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VERIFICATION OF THE REFRACTION MODULE OF THE IBM RTCC NAVIGATION PROGRAM IN SUPPORT OF MISSION D

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Mathematical Physics Branch

MISSION PLANNING AND ANALYSIS DIVISION

MANNED SPACECRAFT CENTER

HOUSTON, TEXAS

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PROJECT APOLLO

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By Herbert A. Perkins
Mathematical Physics Branch

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MISSION PLANNING AND ANALYSIS DIVISION
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CONTENTS

Section	Page
SUMMARY	1
INTRODUCTION	1
SYMBOLS	2
PROCEDURES	4
RESULTS	5
C-band	5
S-band, 2-way Doppler With X-Y Mounts in Earth Orbit	5
S-band, 2-way Doppler With Polar Mounts in Earth Orbit	6
S-band, 3-way Doppler With X-Y Mounts and S-band, 3-way Doppler With Polar Mounts	6
Primary Station Change Test Case	7
CONCLUSIONS	7
APPENDIX - LISTING, INPUT, AND RESULTS OF PROGRAM USED IN MPB COMPUTATION OF REFRACTION CORRECTIONS	15
REFERENCES	56

TABLES

Table		Page
I	AGREEMENT BETWEEN IBM AND MPB RESULTS	
	(a) C-band	9
	(b) S-band, 2-way Doppler with X-Y mounts in earth orbit	10
	(c) S-band, 2-way Doppler with polar mounts in earth orbit	11
	(d) S-band, 3-way Doppler with X-Y mounts	12
	(e) S-band, 3-way Doppler with polar mounts	13
II	COMPARISON OF HARDWARE RESOLUTION AND SOFTWARE CAPABILITY	
	(a) Hardware resolution of measurements	14
	(b) Largest error found between IBM and MPB measurements	14

VERIFICATION OF THE REFRACTION MODULE OF THE IBM RTCC NAVIGATION PROGRAM IN SUPPORT OF MISSION D

By Herbert A. Perkins

SUMMARY

Given low-speed radar data the effects of atmospheric refraction on the tracking data must be taken into account. This may be accomplished by computing corrections for, and subtracting them from, the observables. The IBM RTCC navigation program accounts for the atmospheric refraction on the tracking data in this manner with the low-speed refraction module. This note presents a verification of that module in support of Mission D.

To determine whether or not the low-speed refraction module was functioning properly in earth orbit, five test cases were conducted by IBM and Mathematical Physics Branch (MPB). The test cases included atmospheric refraction corrections on tracking data from C-band, low-speed radar data; S-band, 2-way, low-speed, earth orbit radar data with X-Y and polar mounts; and S-band, 3-way, low-speed radar data with X-Y and polar mounts. Since special logic must be used to compute the correction for the elevation when the initial elevation is less than 10°, data was used that also tested this situation.

The IBM and MPB results (corrections and corrected observables) were compared. The results were found to be in good agreement within the limitations imposed by the accuracy of the input supplied to MPB by IBM.

Despite the limitations, however, the results were in agreement to more accuracy than the hardware resolution. Thus, MPB concludes that the IBM low-speed refraction module is functioning properly for situations that could be encountered during Mission D.

INTRODUCTION

When low-speed radar data is received, the effects of atmospheric refraction in the tracking data must be taken into account. This may be accomplished by computing corrections for, and subtracting them from, the observables. These corrections are generally referred to as refraction corrections.

The manner in which the corrections are computed depends on various factors. The first consideration is the type of frequency on which the receiver is operating. If the receiver is a C-band station, the correction process may begin. If the receiver is an S-band station, other factors must be considered. The second consideration, if necessary, is the type of Doppler to be processed. If it is 3-way Doppler, the last consideration is the type of S-band station involved. It will be either a USB station (X-Y mounts with either a 30-ft or an 85-ft dish) or a DSN station (polar mounts). If it is 2-way Doppler, the next consideration is whether or not the vehicle whose tracking data is to be processed is in earth orbit. In either case, the remaining consideration is the type of S-band station involved, either USB or DSN.

Summarizing, low-speed radar data to be corrected for the effects of atmospheric refraction may be classified as

1. C-band
2. S-band, 3-way Doppler, with X-Y mounts (USB)
3. S-band, 3-way Doppler, with polar mounts (DSN)
4. S-band, 2-way Doppler, with X-Y mounts in earth orbit (USB)
5. S-band, 2-way Doppler, with polar mounts in earth orbit (DSN)
6. S-band, 2-way Doppler, with X-Y mounts not in earth orbit (USB)
7. S-band, 2-way Doppler, with polar mounts not in earth orbit (DSN)

In support of Mission D, the first five types of low-speed radar data mentioned above must be considered. Thus, the verification of the refraction module of the IBM RTCC navigation program consisted of checking the refraction corrections and the corrected observables for those five types of low-speed radar data.

Each of the five types of low-speed radar data has associated with it a test case for which IBM and MPB computed the effects of atmospheric refraction in the tracking data.

SYMBOLS

D	angle used in polar mounts (Declination, observed)
ΔD	refraction correction for D

D_c	corrected D
E	elevation (observed)
E_{rec}	elevation of receiver (computed)
E_{tra}	elevation of transmitter (computed)
ΔE	refraction correction for elevation
E_c	corrected elevation
e.r.	earth radius
f	Doppler (observed)
Δf	refraction correction for f
f_c	corrected f
HA	angle used in polar mounts (Hour angle, observed)
ΔHA	refraction correction for HA
HA_c	corrected HA
Hz	hertz (cycle per second)
Mc	megacycle
rad	radians
X	angle used in X-Y mounts (observed)
ΔX	refraction correction for X
X_c	corrected X
Y	angle used in X-Y mounts (observed)
ΔY	refraction correction for Y
Y_c	corrected Y
ρ	slant range (observed)
$\Delta\rho$	refraction correction for ρ
ρ_c	corrected ρ

PROCEDURES

The effects of atmospheric refraction in tracking data is taken into account in the IBM RTCC navigation program by the low-speed refraction module. In particular, this module handles the refraction corrections for the situations that could be encountered during Mission D, and is the module used by IBM to conduct the five test cases mentioned previously.

The program used by MPB to conduct the same test cases is one written specifically for that purpose, and is a double precision program based on the flow chart and equations found on pages 15 and 16 of reference 1. It may be noted that although IBM's low-speed refraction does not follow the flow chart outlined in reference 1, it computes the refraction corrections effectively in the same manner.

IBM provided MPB with the results of the five test cases and with the input necessary to conduct each case. However, the input data as well as the results were quantities of at most 10 digits, and in many cases, 8 digits. Relative to the IBM double precision program and quantities, the input from IBM limited the accuracy in the MPB computations and, consequently, the agreement between the two final results.

In four of the five test cases MPB chose 12 frames of observations to correct for effects of atmospheric refraction. In order to sample the refraction corrections at different elevations, the 12 frames were not consecutive. Also, the frames were chosen so that refraction corrections were computed when the elevation angle was both greater than or equal to and less than 10°. This was necessary due to special logic that is used when the elevation angle is less than 10°. For one test case, only 5 frames were provided.

Based on the IBM results, the time interval between frames appeared to be 0.001667 hours; however, when a time interval of 0.0016666666666666667 hours (or approximately 6 seconds) was used, much better results were obtained in the Doppler computations. It should be noted that this deviation was made in the input data in order to achieve a more realistic duplication of the IBM input and results.

The appendix presents a listing of the program used by MPB to compute the refraction corrections, the input, and the MPB final results. The IBM results may be found in IBM Unit Test File 503705.

Also in the IBM Unit Test File 503705 will be found a test case that was run by IBM to check the logic associated with a primary station change.

RESULTS

Table I is a summary of each frame used to verify the IBM refraction correction process for each type of low-speed radar data used in the test cases. The quantities in the tables are explained in the list of symbols. The discussion that follows will be simplified by considering these tables.

C-band

A C-band station observes range, azimuth, and elevation. Azimuth is not corrected for refraction effects, leaving only range and elevation to consider. The digital agreement in the refraction corrections was not very good. However, this is explained by pointing out that IBM did not provide refraction corrections for the C-band observables. IBM provided only the observable as observed and corrected, and only to 10 digits. Subtracting these truncated results in order to obtain the IBM refraction corrections led to the few digits of agreement in $\Delta\rho$ and ΔE.

The calculations of $\Delta\rho$ and ΔE were, in general, in agreement to 10^{-9} e.r. and 10^{-10} rad, respectively. This corresponds to 0.006378 m (or 0.019134 ft) and 0.000000005729°.

The digital agreement in ρ_c and E_c was, in general, 10 digits. This is as much as the IBM results would permit. At worst, the calculations for ρ_c and E_c agreed to 10^{-8} e.r. and 10^{-9} rad, or 0.06378 m and 0.00000005729°.

The frames provided by IBM for this test case did not include an elevation that was less than 10°. However, since the subprogram that handles C-band radar data also handles S-band, 2-way, earth orbit radar data, the logic for elevation angles less than 10° could be, and was, exercised in those test cases.

S-band, 2-way Doppler With X-Y Mounts in Earth Orbit

An S-band station observes range, X and Y (or polar) angles, and Doppler. The digital agreement in $\Delta\rho$ and ρ_c was subject to the same limitations mentioned in the C-band results. The calculations for $\Delta\rho$ and ρ_c both agreed to 10^{-10} e.r., or 0.0006378 m.

Again, the digital agreement in ΔX, X_c, ΔY, and Y_c was restricted by the limitations mentioned in the C-band results. In general, the calculations for ΔX, X_c, ΔY, and Y_c agreed to 10^{-9} rad, or 0.00000005729°.

The Doppler refraction correction, Δf, had a digital agreement of 7 digits. This is as much as could be expected considering that E is a function of X and Y, which were provided to only 10 digits, the $\Delta\rho$'s had to be differenced, and a division by the time interval had to be made among other calculations. The calculations for Δf were in agreement to 10^{-12} Mc (and in some cases to 10^{-13} and 10^{-14}) corresponding at worst to 10^{-6} Hz. In computing f_c, the digital agreement was 9 or 10 digits and the calculations agreed to 10^{-9} or 10^{-10} Mc, corresponding to 10^{-3} Hz.

The first three frames used in the test case involved an elevation angle that was less than 10°. Therefore, the special logic for such elevation angles was exercised.

S-band, 2-way Doppler With Polar Mounts in Earth Orbit

In this test case it was only necessary to check the logic for the angles since the logic for range and Doppler was checked in the test case involving S-band, 2-way radar data obtained with X-Y mounts while tracking a vehicle in earth orbit. In general, the digital agreement obtained in computing ΔHA and ΔD was 5 digits and the calculations agreed to 10^{-6} or 10^{-7} rad. At the worst, this corresponds to 0.00005729°. In computing HA_c and D_c, the digital agreement was 7 or 8 digits and the calculations agreed to approximately 10^{-7} rad, and in two frames 10^{-6} rad for HA_c, which means 0.00005729°. The digital agreement in all the quantities was again limited by the limitations mentioned in the C-band results.

S-band, 3-way Doppler With X-Y Mounts and S-band, 3-way Doppler With Polar Mounts

Since the only difference between the test case dealing with S-band, 3-way Doppler with X-Y mounts and the test case dealing with S-band, 3-way Doppler with polar mounts is the type of angles involved, and since the results of both test cases were so similar, the results of both test cases are discussed together.

In processing S-band, 3-way Doppler radar data, an ephemeris must be used to compute elevation angles. The ephemeris provided by IBM was good only to 8 digits. Since all refraction corrections in S-band, 3-way Doppler are a function of the computed elevation angles which in turn are computed from the ephemeris, the digital agreement in the

refraction corrections was less than, or at best, 8 digits. The digital agreement in Δf was the worst, due to the additional loss of digits in differencing $\Delta\rho$'s.

In computing the refraction corrections, the calculation agreements differed slightly among the quantities corrected. Generally, ΔE agreed to 10^{-9} rad or 0.00000005729°; $\Delta\rho$ to, at the worst, 10^{-11} e.r. or 0.00006378 m; ΔX, ΔY, ΔHA, and ΔD to generally 10^{-9} rad or 0.00000005729°; and Δf to generally 10^{-11} Mc or 10^{-5} Hz.

In the computation of ρ_c the digital agreement was generally 10 digits and the calculation agreement was to 10^{-10} e.r., or 0.0006378 m. In the computation of X_c, Y_c, HA_c, and D_c the digital agreement was approximately 7 digits and the calculation agreement to 10^{-6} rad, or 0.00005729°. The digital agreement in computing f_c was 10 digits and the calculation agreement was 10^{-9} Mc or 10^{-3} Hz.

It should be noted that in the S-band, 3-way Doppler test cases, IBM used a corrected elevation to compute $\Delta\rho$. This is incorrect since an observed elevation is to be used for that purpose. This discrepancy has since been corrected by IBM; however, for the purposes of the two S-band, 3-way Doppler test cases mentioned above, MPB also used a corrected elevation in computing $\Delta\rho$ in order to maintain numerical consistency with IBM.

Primary Station Change Test Case

Included in the IBM test case that checks the primary station change logic are a timeline table, data and station characteristics, and the results. From the timeline table it may be determined what stations were transmitting at particular times. Combining this information with the data processed, which includes the time of each frame, it may be determined at what frame the new transmitter should take over if a primary station change occurs. Inspection of the timeline table and the data indicated that a primary station change occurred between frames 25 and 26. Inspection of the results indicated the same by means of an online print statement indicating the current transmitter.

CONCLUSIONS

The major point of the results is presented in table II which states that the largest errors between the IBM and MPB calculations are smaller than the hardware resolution capabilities. This implies that

IBM can effectively apply the refraction correction processes with more accuracy than the hardware is capable of obtaining. Thus, in support of Mission D, MPB concludes that the IBM low-speed refraction module is functioning properly.

TABLE I.- AGREEMENT BETWEEN IBM AND MPB RESULTS

(a) C-band

Frame	$\Delta\rho$, e.r.		ρ_c, e.r.		ΔE, rad		E_c, rad	
	Agreement		Agreement		Agreement		Agreement	
	Digits	e.r.	Digits	e.r.	Digits	rad	Digits	rad
1	3	10^{-9}	10	10^{-9}	7	10^{-10}	10	10^{-10}
2	3	10^{-9}	9	10^{-8}	7	10^{-10}	10	10^{-10}
3	3	10^{-9}	10	10^{-9}	7	10^{-10}	10	10^{-10}
31	3	10^{-9}	10	10^{-9}	6	10^{-9}	10	10^{-10}
32	3	10^{-9}	10	10^{-9}	7	10^{-10}	10	10^{-10}
33	3	10^{-9}	10	10^{-9}	7	10^{-10}	9	10^{-9}
51	3	10^{-9}	10	10^{-9}	7	10^{-10}	10	10^{-10}
52	3	10^{-9}	10	10^{-9}	7	10^{-10}	10	10^{-10}
53	3	10^{-9}	9	10^{-8}	7	10^{-10}	10	10^{-10}
71	3	10^{-9}	9	10^{-8}	7	10^{-10}	10	10^{-10}
72	3	10^{-9}	9	10^{-8}	7	10^{-10}	9	10^{-9}
73	3	10^{-9}	9	10^{-8}	7	10^{-10}	10	10^{-10}

TABLE I.- AGREEMENT BETWEEN IBM AND MPB RESULTS - Continued

(b) S-band, 2-way Doppler with X-Y mounts in earth orbit

Frame	$\Delta\rho$, e.r.		ρ_c, e.r.		ΔX, rad		X_c, rad		ΔY, rad		Y_c, rad		Δf, Mc		f_c, Mc	
	Agreement		Agreement		Agreement		Agreement		Agreement		Agreement		Agreement		Agreement	
	Digits	e.r.	Digits	e.r.	Digits	rad	Digits	rad	Digits	rad	Digits	rad	Digits	Mc	Digits	Mc
1	5	10^{-10}	10	10^{-10}	7	10^{-9}	10	10^{-9}	6	10^{-9}	10	10^{-9}				
2	5	10^{-10}	10	10^{-10}	7	10^{-9}	10	10^{-9}	6	10^{-9}	10	10^{-9}	7	10^{-12}	9	10^{-9}
3	5	10^{-10}	10	10^{-10}	7	10^{-9}	10	10^{-9}	6	10^{-9}	10	10^{-9}	7	10^{-12}	10	10^{-10}
31	4	10^{-10}	10	10^{-10}	6	10^{-9}	10	10^{-9}	6	10^{-9}	10	10^{-9}				
32	4	10^{-10}	10	10^{-10}	6	10^{-9}	10	10^{-9}	6	10^{-9}	10	10^{-9}	7	10^{-13}	10	10^{-10}
33	4	10^{-10}	10	10^{-10}	6	10^{-9}	10	10^{-9}	6	10^{-9}	9	10^{-8}	7	10^{-13}	10	10^{-10}
51	4	10^{-10}	10	10^{-10}	6	10^{-9}	10	10^{-9}	5	10^{-9}	10	10^{-9}				
52	4	10^{-10}	10	10^{-10}	5	10^{-8}	9	10^{-8}	5	10^{-9}	10	10^{-9}	7	10^{-14}	10	10^{-9}
53	4	10^{-10}	10	10^{-10}	6	10^{-9}	10	10^{-9}	4	10^{-9}	10	10^{-9}	7	10^{-14}	10	10^{-9}
71	3	10^{-9}	10	10^{-10}	5	10^{-9}	10	10^{-9}	4	10^{-8}	9	10^{-8}				
72	4	10^{-10}	10	10^{-10}	5	10^{-9}	10	10^{-9}	5	10^{-9}	10	10^{-9}	7	10^{-14}	10	10^{-9}
73	4	10^{-10}	10	10^{-10}	5	10^{-9}	10	10^{-9}	5	10^{-9}	10	10^{-9}	7	10^{-14}	10	10^{-9}

TABLE I.- AGREEMENT BETWEEN IBM AND MPB RESULTS - Continued

(c) S-band, 2-way Doppler with polar mounts in earth orbit

Frame	ΔHA, rad		HA_c, rad		ΔD, rad		D_c, rad	
	Agreement		Agreement		Agreement		Agreement	
	Digits	rad	Digits	rad	Digits	rad	Digits	rad
1	5	10^{-6}	8	10^{-7}	5	10^{-7}	7	10^{-7}
2	5	10^{-7}	8	10^{-7}	5	10^{-7}	7	10^{-7}
3	4	10^{-6}	7	10^{-6}	5	10^{-8}	8	10^{-8}
4	5	10^{-7}	8	10^{-7}	5	10^{-8}	8	10^{-8}
5	4	10^{-6}	7	10^{-6}	4	10^{-7}	8	10^{-9}

TABLE I.- AGREEMENT BETWEEN IBM AND MPB RESULTS - Continued

(d) S-band, 3-way Doppler with X-Y mounts

Frame	E_{rec}, rad		E_{tra}, rad		ΔE, rad		$\Delta\rho$, e.r.		ρ_c, e.r.	
	Agreement		Agreement		Agreement		Agreement		Agreement	
	Digits	rad	Digits	rad	Digits	rad	Digits	e.r.	Digits	e.r.
1	6	10^{-7}	8	10^{-7}	6	10^{-8}	6	10^{-11}	10	10^{-10}
2	7	10^{-7}	8	10^{-7}	7	10^{-9}	7	10^{-12}	10	10^{-10}
3	7	10^{-7}	8	10^{-7}	7	10^{-9}	6	10^{-11}	9	10^{-9}
7	7	10^{-7}	8	10^{-7}	7	10^{-9}	7	10^{-12}	10	10^{-10}
8	8	10^{-8}	8	10^{-7}	8	10^{-10}	8	10^{-13}	10	10^{-10}
9	7	10^{-7}	8	10^{-7}	7	10^{-9}	7	10^{-12}	9	10^{-9}
14	7	10^{-7}	8	10^{-7}	7	10^{-9}	7	10^{-12}	10	10^{-10}
15	7	10^{-7}	7	10^{-6}	7	10^{-9}	7	10^{-12}	10	10^{-10}
16	7	10^{-7}	8	10^{-7}	8	10^{-10}	8	10^{-13}	10	10^{-10}
50	7	10^{-7}	7	10^{-7}	7	10^{-10}	7	10^{-13}	10	10^{-10}
51	7	10^{-7}	8	10^{-8}	8	10^{-11}	8	10^{-14}	10	10^{-10}
52	7	10^{-7}	8	10^{-8}	7	10^{-10}	7	10^{-13}	10	10^{-10}

Frame	ΔX, rad		X_c, rad		ΔY, rad		Y_c, rad		Δf, Mc		f_c, Mc	
	Agreement		Agreement		Agreement		Agreement		Agreement		Agreement	
	Digits	rad	Digits	rad	Digits	rad	Digits	rad	Digits	Mc	Digits	Mc
1	6	10^{-8}	7	10^{-6}	5	10^{-9}	7	10^{-6}				
2	7	10^{-9}	7	10^{-6}	5	10^{-9}	7	10^{-6}	6	10^{-11}	10	10^{-9}
3	7	10^{-9}	7	10^{-6}	6	10^{-10}	7	10^{-6}	6	10^{-11}	10	10^{-9}
7	6	10^{-8}	7	10^{-6}	5	10^{-9}	7	10^{-6}				
8	7	10^{-9}	7	10^{-6}	6	10^{-10}	7	10^{-6}	6	10^{-11}	10	10^{-9}
9	7	10^{-9}	7	10^{-6}	7	10^{-10}	7	10^{-6}	5	10^{-11}	10	10^{-9}
14	7	10^{-9}	7	10^{-6}	6	10^{-9}	7	10^{-6}				
15	7	10^{-9}	7	10^{-6}	6	10^{-9}	8	10^{-7}	5	10^{-11}	10	10^{-9}
16	7	10^{-9}	8	10^{-7}	7	10^{-10}	7	10^{-6}	5	10^{-11}	10	10^{-9}
50	6	10^{-9}	7	10^{-6}	7	10^{-10}	7	10^{-6}				
51	6	10^{-9}	7	10^{-6}	7	10^{-10}	7	10^{-6}	3	10^{-10}	9	10^{-10}
52	6	10^{-9}	7	10^{-6}	7	10^{-10}	8	10^{-7}	3	10^{-10}	10	10^{-9}

TABLE I.- AGREEMENT BETWEEN IBM AND MPB RESULTS - Concluded

(e) S-band, 3-way Doppler with polar mounts

Frame	E_{rec}, rad		E_{tra}, rad		ΔE, rad		$\Delta\rho$, e.r.		ρ_c, e.r.	
	Agreement		Agreement		Agreement		Agreement		Agreement	
	Digits	rad	Digits	rad	Digits	rad	Digits	e.r.	Digits	e.r.
1	6	10^{-7}	8	10^{-7}	6	10^{-8}	6	10^{-11}	10	10^{-10}
2	7	10^{-7}	8	10^{-7}	7	10^{-9}	7	10^{-12}	10	10^{-10}
3	7	10^{-7}	8	10^{-7}	7	10^{-9}	6	10^{-11}	9	10^{-9}
7	7	10^{-7}	8	10^{-7}	7	10^{-9}	7	10^{-12}	10	10^{-10}
8	8	10^{-8}	8	10^{-7}	8	10^{-10}	8	10^{-13}	10	10^{-10}
9	7	10^{-7}	8	10^{-7}	7	10^{-9}	7	10^{-12}	9	10^{-9}
14	7	10^{-7}	8	10^{-7}	7	10^{-9}	7	10^{-12}	10	10^{-10}
15	7	10^{-7}	7	10^{-6}	7	10^{-9}	7	10^{-12}	10	10^{-10}
16	7	10^{-7}	8	10^{-7}	8	10^{-10}	8	10^{-13}	10	10^{-10}
20	7	10^{-7}	8	10^{-7}	7	10^{-9}	7	10^{-12}	10	10^{-10}
21	7	10^{-7}	8	10^{-7}	8	10^{-10}	8	10^{-13}	10	10^{-10}
22	7	10^{-7}	8	10^{-7}	7	10^{-9}	7	10^{-12}	10	10^{-10}

Frame	ΔHA, rad		HA_c, rad		ΔD, rad		ΔD_c, rad		Δf, Mc		f_c, Mc	
	Agreement		Agreement		Agreement		Agreement		Agreement		Agreement	
	Digits	rad	Digits	rad	Digits	rad	Digits	rad	Digits	Mc	Digits	Mc
1	6	10^{-8}	7	10^{-6}	7	10^{-9}	8	10^{-7}				
2	7	10^{-9}	7	10^{-6}	7	10^{-9}	7	10^{-6}	6	10^{-11}	10	10^{-9}
3	7	10^{-9}	7	10^{-6}	7	10^{-9}	7	10^{-6}	6	10^{-11}	10	10^{-9}
7	6	10^{-8}	7	10^{-6}	6	10^{-9}	7	10^{-6}				
8	7	10^{-9}	7	10^{-6}	6	10^{-9}	7	10^{-6}	6	10^{-11}	10	10^{-9}
9	7	10^{-9}	7	10^{-6}	8	10^{-11}	7	10^{-6}	5	10^{-11}	10	10^{-9}
14	7	10^{-9}	7	10^{-6}	6	10^{-9}	7	10^{-6}				
15	8	10^{-10}	7	10^{-6}	6	10^{-9}	9	10^{-8}	5	10^{-11}	10	10^{-9}
16	7	10^{-9}	8	10^{-7}	7	10^{-10}	7	10^{-6}	5	10^{-11}	10	10^{-9}
20	7	10^{-9}	7	10^{-6}	6	10^{-9}	7	10^{-6}				
21	9	10^{-11}	7	10^{-6}	8	10^{-11}	7	10^{-6}	5	10^{-11}	10	10^{-9}
22	6	10^{-9}	7	10^{-6}	6	10^{-9}	7	10^{-6}	5	10^{-11}	10	10^{-9}

TABLE II.- COMPARISON OF HARDWARE RESOLUTION

AND SOFTWARE CAPABILITY

(a) Hardware resolution of measurements

Range	1 range unit $\doteq$ 1 meter
Angles[a]	0.004°
Doppler	0.01Hz

(b) Largest error found between IBM and MPB measurements

Range	10^{-8} e.r. $\doteq$ 0.0666...m
Angles	10^{-6} rad $\doteq$ 0.00005729°
Doppler	10^{-9} Mc = 0.001 Hz

[a]Angles include elevation angle, angles used in X-Y mounts and angles used in polar mounts.

APPENDIX

LISTING, INPUT, AND RESULTS OF PROGRAM USED IN MPB COMPUTATION OF REFRACTION CORRECTIONS

STORAGE ASSIGNMENT FOR VARIABLES (BLOCK, TYPE, RELATIVE LOCATION, NAME)

0001		000139	1L	0001		000000	1000L	0001		000770	2L	0001		000576	2000L
0001		000630	3000L	0001		000661	3001L	0000		000427	3002F	0001		000051	4L
0001		000716	5L	0001		000110	500L	0001		000742	5000L	0000		000450	5001F
0000		000312	502F	0001		000270	550L	0000		000324	601F	0000		000347	602F
0001		000360	800L	0001		000474	801L	0000		000415	802F	0000		000372	881F
0001		000766	900L	0000		000460	901F	0000		000467	902F	0000	D	000123	A
0000	D	000035	A20B	0000	D	000125	B	0000	D	000007	C	0000	D	000053	DELTAD
0000	D	000127	DELTAF	0000	D	000051	DELTAH	0000	D	000055	DELTAX	0000	D	000057	DELTAY
0000	D	000047	DELTPP	0000	D	000117	DPORLC	0000	D	000121	DPDTRA	0000	D	000041	E
0000	D	000103	ETR	0000	D	000105	ETRP	0000	I	000000	F	0000	D	000037	FD
0000	I	000132	JMAX	0000	I	000131	KIND	0002	D	000002	KR	0000	D	000015	KT
0000	D	000013	NT	0000	D	000011	PHIR	0000	D	000023	PHIT	0000	D	000031	PHOOB
0000	D	000025	ROT	0000	I	000002	STASWI	0000	D	000107	TOB	0000	D	000111	TP
0000	D	000115	TTRP	0000	D	000005	VTR	0000	D	000021	VTT	0000	D	000003	W4R
0000	I	000001	XORHA	0000	D	000061	XR	0000	D	000067	XT	0000	D	000075	XV
0000	D	000071	YT	0000	D	000077	YV	0000	D	000065	ZR	0000	D	000073	ZT

0001		000372	3L	0001	
0001		000702	4000L	0001	
0001		000125	501L	0001	
0001		000370	700L	0000	
0000		000405	882F	0000	D
0000	D	000033	A10B	0000	D
0000	D	000043	DELTAE	0000	D
0000	D	000045	DELTP	0000	D
0000	D	000027	EOB	0000	I
0000	I	000133	J	0002	D
0002	D	000000	NR	0002	D
0002	D	000004	ROR	0000	D
0000	D	000113	TTR	0000	D
0000	D	000017	W4T	0000	D
0000	D	000063	YR	0000	D
0000	D	000101	ZV		

```
00100      1*    C
00100      2*    C   THIS PROGRAM COMPUTES THE REFRACTION CORRECTIONS TO LOW SPEED
00100      3*    C   RADAR DATA AS SPECIFIED BY THE 504 RTCC REQUIREMENTS
00100      4*    C
00101      5*          INTEGER F,XORHA,STASWI
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```
00103      6•          DOUBLE PRECISION NR,KR,W4R,VTR,C,PHIR,ROR,NT,KT,W4T,VTT,PHIT,ROT,
00103      7•         1E0B,PH00B,A10B,A20B,FD,E,DELTAE,DELTP,DELTPP,DELTAH,DELTAD,DELTAX,
00103      8•         2DELTAY,XR,YR,ZR,XT,YT,ZT,XV,YV,ZV,ETR,ETRP,T0B,TP,TTR,TTRP,DPDREC,
00103      9•         3DPDTRA,A,B,DELTAF
00104     10•          COMMON NR,KR,ROR
00105     11•          NAMELIST/RECCHA/NR,KR,W4R,VTR,C,PHIR,ROR
00106     12•          NAMELIST/OBSERV/T0B,E0B,PH00B,A10B,A20B,FD,KIND,JMAX,XORHA,STAS#1
00107     13•          NAMELIST/TRACHA/NT,KT,W4T,VTT,C,PHIT,ROT
00110     14•          NAMELIST/LTR/XR,YR,ZR,XT,YT,ZT,XV,YV,ZV,TTR
00111     15•     1000 F=0
00112     16•          J=1
00113     17•     1001 READ(5,RECCHA)
00116     18•          WRITE(6,RECCHA)
00121     19•          READ(5,OBSERV)
00124     20•          WRITE(6,OBSERV)
00124     21•    C
00124     22•    C  IS THIS C-BAND
00124     23•    C
00127     24•          IF(KIND.EQ.0) GO TO 900
00127     25•    C
00127     26•    C  IS THIS S-BAND,3-WAY
00127     27•    C
00131     28•          IF(KIND.EQ.3) GO TO 800
00133     29•          NT=NR
00134     30•          KT=KR
00135     31•          W4T=W4R
00136     32•          VTT=VTR
00137     33•          PHIT=PHIR
00140     34•          ROT=ROR
00140     35•    C
00140     36•    C  IS THIS S-BAND,2-WAY,NOT EARTH ORBIT
00140     37•    C
00141     38•          IF(KIND.EQ.2) GO TO 700
00141     39•    C
00141     40•    C  IS THIS MSFN OR DSIF (X AND Y OR HA AND D)
00141     41•    C
00143     42•        4 IF(XORHA.EQ.0) GO TO 500
00145     43•          E=DASIN(DSIN(A20B)*DSIN(PHIR)+DCOS(A20B)*DCOS(A10B)*DCOS(PHIR))
00146     44•          GO TO 501
00147     45•      500 E=DASIN(DCOS(A10B)*DCOS(A20B))
00147     46•    C
00147     47•    C  THIS IS FOR S-BAND,2-WAY,EARTH ORBIT
00147     48•    C
00150     49•      501 WRITE(6,502) J
00153     50•      502 FORMAT(1H0,5X,45HTHIS IS FOR S-BAND,2-WAY,EARTH ORBIT   FRAME ,I2)
00154     51•        1 CONTINUE
00155     52•       22 CALL REFCOR(E,PH00B,DELTAE,DELTP)
00156     53•          WRITE(6,902)DELTAE,E,DELTP,PH00B
00164     54•          IF(XORHA.EQ.0) GO TO 550
00166     55•          A=DSQRT(1.0D+00-(DSIN(A20B)*DSIN(PHIR)+DCOS(A20B)*DCOS(A10B)*DCOS(
00166     56•         1PHIR))**2)
00167     57•          DELTAH=(-1.0D+00*DSIN(A10B)*DCOS(PHIR)*DELTAE)/(DCOS(A20B)*A)
00170     58•          DELTAD=((DSIN(PHIR)*DCOS(A20B))-(DCOS(A10B)*DSIN(A20B)*DCOS(PHIR))
00170     59•         1)*DELTAE/A
00171     60•          A10B=A10B-DELTAH
00172     61•          A20B=A20B-DELTAD
00173     62•          WRITE(6,601)DELTAH,A10B,DELTAD,A20B
00201     63•      601 FORMAT(1H0,10X,8HHA AND D/15X,9HDELTAH = ,D25.16/15X,9HHA      = ,D
```

```
00201          125.16/15X,9HDELTAD = ,D25.16/15X,9HD       = ,D25.16)
00202          GO TO 2000
00203      550 A=DSQRT(+1.00D+00-(DCOS(A20B)**2+DCOS(A10B)**2))
00204          DELTAX=(-1.00D+00*DSIN(A10B)*DELTAE)/(DCOS(A20B)*A)
00205          DELTAY=(-1.00D+00*DCOS(A10B)*DSIN(A20B)*DELTAE)/A
00206          A10B=A10B-DELTAX
00207          A20B=A20B-DELTAY
00210          WRITE(6,602)DELTAX,A10B,DELTAY,A20B
00216      602 FORMAT(1H0,10X,7HX AND Y/15X,9HDELTAX = ,D25.16/15X,9HX       = ,D2
00216         15.16/15X,9HDELTAY = ,D25.16/15X,9HY       = ,D25.16)
00217          GO TO 2000
00220      800 READ(5,TRACHA)
00220    C
00220    C THIS IS FOR S-BAND,3-WAY ( IF ENTRY WAS AT 800 )
00220    C
00223          WRITE(6,TRACHA)
00226      700 CONTINUE
00227          F=2
00227    C
00227    C  THIS IS FOR S-BAND,2-WAY,NOT EARTH ORBIT ( IF ENTRY WAS AT 700 )
00227    C
00227    C
00227    C  THIS SIMULATES --- GENERATE VEHICLE EPHEMERIS OVER TIME ARC OF DATA
00227    C                     BATCH --- AND LIGHT TIME ROUTINE.
00227    C
00230        3 CONTINUE
00231          READ(5,LTR)
00234          WRITE(6,LTR)
00237          E=DASIN((XR*(XV-XR)+YR*(YV-YR)+ZR*(ZV-ZR))/((DSQRT(XR**2+YR**2+ZR*
00237         1*2))*(DSQRT((XV-XR)**2+(YV-YR)**2+(ZV-ZR)**2))))
00240          IF(KIND.EQ.3) GO TO 801
00242          WRITE(6,881) J
00245      881 FORMAT(1H0,5X,49HTHIS IS FOR S-BAND,2-WAY,NOT EARTH ORBIT   FRAME
00245         1,I2)
00246          GO TO 1
00247      801 ETR=DASIN((XT*(XV-XT)+YT*(YV-YT)+ZT*(ZV-ZT))/((DSQRT(XT**2+YT**2+Z
00247         1T**2))*(DSQRT((XV-XT)**2+(YV-YT)**2+(ZV-ZT)**2))))
00250          WRITE(6,882) J
00253      882 FORMAT(1H0,5X,33HTHIS IS FOR S-BAND,3-WAY   FRAME ,I2)
00254          WRITE(6,802)E,ETR
00260      802 FORMAT(1H0,7X,9HE AND ETR/8X,7HE     = ,D25.16/8X,7HETR  = ,D25.16)
00261          GO TO 1
00262     2000 IF(J.EQ.1) GO TO 4000
00262    C
00262    C  IS DOPPLER VALID  (I.E. IS THE DOPPLER POSITIVE)
00262    C
00264          IF(FD.LT.0.0D+00) GO TO 4000
00264    C
00264    C  NOTE    STARRED COMMENT IS ORIGINAL
00264    C
00264    C    *DPDREC=(DELTP-DELTPP)/(TOB-TP)
00266          DPDREC=(DELTP-DELTPP)/(0.1666666666666667D-02)
00266    C
00266    C  IS THIS S-BAND,3-WAY
00266    C
00267          IF(KIND.EQ.3) GO TO 3000
00271          DELTAF=((2.0D+00*W4T*VTT)/C)*DPDREC
00272          GO TO 3001
```

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00272   122*   C
00272   123*   C  NOTE     STARRED COMMENT IS ORIGINAL
00272   124*   C
00272   125*   C3000*A=(NT*KT)/(TTR-TTRP)
00273   126*    3000 A=(NT*KT)/(0.1666666666666667D-02)
00274   127*         B=1.0D+00/DSIN(ETR)-1.0D+00/DSIN(ETRP)
00275   128*         DPDTRA=A*B
00276   129*         DELTAF=(W4T*VTT/C)*(DPDREC+DPDTRA)
00277   130*    3001 FD=FD-DELTAF
00300   131*         WRITE(6,3002) DELTAF,FD,DPDREC,DPDTRA
00306   132*    3002 FORMAT(1H0,14X,9HDELTAF = ,D25.16/15X,9HFD      = ,D25.16/15X,9HDPD
00306   133*        1REC = ,D25.16/15X,9HDPDTRA = ,D25.16)
00307   134*    4000 TP=TOB
00310   135*         ETRP=ETR
00311   136*         DELTPP=DELTP
00312   137*         TTRP=TTR
00313   138*         IF(J.EQ.JMAX) GO TO 1000
00315   139*       5 CONTINUE
00316   140*         J=J+1
00317   141*         READ(5,OBSERV)
00322   142*         WRITE(6,OBSERV)
00325   143*         IF(F.EQ.1) GO TO 2
00327   144*         IF(F.EQ.2) GO TO 5000
00331   145*         GO TO 4
00332   146*    5000 IF(KIND.NE.3) GO TO 3
00334   147*         IF(STASWI.EQ.0) GO TO 3
00336   148*         READ(5,TRACHA)
00341   149*         WRITE(6,5001)
00343   150*    5001 FORMAT(1H0,6X,35HPRIMARY STATION SWITCH HAS OCCURRED)
00344   151*         WRITE(6,TRACHA)
00347   152*         GO TO 3
00350   153*    900  F=1
00350   154*   C
00350   155*   C  THIS IS FOR C-BAND
00350   156*   C
00351   157*       2 E=EOB
00352   158*         WRITE(6,901) J
00355   159*     901 FORMAT(1H0,5X,27HTHIS IS FOR C-BAND   FRAME ,I2)
00356   160*      21 CALL REFCOR(E,PHOOB,DELTAE,DELTP)
00357   161*         WRITE(6,902)DELTAE,E,DELTP,PHOOB
00365   162*     902 FORMAT(1H0,9X,9HDELTAE = ,D25.16/10X,9HE       = ,D25.16/10X,9HDELT
00365   163*        1P  = ,D25.16/10X,9HRHO     = ,D25.16)
00366   164*         IF(J.EQ.JMAX) GO TO 1000
00370   165*         GO TO 5
00371   166*         END
```

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STORAGE ASSIGNMENT FOR VARIABLES (BLOCK, TYPE, RELATIVE LOCATION, NAME)
 0001    000040 IL          0001    000017 2L          0000    000004 3F          0000    000013 4F          0000 D 000000 F
 0002 D 000002 KR           0002 D 000000 NR           0002 D 000004 ROR          0000 D 000002 T


00101      1*          SUBROUTINE REFCOR(E,PHOOB,DELTAE,DELTP)
00103      2*          DOUBLE PRECISION NR,KR,ROR,F,T,E,PHOOB,DELTAE,DELTP
00104      3*          COMMON NR,KR,ROR
00105      4*          IF(E.LT.0.175438596D+00)GO TO 1
00107      5*          DELTAE=NR*(DCOS(E)/DSIN(E))
00110      6*        2 CONTINUE
00111      7*          DELTP=NR*KR/DSIN(E)
00112      8*          E=E-DELTAE
00113      9*          PHOOB=PHOOB-DELTP
00114     10*          RETURN
00115     11*        1 F=ROR/PHOOB
00116     12*          T=1.03585796D+00-(0.010720149D+00/E)+(0.12791190-07/E**2)-(0.122736
00116     13*         13D-07/E**3)
00117     14*          WRITE(6,3) F,T
00123     15*        3 FORMAT(1H0,8X,4HF = ,D25.16/9X,4HT = ,D25.16)
00124     16*          T=T*NR*(DCOS(E)/DSIN(E))
00125     17*          DELTAE=T-F*(((NR*T**2/2.0D.00)*DCOS(E))-T*DSIN(E))
00126     18*          T=DELTAE/DCOS(E)
00127     19*          WRITE(6,4) T
00132     20*        4 FORMAT(1H0,8X,16HDELTAE/COS(E) = ,D25.16)
00133     21*          GO TO 2
00134     22*          END
```

```
STORAGE ASSIGNMENT FOR VARIABLES (BLOCK, TYPE, RELATIVE LOCATION, NAME)

 0001    000040 IL        0001    000017 ZL        0000    000004 3F        0000    000013 4F        0000 D 000000 F
 0002 D 000002 KR         0002 D 000000 NR         0002 D 000004 ROR        0000 D 000002 T


00101      1*          SUBROUTINE REFCOR(E,PHOOB,DELTAE,DELTP)
00103      2*          DOUBLE PRECISION NR,KR,ROR,F,T,E,PHOOB,DELTAE,DELTP
00104      3*          COMMON NR,KR,ROR
00105      4*          IF(E.LT.0.1754385960D+00)GO TO 1
00107      5*          DELTAE=NR*(DCOS(E)/DSIN(E))
00110      6*        2 CONTINUE
00111      7*          E=E-DELTAE
00112      8*          DELTP=NR*KR/DSIN(E)
00113      9*          PHOOB=PHOOB-DELTP
00114     10*          RETURN
00115     11*        1 F=ROR/PHOOB
00116     12*          T=1.03585796D+00-(0.01072014D+00/E)+(0.12791119D-07/E**2)-(0.12273*
00116     13*         13D-07/E**3)
00117     14*          WRITE(6,3) F,T
00123     15*        3 FORMAT(1H0,8X,4HF = ,D25.16/9X,4HT = ,D25.16)
00124     16*          T=T*NR*(DCOS(E)/DSIN(E))
00125     17*          DELTAE=T-F*(((NR+T**2/2.0D+00)*DCOS(E))-T*DSIN(E))
00126     18*          T=DELTAE/DCOS(E)
00127     19*          WRITE(6,4) T
00132     20*        4 FORMAT(1H0,8X,16HDELTAE/COS(E) = ,D25.16)
00133     21*          GO TO 2
00134     22*          END
```

Change in subroutine for 3-way cases

```
$RECCHA
NR      =          .33859999999999598-003,
KR      =          .10159999999999900-002,
W4R     =          .10859729000000000+001,
VTR     =          .00000000000000000+000,
C       =          .16921058000000000+006,
PHIR    =         -.43454165366740419 9+000,
ROR     =          .99941981429176559 6+000,
$END
$OBSERV
TOB     =          .13250000000000000+002,
EOB     =          .53745335339999979 8+000,
PHOOB   =          .16436925739999999+001,
A1OB    =          .00000000000000000+000,
A2OB    =          .00000000000000000+000,
FD      =          .00000000000000000+000,
KIND    =                ,
JMAX    =              12,
XORHA   =                ,
STASWI  =                ,
$END

     THIS IS FOR C-BAND   FRAME  1

         DELTAE =     .56814635774786 24-003
         E      =     .53688520704225 21+000
         DELTP  =     .67197493727585 44-006
         RHO    =     .16436919020250 62+001
$OBSERV
TOB     =          .13251667000000000+002,
EOB     =          .53765130039999999 8+000,
PHOOB   =          .16466886510000000+001,
A1OB    =          .00000000000000000+000,
A2OB    =          .00000000000000000+000,
FD      =          .00000000000000000+000,
KIND    =                ,
JMAX    =              12,
XORHA   =                ,
STASWI  =                ,
$END

     THIS IS FOR C-BAND   FRAME  2

         DELTAE =     .56789071322760 63-003
         E      =     .53708340968677 23+000
         DELTP  =     .67175183426178 95-006
         RHO    =     .16466879792481 65+001
$OBSERV
TOB     =          .13253333000000000+002,
EOB     =          .53784734009999999+000,
PHOOB   =          .16496760600000000+001,
A1OB    =          .00000000000000000+000,
A2OB    =          .00000000000000000+000,
FD      =          .00000000000000000+000,
KIND    =                ,
JMAX    =              12,
XORHA   =                ,
STASWI  =                ,
```

```
$END

     THIS IS FOR C-BAND   FRAME  3

          DELTAE =      .5676376991896284-003
          E      =      .5372797024008103+000
          DELTP  =      .6715310528241459-006
          RHO    =      .1649675388468947+001
$OBSERV
TOB      =            .1330000000000000+002,
EOB      =            .5426437854999999999+000,
PHOOB    =            .1729877350000000000+001,
A1OB     =            .0000000000000000000+000,
A2OB     =            .0000000000000000000+000,
FD       =            .0000000000000000000+000,
KIND     =                 ,
JMAX     =                12,
XORHA    =                 ,
STASWI   =                 ,
$END

     THIS IS FOR C-BAND   FRAME  4

          DELTAE =      .5614986304962222-003
          E      =      .5420822868695037+000
          DELTP  =      .6661820440440801-006
          RHO    =      .1729876683817955+001
$OBSERV
TOB      =            .1330166700000000000+002,
EOB      =            .5427924990999999998+000,
PHOOB    =            .1732621136999999999+001,
A1OB     =            .0000000000000000000+000,
A2OB     =            .0000000000000000000+000,
FD       =            .0000000000000000000+000,
KIND     =                 ,
JMAX     =                12,
XORHA    =                 ,
STASWI   =                 ,
$END

     THIS IS FOR C-BAND   FRAME  5

          DELTAE =      .5613098508893226-003
          E      =      .5422311892491106+000
          DELTP  =      .6660178040964022-006
          RHO    =      .1732620470982195+001
$OBSERV
TOB      =            .1330333300000000000+002,
EOB      =            .5429397820999999998+000,
PHOOB    =            .1735356779000000000+001,
A1OB     =            .0000000000000000000+000,
A2OB     =            .0000000000000000000+000,
FD       =            .0000000000000000000+000,
KIND     =                 ,
JMAX     =                12,
XORHA    =                 ,
STASWI   =                 ,
$END
```

```
     THIS IS FOR C-BAND   FRAME  6

          DELTAE =      .5611229790285026-003
          E      =      .5423786591209714+000
          DELTP  =      .6658552384189573-006
          RHO    =      .1735356113144761+001
$OBSERV
TOB      =            .1333333300000000000+002,
EOB      =            .5453592538999999998+000,
PHOOB    =            .1783223578000000000+001,
A1OB     =            .0000000000000000000+000,
A2OB     =            .0000000000000000000+000,
FD       =            .0000000000000000000+000,
KIND     =                  ,
JMAX     =                12,
XORHA    =                  ,
STASWI   =                  ,
$END

     THIS IS FOR C-BAND   FRAME  7

          DELTAE =      .5580661661626736-003
          E      =      .5448011877338373+000
          DELTP  =      .6631980805761493-006
          RHO    =      .1783222914801919+001
$OBSERV
TOB      =            .1333500000000000000+002,
EOB      =            .5454815029999999999+000,
PHOOB    =            .1785807449000000000+001,
A1OB     =            .0000000000000000000+000,
A2OB     =            .0000000000000000000+000,
FD       =            .0000000000000000000+000,
KIND     =                  ,
JMAX     =                12,
XORHA    =                  ,
STASWI   =                  ,
$END

     THIS IS FOR C-BAND   FRAME  8

          DELTAE =      .5579123612069957-003
          E      =      .5449235906387930+000
          DELTP  =      .6630644874629011-006
          RHO    =      .1785806785935512+001
$OBSERV
TOB      =            .1333666700000000000+002,
EOB      =            .5456025003999999998+000,
PHOOB    =            .1788383483000000000+001,
A1OB     =            .0000000000000000000+000,
A2OB     =            .0000000000000000000+000,
FD       =            .0000000000000000000+000,
KIND     =                  ,
JMAX     =                12,
XORHA    =                  ,
STASWI   =                  ,
$END
```

```
     THIS IS FOR C-BAND   FRAME  9

          DELTAE =      .5577601920509295-003
          E      =      .5450447402079490+000
          DELTP  =      .6629323249410703-006
          RHO    =      .1788382820067675+001
$OBSERV
TOB      =            .1336666700000000000+002,
EOB      =            .5475828051999999998+000,
PHOOB    =            .1833428575000000000+001,
A1OB     =            .0000000000000000000+000,
A2OB     =            .0000000000000000000+000,
FD       =            .0000000000000000000+000,
KIND     =                  ,
JMAX     =                12,
XORHA    =                  ,
STASWI   =                  ,
$END

     THIS IS FOR C-BAND   FRAME 10

          DELTAE =      .5552783037199219-003
          E      =      .5470275268962800+000
          DELTP  =      .6607781208704417-006
          RHO    =      .1833427914221879+001
$OBSERV
TOB      =            .1336833300000000000+002,
EOB      =            .5476822852999999998+000,
PHOOB    =            .1835858438999999999+001,
A1OB     =            .0000000000000000000+000,
A2OB     =            .0000000000000000000+000,
FD       =            .0000000000000000000+000,
KIND     =                  ,
JMAX     =                12,
XORHA    =                  ,
STASWI   =                  ,
$END

     THIS IS FOR C-BAND   FRAME 11

          DELTAE =      .5551540520285980-003
          E      =      .5471271312479714+000
          DELTP  =      .6606703425026059-006
          RHO    =      .1835857778329657+001
$OBSERV
TOB      =            .1337000000000000000+002,
EOB      =            .5477807521999999998+000,
PHOOB    =            .1838280747999999999+001,
A1OB     =            .0000000000000000000+000,
A2OB     =            .0000000000000000000+000,
FD       =            .0000000000000000000+000,
KIND     =                  ,
JMAX     =                12,
XORHA    =                  ,
STASWI   =                  ,
$END

     THIS IS FOR C-BAND   FRAME 12
```

```
        DELTAE =      .5550311057427032-003
        E      =      .5472257210942570+000
        DELTP  =      .6605637029069598-006
        RHO    =      .1838280087436297+001
$RECCHA
NR      =            .2786000145519137 9-003,
KR      =            .1180999999999999 00-002,
W4R     =            .1085972900000000000+001,
VTR     =            .2106405999999999900+004,
C       =            .1692105800000000000+006,
PHIR    =            .6168289312893435 99+000,
ROR     =            .9990360003285946 98+000,
$END
$OBSERV
TOB     =            .2146222200000000000+002,
EOB     =            .0000000000000000000+000,
PHOOB   =            .4340689246999999999+000,
A1OB    =            .7613529204999999998+001,
A2OB    =            .5161762237999999999+001,
FD      =           -.1000000000000000000+003,
KIND    =                 1,
JMAX    =                12,
XORHA   =                  ,
STASNI  =                  ,
$END

     THIS IS FOR S-BAND,2-WAY,EARTH ORBIT    FRAME  1

        F =      .2301560751023729+001
        T =      .9324063992096202+000

        DELTAE/COS(E) =      .2460552474568104-002

        DELTAE =      .2447350973635053-002
        E      =      .1011872319635852+000
        DELTP  =      .3180563005696844-005
        RHO    =      .4340657441369943+000

         X AND Y
             DELTAX =     -.5501282557862915-002
             X      =      .7619030487557862+001
             DELTAY =      .5277845598877599-003
             Y      =      .5161234451440112+001
$OBSERV
TOB     =            .2146388900000000000+002,
EOB     =            .0000000000000000000+000,
PHOO3   =            .4277547802999999999+000,
A1OB    =            .7541135749999999998+001,
A2OB    =            .5149624328999999999+001,
FD      =            .8975698332999999997+000,
KIND    =                 1,
JMAX    =                12,
XORHA   =                  ,
STASNI  =                  ,
$END

     THIS IS FOR S-BAND,2-WAY,EARTH ORBIT    FRAME  2
```

```
F =      .2335534391054469+001
T =      .9459526136201514+000

DELTAE/COS(E) =      .2174493572533273-002

 DELTAE =      .2159051535813447-002
 E      =      .1170874287307589+000
 DELTP  =      .2705764573616705-005
 RHO    =      .4277520145354263+000

  X AND Y
      DELTAX =     -.4743376858603675-002
      X      =      .7585879126858603+001
      DELTAY =      .5257749142887859-003
      Y      =      .5169098554085711+001

      DELTAF =     -.6729021392364634-005
      FD     =      .8775765623213923+000
      DPDREC =     -.2488790592480836-003
      DPDTRA =      .0000000000000000
$OBSERV
TOB      =            .2146555600000000+002,
EOB      =            .0000000000000000+000,
PHOOB    =            .4215406649999999+000,
A1OB     =            .7549041747999999998+001,
A2OB     =            .5178109168999999999+001,
FD       =            .8991914999999999997+000,
KIND     =                 1,
JMAX     =                12,
XORMA    =                 ,
STAS#I   =                 ,
$END

     THIS IS FOR S-BAND,2-WAY,EARTH ORBIT    FRAME  3

F =      .2369963527750226+001
T =      .9565848143921781+000

DELTAE/COS(E) =      .1943446354310981-002

 DELTAE =      .1925701354811961-002
 E      =      .1333119812154098+000
 DELTP  =      .2440382707608429-005
 RHO    =      .4215382241172923+000

  X AND Y
      DELTAX =     -.4128087606717336-002
      X      =      .7553169835606717+001
      DELTAY =      .5213493732307176-003
      Y      =      .5177587819626769+001

      DELTAF =     -.5278471102403290-005
      FD     =      .8991967784711024+000
      DPDREC =     -.1952291196049653-003
      DPDTRA =      .0000000000000000
$OBSERV
TOB      =            .2151222200000000+002,
```

```
EOB      =          .0000000000000000000+000,
PHOOB    =          .3073985900000000000+000,
A1OB     =          .6883630752999999998+001,
A2OB     =          .5686191558999999998+001,
FD       =         -.1000000000000000000+001,
KIND     =                1,
JMAX     =               12,
XORHA    =                ,
STASWI   =                ,
$END
```

THIS IS FOR S-BAND,2-WAY,EARTH ORBIT FRAME 4

```
DELTAE =      .2984587296788386-003
E      =      .7506996001318841+000
DELTP  =      .4821830522225500-006
RHO    =      .3073981078169477+000

 X AND Y
     DELTAX =     -.2789313361196943-003
     X      =      .6883909684336119+001
     DELTAY =      .1893734971528854-003
     Y      =      .5686002185502847+001
$OBSERV
TOB      =          .2151388900000000000+002,
EOB      =          .0000000000000000000+000,
PHOOB    =          .3061821230999999999+000,
A1OB     =          .6868378665999999998+001,
A2OB     =          .5712281226999999998+001,
FD       =          .9802603332999999996+000,
KIND     =                1,
JMAX     =               12,
XORHA    =                ,
STASWI   =                ,
$END
```

THIS IS FOR S-BAND,2-WAY,EARTH ORBIT FRAME 5

```
DELTAE =      .2831179084833940-003
E      =      .7770722248319937+000
DELTP  =      .4691019388017474-006
RHO    =      .3061816539980611+000

 X AND Y
     DELTAX =     -.2607618295593652-003
     X      =      .6868659427829559+001
     DELTAY =      .1789294119436903-003
     Y      =      .5712102297588056+001

     DELTAF =     -.2122069063836827-006
     FD     =      .9802665455069063+000
     OPDREC =     -.7848668052481534-005
     OPDTRA =      .0000000000000000
$OBSERV
TOB      =          .2151555600000000000+002,
EOB      =          .0000000000000000000+000,
PHOOB    =          .3052024015999999999+000,
A1OB     =          .6853610038999999998+001,
```

```
A2OB     =          .5738622664999999999+001,
FD       =          .9841063332999999996+000,
KIND     =                 1,
JMAX     =                12,
XORHA    =                  ,
STASWI   =                  ,
$END

     THIS IS FOR S-BAND,2-WAY,EARTH ORBIT    FRAME  6

          DELTAE =      .2685857961908983-003
          E      =      .8034288469564620+000
          DELTP  =      .4570276184083499-006
          RHO    =      .3052019445723815+000

           X AND Y
               DELTAX =     -.2443048379056530-003
               X      =      .6853854343837905+001
               DELTAY =      .1687337498543380-003
               Y      =      .5738453931250145+001

               DELTAF =     -.1958743185647796-006
               FD     =      .9841065291743185+000
               DPDREC =     -.7244592236038501-005
               DPDTRA =      .0000000000000000
$OBSERV
TOB      =          .2154555600000000000+002,
EOB      =          .0000000000000000000+000,
PHOOB    =          .3268520248999999999+000,
A1OB     =          .6650130271999999998+001,
A2OB     =          .6204340934999999998+001,
FD       =         -.1000000000000000000+001,
KIND     =                 1,
JMAX     =                12,
XORHA    =                  ,
STASWI   =                  ,
$END

     THIS IS FOR S-BAND,2-WAY,EARTH ORBIT    FRAME  7

          DELTAE =      .1096465133864502-003
          E      =      .1195742176321241+001
          DELTP  =      .3535913329546383-006
          RHO    =      .3268516713086670+000

           X AND Y
               DELTAX =     -.1077490913241228-003
               X      =      .6650238021091324+001
               DELTAY =      .2201167352987141-004
               Y      =      .6204318923326470+001
$OBSERV
TOB      =          .2154722200000000000+002,
EOB      =          .0000000000000000000+000,
PHOOB    =          .3300152665999999999+000,
A1OB     =          .6641537665999999998+001,
A2OB     =          .6227410315999999998+001,
FD       =          .1051315833000000000+001,
KIND     =                 1,
```

```
JMAX     =                12,
XORHA    =                  ,
STASWI   =                  ,
$END

     THIS IS FOR S-BAND,2-WAY,EARTH ORBIT   FRAME  8

          DELTAE =      .1056659109380874-003
          E      =      .1208209057180166+001
          DELTP  =      .3518926982530104-006
          RHO    =      .3300149147073017+000

           X AND Y
               DELTAX =     -.1046673629961949-003
               X      =      .6641642333362996+001
               DELTAY =      .1555504650402799-004
               Y      =      .6227394760953495+001

               DELTAF =     -.2755591236868237-007
               FD     =      .1051315860555912+001
               DPDREC =     -.1019180820976749-005
               DPDTRA =      .0000000000000000
$OBSERV
TOB      =            .2154888900000000000+002,
EOB      =            .0000000000000000000+000,
PHOOB    =            .3333499390999999999+000,
A1OB     =            .6633172034999999998+001,
A2OB     =            .6250024795999999998+001,
FD       =            .1054097667000000000+001,
KIND     =                 1,
JMAX     =                12,
XORHA    =                  ,
STASWI   =                  ,
$END

     THIS IS FOR S-BAND,2-WAY,EARTH ORBIT   FRAME  9

          DELTAE =      .1021675533233558-003
          E      =      .1219204390900668+001
          DELTP  =      .3504530233468540-006
          RHO    =      .3333495886469766+000

           X AND Y
               DELTAX =     -.1018046590305337-003
               X      =      .6633273839659030+001
               DELTAY =      .9241906672477046-005
               Y      =      .6250015554093327+001

               DELTAF =     -.2335496591198603-007
               FD     =      .1054097690354965+001
               DPDREC =     -.8638049436938352-006
               DPDTRA =      .0000000000000000
$OBSERV
TOB      =            .2157888900000000000+002,
EOB      =            .0000000000000000000+000,
PHOOB    =            .4161264490000000000+000,
A1OB     =            .6512443541999999998+001,
A2OB     =            .6577265738999999999+001,
```

```
FD      =          -.1000000000000000+001,
KIND    =                1,
JMAX    =               12,
XORHA   =                ,
STASWI  =                ,
$END

     THIS IS FOR S-BAND,2-WAY,EARTH ORBIT   FRAME 10

         DELTAE =      .1083241566052324-003
         E      =      .1199859987440765+001
         DELTP  =      .3530223956249391-006
         RHO    =      .4161260959776043+000

          X AND Y
              DELTAX =     -.7097786856835173-004
              X      =      .6512514519868568+001
              DELTAY =     -.8437736427805819-004
              Y      =      .6577350116364278+001
$OBSERV
TOB     =            .2158055600000000+002,
EOB     =            .0000000000000000+000,
PHOOB   =            .4216650421999999999+000,
A1OB    =            .6507061957999999997+001,
A2OB    =            .6591359137999999998+001,
FD      =            .1089047833000000000+001,
KIND    =                1,
JMAX    =               12,
XORHA   =                ,
STASWI  =                ,
$END

     THIS IS FOR S-BAND,2-WAY,EARTH ORBIT   FRAME 11

         DELTAE =      .1108890853446850-003
         E      =      .1191884929325369+001
         DELTP  =      .3541313866088084-006
         RHO    =      .4216646880686133+000

          X AND Y
              DELTAX =     -.6986296872086144-004
              X      =      .6507131820968720+001
              DELTAY =     -.8868259933609064-004
              Y      =      .6591447820599336+001

              DELTAF =      .1799048279178162-007
              FD     =      .1089847815009517+001
              DPDREC =      .6653945903215552-006
              DPDTRA =      .000000000000000
$OBSERV
TOB     =            .2158222200000000000+002,
EOB     =            .0000000000000000000+000,
PHOOB   =            .4272737213999999999+000,
A1OB    =            .6501801490999999998+001,
A2OB    =            .6605069159999999998+001,
FD      =            .1090987500000000000+001,
KIND    =                1,
JMAX    =               12,
```

```
XORHA    =                    ,
STASWI   =                    ,
$END

     THIS IS FOR S-BAND,2-WAY,EARTH ORBIT    FRAME 12

          DELTAE =      .1135297958501588-003
          E      =      .1183726777635199+001
          DELTP  =      .3552965094588214-006
          RHO    =      .4272733661034905+000

           X AND Y
               DELTAX =     -.6877910108914810-004
               X      =      .6501870270101089+001
               DELTAY =     -.9290793662085396-004
               Y      =      .6605162067936620+001

               DELTAF =      .1690107574214611-007
               FD     =      .1090987481098924+001
               DPDREC =      .6990737100077853-006
               DPDTRA =      .0000000000000000

$RECCHA
NR       =            .3379999999999999999-003,
KR       =            .1018700000000000000-002,
#4R      =            .0000000000000000000+000,
VTR      =            .0000000000000000000+000,
C        =            .0000000000000000000+000,
PHIR     =            .4961078591999999999+000,
ROR      =            .9992468999999999998+000,
$END
$OBSERV
TOB      =            .1000000000000000000+001,
EOB      =            .0000000000000000000+000,
PHOOB    =            .2147101860000000000-002,
AIOB     =           -.1797643600000000000+001,
AZOB     =            .5306519599999999999+000,
FD       =           -.1000000000000000000+003,
KIND     =                  1,
JMAX     =                  5,
XORHA    =                  1,
STASWI   =                    ,
$END

     THIS IS FOR S-BAND,2-WAY,EARTH ORBIT    FRAME  1

          F =      .4653933935869639+003
          T =      .8834886652672245+000

          DELTAE/COS(E) =     -.1825696059687368-001

           DELTAE =     -.1821177382485175-001
           E      =      .8858314823078947-001
           DELTP  =      .4896947856020001-005
           RHO    =      .2142204652143980-002

            HA AND D
                DELTAH =     -.1813913012878368-001
                HA     =     -.1779504469871216+001
```

```
            DELTAD =     -.9322852194966233-002
            D      =      .5399748121949662+000
$OBSERV
TOB     =            .2000000000000000+001,
EOB     =            .0000000000000000+000,
PHOOB   =            .2163902100000000-002,
A1OB    =           -.1745608800000000+001,
A2OB    =            .5535970199999999+000,
FD      =           -.1000000000000000+003,
KIND    =                  1,
JMAX    =                  5,
XORHA   =                  1,
STASWI  =                   ,
$END

     THIS IS FOR S-BAND,2-WAY,EARTH ORBIT   FRAME  2

        F =      .4617800870011633+003
        T =      .9468447680488748+000

        DELTAE/COS(E) =     -.7247421133109335-002

         DELTAE =     -.7194918563949226-002
         E      =      .1276363909002008+000
         DELTP  =      .2865744375686505-005
         RHO    =      .2161036355624313-002

          HA AND D
            DELTAH =     -.7378625186734731-002
            HA     =     -.1738230174813265+001
            DELTAD =     -.3517361060302524-002
            D      =      .5571143810603025+000
$OBSERV
TOB     =            .3000000000000000+001,
EOB     =            .0000000000000000+000,
PHOOB   =            .2208983399999999-002,
A1OB    =           -.1675369700000000+001,
A2OB    =            .5785291699999999+000,
FD      =           -.1000000000000000+003,
KIND    =                  1,
JMAX    =                  5,
XORHA   =                  1,
STASWI  =                   ,
$END

     THIS IS FOR S-BAND,2-WAY,EARTH ORBIT   FRAME  3

         DELTAE =      .1811534505042727-002
         E      =      .1826495890837501+000
         DELTP  =      .1877257436503518-005
         RHO    =      .2207106142563496-002

          HA AND D
            DELTAH =      .1925046926991862-002
            HA     =     -.1677294746926991+001
            DELTAD =      .8269360031797138-003
            D      =      .5777022339968202+000
$OBSERV
```

```
TOB      =          .40000000000000000+001,
EOB      =          .00000000000000000+000,
PHOOB    =          .22977459999999999-002,
A1OB     =         -.15877148000000000+001,
A2OB     =          .60035936999999999+000,
FD       =         -.10000000000000000+003,
KIND     =                1,
JMAX     =                5,
XORHA    =                1,
STASWI   =                 ,
$END
```

THIS IS FOR S-BAND,2-WAY,EARTH ORBIT FRAME 4

```
DELTAE =      .1272919187667831-002
E      =      .2582692667732476+000
DELTP  =      .1341658166083727-005
RHO    =      .2296404341833916-002

 HA AND D
     DELTAH =      .1403514158473942-002
     HA     =     -.1589118314158473+001
     DELTAD =      .5283574332864345-003
     D      =      .5998310125667135+000
$OBSERV
TOB      =          .50000000000000000+001,
EOB      =          .00000000000000000+000,
PHOOB    =          .24447501999999999-002,
A1OB     =         -.14910996000000000+001,
A2OB     =          .61417939999999999+000,
FD       =         -.10000000000000000+003,
KIND     =                1,
JMAX     =                5,
XORHA    =                1,
STASWI   =                 ,
$END
```

THIS IS FOR S-BAND,2-WAY,EARTH ORBIT FRAME 5

```
DELTAE =      .9618375994303290-003
E      =      .3369691545993680+000
DELTP  =      .1038562310673419-005
RHO    =      .2443711637689326-002

 HA AND D
     DELTAH =      .1093602722489707-002
     HA     =     -.1492193202722489+001
     DELTAD =      .3554641753537371-003
     D      =      .6138239358246462+000
$RECCHA
NR       =          .35557999999999298-003,
KR       =          .96659999999999696-003,
W4R      =          .10359729000000000+001,
VTR      =          .21064059999999900+004,
C        =          .16721058000000000+006,
PHIR     =          .46483105258946539+000,
ROR      =          .99933180496819269 6+000,
$END
```

```
$OBSERV
TOB     =          .21546389000000000+002,
EOB     =          .00000000000000000+000,
PHOOB   =          .54217176899999998+000,
A1OB    =          .48153457639999999+001,
A2OB    =          .65505943299999998+001,
FD      =         -.10000000000000000+003,
KIND    =                3,
JMAX    =               12,
XORHA   =                ,
STASWI  =                ,
$END
$TRACHA
NT      =          .27860000000000000-003,
KT      =          .11810000000000000-002,
W4T     =          .10859729000000000+001,
VTT     =          .21064060000000000+004,
C       =          .16921058000000000+006,
PHIT    =          .00000000000000000+000,
ROT     =          .00000000000000000+000,
$END
$LTR
XR      =         -.30227702000000000+000,
YR      =          .84189345999999998+000,
ZR      =          .44554243999999999+000,
XT      =          .26436272000000000+000,
YT      =          .77281704999999998+000,
ZT      =          .57527305999999998+000,
XV      =          .38780497999999999+000,
YV      =          .10657403000000000+001,
ZV      =          .65770700999999999+000,
TTR     =          .21546382000000000+002,
$END

     THIS IS FOR S-BAND,3-WAY    FRAME  1

       E AND ETR
       E     =      .98639311323037 71-001
       ETR   =      .12055758137150 02+001

        F =      .18432014761878 77+001
        T =      .92716628689021 45+000

        DELTAE/COS(E) =      .32899426205666 76-002

         DELTAE =      .32739504934886 28-002
         E      =      .95365360829549 08-001
         DELTP  =      .36097437412562 28-005
         RHO    =      .54216815925625 87+000

          X AND Y
              DELTAX =      .33933343764754 91-002
              X      =      .48119524296235 24+001
              DELTAY =     -.89349347184369 37-004
              Y      =      .65506836793471 84+001
$OBSERV
TOB     =          .21548056000000000+002,
EOB     =          .00000000000000000+000,
```

```
PHOOB    =          .54232279909999998+000,
A1OB     =          .48264675139999999+001,
A2OB     =          .65519609449999998+001,
FD       =          .10024506670000000+001,
KIND     =               3,
JMAX     =              12,
XORHA    =                ,
STASW    =                ,
$END
$LTR
XR       =         -.30264533000000000+000,
YR       =          .84176111999999998+000,
ZR       =          .44554244999999999+000,
XT       =          .26402457999999999+000,
YT       =          .77293262999999998+000,
ZT       =          .57527305999999998+000,
XV       =          .38130212999999999+000,
YV       =          .10709610000000000+001,
ZV       =          .66134555999999999+000,
TTR      =          .21548049000000000+002,
$END

     THIS IS FOR S-BAND,3-WAY   FRAME  2

       E AND ETR
       E     =      .10931608347434 30+000
       ETR   =      .12173300156814 16+001

        F =      .18426881676864 99+001
        T =      .93778410179278 41+000

        DELTAE/COS(E) =      .30073777538980 81-002

         DELTAE =      .29894265497396 02-002
         E      =      .10632665692460 34+000
         DELTP  =      .32388064955392 67-005
         RHO    =      .54231956029350 44+000

          X AND Y
              DELTAX =      .30993194519340 91-002
              X      =      .48233681945480 65+001
              DELTAY =     -.90913611576018 42-004
              Y      =      .65520518586115 75+001

              DELTAF =     -.30213326402156 13-005
              FD     =      .10024536883326 40+001
              DPDREC =     -.22256234743017 44-003
              DPDTRA =     -.93119831055327 44-006
$OBSERV
TOB      =          .21549722000000000+002,
EOB      =          .00000000000000000+000,
PHOOB    =          .54259475199999999+000,
A1OB     =          .48376483919999999+001,
A2OB     =          .65532913209999998+001,
FO       =          .10044108330000000+001,
KIND     =               3,
JMAX     =              12,
XORHA    =                ,
```

```
STASWI  =                  ,
$END
$LTR
XR      =          -.30301358000000000+000,
YR      =           .84162861999999998+000,
ZR      =           .44554246999999999+000,
XT      =           .26368638999999999+000,
YT      =           .77304806999999998+000,
ZT      =           .57527306999999998+000,
XV      =           .37479000999999999+000,
YV      =           .10761557000000000+001,
ZV      =           .66496799999999998+000,
TTR     =           .21549716000000000+002,
$END

     THIS IS FOR S-BAND,3-WAY   FRAME  3

       E AND ETR
       E     =      .12004676469679 71+000
       ETR   =      .12275857562946 86+001

        F =      .18417645973991 88+001
        T =      .94655205369893 21+000

        DELTAE/COS(E) =      .27684275068099 55-002

         DELTAE =      .27485032349891 32-002
         E      =      .11729826146180 80+000
         DELTP  =      .29370634318023 15-005
         RHO    =      .54259181493656 81+000

          X AND Y
              DELTAX =      .28502974705979 85-002
              X      =      .48347980945294 02+001
              DELTAY =     -.92295780567260 42-004
              Y      =      .65533836167805 67+001

              DELTAF =     -.24580715077579 44-005
              FD     =      .10044132918715 07+001
              DPDREC =     -.18104583824217 10-003
              DPDTRA =     -.78224306233402 52-006
$OBSERV
T0B     =           .21556389000000000+002,
E0B     =           .00000000000000000+000,
PHI0B   =           .54483601909999998+000,
A10B    =           .48830204009999999+001,
A20B    =           .65583515169999998+001,
FD      =          -.10000000000000000+001,
KIND    =                3,
JMAX    =               12,
XORHA   =                ,
STASWI  =                ,
$END
$LTR
XR      =          -.30448603000000000+000,
YR      =           .84109700999999998+000,
ZR      =           .44554251999999999+000,
XT      =           .26233311000000000+000,
```

```
YT      =          .77350833999999998+000,
ZT      =          .57527307999999998+000,
XV      =          .34865368999999999+000,
YV      =          .10966764000000000+001,
ZV      =          .67929804999999998+000,
TTR     =          .21556382000000000+002,
$END

     THIS IS FOR S-BAND,3-WAY   FRAME  4

       E AND ETR
       E    =      .16348218171385 45+000
       ETR  =      .12532046400761 30+001

        F =      .18341882143162 30+001
        T =      .97028187777780 46+000

        DELTAE/COS(E) =      .20965537265313 59-002

         DELTAE =      .20685993781567 11-002
         E      =      .16141358233569 78+000
         DELTP  =      .21387301109467 98-005
         RHO    =      .54483388036988 90+000

          X AND Y
              DELTAX =      .21471102692590 10-002
              X      =      .48808732907307 40+001
              DELTAY =     -.96739612002327 93-004
              Y      =      .65584482566120 02+001
$OBSERV
TOB     =          .21558056000000000+002,
EOB     =          .00000000000000000+000,
PHOOB   =          .54567096229999999+000,
AIOB    =          .48945016859999998+001,
A2OB    =          .65595502849999998+001,
FD      =          .10135458330400000+001,
KIND    =                3,
JMAX    =               12,
XORHA   =                 ,
STASWI  =                 ,
$END
$LTR
XR      =         -.30485398999999999+000,
YR      =          .84096369999999998+000,
ZR      =          .44554253999999999+000,
XT      =          .26199467000000000+000,
YT      =          .77362303999999998+000,
ZT      =          .57527307999999998+000,
XV      =          .34209881999999999+000,
YV      =          .11017428000000000+001,
ZV      =          .68284097999999998+000,
TTR     =          .21558049000000000+002,
$END

     THIS IS FOR S-BAND,3-WAY   FRAME  5

       E AND ETR
       E    =      .17446239130735 72+000
```

```
ETR  =      .1255827141411655+001

 F =      .1831381682389722+001
 T =      .9744093586866712+000

 DELTAE/COS(E) =      .1976007717592881-002

  DELTAE =      .1946011917760941-002
  E      =      .1725163793895962+000
  DELTP  =      .2002325081834349-005
  RHO    =      .5456689599749181+000

   X AND Y
       DELTAX =      .2020219825865685-002
       X      =      .4892481466174134+001
       DELTAY =     -.9766012314904774-004
       Y      =      .6559647945123149+001

       DELTAF =     -.1108817760134669-005
       FD     =      .1013546941817760+001
       DPDREC =     -.8184301746746929-004
       DPDTRA =     -.1782765450642373-006
$OBSERV
TOB      =            .2155972200000000000+002,
EQB      =            .0000000000000000000+000,
PHOOB    =            .5466105405999999999+000,
A1OB     =            .4906054496999999999+001,
A2OB     =            .6560712813999999998+001,
FD       =            .1015242500000000000+001,
KIND     =                 3,
JMAX     =                12,
XORHA    =                  ,
STASWI   =                  ,
$END
$LTR
XR       =           -.3052219000000000000+000,
YR       =            .8408302399999999998+000,
ZR       =            .4455425499999999999+000,
XT       =            .2616561800000000000+000,
YT       =            .7737375899999999998+000,
ZT       =            .5752730799999999998+000,
XV       =            .3355361000000000000+000,
YV       =            .1106783900000000000+001,
ZV       =            .6863681999999999998+000,
TTR      =            .2155971600000000000+002,
$END

 THIS IS FOR S-BAND,3-WAY   FRAME  6

  E AND ETR
  E    =      .1854880526383382+000
  ETR  =      .1257037315374177+001

    DELTAE =      .1895067491684959-002
    E      =      .1835929851466533+000
    DELTP  =      .1882759970874322-005
    RHO    =      .5466086578400291+000
```

```
          X AND Y
              DELTAX =      .1967627288632978-002
              X      =      .4904086869711367+001
              DELTAY =     -.1016822580025611-003
              Y      =      .6560814496258002+001

              DELTAF =     -.9709200956372828-006
              FD     =      .1015243470920095+001
              DPDREC =     -.7173906657601658-004
              DPDTRA =     -.8168295569246709-007
$OBSERV
TOB      =            .2156805600000000000+002,
EOB      =            .0000000000000000000+000,
PHOOB    =            .5527894488999999998+000,
A1OB     =            .4964549064999999999+001,
A2OB     =            .6566061019999999998+001,
FD       =           -.1000000000000000000+001,
KIND     =                 3,
JMAX     =                12,
XORHA    =                 ,
STASWI   =                 ,
$END
$LTR
XR       =           -.3070605600000000000+000,
YR       =            .8401604899999999998+000,
ZR       =            .4455426199999999999+000,
XT       =            .2599629700000000000+000,
YT       =            .7743081099999999998+000,
ZT       =            .5752730899999999999+000,
XV       =            .3026124300000000000+000,
YV       =            .1131614400000000000+001,
ZV       =            .7037712899999999998+000,
TTR      =            .2156804900000000000+002,
$END

     THIS IS FOR S-BAND,3-WAY   FRAME  7

       E AND ETR
       E    =      .2412402371325117+000
       ETR  =      .1245206318678053+001

         DELTAE =      .1445342718320526-002
         E      =      .2397948944141911+000
         DELTP  =      .1447233883126606-005
         RHO    =      .5527880016661168+000

          X AND Y
              DELTAX =      .1501285838414845-002
              X      =      .4963047779161585+001
              DELTAY =     -.1036714498140796-003
              Y      =      .6566164691449814+001
$OBSERV
TOB      =            .2156972200000000000+002,
EOB      =            .0000000000000000000+000,
PHOOB    =            .5543045210999999999+000,
A1OB     =            .4976388930999999999+001,
A2OB     =            .6567031859999999998+001,
FD       =            .1024579500000000000+001,
```

```
KIND     =                 3,
JMAX     =                12,
XORMA    =                  ,
STASWI   =                  ,
$END
$LTR
XR       =          -.30742810999999999+000,
YR       =           .84002605999999998+000,
ZR       =           .44554262999999999+000,
XT       =           .25962418000000000+000,
YT       =           .77442176999999998+000,
ZT       =           .57527309999999999+000,
XV       =           .29600718000000000+000,
YV       =           .11365065000000000+001,
ZV       =           .70720579999999998+000,
TTR      =           .21569716000000000+002,
$END

     THIS IS FOR S-BAND,3-WAY   FRAME  8

       E AND ETR
       E     =      .25250306994765 89+000
       ETR   =      .12400241141002 68+001

         DELTAE =      .13782416308180 8-002
         E      =      .25112482826457 71+000
         DELTP  =      .13832262618587 33-005
         RHO    =      .55430313787373 81+000

          X AND Y
              DELTAX =      .14315943550554 81-002
              X      =      .49749573366449 44+001
              DELTAY =     -.10403546591177 69-003
              Y      =      .65671358954651 11+001

              DELTAF =     -.51420361102900 73-006
              FD     =      .10245800142036 11+001
              DPDREC =     -.38404572760723 85-004
              DPDTRA =      .36798363051883 81-006
$OBSERV
TOB      =          .21571389000000000+002,
EOB      =          .00000000000000000+000,
PHOOB    =          .55590761199999999+000,
A1OB     =          .49882659909999999+001,
A2OB     =          .65679674149999998+001,
FD       =          .10260056670000000+001,
KIND     =                 3,
JMAX     =                12,
XORMA    =                  ,
STASWI   =                  ,
$END
$LTR
XR       =          -.30779561000000000+000,
YR       =           .83989145999999998+000,
ZR       =           .44554264999999999+000,
XT       =           .25928532999999999+000,
YT       =           .77453527999999998+000,
ZT       =           .57527309999999999+000,
```

```
XV      =          .28939558000000000+000,
YV      =          .11413741000000000+001,
ZV      =          .71062510999999998+000,
TTR     =          .21571382000000000+002,
SEND

     THIS IS FOR S-BAND,3-WAY   FRAME  9

       E AND ETR
       E     =     .26379879184264980+000
       ETR   =     .12341584077374164+001

         DELTAE =      .13165820908074340-002
         E      =      .26248220975184240+000
         DELTP  =      .13246681590803450-005
         RHO    =      .55590628733184090+000

           X AND Y
               DELTAX =      .13675171236064760-002
               X      =      .49868984738743930+001
               DELTAY =     -.10438505845295410-003
               Y      =      .65680718000584520+001

               DELTAF =     -.46923234624854330-006
               FD     =      .10260061362323460+001
               DPDREC =     -.35134861667032980-004
               DPDTRA =      .42487990486466180-006
SOBSERV
TOB     =          .21628056000000000+002,
EOB     =          .00000000000000000+000,
PHOOB   =          .65128082249999999+000,
A1OB    =          .53989191059999999+001,
A2OB    =          .65757150649999999+001,
FD      =         -.10000000000000000+001,
KIND    =                3,
JMAX    =               12,
XORHA   =                 ,
STASWI  =                 ,
SEND
SLTR
XR      =         -.32025497000000000+000,
YR      =          .83521981999999998+000,
ZR      =          .44554311999999999+000,
XT      =          .24773575000000000+000,
YT      =          .77830628999999998+000,
ZT      =          .57527319999999998+000,
XV      =          .62086762999999998-001,
YV      =          .12932908000000000+001,
ZV      =          .81836471999999998+000,
TTR     =          .21628048000000000+002,
SEND

     THIS IS FOR S-BAND,3-WAY   FRAME 10

       E AND ETR
       E     =     .65133166362231180+000
       ETR   =     .97314151279093940+000
```

```
        DELTAE =      .4664782535175207-003
        E      =      .6508651853687943+000
        DELTP  =      .5673166816468530-006
        RHO    =      .6512802553833183+000

         X AND Y
            DELTAX =      .4741145656802935-003
            X      =      .5398444991434319+001
            DELTAY =     -.1072870747360817-003
            Y      =      .6575822352074736+001
$OBSERV
TOB     =            .2162972200000000000+002,
EOB     =            .0000000000000000000+000,
PHOOB   =            .6550396297999999999+000,
AIOB    =            .5410615920999999998+001,
A2OB    =            .6575223922999999998+001,
FD      =            .1060977333000000000+001,
KIND    =                 3,
JMAX    =                12,
XORHA   =                  ,
STASWI  =                  ,
$END
$LTR
XR      =           -.3206203499999999999+000,
YR      =            .8350796099999999998+000,
ZR      =            .4455431299999999999+000,
XT      =            .2473952100000000000+000,
YT      =            .7784145999999999998+000,
ZT      =            .5752731999999999998+000,
XV      =            .5535925799999999999-001,
YV      =            .1297386400000000000+001,
ZV      =            .8212986699999999998+000,
TTR     =            .2162971400000000000+002,
$END

     THIS IS FOR S-BAND,3-WAY   FRAME 11

       E AND ETR
       E    =      .6623335937137409+000
       ETR  =      .9669022041297284+000

        DELTAE =      .4559845921449430-003
        E      =      .6618776091215960+000
        DELTP  =      .5592637191773971-006
        RHO    =      .6550390705362808+000

         X AND Y
            DELTAX =      .4628259155837920-003
            X      =      .5410153095084416+001
            DELTAY =     -.1070965433602422-003
            Y      =      .6575331019643360+001

            DELTAF =     -.5148596475470953-007
            FD     =      .1060977389485964+001
            DPDREC =     -.4831777481673542-005
            DPDTRA =      .1023265745577180-005
$OBSERV
TOB     =            .2163138900000000000+002,
```

```
EOB      =          .0000000000000000000+000,
PHOOB    =          .6588420348999999998+000,
AIOB     =          .5422264098999999999+001,
A2OB     =          .6574696540999999998+001,
FD       =          .1061685000000000000+001,
KIND     =               3,
JMAX     =              12,
XORHA    =                ,
STASWI   =                ,
$END
$LTR
XR       =         -.3209856800000000000+000,
YR       =          .8349392499999999998+000,
ZR       =          .4455431499999999999+000,
XT       =          .2470546300000000000+000,
YT       =          .7785227599999999998+000,
ZT       =          .5752731999999999998+000,
XV       =          .4863091299999999999-001,
YV       =          .1301462300000000000+001,
ZV       =          .8242200799999999998+000,
TTR      =          .2163138100000000000+002,
$END

     THIS IS FOR S-BAND,3-WAY   FRAME 12

       E AND ETR
       E      =      .6732858093290383+000
       ETR    =      .9607701644321250+000

         DELTAE =      .4458283706040746-003
         E      =      .6728399809584343+000
         DELTP  =      .5515367623031425-006
         RHO    =      .6588414833632376+000

          X AND Y
             DELTAX =      .4518891678311109-003
             X      =      .5421812209832168+001
             DELTAY =     -.1068929450702586-003
             Y      =      .6574803433945070+001

             DELTAF =     -.4883947109549744-007
             FD     =      .1061685048839471+001
             DPDREC =     -.4636174124552712-005
             DPDTRA =      .1023428403692413-005
$RECCHA
NR       =          .3555999999999999298-003,
KR       =          .9665999999999999696-003,
W4R      =          .1085972900000000000+001,
VTR      =          .2106405999999999900+004,
C        =          .1692105800000000000+006,
PHIR     =          .4648310525894653 98+000,
ROR      =          .9993318049681926 96+000,
$END
$OBSERV
TOB      =          .2154638900000000000+002,
EOB      =          .0000000000000000000+000,
PHOOB    =          .5421717689999999998+000,
AIOB     =          .4815345763999999999+001,
```

```
AZOB     =          .655059432999999998+001,
FD       =         -.100000000000000000+003,
KIND     =                 3,
JMAX     =                12,
XORMA    =                 1,
STASWI   =                  ,
SEND
STRACHA
NT       =          .278600000000000000-003,
KT       =          .118100000000000000-002,
W4T      =          .108597290000000000+001,
VTT      =          .210640600000000000+004,
C        =          .169210580000000000+006,
PHIT     =          .000000000000000000+000,
ROT      =          .000000000000000000+000,
SEND
SLTR
XR       =         -.302277020000000000+000,
YR       =          .841893459999999998+000,
ZR       =          .445542439999999999+000,
XT       =          .264362720000000000+000,
YT       =          .772817049999999998+000,
ZT       =          .575273059999999998+000,
XV       =          .387804979999999999+000,
YV       =          .106574030000000000+001,
ZV       =          .657707009999999999+000,
TTR      =          .215463820000000000+002,
SEND

     THIS IS FOR S-BAND,3-WAY    FRAME  1

       E AND ETR
       E     =      .986393113230377 1-001
       ETR   =      .120557581371500 2+001

        F =      .184320147618787 7+001
        T =      .927166286890214 5+000

        DELTAE/COS(E) =      .328994262056667 6-002

         DELTAE =      .327395049348862 8-002
         E      =      .953653608295490 8-001
         DELTP  =      .360974374125622 5-005
         RHO    =      .542168159256258 7+000

          HA AND D
              DELTAH =      .308521202702635 7-002
              HA     =      .481226055197297 3+001
              DELTAD =      .136557533386795 4-002
              D      =      .654922875466613 2+001
SOBSERV
TOB      =          .215480560000000008+002,
EOB      =          .000000000000000000+000,
PHOOB    =          .542322799099999998+000,
AIOB     =          .482646751399999999+001,
AZOB     =          .655196094499999998+001,
FD       =          .100245066700000000+001,
KIND     =                 3,
```

```
JMAX     =                12,
XORMA    =                 1,
STASWI   =                  ,
$END
$LTR
XR       =          -.30264533000000000+000,
YR       =           .84176111999999998+000,
ZR       =           .44554244999999999+000,
XT       =           .26402457999999999+000,
YT       =           .77293262999999998+000,
ZT       =           .57527305999999998+000,
XV       =           .38130212999999999+000,
YV       =           .10709610000000000+001,
ZV       =           .66134555999999999+000,
TTR      =           .21548049000000000+002,
$END

     THIS IS FOR S-BAND,3-WAY   FRAME  2

       E AND ETR
       E     =      .10931608347434 30+000
       ETR   =      .12173300156814 16+001

        F =      .18426881676864 99+001
        T =      .93778410179278 41+000

        DELTAE/COS(E) =      .30073777538980 81-002

         DELTAE =      .29894265497396 02-002
         E      =      .10632665692460 34+000
         DELTP  =      .32388064955392 67-005
         RHO    =      .54231956029350 44+000

          HA AND D
              DELTAH =      .28210476770220 57-002
              HA     =      .48236464663229 77+001
              DELTAD =      .12407904269179 22-002
              D      =      .65507201545730 82+001

              DELTAF =     -.30213326402156 13-005
              FD     =      .10024536883326 40+001
              DPDREC =     -.22256234743017 44-003
              DPDTRA =     -.93119831055327 44-006
$OBSERV
TOB      =           .21549722000000000+002,
EOB      =           .00000000000000000+000,
PHOOB    =           .54259475199999999+000,
A1OB     =           .48376483919999999+001,
A2OB     =           .65532913209999998+001,
FB       =           .10044108330000000+001,
KIND     =                3,
JMAX     =               12,
XORMA    =                1,
STASWI   =                 ,
$END
$LTR
XR       =          -.30301358000000000+000,
YR       =           .84162861999999998+000,
```

```
ZR      =          .44554246999999999+000,
XT      =          .26368638999999999+000,
YT      =          .77304806999999998+000,
ZT      =          .57527306999999998+000,
XV      =          .37479000999999999+000,
YV      =          .10761557000000000+001,
ZV      =          .66496799999999998+000,
TTR     =          .21549716000000000+002,
$END

     THIS IS FOR S-BAND,3-WAY   FRAME  3

      E AND ETR
      E     =      .12004676469679 71+000
      ETR   =      .12275857562946 86+001

       F =      .18417645973991 88+001
       T =      .94655205369893 21+000

       DELTAE/COS(E) =      .27684275068099 55-002

        DELTAE =      .27485032349891 32-002
        E      =      .11729826146180 80+000
        DELTP  =      .29370634318023 15-005
        RHO    =      .54259181493656 81+000

         HA AND D
             DELTAH =      .25972869054830 76-002
             HA     =      .48350511050945 16+001
             DELTAD =      .11352004088901 51-002
             D      =      .65521561205911 09+001

             DELTAF =     -.24580715077579 44-005
             FD     =      .10044132910715 07+001
             DPDREC =     -.18104583829217 10-003
             DPDTRA =     -.78224306233402 52-006
$OBSERV
T0B     =          .21556389000000000+002,
E0B     =          .00000000000000000+000,
PHOOB   =          .54483601909999999+000,
A10B    =          .48830204009999999+001,
A20B    =          .65583515169999998+001,
FD      =         -.10000000000000000+001,
KIND    =                3,
JMAX    =               12,
XORHA   =                1,
STASWI  =                ,
$END
$LTR
XR      =         -.30448603000000000+000,
YR      =          .84109700999999998+000,
ZR      =          .44554251999999999+000,
XT      =          .26233311000000000+000,
YT      =          .77350833999999998+000,
ZT      =          .57527307999999998+000,
XV      =          .34865368999999999+000,
YV      =          .10966764000000000+001,
ZV      =          .67929804999999998+000,
```

```
TTR      =            .21556382000000000+002,
$END

     THIS IS FOR S-BAND,3-WAY   FRAME  4

       E AND ETR
       E     =      .1634821817138545+000
       ETR   =      .1253204640076130+001

        F =      .1834188214316230+001
        T =      .9702818777778046+000

        DELTAE/COS(E) =      .2096553726531359-002

         DELTAE =      .2068599378156714-002
         E      =      .1614135823356978+000
         DELTP  =      .2138730110946798-005
         RHO    =      .5448338803698890+000

          HA AND D
              DELTAH =      .1965321214207713-002
              HA     =      .4881055079785792+001
              DELTAD =      .8377127508660111-003
              D      =      .6557513804249133+001

$OBSERV
TOB      =            .21558056000000000+002,
EOB      =            .00000000000000000+000,
PHOOB    =            .54567096229999999+000,
A1OB     =            .48945016859999998+001,
A2OB     =            .65595502849999998+001,
FO       =            .10135458330000000+001,
KIND     =                 3,
JMAX     =                12,
XORMA    =                 1,
STASWI   =                  ,
$END
$LTR
XR       =           -.30485398999999999+000,
YR       =            .84096369999999998+000,
ZR       =            .44554253999999999+000,
XT       =            .26199467000000000+000,
YT       =            .77362303999999998+000,
ZT       =            .57527307999999998+000,
XV       =            .34209881999999999+000,
YV       =            .11017428000000000+001,
ZV       =            .68284097999999998+000,
TTR      =            .21558049000000000+002,
$END

     THIS IS FOR S-BAND,3-WAY   FRAME  5

       E AND ETR
       E     =      .1744623913073572+000
       ETR   =      .1255827141411655+001

        F =      .1831381682389722+001
        T =      .9744093586866712+000
```

```
DELTAE/COS(E) =      .197600771759288I-002

 DELTAE =      .194601191776094I-002
 E      =      .172516379389596 2+000
 DELTP  =      .200232508183434 9-005
 RHO    =      .545668959974918I+000

  HA AND D
      DELTAH =      .185125542862052 5-002
      HA     =      .489265043057137 9+001
      DELTAD =      .784204264613121I-003
      D      =      .655876608073538 6+001

      DELTAF =     -.110881776013466 9-005
      FD     =      .101354694181776 0+001
      DPDREC =     -.818430174674692 9-004
      DPDTRA =     -.178276545064237 3-006
$OBSERV
TOB     =          .215597220000000000+002,
EOB     =          .000000000000000000+000,
PHOOB   =          .546610540599999999+000,
AIOB    =          .490605449699999999+001,
AZOB    =          .656071281399999998+001,
FD      =          .101524250000000000+001,
KIND    =                3,
JMAX    =               12,
XORHA   =                1,
STASWI  =                ,
$END
$LTR
XR      =         -.305221900000000000+000,
YR      =          .840830239999999998+000,
ZR      =          .445542549999999999+000,
XT      =          .261656180000000000+000,
YT      =          .773737589999999998+000,
ZT      =          .575273079999999998+000,
XV      =          .335536100000000000+000,
YV      =          .110678390000000000+001,
ZV      =          .686368199999999998+000,
TTR     =          .215597160000000000+002,
$END

     THIS IS FOR S-BAND,3-WAY   FRAME  6

       E AND ETR
       E    =      .185488052638338 2+000
       ETR  =      .125703731537417 7+001

        DELTAE =      .189506749168495 9-002
        E      =      .183592985146653 3+000
        DELTP  =      .188275997087432 8-005
        RHO    =      .546608657840029 1+000

         HA AND D
             DELTAH =      .180509375192112 6-002
             HA     =      .490424940324807 8+001
             DELTAD =      .759936862679323 5-003
             D      =      .655995287713732 0+001
```

```
            DELTAF =     -.9709200956372828-006
            FD     =      .1015243470920095+001
            DPDREC =     -.7173906657601658-004
            DPDTRA =     -.8168295569246709-007
$OBSERV
TOB      =            .2156805600000000000+002,
EOB      =            .0000000000000000000+000,
PHOOB    =            .5527894488999999998+000,
AIOB     =            .4964549064999999999+001,
AZOB     =            .6566061019999999998+001,
FD       =           -.1000000000000000000+001,
KIND     =                 3,
JMAX     =                12,
XORHA    =                 1,
STASWI   =                  ,
$END
$LTR
XR       =           -.3070605600000000000+000,
YR       =            .8401604899999999996+000,
ZR       =            .4455426199999999999+000,
XT       =            .2599629700000000000+000,
YT       =            .7743081099999999998+000,
ZT       =            .5752730899999999999+000,
XV       =            .3026124300000000000+000,
YV       =            .1131619400000000000+001,
ZV       =            .7037712899999999998+000,
TTR      =            .2156804900000000000+002,
$END

     THIS IS FOR S-BAND,3-WAY   FRAME  7

       E AND ETR
       E     =      .2412402371325117+000
       ETR   =      .1245206318678053+001

         DELTAE =      .1445342718320526-002
         B      =      .2397948944141911+000
         DELTP  =      .1447233883126606-005
         RHO    =      .5527880016661168+000

          HA AND D
            DELTAH =      .1385067026812748-002
            HA     =      .4963163997973187+001
            DELTAD =      .5657406554849914-003
            D      =      .6565495279344514+001
$OBSERV
TOB      =            .2156972200000000000+002,
EOB      =            .0000000000000000000+000,
PHOOB    =            .5543045210999999999+000,
AIOB     =            .4976388930999999999+001,
AZOB     =            .6567031859999999998+001,
FD       =            .1024579500000000000+001,
KIND     =                 3,
JMAX     =                12,
XORHA    =                 1,
STASWI   =                  ,
$END
```

```
$LTR
XR      =          -.30742810999999999+000,
YR      =           .84002605999999998+000,
ZR      =           .44554262999999999+000,
XT      =           .25962418000000000+000,
YT      =           .77442176999999998+000,
ZT      =           .57527309999999999+000,
XV      =           .29600718000000000+000,
YV      =           .11365065000000000+001,
ZV      =           .70720579999999998+000,
TTR     =           .21569716000000000+002,
$END

     THIS IS FOR S-BAND,3-WAY   FRAME  8

       E AND ETR
       E     =      .25250306994765 89+000
       ETR   =      .12400241141002 68+001

         DELTAE =      .13782416830818 08-002
         E      =      .25112482826457 71+000
         DELTP  =      .13832262618587 33-005
         RHO    =      .55430313787373 81+000

          HA AND D
              DELTAH =      .13222645297714 78-002
              HA     =      .49750466664702 28+001
              DELTAD =      .53692570536188 36-003
              D      =      .65664494342946 38+001

              DELTAF =     -.51420361102900 73-006
              FD     =      .10245800142036 11+001
              DPDREC =     -.38404572760723 85-004
              DPDTRA =      .36798363051883 81-006
$OBSERV
TOB     =          .21571389000000000+002,
EOB     =          .00000000000000000+000,
PHOOB   =          .55590761199999999+000,
A1OB    =          .49882659909999999+001,
A2OB    =          .65679674149999998+001,
FD      =          .10260056670000000+001,
KIND    =               3,
JMAX    =              12,
XORMA   =               1,
STASWI  =                ,
$END
$LTR
XR      =          -.30779561000000000+000,
YR      =           .83989145999999998+000,
ZR      =           .44554264999999999+000,
XT      =           .25928532999999999+000,
YT      =           .77453527999999998+000,
ZT      =           .57527309999999999+000,
XV      =           .28939558000000000+000,
YV      =           .11413741000000000+001,
ZV      =           .71062510999999998+000,
TTR     =           .21571382000000000+002,
$END
```

```
THIS IS FOR S-BAND,3-WAY   FRAME  9

  E AND ETR
  E     =      .2637987918426498+000
  ETR   =      .1234158407737416+001

    DELTAE =      .1316582090807434-002
    E      =      .2624822097518424+000
    DELTP  =      .1324668159080345-005
    RHO    =      .5559062873318409+000

     HA AND D
         DELTAH =      .1264509401151562-002
         HA     =      .4987001481598848+001
         DELTAD =      .5105049819903605-003
         D      =      .6567456910018009+001

         DELTAF =     -.4692323462485433-006
         FD     =      .1026006136232346+001
         DPDREC =     -.3513486166703298-004
         DPDTRA =      .4248799048646618-006
$OBSERV
T0B      =            .2157805600000000000+002,
E0B      =            .0000000000000000000+000,
PHOOB    =            .5631582088999999998+000,
A1OB     =            .5036178588999999999+001,
A2OB     =            .6571336745999999998+001,
FD       =           -.1000000000000000000+001,
KIND     =                  3,
JMAX     =                 12,
XORHA    =                  1,
STASWI   =                   ,
$END
$LTR
XR       =           -.3092650000000000000+000,
YR       =            .8393514899999999998+000,
ZR       =            .4455426999999999999+000,
XT       =            .2579294799999999999+000,
YT       =            .7749878499999999998+000,
ZT       =            .5752731099999999999+000,
XV       =            .2628896099999999999+000,
YV       =            .1160603400000000000+001,
ZV       =            .7241517699999999998+000,
TTR      =            .2157804900000000000+002,
$END

THIS IS FOR S-BAND,3-WAY   FRAME 10

  E AND ETR
  E     =      .3092713757794950+000
  ETR   =      .1205730215888163+001

    DELTAE =      .1112904387109939-002
    E      =      .3081584713923851+000
    DELTP  =      .1133260820646170-005
    RHO    =      .5631570756391793+000
```

```
          HA AND D
              DELTAH =      .1073322338710063-002
              HA     =      .5035105266661289+001
              DELTAD =      .4237579310954585-003
              D      =      .6570912988068904+001
$OBSERV
TOB      =            .2157972200000000000+002,
EOB      =            .0000000000000000000+000,
PHOOB    =            .5651706274999999998+000,
A1OB     =            .5048234939999999999+001,
A2OB     =            .6572080611999999998+001,
FD       =            .1032648000000000000+001,
KIND     =                 3,
JMAX     =                12,
XORHA    =                 1,
STASWI   =                  ,
$END
$LTR
XR       =           -.3096322000000000000+000,
YR       =            .8392160899999999998+000,
ZR       =            .4455427099999999999+000,
XT       =            .2575903900000000000+000,
YT       =            .7751006199999999998+000,
ZT       =            .5752731099999999999+000,
XV       =            .2562491900000000000+000,
YV       =            .1165351100000000008+001,
ZV       =            .7274961599999999998+000,
TTR      =            .2157971600000000000+002,
$END

     THIS IS FOR S-BAND,3-WAY   FRAME 41

       E AND ETR
       E    =      .3207013695533977+000
       ETR  =      .1197777151539307+001

         DELTAE =      .1070542682974626-002
         E      =      .3196308268704230+000
         DELTP  =      .1093906239580274-005
         RHO    =      .5651695335937604+000

          HA AND D
              DELTAH =      .1033454675050945-002
              HA     =      .5047201485324949+001
              DELTAD =      .4058557111546690-003
              D      =      .6571674756288845+001

              DELTAF =     -.3104108528914676-006
              FD     =      .1032648310410852+001
              DPDREC =     -.2361274863953798-004
              DPDTRA =      .6510855556060224-006
$OBSERV
TOB      =            .2158138900000000000+002,
EOB      =            .0000000000000000000+000,
PHOOB    =            .5672595482999999998+000,
A1OB     =            .5060326575999999999+001,
A2OB     =            .6572788238999999999+001,
FD       =            .1033886833000000000+001,
```

```
KIND     =                 3,
JMAX     =                12,
XORHA    =                 1,
STASWI   =                  ,
$END
$LTR
XR       =          -.309999350000000000+000,
YR       =           .839080529999999998+000,
ZR       =           .445542729999999999+000,
XT       =           .257251260000000000+000,
YT       =           .775213239999999998+000,
ZT       =           .575273119999999999+000,
XV       =           .249603590000000000+000,
YV       =           .117007510000000000+001,
ZV       =           .730825789999999998+000,
TTR      =           .215813820000000000+002,
$END

     THIS IS FOR S-BAND,3-WAY   FRAME 12

       E AND ETR
       E     =      .332151573957611 3+000
       ETR   =      .118961479684731 7+001

         DELTAE =      .103093187618511 7-002
         E      =      .331120642081426 2+000
         DELTP  =      .105727403458000 8-005
         RHO    =      .567258491025965 4+000

          HA AND D
              DELTAH =      .996136846131918 8-003
              HA     =      .505933043945386 8+001
              DELTAD =      .389171232953232 1-003
              D      =      .657239906776704 6+001

              DELTAF =     -.287851243728105 2-006
              FD     =      .103388712085124 3+001
              DPDREC =     -.219793230001591 9-004
              DPDTRA =      .686435798542878 7-006
```

REFERENCES

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