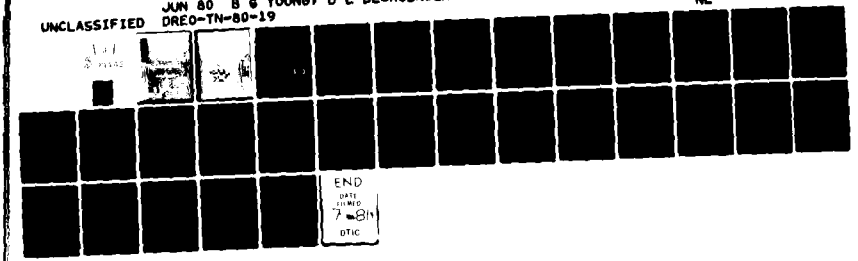
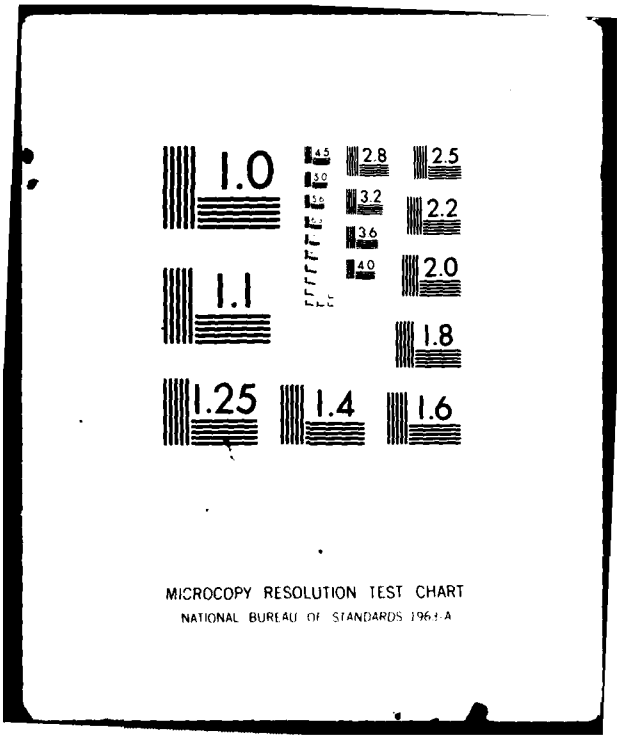
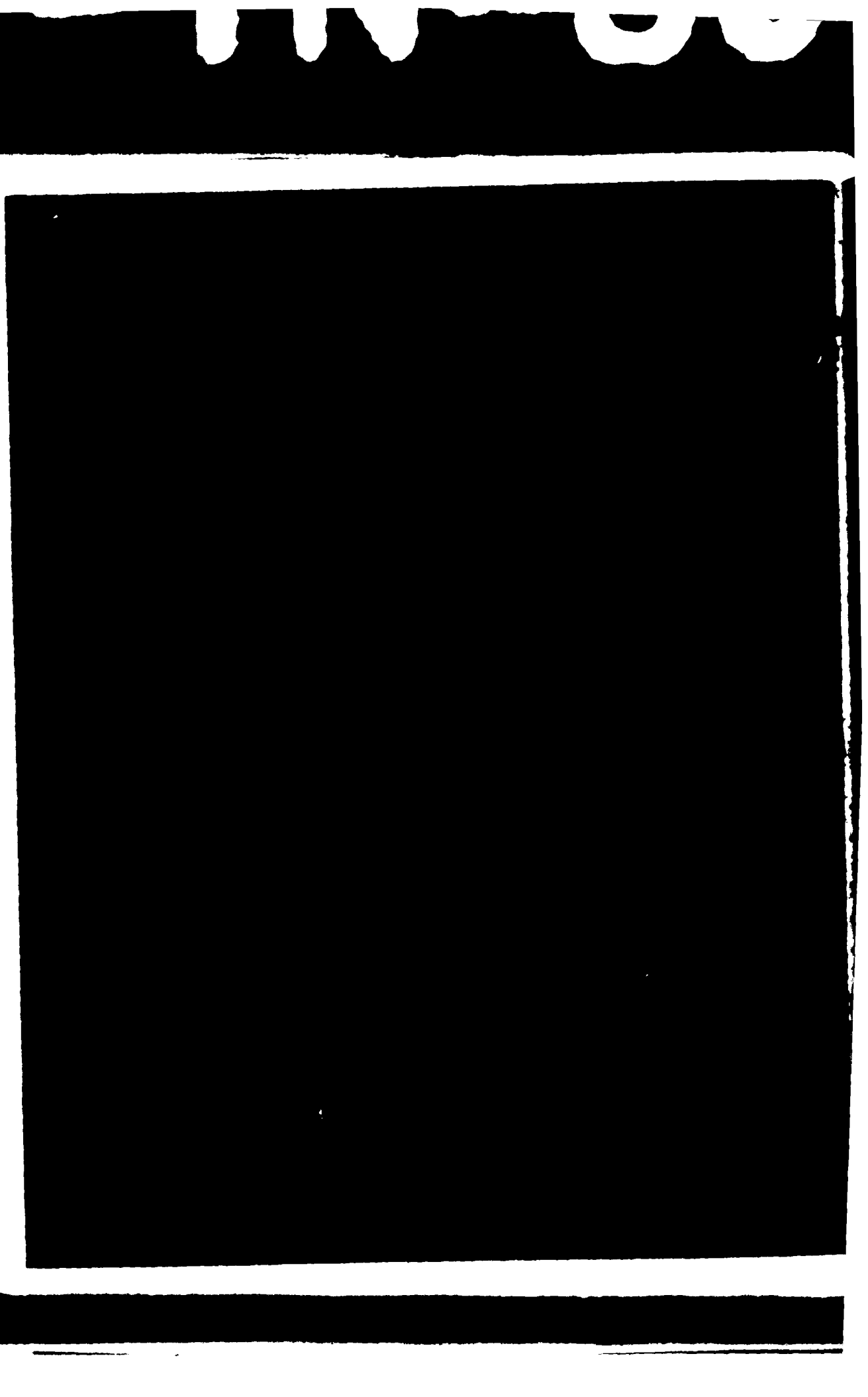
AD-A099 442 DEFENCE RESEARCH ESTABLISHMENT OTTAWA (ONTARIO)
SEASAT EQUATOR CROSSING PROGRAM.(U)
JUN 80 B G YOUNG, D L DESAULNIERS
UNCLASSIFIED DREO-TN-80-19 NL



END
DATE FILMED
7-81
DTIC


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A



RESEARCH AND DEVELOPMENT BRANCH

DEPARTMENT OF NATIONAL DEFENCE
CANADA

DEFENCE RESEARCH ESTABLISHMENT OTTAWA

TECHNICAL NOTE NO. 88-19

SEASAT EQUATOR CROSSING PROGRAM

by

S.G. Young and D.L. Desjardins
Defence Electronics Division

PROJECT NO.
33D00

OTTAWA

ABSTRACT

A programmable pocket calculator is used to extrapolate the SEASAT orbit from the equator crossing to the position at which the synthetic aperture radar images a given target. The program predicts the coordinates of the satellite at image time, the Azimuth direction of the image at the target, and the time elapsed between equator crossing and imaging. Program predictions are compared with measured SEASAT data from the definitive attitude-orbit files.

RÉSUMÉ

Ce rapport décrit le logiciel d'une calculateur de poche programmable pour l'extrapolation de l'orbite du satellite SEASAT à partir de sa traversée au-dessus de l'équateur jusqu'à sa position lorsque le radar à antenne synthétique image une cible. Ce programme permet de prévoir les coordonnées du satellite au moment de la production de l'image, la direction azimuthale de l'image au point de la cible et le temps écoulé entre le passage à l'équateur et celui de la production de l'image. Ces prédictions sont comparées avec les données acquises de SEASAT contenues dans les fichiers à bandes magnétiques des données définitives d'attitudes et d'orbites.

TABLE OF CONTENTS

TABLE OF CONTENTS - Continued

1.0 [illegible]

[illegible] is a program for the [illegible] hand calculator to predict when a given target will be imaged by the [illegible] synthetic aperture radar (SAR) [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible] the satellite [illegible] Table 1 [illegible]

Table 1

[illegible]

[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

[illegible]

[illegible]

i) [illegible]
ii) [illegible]
iii) [illegible]

[illegible]

[illegible]

$$[illegible] \qquad (1)$$

$$[illegible] \qquad (2)$$

$$[illegible] \qquad (3)$$

The equivalent scattering point $\phi_{scatter}$ for an orbit axis (θ_z, ϕ_z) was calculated in three steps. First, the intersection of the Earth orbit plane through θ_z, ϕ_z with the equator was found from the right spherical triangle ABC in Figure 1 (ascending leg only shown). Here $\epsilon = 23°$, $\beta = 77°$ (inclination 103°), $a = \theta_z$, and

$$\phi = \sin^{-1} \frac{\sin\theta_z \sin(\phi_z - \beta)}{\sin \theta_z} \quad (4)$$

$$\phi = \sin^{-1} \frac{\sin \phi}{\cos(\phi_z - \beta)} \quad (5)$$

$$\phi = \sin^{-1} \sin \phi \sin \theta_z \quad (6)$$

Next, the node longitude (measured backward along the equator) and angular distance (measured forward along the orbit) of the ascending node ϕ_{ascend} were found from the orbit plane equation (17). Here ϕ_{ascend} is determined by

$$\phi_{ascend} = \quad (7)$$

The point ϕ^h on the equatorial scattering annulus that is equal distance ϕ from ϕ_{ascend} is found by

$$\phi^h \quad \phi_{ascend}(\phi) = \quad (8)$$

where ϕ = the smaller of [illegible] and [illegible]

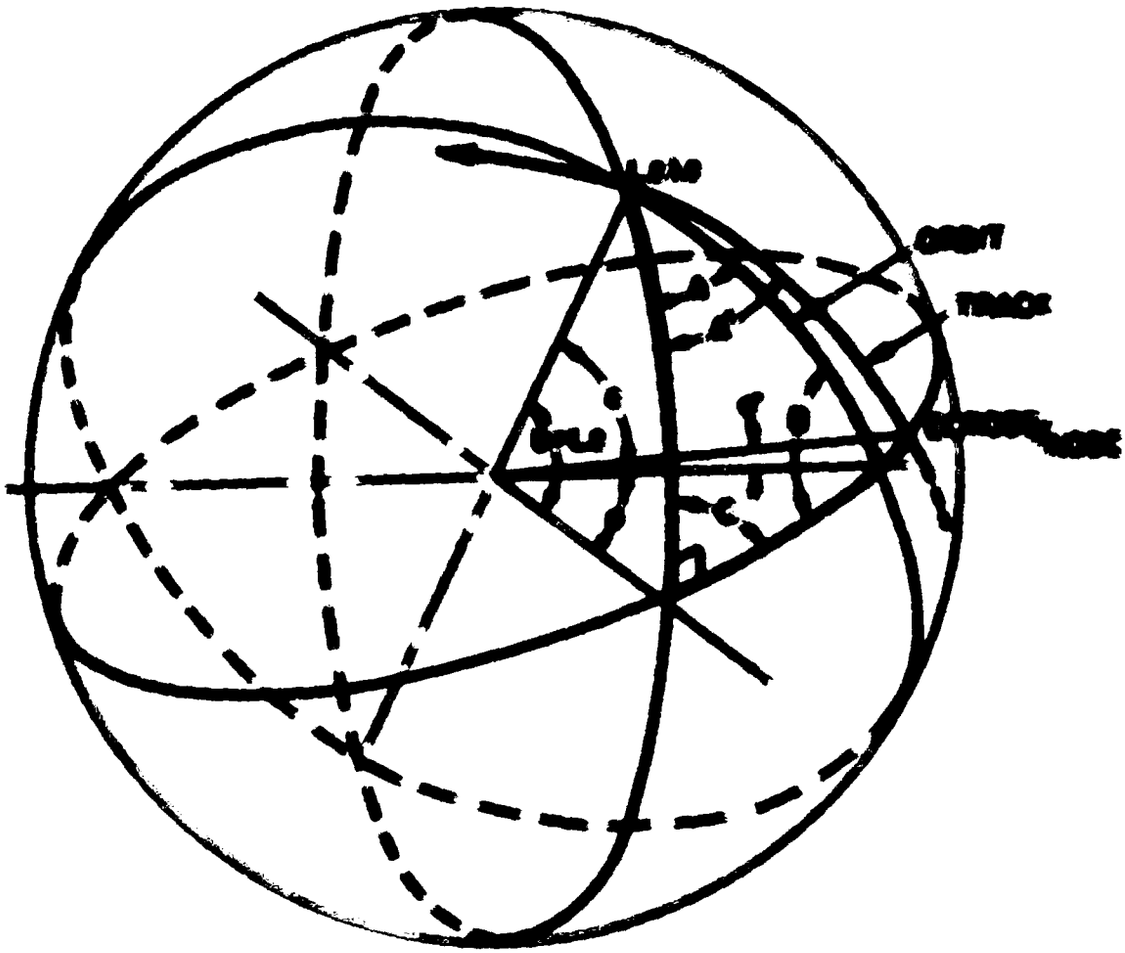
Finally, the equatorial scattering position $\phi_{scatter}$ is computed from either

$$\phi_{scatter}(a) \quad \quad \phi_z \quad (a) = \phi = \phi^{-1} \quad (9)$$

$$\phi_{scatter}(b) \quad \quad \phi_z \quad (b) = \phi = \phi^{-1} \quad (10)$$

$\phi_{scatter}$ is the appropriate combination from the node that the orbit plane is ascending.

In the case of three-axis stabilization a satellite direction ϕ and the gain are constant unless the spacecraft is maneuvering. Here the orbit precesses from ϕ 90° right angle point relative to the sun-earth line. This case is shown in Figure 2. The coordinate ϕ_o about the satellite center of (θ_y, ϕ_y) is the angle of (θ_z, ϕ_z) are calculated using the general spherical coordinate equation given by (17). The point, the maximum of two values for the longitude of each of the great circle angles (θ_y, ϕ_y) or (θ_z, ϕ_z) are found by equation (17). For the ascending leg, only the equation (17) for the descending leg.


ORBIT
TRACK

Finally, [illegible] values of [illegible] were calculated by relations (14) and (15).

$$[illegible] = \cos^{-1}\left[\frac{\sin L_1 - \cos(D/60)\sin L_2}{\sin(D/60)\cos L_2}\right] \quad (11)$$

[illegible] (12)

[illegible] (13)

[illegible] (14)

[illegible] (15)

[illegible] Figure [illegible].

[illegible]

[illegible] (16)

where [illegible]

[illegible] (17)

[illegible] (18)

[illegible] (19)

[illegible]

[illegible]

[illegible]

[illegible] (20)

[illegible]

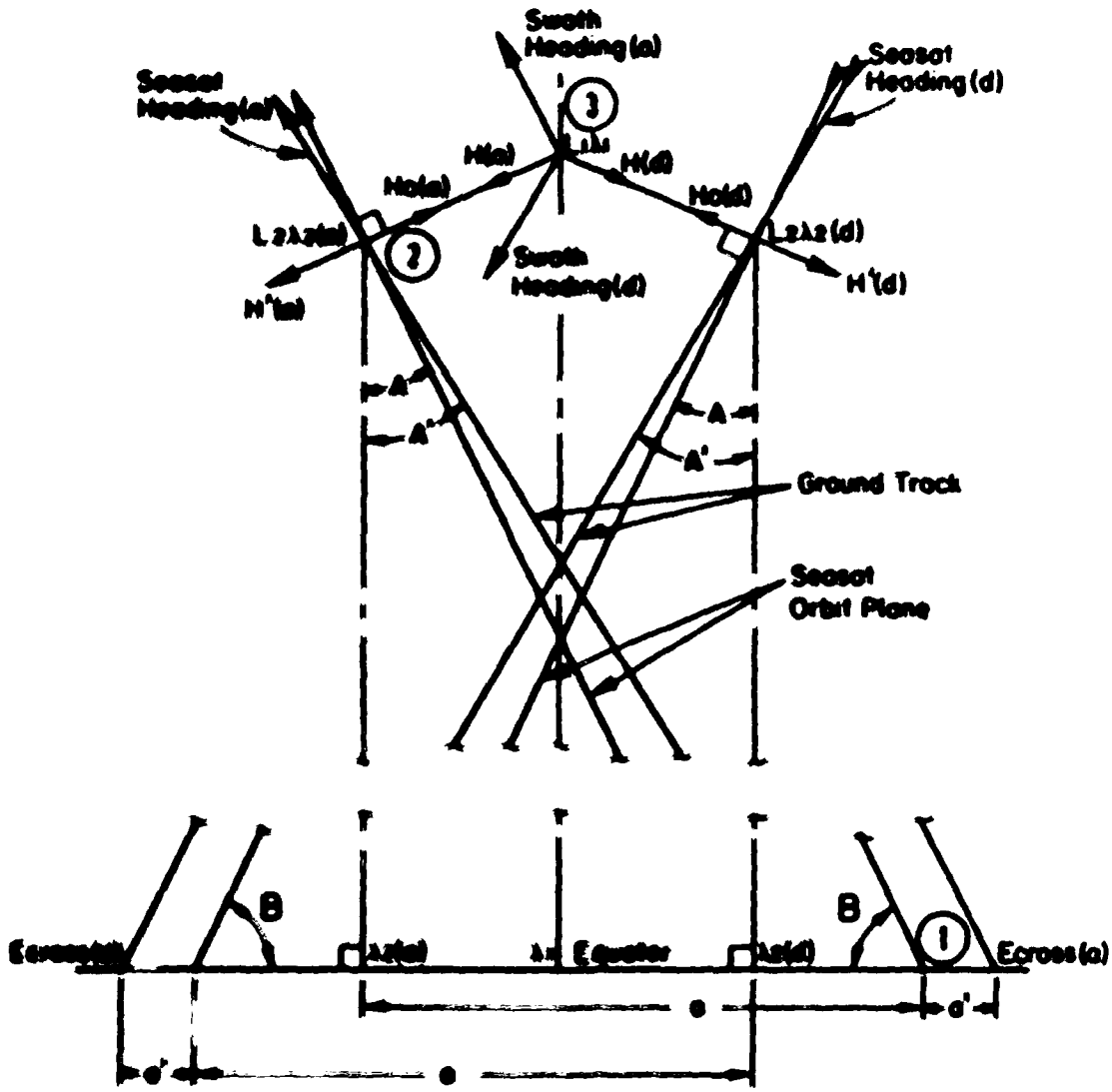
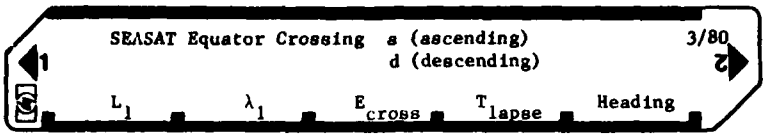

South Heading (a)
Seasat Heading (d)
Seasat Heading (a)
H(a)
H(d)
Ha(a)
Ha(d)
L2λ2(a)
L2λ2(d)
H'(a)
H'(d)
South Heading (d)
A
A'
Ground Track
Seasat Orbit Plane
B
B
Equator
Ecross (a)
a'
a'
a

TABLE II

User Instructions



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Enter program, both sides			
2	Enter latitude of target *	L_1	A	6.0 (I)
3	Change I?	I	h STI	
4	Change D/60? (nm/min)	D/60	STO 6	
5	Change inclination? (dec. deg)	90-B	STO 7	
6	Change T/360? (min/deg)	T/360	STO 8	
7	Enter longitude of target * (W)	λ_1	B	
8	Calculate SEASAT equator crossing (E. Long)		C	E_{cross}
9	Calculate time in minutes between equator crossing and target imaging		D	T_{lapse}
10	Calculate heading of SAR swath at target		E	Swath Heading
	* Enter lat. and long. in the form DDD.MMSS eg. 130.5732 means 130 degrees, 57 minutes, 32 seconds			

TABLE III

PROGRAM LISTING, ASCENDING (a)

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	LBL A	31 25 11	
	DSP 4	23 04	
	H ↑	31 74	
	STO 1	33 01	L_1
	2	02	
	.	83	
	7	07	
	7	07	
	1	01	
010	7	07	
	7	07	
	8	08	
	2	02	
	5	05	
	8	08	
	STO 6	33 06	D/60
	1	01	
	8	08	
	.	83	
020	0	00	
	0	00	
	0	00	
	0	00	
	0	00	
	0	00	
	0	00	
	STO 7	33 07	90-B
	.	83	
	2	02	
030	4	04	
	9	09	
	2	02	
	6	06	
	3	03	
	6	06	
	8	08	
	9	09	
	STO 9	33 09	(W - Ω)/(24 x 60)
	.	83	
040	2	02	
	7	07	
	9	09	
	8	08	
	6	06	
	1	01	
	1	01	
	1	01	
	1	01	
	STO 8	33 08	T/360
050	1	01	
	8	08	
	5	05	
	STO 5	33 05	H initial
	6	06	
	STI	35 33	
	RTN	35 22	

STEP	KEY ENTRY	KEY CODE	COMMENTS
	LBL B	31 25 12	
	H ↑	31 74	
	STO 2	33 02	λ_1
060	RTN	35 22	
	LBL E	31 25 15	
	P/S	31 42	
	RCL 6	34 06	
	P/S	31 42	
	RTN	35 22	
	LBL D	31 25 14	
	P/S	31 42	
	RCL 1	34 01	
	P/S	31 42	
070	RTN	35 22	
	LBL C	31 25 13	
	RCL 1	34 01	
	COS	31 63	
	RCL 6	34 06	
	SIN	31 62	
	X	71	
	RCL 5	34 05	
	COS	31 63	
	X	71	
080	RCL 6	34 06	
	COS	31 63	
	RCL 1	34 01	
	SIN	31 62	
	X	71	
	+	61	
	SIN^{-1}	32 62	
	STO 3	33 03	L_2
	SIN	31 62	
	RCL 1	34 01	
090	SIN	31 62	
	X	71	
	RCL 6	34 06	
	COS	31 63	
	-	51	
	CHS	42	
	RCL 1	34 01	
	COS	31 63	
	RCL 3	34 03	
	COS	31 63	
100	X	71	
	÷	81	
	COS^{-1}	32 63	
	RCL 2	34 02	
	+	61	
	STO 4	33 04	λ_2
	3	03	
	6	06	
	0	00	
	-	51	
110	CHS	42	
	P/S	31 42	
	STO 8	33 08	

REGISTERS

0 a	1 L_1	2 λ_1	3 L_2	4 λ_2	5 H	6 D/60	7 90-B	8 T/360	9 $\frac{W - \Omega}{24 \times 60}$
S0 H^1	S1 T_{lapse}	S2 $a + a^1$	S3 H_o	S4 SEASAT Heading	S5 ΔH	S6 Swath Heading	S7	S8 E_{cross}	S9
A L_1	B λ_1	C E_{cross}	D T_{lapse}	E Swath Heading	I 6				

TABLE III (cont'd)

STEP	KEY ENTRY	KEY CODE	COMMENTS
	P/S	31 42	
	RCL 7	34 07	
	SIN	31 62	
	RCL 3	34 03	
	COS	31 63	
	:	81	
	SIN^{-1}	32 62	A
120	2	02	
	7	07	
	0	00	
	-	51	
	CHS	42	
	P/S	31 42	
	STO 0	33 00	H^1
	P/S	31 42	
	SIN	31 62	
	CHS	42	
130	RCL 7	34 07	
	COS	31 63	
	:	81	
	COS^{-1}	32 63	
	STO 0	33 00	a
	COS	31 63	
	RCL 3	34 03	
	COS	31 63	
	X	71	
	COS^{-1}	32 63	c
140	RCL 8	34 08	
	X	71	
	P/S	31 42	
	STO 1	33 01	T_{lapse}
	P/S	31 42	
	RCL 9	34 09	
	X	71	
	RCL 0	34 00	
	+	61	
	P/S	31 42	
150	STO 2	33 02	$a + a^1$
	STO + 8	33 61 08	F_{cross}
	P/S	31 42	
	RCL 1	34 01	
	SIN	31 62	
	RCL 6	34 06	
	COS	31 63	
	RCL 3	34 03	
	SIN	31 62	
	X	71	
160	-	51	
	RCL 6	34 06	
	SIN	31 62	
	RCL 3	34 03	
	COS	31 63	
	X	71	
	:	81	
	COS^{-1}	32 63	
	P/S	31 42	

STEP	KEY ENTRY	KEY CODE	COMMENTS
	STO 3	33 03	H_o
170	P/S	31 42	
	1	01	
	8	08	
	0	00	
	+	61	
	RCL 5	34 05	
	-	51	
	CHS	42	
	P/S	31 42	
	STO 5	33 05	
180	RCL 0	34 00	
	P/S	31 42	
	+	61	
	STO 5	33 05	H
	RCL 3	34 03	
	COS	31 63	
	RCL 8	34 08	
	X	71	
	RCL 9	34 09	
	X	71	
190	P/S	31 42	
	RCL 0	34 00	
	COS	31 63	
	-	51	
	CHS	42	
	RCL 0	34 00	
	SIN	31 62	
	:	81	
	TAN^{-1}	32 64	A^1
	3	03	
200	6	06	
	0	00	
	-	51	
	CHS	42	
	STO 4	33 04	SEASAT Heading
	RCL 5	34 05	
	+	61	
	STO 6	33 06	Swath Heading
	P/S	31 42	
	DSZ	31 33	
210	GTO C	22 13	
	P/S	31 42	
	RCL 8	34 08	E_{cross}
	P/S	31 42	
	RTN	35 22	
220			

LABELS					FLAGS	SET STATUS		
A L_1	B λ_1	C E_{cross}	D T_{lapse}	E Swath Heading	0	FLAGS ON OFF	TRIG	DISP 4
a	b	c	d	e	1	0	DEG	FIX
f	g	h	i	j	2	1	GRAD	SCI
k	l	m	n	o	3	2	RAD	ENG
p	q	r	s	t		3		n____

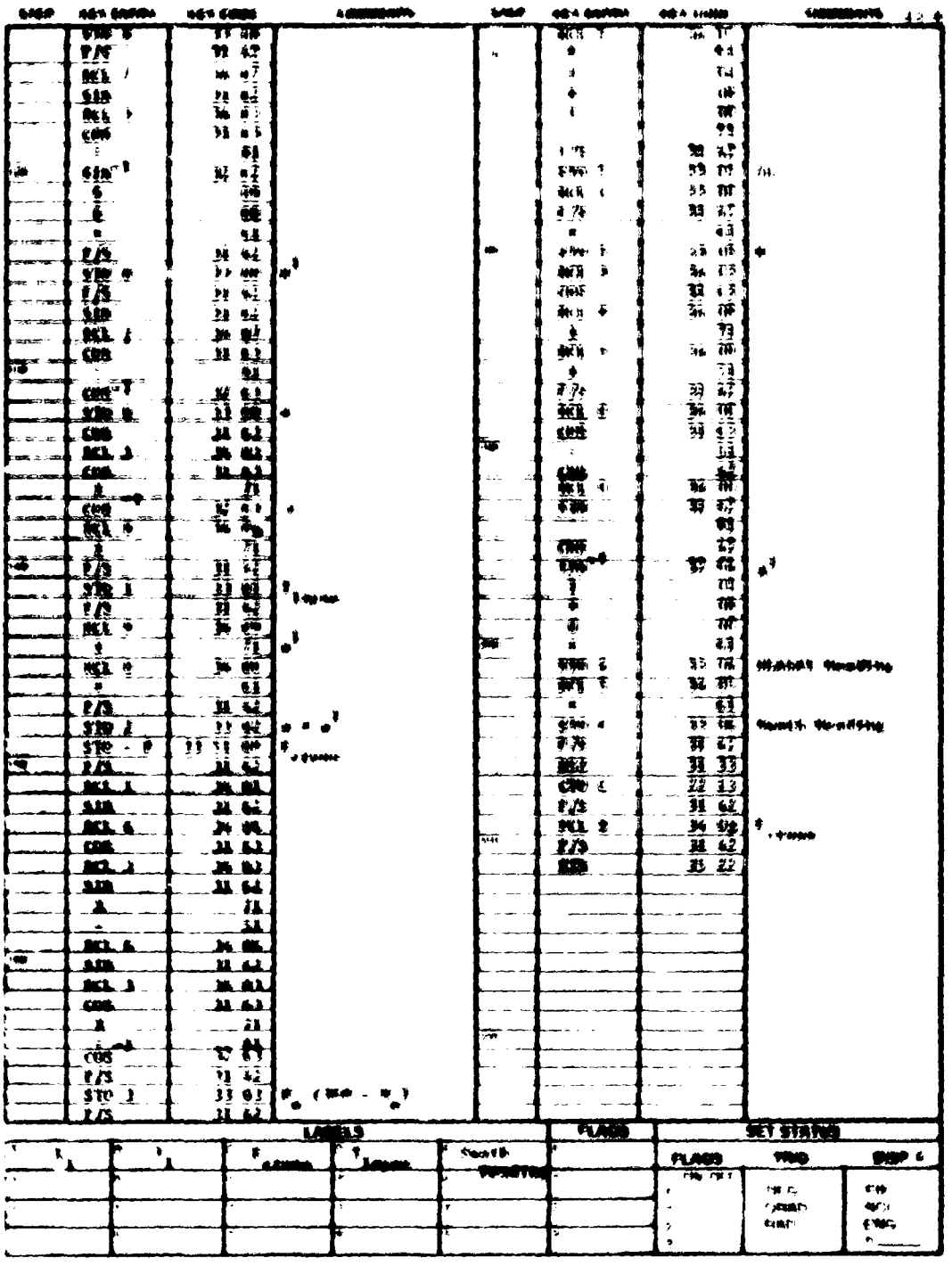
TABLE IV

PROGRAM LISTING, DESCENDING (d)

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
000	LBL A	31 25 11			LBL B	31 25 12	
	DSP 4	23 04			R/S	31 32	
	R/S	31 32			STO 2	33 02	λ_1
	STO 1	33 01	L_1	000	RTN	35 22	
	2	02			LBL E	31 25 15	
	.	81			P/S	31 42	
	7	07			RCL 6	36 06	
	2	02			P/S	31 42	
	1	01			RTN	35 22	
040	2	02			LBL D	31 25 14	
	7	07			P/S	31 42	
	8	08			RCL 1	36 01	
	2	02			P/S	31 42	
	5	05		070	RTN	35 22	
	8	08			LBL C	31 25 13	
	STO 6	33 06	D/60		RCL 1	36 01	
	1	01			COS	31 61	
	8	08			RCL 6	36 06	
	.	81			SIN	31 62	
090	0	00			X	71	
	0	00			RCL 5	36 05	
	0	00			COS	31 61	
	0	00			X	71	
	0	00		000	RCL 6	36 06	
	0	00			COS	31 61	
	0	00			RCL 1	36 01	
	STO 7	33 07	90-B		SIN	31 62	
	.	81			X	71	
	2	02			.	81	
000	4	04			SIN-1	32 62	
	9	09			STO 3	33 03	L_2
	2	02			SIN	31 62	
	6	06			RCL 1	36 01	
	3	03		000	SIN	31 62	
	6	06			X	71	
	8	08			RCL 6	36 06	
	9	09			COS	31 61	
	STO 9	33 09	(M - Ω)/(24 x 60)		-	51	
	.	81			CMS	42	
040	2	02			RCL 1	36 01	
	7	07			COS	31 61	
	9	09			RCL 3	36 03	
	8	08			COS	31 61	
	6	06		000	X	71	
	1	01			.	81	
	1	01			COS-1	32 61	
	1	01			RCL 2	36 02	
	1	01			-	51	
	STO 8	33 08	T/360		CMS	42	
050	1	01			STO 4	33 04	λ_2
	7	07			3	03	
	5	05			6	06	
	STO 5	33 05	H initial		0	00	
	6	06		100	-	51	
	STI	35 33			CMS	42	
	RTN	35 22			R/S	31 42	

REGISTERS

0 A	1 L_1	2 λ_1	3 L_2	4 λ_2	5 M	6 D/60	7 90 - B	8 T/360	9 $\frac{M-\Omega}{24\times60}$
50 H_i	51 T_{lapse}	52 $\alpha + \alpha_i$	53 360 - H_i	54 Sensat Heading	55 ΔH	56 Swath Heading	57	58 E_{cross}	59
A L_1	B λ_1	C E_{cross}	D T_{lapse}	E Swath Heading	F



[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

Given the radius of curvature and the convergence of the [illegible] at Belfast, U.S., find the coordinates of the geographic origin in the north of Antwerp [illegible] and the longitude of the tangent to the geographic mode from the northward.

The geographic coordinates of the Citadel are 44° 39' E, 63° 35' W and the corresponding geocentric latitude L_g, given by equation (28), is 44° 27' 24" N. Using these coordinates with the grid values for north and for range edges of the 500 meter, we find that the scale changes from 313.2779'

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

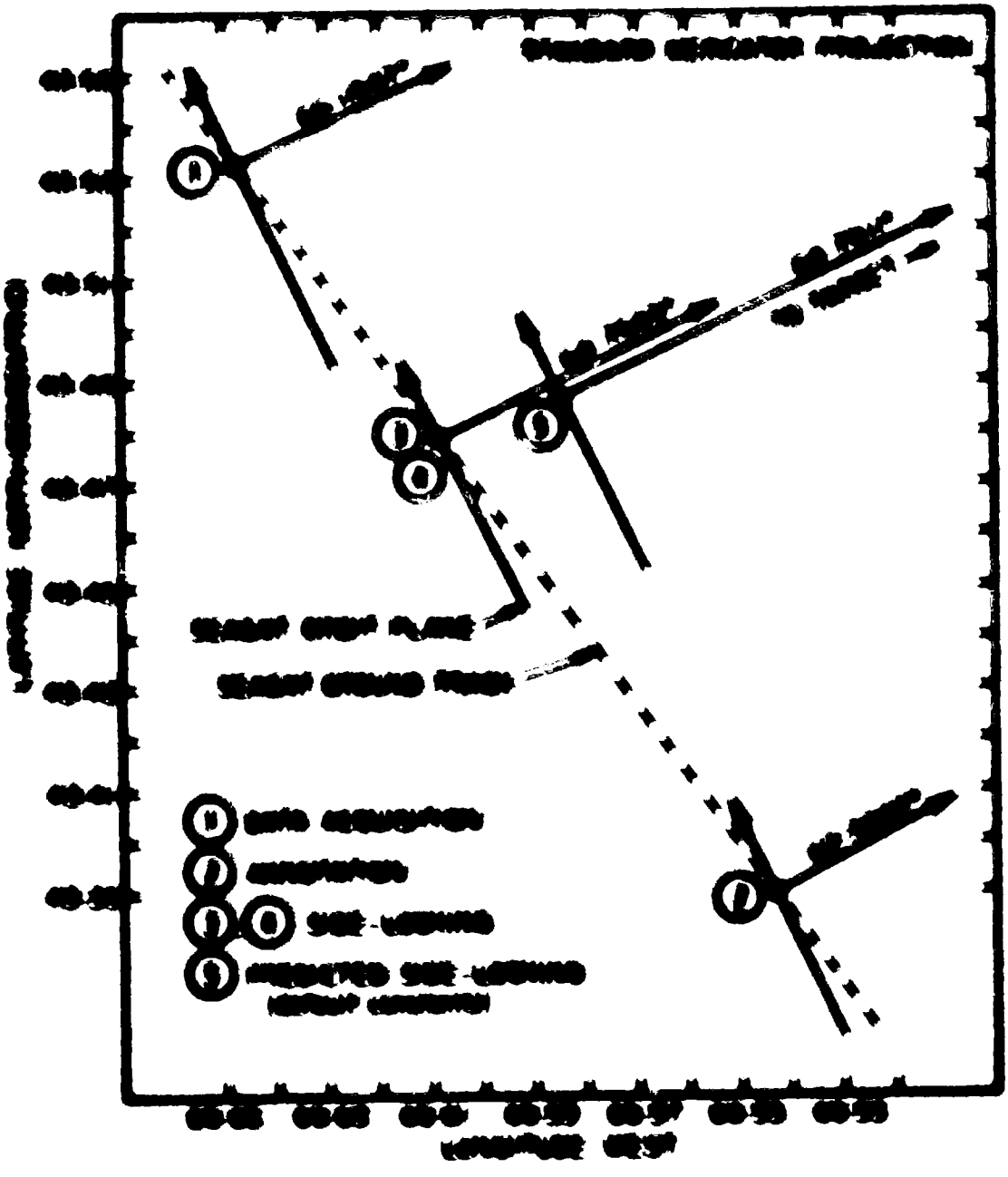
[illegible]

[illegible]

[redacted]

[redacted]

[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]



[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

$$[illegible]$$

[illegible]

[illegible]

[illegible]

TABLE VIII

SEASAT SAR IMAGING PARAMETERS

Parameter	3 A/D Tape (side-looking time)	4 HP-67 (constants from 3)
Latitude L_1 N	44.4566	44.4566
Longitude λ_1 W	63.5833	63.5833
K_{ascend}/Node K	314.5999	314.5999
Node Time (GMT)	13:33:30.55	13:33:30.55
Latitude L_2 N	43.4784	43.4784
Longitude λ_2 W	66.6077	66.6077
"Image" Time (GMT)	13:46:28.42	13:46:28.42
$\theta_{Layover}$ (rate)	12.9643	12.9643
Clock Angle	90.0000	90.0000
North Heading	334.2897	334.2897
SEASAT Heading	332.1897	332.1897
Distance to Target (Km)	265.1617	265.1617
Heading to Target	64.7543	64.7543
Orbit/Equator Intersect W	48.6317	48. 6317
Orbit Inclination	108.0281	108.0281
Orbit Period (min)	100.6889	100.6889

TABLE IX

SEASAT SAR IMAGING PARAMETERS

Parameter	3 A/O Tape (side-looking time)	5 HP-67 (default constants)	Diff.
Latitude L_1 N	44.4566	44.4566	-
Longitude λ_1 W	63.5833	63.5833	-
Σ_{cross}/Node E	314.5999	314.5999	-
Node Time (GMT)	13:33:30.55	13:33:30.55	-
Latitude L_2 N	43.4784	43.4873	+0.0089
Longitude λ_2 W	66.6077	66.5844	-0.0233
'Image' Time (GMT)	13:46:28.42	13:46:28.90	+0.48 sec
t_{lapse} (min)	12.9645	12.9725	+0.0080 min
Clock Angle	90.0000	90.0000	-
South Heading	334.2897	334.3085	+0.0188
SEASAT Heading	332.1897	332.2245	+0.0348
Distance to Target (Km)	265.1617	263.0470	-2.1147
Heading to Target	64.7543	64.7911	+0.0368
Orbit/Equator Intersect W	48.6317	48.6337	+0.0020
Orbit Inclination	108.0281	108.0000	-0.0281
Orbit Period (min)	100.6889	100.7500	+0.0611

change in image time is 1.9833 seconds.

The effect of satellite attitude on annotation time can be shown by expressing the pitch and yaw angles (-0.3587° and 0.3818° respectively at data acquisition time) as a squint angle in the slant range plane. Pitch and yaw normally deviate from the design specifications by less than 0.5°. Small angle approximation is therefore acceptable. Let the SEASAT SAR beam shift ϕs radians from the side-looking position in the slant range plane. The velocity component in the slant range direction due to ϕs is $v_s = \phi sV$ and the corresponding shift of the image in the cross range direction is, from equation (21) $\Delta X = \phi sR$. The change in time is $\Delta T = \phi sR/V$. Note that the image shift ΔX is equal in magnitude but opposite in direction to the extra distance the satellite travels beyond the side-looking position to acquire the radar data in the squint mode. In other words, the annotation time on the image will always be the side-looking time, to the small angle approximation, independent of the radar squint angle if corrections for earth rotation and precession have been applied.

The image shift ΔX from a squint angle of 0.008030 radians at the data acquisition position is 6.8099 km. The annotation time due to misalignment alone would be 1.0284 seconds earlier. These values are in good agreement with the great circle distance between the satellite nadir positions in data sets 1 and 3 of 6.8120 km, and the time difference of 1.0053 seconds between the data acquisition time and the side-looking time.

The annotation time in the Halifax frame from Rev. No. 1238 correlated by MDA (MacDonald Dettwiler and Associates) is about 2.66 seconds earlier than the acquisition time [4]. Interpolation from the Halifax frame yields an annotation time for the Halifax Citadel of 13:46:26.78 and the data acquisition time, 2.66 seconds later, of 13:46:29.44 GMT. This value of the data acquisition time is in good agreement with that in data set 1, 13:36:29.43, calculated from the A/O tape. However the annotation time is 0.33 seconds later than would be expected from the sum of the time diplacements from radar squint and earth rotation, 2.99 seconds. The reason for this difference is not known but is assumed to result from the approximations used in calculating the slant range velocity. The MDA annotation time was used to extract data set 2 in Table VII from the A/O tape and the coordinates for point 2 in Figure 3.

5.5 *Discussion*

The SEASAT ground track shown by the dotted line in Figure 3 represents the attitude - orbit tape data to within 0.002°, the error ascribed to the linear interpolation between orbit entries. Satellite positions along the ground track are less accurate and the data acquisition and side-looking positions, 1 and 3 respectively, depend on the unknown accuracy of the precession correction.

The attitude of the satellite is apparently not predictable and no attempt was made to incorporate an equivalent yaw correction into the calculator

program.

Nominal beamwidth of the SEASAT SAR was 1.25° and the equivalent yaw at image time was about 1.4648°. Therefore, it is clear that the target could not have been illuminated from the side-looking or annotation positions at 2 and 3.

6.0 CONCLUSIONS

1. A program for the HP-67 programmable pocket calculator to extrapolate the SEASAT ground track up to one quarter of a revolution beyond the node has been developed and tested. It was shown that SEASAT orbit parameters which were measured during the satellite's lifetime can be fitted by the program using three constants.

2. Using the prelaunch design parameters as the default constants, the calculator program predicts SEASAT SAR imaging parameters which fall well within the limits imposed by the normal, but unpredictable, attitude variations. These limits introduce an uncertainty of a few seconds in the data acquisition time and up to a tenth of a degree uncertaintly in the satellite position coordinates. When accurate data acquisition times are required, the program can provide information to help aim a radar detector at the passing satellite.

7.0 REFERENCES

1. Helton, M.R. and Baerg, H.R., Seatrack Calcualtor Operating Instructions, JPL Document 622-52, 1978.

2. Deutsh, R., Orbital Dynamics of Space Vehicles, Prentice-Hall, Inc. 1963.

3. Raney, R.K., Synthetic Aperture Imaging Radar and Moving Targets, IEEE, Vol. AES-7, No. 3, P. 499, 1971.

4. Fielden, R.L., MacDonald, Dettwiler and Associates, Private Communication , April 15, 1980.

UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall document is classified)

1 ORIGINATING ACTIVITY
Defence Research Estab. Ottawa,
National Defence Headquarters,
Ottawa, Ontario, Canada K1A 0Z4

2a DOCUMENT SECURITY CLASSIFICATION
U

2b GROUP
IV

3 DOCUMENT TITLE
SEASAT EQUATOR CROSSING PROGRAM

4 DESCRIPTIVE NOTES (Type of report and inclusive dates)
Technical Note

5 AUTHOR(S) (Last name, first name, middle initial)
B.C. Young and D.L. Desaulniers

6 DOCUMENT DATE	7a TOTAL NO OF PAGES	7b NO OF REFS
1980	31	4

8a PROJECT OR GRANT NO	9a ORIGINATOR'S DOCUMENT NUMBER(S)
33D00	DREO TN 80-19
8b CONTRACT NO	9b OTHER DOCUMENT NO (S) (Any other numbers that may be assigned this document)

10 DISTRIBUTION STATEMENT
Unlimited

11 SUPPLEMENTARY NOTES	12 SPONSORING ACTIVITY
	DTA (CE)

13 ABSTRACT

A programmable pocket calculator is used to extrapolate the SEASAT orbit from the equator crossing to the position at which the synthetic aperture radar images a given target. The program predicts the coordinates of the satellite at image time, the Azimuth direction of the image at the target, and the time elapsed between equator crossing and imaging. Program predictions are compared with measured SEASAT data from the definitive attitude-orbit files.

DSIS

77-0[illegible]

Security Classification

KEY WORDS

SEASAT SATELLITE

SYNTHETIC APERTURE RADAR

HP-67 PROGRAM

INSTRUCTIONS

1 ORIGINATING ACTIVITY Enter the name and address of the organization making the document

2a DOCUMENT SECURITY CLASSIFICATION Enter the overall security classification of the document including special warning terms whenever applicable

2b GROUP Enter security reclassification group number The three groups are defined in Appendix IV of the DRB Security Regulations

3 DOCUMENT TITLE Enter the complete document title in all capital letters Titles in all cases should be unclassified If a sufficiently descriptive title cannot be selected without classification, show title classification with the usual one capital letter abbreviation in parentheses immediately following the title

4 DESCRIPTIVE NOTES Enter the category of document, e g technical report, technical note or technical letter If appropriate, enter the type of document, e g interim, progress, summary, annual or final Give the inclusive dates when a specific reporting period is covered

5 AUTHOR(S) Enter the name(s) of author(s) as shown on or in the document Enter last name, first name, middle initial If military, show rank The name of the principal author is an absolute minimum requirement

6 DOCUMENT DATE Enter the date (month, year) of Establishment approval for publication of the document

7a TOTAL NUMBER OF PAGES The total page count should follow normal pagination procedures, i e , enter the number of pages containing information

7b NUMBER OF REFERENCES Enter the total number of references cited in the document

8a PROJECT OR GRANT NUMBER If appropriate, enter the applicable research and development project or grant number under which the document was written

8b CONTRACT NUMBER If appropriate, enter the applicable number under which the document was written

9a ORIGINATOR'S DOCUMENT NUMBER(S) Enter the official document number by which the document will be identified and controlled by the originating activity This number must be unique to this document

9b OTHER DOCUMENT NUMBER(S) If the document has been assigned any other document numbers (either by the originator or by the sponsor), also enter this number(s)

10 DISTRIBUTION STATEMENT Enter any limitations on further dissemination of the document, other than those imposed by security classification, using standard statements such as

(1) "Qualified requesters may obtain copies of this document from their defence documentation center"

(2) "Announcement and dissemination of this document is not authorized without prior approval from originating activity"

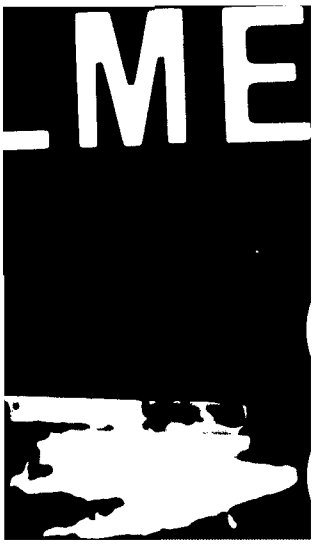
11 SUPPLEMENTARY NOTES Use for additional explanatory notes

12 SPONSORING ACTIVITY Enter the name of the departmental project office or laboratory sponsoring the research and development Include address

13 ABSTRACT Enter an abstract giving a brief and factual summary of the document, even though it may also appear elsewhere in the body of the document itself It is highly desirable that the abstract of classified documents be unclassified Each paragraph of the abstract shall end with an indication of the security classification of the information in the paragraph (unless the document itself is unclassified) represented as (TS), (S), (C), (R), or (U)

The length of the abstract should be limited to 20 single-spaced standard typewritten lines, 7½ inches long

14 KEY WORDS Key words are technically meaningful terms or short phrases that characterize a document and could be helpful in cataloging the document Key words should be selected so that no security classification is required Identifiers, such as equipment model designation, trade name, military project code name, geographic location, may be used as key words but will be followed by an indication of technical content


LME