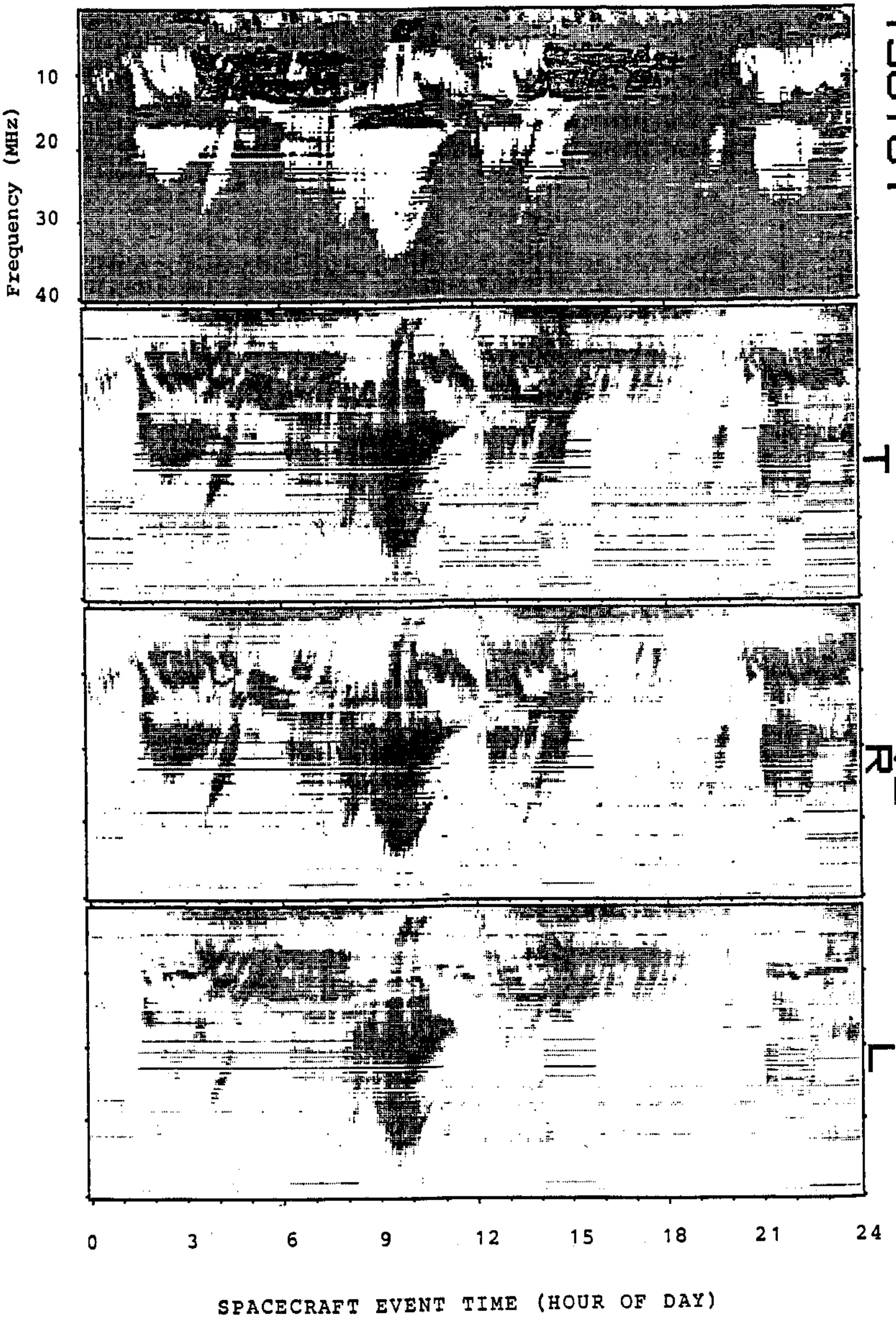

FIGURE 8. Same as Figure 7 except for high band frequencies.

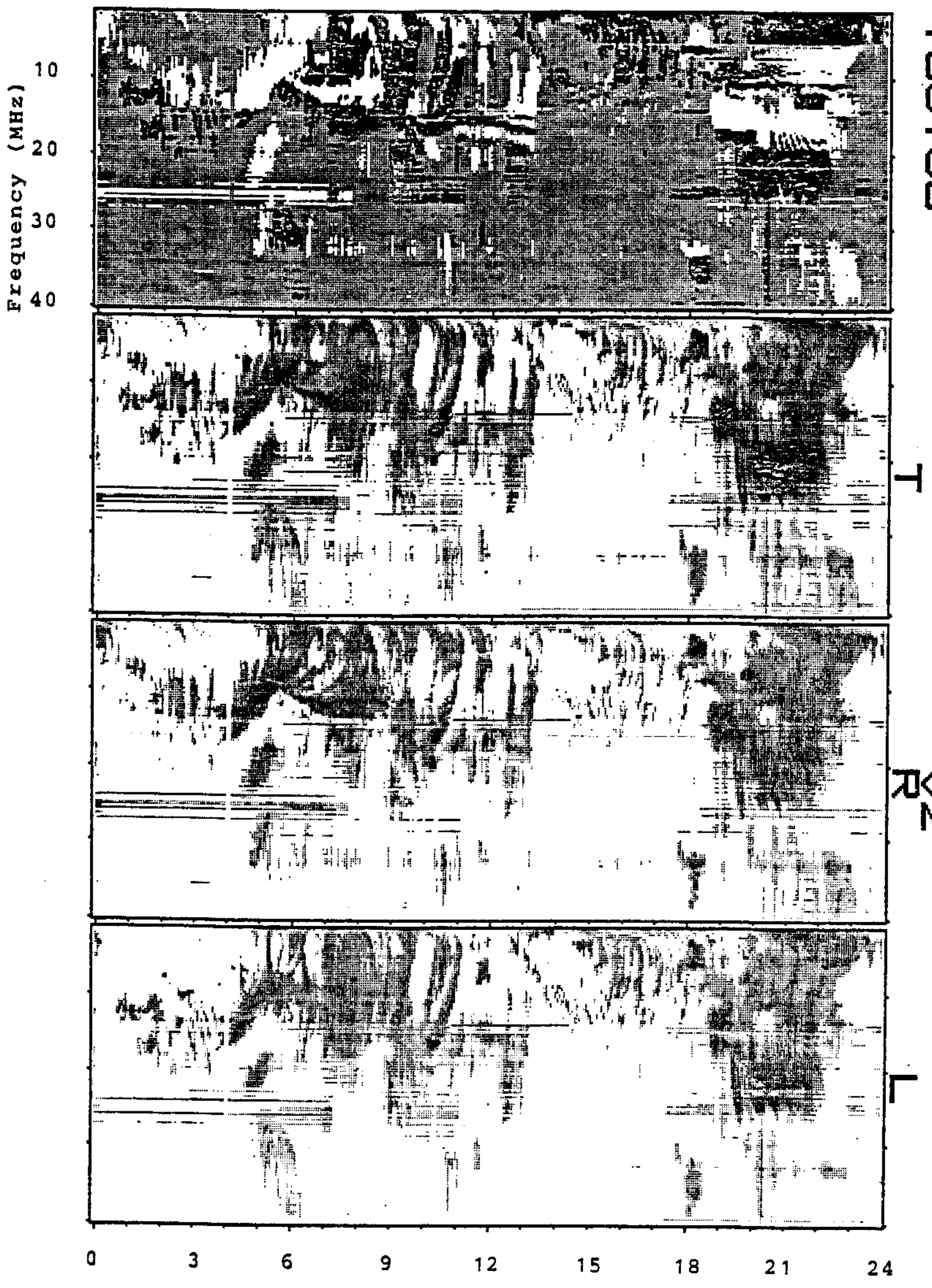

FIGURE 9. Same as Figure 8 except for data from July 9, 1979. The figure illustrates high-frequency (greater than 25 MHz) "ghost mirror images appearing as a result of strong lower frequency (less than 10 MHz) signals. The images are elongated in frequency span. The appearance at 18 hours is a good example.

All 70 channels are displayed in the low band plot. The presence of the horizontal streaks shows the problem of spacecraft interference which made some of the channels permanently unusable. Of the 129 possible channels in high band, 128 are displayed. The lowest frequency, 1.2 MHz, is not shown since it overlaps the low band frequencies. As discussed earlier the highest frequency, 40.5 MHz, is never sampled in the lower channel POLLO sampling mode so it is always zero. Interpretation of these and similar plots has been discussed in many of the references listed in the bibliography.

PRA PUBLICATIONS

This section summarizes the research which has been published based on the PRA data described in this document. We have already referred to the pre-launch publications by Warwick et al. (1977) and Lang and Peltzer (1977) describing the instrument. The initial observations using the PRA instrument were concentrated on Terrestrial Kilometric Radiation (TKR). A paper describing these observations was published by Kaiser et al. (1978) who presented the first direct polarization measurements of TKR and confirmed that the emission is generated in the extraordinary mode.

Very soon after leaving the earth the PRA instrument began to detect Jovian radio emissions in low band. These initial observations at hectometric (HOM) wavelengths are described in Kaiser et al (1979). An explanation of the longitudinal profile of these emissions was put forth in Alexander et al. (1979). A more recent discussion of the dynamic spectra of the HOM component of the emission is given by Lecacheux et al. (1980).

The encounters of Voyagers 1 and 2 with Jupiter resulted in a large variety of new information. Overviews reflecting on the initial results were published in special issues of Science (Warwick et al., 1979a and 1979b). Since the encounters there has been time to study the many phenomena in more detail. Most of these results will appear in a special issue of the Journal of Geophysical Research to be published in the spring of 1981. An overview paper (Boischot et al., 1981) will be published in that issue which describes much of the work to date.

Research on the PRA data has been concentrated in several areas. The newly-discovered Jovian Kilometric Radiation (JKR or KOM) has been analyzed by Kaiser and Desch (1980) and Desch and Kaiser (1980). Alexander et al. (1981) described the general statistical properties of both the high band-and low-band observations, especially in their relationship to previous ground-based results. Many groups have become interested in the study of the arc-like patterns which appear in the dynamic spectral plots of high-band data taken close to encounter. The publications on this topic are by Boischot and Aubier (1981), Goldstein and Thieman (1981), Leblanc (1981), Pearce (1981), Staelin (1981), and Warwick (1981).

During the Voyager 1 Jupiter encounter the spacecraft traveled through the Io plasma torus and made direct measurements of the electron plasma frequency. Birmingham et al. (1981) used these measurements as a basis for modelling the plasma structure within the plasma torus. Lecacheux (1981) performed ray tracing calculations to consider the effects of the torus on the Jovian radio emission measured during the encounter.

Other topics of interest are currently under investigation and further inquiries on the work in progress should be directed to the investigators listed in the above publications.

ACKNOWLEDGMENTS

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Warwick, J. W., J. B. Pearce, A. C. Riddle, J. K. Alexander, M. D. Desch, M. L. Kaiser, J. R. Thieman, T. D. Carr, S. Gulkis, A. Boischot, Y. Leblanc, B. M. Pedersen, and D. H. Staelin, Planetary radio astronomy observations from Voyager 2 near Jupiter, Science, 206, 991, 1979b.

Table A-1
Voyager 2 Antenna Angles
θ = Angle between normal to antenna plane and Jupiter

Yr/Mo/Day	Hr/Min/Sec	θ
770820	160618	161.1
770820	163018	139.7
770820	165418	90.0
770820	180618	138.0
770821	51818	137.0
770821	74218	138.1
770821	91818	139.3
770821	100618	138.6
770822	60618	137.6
770823	30218	138.6
770825	60218	111.6
770826	90218	76.4
770826	120218	111.1
770827	180218	101.0
770827	210218	110.1
770829	218	108.9
770829	180219	38.5
770829	210219	99.3
770830	219	108.8
770831	150219	107.7
770902	30219	106.7
770903	150219	105.7
770905	30219	104.7
770906	150219	103.7
770908	30219	102.6
770909	150219	101.6
770911	30219	100.6
770912	180219	99.6
770914	90219	98.6
770916	219	97.5
770917	150219	96.4
770919	60219	95.4
770920	210220	94.3
770922	120220	93.3
770924	30220	92.2
770925	180220	91.2
770927	90220	90.2
770929	220	89.2
770930	180220	88.1
771002	120220	87.1
771004	30220	86.0
771005	210220	85.0
771007	150220	84.0
771009	120220	82.9
771011	120223	81.9
771012	114223	81.1
771012	144223	81.2
771014	114223	80.2
771016	114223	79.2
771018	114224	78.1
771020	114224	77.1
771022	144224	76.1
771024	174224	75.1
771027	30224	74.0
771029	90224	73.0
771031	180224	71.9
771031	210224	95.3
771101	224	90.5
771103	120224	91.6
771105	210224	92.6
771108	120224	93.6
771111	60224	94.6
771114	224	95.7
771117	224	96.7
771120	60224	97.7
771123	180224	98.7
771127	180224	99.7
771130	224	75.8
771206	60224	76.6
771214	180224	77.6
771228	30223	80.9
771228	60223	55.4
771228	90223	61.3
771228	120223	121.2
771228	150223	33.5
771229	180223	131.0

Yr/Mo/Day	Hr/Min/Sec	θ
771228	210223	42.6
771229	223	88.0
771229	60223	90.0
771229	90223	78.5
780119	30222	77.5
780128	150221	76.5
780205	30221	75.5
780211	150221	74.5
780217	180221	73.5
780223	60220	72.4
780301	220	71.4
780305	210220	70.4
780307	180220	72.1
780307	210220	115.4
780308	220	70.0
780313	220	68.9
780317	210219	67.9
780322	150219	66.9
780327	60219	65.9
780401	219	64.9
780405	90218	63.8
780410	218	62.8
780413	210218	61.8
780418	60218	60.8
780422	180217	59.8
780427	90217	58.8
780501	210217	57.7
780506	90217	56.7
780511	216	55.7
780515	150216	54.7
780520	90216	53.6
780525	30215	52.6
780529	210215	51.6
780603	180215	50.6
780608	180215	49.6
780613	210214	48.6
780619	60214	47.5
780624	150214	46.5
780630	90213	45.5
780706	213	44.5
780712	60213	43.5
780718	150212	42.5
780725	120212	41.5
780802	30211	40.5
780810	90210	39.4
780820	120210	38.4
780831	180209	37.4
780914	90208	36.4
781001	60206	35.4
781003	206	62.0
781003	30206	89.7
781003	60206	52.7
781003	90206	69.6
781003	120206	90.9
781003	150206	27.7
781003	180206	35.3
790114	120225	36.3
790124	210225	37.3
790203	30225	38.3
790211	120224	39.3
790220	30224	40.4
790301	120223	41.4
790312	60222	42.4
790328	90221	43.4
790414	210220	145.7
790415	220	43.8
790417	150229	62.9
790418	229	43.8
790420	30229	79.4
790420	90229	88.0
790420	120229	43.8
790424	141	73.6
790507	171339	74.6
790523	173738	75.6
790524	181338	74.6
790525	92145	75.6

Yr/Mo/Day	Hr/Min/Sec	θ
790525	194714	53.3
790525	200802	91.6
790525	202850	88.3
790525	204936	29.9
790525	211026	90.0
790525	213114	75.3
790603	82537	76.3
790603	232001	75.3
790604	112801	102.3
790604	114849	96.8
790604	120937	155.7
790604	123025	83.1
790604	125113	123.8
790604	131201	128.8
790604	133249	81.4
790604	135337	55.6
790604	141425	83.2
790604	143513	12.7
790604	145601	77.6
790604	151649	64.8
790604	153737	27.1
790604	155825	90.0
790604	161913	75.6
790613	195824	76.7
790614	121600	75.6
790615	133424	76.6
790616	61736	75.6
790617	71512	76.6
790618	1424	75.6
790619	23512	76.6
790619	181112	75.6
790620	205248	76.6
790621	120800	75.6
790621	180136	74.6
790622	94224	75.6
790622	172000	76.6
790623	50712	75.6
790623	104000	74.5
790624	55823	75.6
790624	131959	49.2
790624	133911	41.6
790624	194359	57.1
790624	200311	76.0
790625	11023	75.0
790625	63647	73.9
790625	231511	75.0
790626	50047	76.0
790626	174847	75.0
790626	215823	74.0
790627	34359	72.9
790627	155423	73.9
790627	194359	75.0
790628	141735	73.9
790628	182711	72.8
790629	124135	73.8
790629	165111	74.8
790630	60623	73.8
790630	95647	72.7
790630	130847	71.7
790630	185423	70.7
790701	35159	71.8
790701	72311	72.8
790701	111335	73.9
790702	2047	72.9
790702	31335	71.8
790702	60623	70.7
790702	91823	69.6
790703	131823	70.6
790703	152423	71.7
790703	172311	72.6
790703	173911	71.7
790703	195959	70.7
790703	222047	69.7
790704	23359	68.7
790704	24447	67.6
790704	54047	66.5

Table A-1 (cont.)
Voyager 2 Antenna Angles
θ = Angle between normal to antenna plane and Jupiter

Yr/Mo/Day	Hr/Min/Sec	θ	Yr/Mo/Day	Hr/Min/Sec	θ	Yr/Mo/Day	Hr/Min/Sec	θ
790704	185247	67.7	790710	45910	101.6	790713	225110	95.0
790704	211335	68.7	790710	52246	103.7	790714	1910	93.8
790704	235159	69.8	790710	54846	105.5	790714	12934	92.7
790705	35823	70.8	790710	61246	107.2	790714	25734	91.6
790705	102535	69.7	790710	63510	108.8	790714	42534	90.4
790705	130359	68.6	790710	65734	110.2	790714	61110	89.4
790705	144935	67.5	790710	71822	111.5	790714	81422	88.4
790705	165511	66.4	790710	73910	112.8	790714	173734	89.5
790705	182047	65.3	790710	75958	114.0	790714	192310	90.6
790705	200623	64.2	790710	82046	115.3	790714	210846	91.7
790705	215159	63.1	790710	83958	116.4	790714	222422	127.5
790705	235511	62.0	790710	85910	117.5	790714	231158	162.7
790706	21559	61.0	790710	93734	119.4	790714	232934	99.3
790706	135023	62.1	790710	95646	120.5	790715	20758	100.3
790706	154223	63.2	790710	103334	122.2	790715	113110	120.9
790706	163023	64.2	790710	110846	123.8	790715	114846	147.5
790706	164623	37.2	790710	114358	125.2	790717	221110	153.3
790706	170223	63.0	790710	121910	126.6	790717	223022	91.6
790706	171823	39.8	790710	125422	127.8	790718	90358	92.6
790706	173423	61.0	790710	132758	129.0	790718	103958	148.5
790706	175023	64.4	790710	141558	130.4	790719	150358	147.5
790706	195823	65.4	790710	150358	131.7	790720	80134	148.5
790707	55023	64.3	790710	155158	132.8	790721	115158	160.6
790707	71023	63.3	790710	165558	133.9	790721	121110	89.8
790707	83023	62.3	790710	181558	135.1	790721	222534	90.8
790707	95023	61.2	790710	191958	133.1	790722	134	84.1
790707	105423	60.1	790710	193558	129.7	790722	2046	90.0
790707	121423	58.8	790711	13734	131.6	790722	22558	148.3
790707	131823	57.7	790711	15334	121.7	790723	154222	135.4
790707	142223	56.7	790711	31334	122.9	790723	160134	109.7
790707	152623	55.5	790711	43334	124.1	790723	162046	99.0
790707	163023	54.4	790711	55334	125.3	790723	204934	98.0
790707	173423	53.4	790711	74534	126.3	790723	222534	74.7
790707	183823	52.4	790711	124934	133.1	790723	224446	136.1
790707	195823	51.2	790711	130534	127.0	790723	230358	85.0
790707	211823	50.1	790711	132134	124.6	790723	232310	157.5
790707	223823	49.1	790711	145734	123.4	790723	234222	148.6
790708	1735	48.0	790711	160134	122.4	790731	20757	90.0
790708	22535	46.9	790711	170534	121.2	790731	61733	148.9
790708	62535	50.5	790711	175334	120.2	790731	182533	90.0
790708	64135	52.8	790711	184134	119.2	790731	223509	148.4
790708	65735	46.7	790711	192934	118.1	790802	15821	90.0
790708	71335	51.0	790711	201734	117.0	790802	60057	149.0
790708	225735	49.7	790711	210534	115.7	790803	15333	90.0
790709	1335	48.7	790711	215334	114.6	790803	60309	148.7
790709	10535	47.5	790711	224134	113.3	790804	14509	90.0
790709	15535	46.4	790711	232934	112.0	790804	55509	148.8
790709	24135	45.1	790712	1734	110.7	790804	141421	90.0
790709	32935	43.9	790712	10534	109.5	790804	151645	148.6
790709	41735	42.5	790712	15334	108.2	790805	14045	90.0
790709	50535	41.2	790712	24134	106.9	790805	55021	149.0
790709	55335	39.7	790712	32934	105.7	790806	135157	90.0
790709	64135	38.4	790712	41734	104.5	790806	54557	148.8
790709	72934	37.1	790712	50534	103.3	790807	131109	90.0
790709	82046	35.8	790712	55334	102.2	790807	54045	149.4
790709	91334	34.6	790712	64134	101.0	790808	84308	90.0
790709	102358	33.5	790712	72934	100.0	790808	133420	149.1
790709	135822	34.5	790712	81734	99.0	790809	51020	90.0
790709	144310	35.8	790712	92134	97.8	790809	132922	149.1
790709	153110	37.7	790712	102534	96.6	790810	52620	90.0
790709	155646	38.9	790712	114534	95.4	790810	132444	149.4
790709	162358	40.3	790712	130534	94.4	790811	52132	90.0
790709	165246	42.0	790712	152934	93.3	790811	125908	149.2
790709	172110	43.8	790712	204934	94.3	790821	131	150.3
790709	175646	46.1	790712	222534	95.4			
790709	183334	48.6	790712	234534	96.6			
790709	191646	52.0	790713	10534	97.7			
790709	201110	56.4	790713	20934	98.6			
790709	214846	64.8	790713	32934	99.9			
790710	4310	80.5	790713	44934	100.9			
790710	13910	85.4	790713	64134	102.0			
790710	22222	89.2	790713	153110	101.0			
790710	25910	92.3	790713	171646	99.8			
790710	33246	95.1	790713	184446	98.6			
790710	40310	97.5	790713	201246	97.3			
790710	43158	99.7	790713	214046	96.1			

Table A-1 (cont.)
Voyager 1 Antenna Angles
θ = Angle between normal to antenna plane and Jupiter

Yr/Mo/Day	Hr/Min/Sec	θ	Yr/Mo/Day	Hr/Min/Sec	θ	Yr/Mo/Day	Hr/Min/Sec	θ
770905	140923	139.2	771229	90223	78.5	790130	52123	90.
770905	144259	152.1	780101	130	79.5	790130	53723	106.
770905	153147	153.3	780112	180130	78.5	790130	55323	85.
770905	153723	141.5	780122	131	77.5	790130	60923	41.
770905	154259	122.5	780129	90131	76.5	790130	62523	63.
770905	154835	114.1	780205	131	75.5	790130	64123	90.
770905	155411	121.7	780210	210131	74.5	790130	65723	69.
770905	155947	140.5	780217	30131	95.0	790131	60923	68.
770905	160523	153.4	780217	60131	48.9	790203	210259	90.
770905	161059	140.3	780217	90131	45.4	790203	211859	123.
770905	161635	121.5	780217	120131	95.6	790203	213459	88.
770905	162211	114.0	780217	150131	74.6	790203	215059	113.
770905	162747	122.6	780217	180131	67.7	790203	220659	97.
770905	163323	128.2	780217	210131	73.2	790203	222259	103.
770905	163811	132.3	780223	60132	72.2	790203	223859	107.
770905	164347	122.3	780228	120132	71.2	790203	225459	93.
770905	170123	107.5	780305	120132	70.2	790203	231059	117.
770906	71235	106.5	780310	150132	69.1	790203	232659	90.
770908	220923	105.4	780315	60132	68.1	790203	234259	70.
770910	105724	104.4	780320	150133	67.1	790203	235859	36.
770911	172124	25.7	780325	90133	66.1	790204	1459	69.
770911	180924	103.6	780329	210133	65.1	790204	3059	39.
770912	172124	25.9	780403	120133	64.1	790204	4659	64.
770912	180924	102.9	780408	30133	63.1	790204	10259	45.
770914	60124	101.9	780412	150133	62.1	790204	11859	59.
770915	180124	100.9	780416	120133	61.1	790204	13459	51.
770917	60124	99.9	780421	133	60.1	790204	15059	53.
770918	180124	98.8	780425	150134	59.1	790204	20659	90.
770920	60124	97.8	780430	60134	58.0	790204	22259	67.
770921	180124	96.8	780504	180134	57.0	790204	161459	68.
770923	60125	95.8	780509	120134	56.0	790205	105459	67.
770924	180125	94.8	780514	30134	55.0	790209	4835	116.
770926	60125	93.8	780519	134	54.0	790209	104835	156.
770927	180125	92.7	780523	180134	53.0	790209	34035	140.
770929	60125	91.7	780528	180134	51.9	790209	40035	70.
770930	210125	90.6	780602	180135	50.9	790209	41635	66.
771002	120125	89.5	780609	210135	49.9	790209	213635	67.
771004	30126	88.4	780615	60135	48.9	790210	180835	66.
771005	180126	87.4	780615	180135	62.5	790214	82335	65.
771007	90126	86.3	780615	210135	48.7	790215	42435	66.
771008	60126	32.6	780621	30135	47.7	790215	234835	65.
771008	90126	85.7	780626	210135	46.7	790217	[illegible]	66.
771010	126	84.7	780702	150135	45.7	790217	152435	65.
771011	150126	83.7	780708	180135	44.7	790217	222835	64.
771013	90126	82.6	780714	210135	43.7	790218	154235	65.
771015	30126	81.5	780721	150135	42.6	790218	212035	66.
771016	210127	80.5	780728	150135	41.6	790218	213635	125.
771018	150127	79.5	780728	180135	113.2	790218	215235	117.
771020	90127	78.5	780728	210135	41.6	790218	220835	141.
771022	60127	77.4	780805	210136	40.6	790218	222435	87.
771024	30127	76.4	780814	60136	39.5	790218	224035	110.
771026	127	75.3	780823	180136	38.5	790219	40035	157.
771028	127	74.3	780902	150136	37.5	790219	41635	109.
771030	30128	73.3	780915	136	50.8	790219	43235	90.
771101	30128	72.2	780915	30136	93.7	790219	44835	65.
771103	60128	71.2	780915	60136	11.7	790219	105635	64.
771105	90128	70.2	780915	90136	103.1	790219	175235	63.
771107	150128	69.2	780915	120136	62.3	790220	191835	64.
771109	210128	74.3	780915	150136	50.6	790221	190235	63.
771115	60129	75.4	780915	180136	36.5	790221	[illegible]	62.
771119	120129	76.5	780925	150136	35.5	790222	[illegible]	63.
771124	180129	77.6	781021	60137	34.5	790222	[illegible]	64.
771203	129	78.7	781211	150123	33.5	790222	232211	63.
771219	120130	79.7	781214	123	69.7	790222	[illegible]	62.
771208	224	77.1	781214	30123	35.7	790224	[illegible]	63.
771217	180224	78.1	781225	60123	36.7	790224	[illegible]	64.
771228	30223	60.9	790101	122	73.7	790224	[illegible]	63.
771228	60223	55.4	790102	215122	72.7	790224	191247	62.
771228	90223	61.3	790103	220922	73.7	790225	231147	61.
771228	120223	121.2	790106	125322	72.7	790225	74123	60.
771228	150223	33.5	790112	112923	71.6	790225	111147	61.
771228	180223	131.0	790118	215323	70.6	790225	160247	62.
771228	210223	42.6	790124	62523	69.6	790226	195547	63.
771229	223	66.0	790129	140523	68.6	790226	111723	62.
771229	60223	90.0	790130	50523	83.2	790226	[illegible]	61.

Table A-1 (Cont.)
Voyager [illegible] Antenna Angles
θ = Angle between normal to antenna plane and Jupiter

Yr/Mo/Day	Hr/Min/Sec	θ	Yr/Mo/Day	Hr/Min/Sec	θ	Yr/Mo/Day	Hr/Min/Sec	θ
790226	192923	60.3	790305	152617	74.6	790308	101156	70.
790227	103411	61.4	790305	154041	93.9	790308	112844	68.
790227	134123	62.6	790305	155329	104.2	790308	124532	67.
790228	50259	61.5	790305	160617	110.6	790308	140220	66.
790228	75547	60.4	790305	161905	114.4	790308	151908	65.
790228	103411	59.3	790305	163153	126.2	790308	163556	64.
790228	134123	58.3	790305	164441	128.6	790308	[illegible]	92.
790228	182923	57.3	790305	165729	119.4	790308	175420	55.
790301	15723	58.3	790305	170841	122.4	790308	180844	125.
790301	45011	59.4	790305	171953	124.2	790308	[illegible]	122.
790301	72835	60.5	790305	173105	125.6	790308	183732	105.
790301	100659	61.5	790305	174217	126.7	790308	185156	90.
790301	215235	53.0	790305	180541	128.0	790308	190620	62.
790301	220659	129.8	790305	182706	124.3	790308	203244	61.
790301	222123	62.1	790305	183918	118.2	790308	[illegible]	60.
790301	223547	37.3	790305	194530	122.1	790308	224220	106.
790301	225011	60.0	790305	195642	141.9	790308	225644	62.
790301	230435	90.0	790305	200754	138.7	790308	231108	134.
790301	231859	59.8	790305	214842	139.9	790308	232532	151.
790302	11411	58.7	790305	234043	140.9	790308	233956	74.
790302	30923	57.6	790306	12131	142.0	790308	235420	59.
790302	50435	56.5	790306	30220	145.8	790309	102756	60.
790302	71059	55.5	790306	31332	112.5	790309	122308	61.
790302	91859	54.4	790306	32444	110.5	790309	140356	62.
790302	121811	53.4	790306	40932	109.1	790309	154444	63.
790302	214123	54.5	790306	44308	108.0	790309	173956	65.
790302	234923	55.7	790306	51644	106.9	790309	203244	66.
790303	13011	56.7	790306	55020	105.9	790310	44844	64.
790303	31235	57.7	790306	62356	104.7	790310	65820	63.
790303	50747	58.8	790306	65732	103.6	790310	[illegible]	62.
790303	83235	59.9	790306	73108	102.4	790310	104844	61.
790303	[illegible]	58.7	790306	80444	101.3	790310	124356	60.
790303	153459	57.5	790306	83820	100.0	790310	142444	78.
790303	170435	56.5	790306	91156	98.9	790310	143908	59.
790303	182123	51.2	790306	94532	97.6	790310	[illegible]	118.
790303	183411	108.9	790306	101908	96.4	790310	150756	106.
790303	184659	99.1	790306	105244	95.2	790310	152220	116.
790303	185947	51.0	790306	112620	93.9	790310	153644	90.
790303	191235	45.2	790306	115956	92.7	790310	155108	58.
790303	192523	56.5	790306	123332	91.5	790310	182932	57.
790303	193811	54.2	790306	130708	90.3	790311	[illegible]	58.
790303	204211	53.2	790306	134044	89.1	790311	[illegible]	60.
790303	214611	52.1	790306	141420	87.8	790311	[illegible]	61.
790303	225011	51.0	790306	144756	86.6	790311	[illegible]	62.
790303	235411	49.9	790306	152132	85.5	790311	[illegible]	63.
790304	5811	48.8	790306	155508	84.3	790312	1508	62.
790304	20211	47.7	790306	162844	83.2	790312	[illegible]	61.
790304	30611	46.7	790306	170220	81.9	790312	51732	60.
790304	41011	45.7	790306	173908	80.7	790312	[illegible]	58.
790304	52659	44.5	790306	181732	79.5	790312	101956	57.
790304	64347	43.5	790306	185556	78.2	790312	141020	56.
790304	81635	42.4	790306	193420	76.9	790313	44	57.
790304	95723	41.3	790306	201244	75.7	790313	[illegible]	[illegible]
790304	121147	40.2	790306	205108	74.5	790313	[illegible]	[illegible]
790304	152947	39.2	790306	212932	73.4	790313	[illegible]	61.
790304	222212	40.4	790306	220756	72.2	790313	120044	107.
790304	232924	41.4	790306	224620	71.2	790313	121508	59.
790305	2524	42.4	790306	232444	70.1	790313	122932	135.
790305	11013	43.4	790307	1556	68.9	790313	124356	147.
790305	20613	44.7	790307	10708	67.6	790313	125820	80.
790305	30213	45.7	790307	15820	66.5	790313	131244	61.
790305	41150	46.7	790307	24932	65.4	790313	191244	60.
790305	72126	45.6	790307	[illegible]	64.3	790313	223420	59.
790305	81239	44.2	790307	45732	63.3	790314	12844	58.
790305	[illegible]	42.9	790307	62708	62.2	790314	25508	105.
790305	[illegible]	41.7	790307	140844	63.3	790314	[illegible]	63.
790305	95815	40.3	790307	[illegible]	64.5	790314	[illegible]	134.
790305	101903	39.3	790307	[illegible]	65.5	790314	[illegible]	149.
790305	104003	38.2	790307	[illegible]	66.6	790314	[illegible]	72.
790305	111640	39.5	790307	183732	67.8	790314	40708	57.
790305	132616	27.4	790307	194132	68.9	790314	84044	56.
790305	135016	24.4	790307	205820	70.1	790314	184532	57.
790305	141105	21.1	790307	221508	71.2	790314	215244	58.
790305	142353	18.9	790307	235732	72.2	790315	12844	59.
790305	145729	29.9	790308	82932	71.1	790315	[illegible]	[illegible]
790305	151153	35.7+						

Table A-1 (Cont.)
Voyager 1 Antenna Angles
θ = Angle between normal to antenna plane and Jupiter

Yr/Mo/Day	Hr/Min/Sec	θ
790315	212356	57.3
790316	12844	56.3
790316	145508	57.3
790316	183108	58.3
790316	234756	59.3
790317	101956	58.3
790317	143908	57.3
790317	185820	56.2
790318	100356	57.2
790318	145156	58.3
790319	75556	57.2
790319	124356	56.1
790320	54756	57.2
790320	112356	58.2
790321	11556	57.2
790321	63556	56.1
790322	13156	57.1
790323	3244	56.1
790323	210444	57.2
790324	184044	56.1
790325	160044	57.1
790326	132044	56.1
790327	105644	57.1
790328	80044	56.1
790329	44844	57.1
790330	22444	56.1
790331	10444	57.2
790331	201644	56.1
790401	194444	57.2
790402	160044	56.2
790403	135244	57.2
790404	111244	56.2
790405	74444	57.2
790406	31244	132.5
790409	4844	133.5
790409	180044	45.7
791206	150049	46.7

TABLE A-2

PRA RECEIVER FREQUENCIES

Ch. #	Freq. (KHz)	Ch. #	Freq. (KHz)
1	40550.2	29	31948.6
2	40243.0	30	31641.4
3	39935.8	31	31334.2
4	39628.6	32	31027.0
5	39321.4	33	30719.8
6	39014.2	34	30412.6
7	38707.0	35	30105.4
8	38399.8	36	29798.2
9	38092.6	37	29491.0
10	37785.4	38	29183.8
11	37478.2	39	28876.6
12	37171.0	40	28569.4
13	36863.8	41	28282.2
14	36556.6	42	27955.0
15	36249.4	43	27647.8
16	35942.2	44	27340.6
17	35635.0	45	27033.4
18	35327.8	46	26726.2
19	35020.6	47	26419.0
20	34713.4	48	26111.8
21	34406.2	49	25804.6
22	34099.0	50	25497.4
23	33791.8	51	25190.2
24	33484.6	52	24883.0
25	33177.4	53	24575.8
26	32870.2	54	24268.6
27	32563.0	55	23981.4
28	32255.8	56	23654.2

TABLE A-2 (Cont.)

PRA RECEIVER FREQUENCIES (Cont.)

Ch. #	Freq. (KHz)	Ch. #	Freq. (KHz)
57	23347.0	87	14131.0
58	23039.8	88	13823.8
59	22732.6	89	13516.6
60	22425.4	90	13209.4
61	22118.2	91	12902.2
62	21811.0	92	12595.0
63	21503.8	93	12287.8
64	21196.6	94	11980.6
65	20889.4	95	11673.4
66	20582.2	96	11366.2
67	20275.0	97	11059.0
68	19967.8	98	10751.8
69	19660.6	99	10444.6
70	19353.4	100	10137.4
71	19046.2	101	9830.2
72	18739.0	102	9523.0
73	18431.8	103	9215.8
74	18124.6	104	8908.6
75	17817.4	105	8601.4
76	17510.2	106	8294.2
77	17203.0	107	7987.0
78	16895.8	108	7679.8
79	16588.6	109	7372.6
80	16281.4	110	7065.4
81	15974.2	111	6758.2
82	15667.0	112	6451.0
83	15359.8	113	6143.8
84	15052.6	114	5836.6
85	14745.4	115	5529.4
86	14438.2	116	5222.2

TABLE A-2 (Cont.)

PRA RECEIVER FREQUENCIES (Cont.)

Ch. #	Freq. (KHz)	Ch. #	Freq. (KHz)
117	4915.0	147	980.4
118	4607.8	148	961.2
119	4300.6	149	942.0
120	3993.4	150	922.8
121	3686.2	151	903.6
122	3379.0	152	884.4
123	3071.8	153	865.2
124	2764.6	154	846.0
125	2457.4	155	826.8
126	2150.2	156	807.6
127	1843.0	157	788.4
128	1535.8	158	769.2
129a	1228.6		
129	1326.0	159	750.0
130	1306.8	160	730.8
131	1287.6	161	711.6
132	1268.4	162	692.4
133	1249.2	163	673.2
134	1230.0	164	654.0
135	1210.8	165	634.8
136	1191.6	166	615.6
137	1172.4	167	596.4
138	1153.2	168	577.2
139	1134.0	169	558.0
140	1114.8	170	538.8
141	1095.6	171	519.6
142	1076.4	172	500.4
143	1057.2	173	481.2
144	1038.0	174	462.0
145	1018.8	175	442.8
146	999.6	176	423.6

TABLE A-2 (Cont.)

PRA RECEIVER FREQUENCIES (Cont.)

Ch. #	Freq. (KHz)	Ch. #	Freq. (KHz)
177	404.4		
178	385.2		
179	366.0		
180	346.8		
181	327.6		
182	308.4		
183	289.2		
184	270.0		
185	250.8		
186	231.6		
187	212.4		
188	193.2		
189	174.0		
190	154.8		
191	135.6		
192	116.4		
193	97.2		
194	78.0		
195	58.8		
196	39.6		
197	20.4		
198	1.2		

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      XXFT05F001 DD  DDNAME=DATA5                                                         00000270
      XXFT06F001 DD SYSOUT=&OUT,DCB=(RECFM=VBA,LRECL=137,BLKSIZE=&BLKSIZE)              00000280
      IEF653I SUBSTITUTION JCL - SYSOUT=A,DCB=(RECFM=VBA,LRECL=137,BLKSIZE=7265)
      XXFT07F001 DD SYSOUT=B,DCB=(RECFM=FB,BLKSIZE=7280,LRECL=80)                         00000290
      XXSYSPRINT DD SYSOUT=&OUT,DCB=(RECFM=VBA,LRECL=137,BLKSIZE=&BLKSIZE),             00000300
      IEF653I SUBSTITUTION JCL - SYSOUT=A,DCB=(RECFM=VBA,LRECL=137,BLKSIZE=7265),
      XX             SPACE=(CYL,(0,1)),UNIT=(DISK,3)                                      00000310
      XXSYSUDUMP DD SYSOUT=A,SPACE=(CYL,(0,5))                                            00000320
      //GO.FT08F001 DD UNIT=6250,DISP=(OLD,KEEP),LABEL=(01,BLP,,IN),
      //      DCB=(BLKSIZE=32600,RECFM=U,DEN=4),
      //      VOL=SER=JJ0101
      //GO.DATA5 DD *
      //
IEF236I ALLOC. FOR YZRWPBR6 GO
IEF237I 235    ALLOCATED TO PGM=*.DD
IEF237I 335    ALLOCATED TO FT05F001
IEF237I 232    ALLOCATED TO FT06F001
IEF237I 235    ALLOCATED TO FT07F001
IEF237I 237    ALLOCATED TO SYSPRINT
IEF237I 232    ALLOCATED TO SYSPRINT
IEF237I 235    ALLOCATED TO SYSPRINT
IEF237I 336    ALLOCATED TO SYSUDUMP
IEF237I 490    ALLOCATED TO FT08F001
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<

Voyager 1

RECORD 1 OF FILE 1
LENGTH = 32484 BYTES

9/05/77 - 6/30/78

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C-21295

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09FF0AC1	0A940AC8	0AD30A89	0AC10B03	0DC30A7F	0BA10E76	0CCD0B9A	0C1F0D0A	0CC50EE0	0DBF0D28
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0C700E12	0B710CAA	0B570AC6	0B7C0AE5	0BAD0B57	0C6A0B43	0C0F0A7B	0A820A70	09E609BA	099F0AC3
0C7A09DA	09AE09AB	099C0A11	0A020A03	0D3209C1	0B1A0A18	0AC30AE6	0B640BFF	0BD80E0F	0CC10E08
0D8A0F2A	0F770F2D	0FFF117B	122610EE	10DF0FDD	0F350F67	101D0E4F	0EC30E86	0E530E18	0E1C0E29
0DF40E71	0D1E0D4C	0D730D08	0D970E1C	0DA40DF7	0E530F04	0F6F112E	10531186	12F51233	13EF1313
12BB1428	14971347	1453137E	15081418	15A0158E	14DD158E	15111547	149F1453	13EF1475	153E15FA
16E816FB	17450000	161E1431	12FC1366	1407138E	12F51240	110D0EE4	0F480FC8	0EDC0CC1	0DB50B27
0A740A6C	0A6C0A9A	0A4D0ADE	0A740A93	0A740A83	0A800A74	0A8B0A84	0A8F0A6C	0A410A41	0A510A61
0ABC118D	0A700A6F	0A450A41	0A830A55	0A590A2D	0A9E0A55	0A150A3D	0A3E0A2D	0A460A93	0BD309F4
0A700A01	0B920A15	0ABC0DB9	10970A29	0A110B11	0A0C0A19	0E1D0A51	0A8B0A39	0A840A31	0DE70A39
0A000C6F	0AE90B3D	0BB10C1B	0BC60C5E	14EA0000	0BBA0CA7	0B680BE5	0C570D6C	0DDF0E2A	0E260DC8
10A40D25	0DF00CB4	0BB30BDF	0B5E0C06	0BC00CAA	0B990C4D	0AA10AC6	0AAB0A03	09E20986	0A82097E
09DE0A0A	09BA098D	0A110A77	0A4D0D04	0A110B22	0A900B11	08220BAA	0C290C0C	0E450CBB	0E590DE2
0F3C0FBF	0F0C1053	11E612E1	112E1143	0FFF0F23	0F731026	0E4C0EC6	0E9B0E53	0E080E1C	0E6A0E18
0E8A0D32	0D700D69	0D280DA7	0E150DB1	0E040E60	0F170F77	112E1053	119E12D8	121913CE	12D81253
13CE1464	12F51410	130B14CB	13CE1558	1535148E	155814DD	15231475	143113CE	1458151A	15D616B1
16FB1732	00001615	141012F5	132213CE	136E12C2	120510B7	0ECA0F2A	0F9B0EB0	0CB10D9D	0B400A7C
0A590A59	0A740A74	0AD30A61	0AAD0A80	0A840A4D	0A680A80	0A740A8B	0A550A41	0A490A59	0A680A93
11830A8F	0A650A49	0A410A64	0AAD0A45	0A250A78	0A550A35	0A210A31	0A150A29	0A9E0BB1	0A000A59
0A090B4F	0A090AC4	0DF010F4	0A290A19	0B270A1D	0A090E27	0A680A83	0A410A9E	0A310DE7	0A390A0D
0D0D0AE5	0B400B8B	0BEF0BAA	0C3D151C	032C0000	000BE956	04E76623	00000002	00000A54	0C690AD4
0B180B50	0C200C6D	0C7E0C20	0C7A0E0E	0B700CB4	0B5A0AC0	0B750AE8	0BAE0B5E	0C7A0B49	0C060A77
0A8B0A74	09DC09BA	09A10ACA	097E09DA	09B5099F	099C0A1C	0A0709FF	0D2209BD	0AF30A18	0AC20AEB
0B630C06	0BDA0E0B	0CC80E01	0D8A0F26	0F770F2A	10001181	123310EE	10E70FDD	0F390F5F	101D0E4C
0EC30E86	0E570E15	0E1C0E30	0DF80E71	0D190D4F	0F130D04	0D970E18	0CA40DF7	0E530F04	0F71112E
104D11B6	12F51233	13EF1313	12BB1420	14971340	143C1376	15171418	15A6158E	14DD1597	1500154F
14A21453	13EF1470	154715FA	16FB16FB	17450000	161E1431	1313135E	1410138E	12F51240	11030EE0
0F520FC8	0EE00CC8	0DB20B11	0A680A77	0A8B0A86	0A690AE5	0A740A90	0A9A0A6C	0A870A48	0A970A7C
0A930A67	0A4D0A62	0A590A58	0A781191	0A700A7C	0A3D0A52	0A7C0A3E	0A490A38	0AAE0A4E	0A270A48
0A380A28	0A330A9F	0BC909F7	0A6D0A18	0B8309F7	0AAA0DE7	10980A1D	0A0D0AF0	0A170A2D	0E270A48
0A710A43	0A7B0A2D	0DDE0A32	0A220C7D	0AC80B1B	0BA90C12	0BC00C75	15400000	0BB20D9A	0B680BDE
0C600D66	0DEB0E29	0E200DC8	10FE0D22	0DEB0CB7	0BB70BE2	0B630C09	0BBB0CAA	0B940C50	0AA60ACA
0AB00A03	09E609AF	0AB4097E	090C0A0A	09B009BD	0A110A77	0A530D08	0A160B25	0A820B0B	0B1C0BA6
0C240C0C	0E450CBE	0E640DE2	0F3E0FBF	0F16105C	11E612D9	112E1143	0FFB0F83	0F711026	0E490EC6
0E980E4F	0E0A0E1F	0E690E1C	0E8A0D2F	0D510D6C	0D2A0CA4	0E130D81	0E010E60	0F110F77	112E1053
119E12D8	121013CE	12D81253	13CE145B	12F513FF	130914D4	13CE1558	15471497	155E14DD	1523147D
143113CE	145E151A	15D616B1	16FB1732	0000160C	14101304	132713CE	136E12C2	120710B7	0EC30F2A
0F970FBB	0CB60DA0	0B400A77	0A650A86	0A490A67	0ACB0A67	0AA20A67	0A800A48	0A510A6C	0A690A86