APPENDIX A: APT PREDICT (TBUS) BULLETIN

APT Predict (TBUS) Bulletin Code

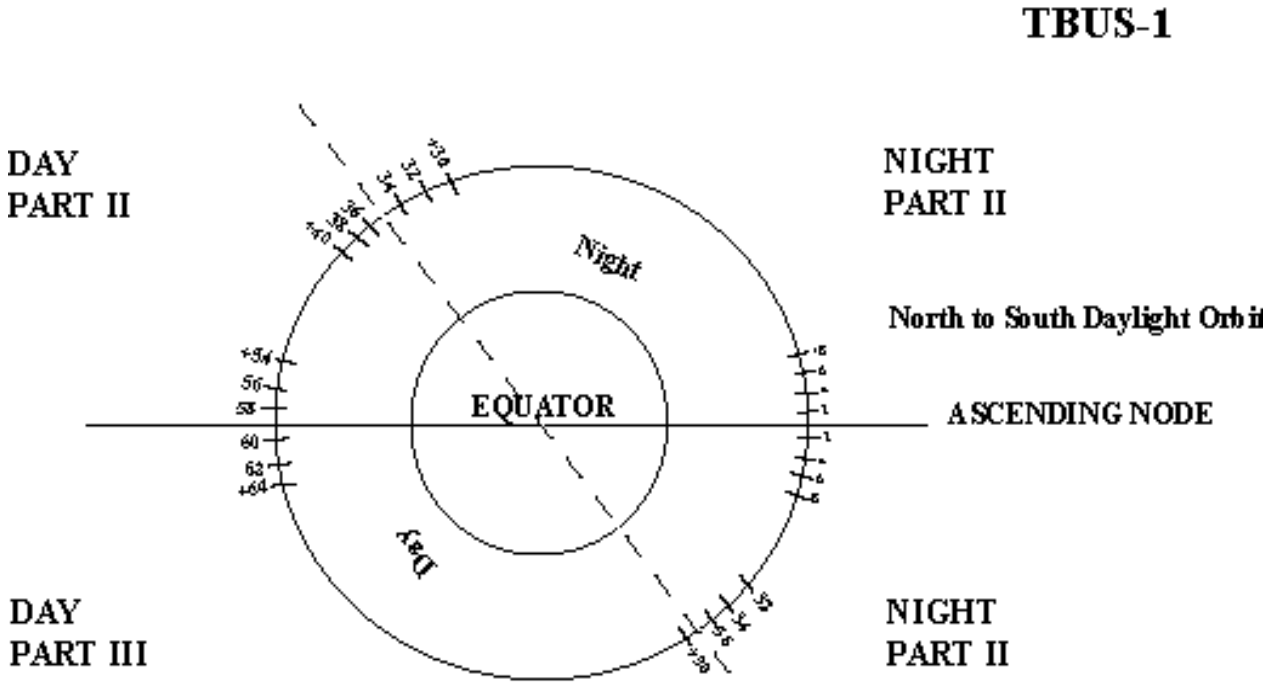
The TBUS is a national practice code form used by the United States to transmit information for predicting the path or locating the position of polar orbiting environmental satellites. It is transmitted daily, at about 1900Z, by KWBC Washington, DC, on the Global Telecommunications Service network.

The TBUS-1 code form is used to convey information about satellites that are descending in daylight (i.e., north to south direction of travel in daytime), while the TBUS-2 code form relates to satellites that are ascending in daylight (south to north). Figure A-1 shows a schematic of the information given in TBUS-1 and TBUS-2 bulletins.

This appendix contains the code forms for TBUS-1 and TBUS-2, a list of the satellite identifiers used in TBUS messages, an explanation of code symbols, samples of an APT Predict (TBUS) bulletin and a Two Line Element message, and how they can be decoded properly.

Table A-1 contains the code symbols for the Heading and Parts I-III of the TBUS message.

Figure A-1. Schematic Representation of Information Conveyed in TBUS-1 and TBUS-2.



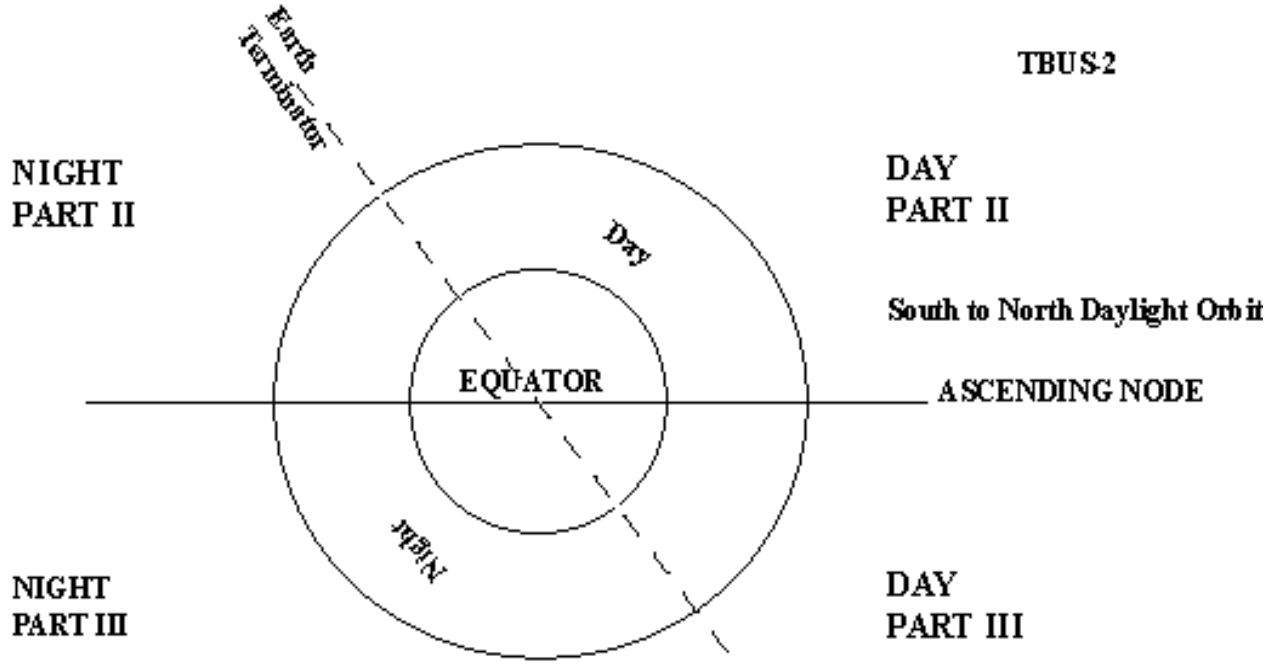


Table A-1. Code Symbols for Heading and Parts I-III.	
Code Symbol	**Meaning**
MM	Month
DD	Day
SS	Satellite (see Table A-2)
NNNN	Orbit number
HH	Hour
mm	Minutes
ss	Seconds
Q	Octant of Globe (see Figure A.3-1)
LoLo	Longitude (tens and units)
1o1o	Longitude (tenths and hundredths)
T	Group indicator (orbital period)
L	Group indicator (nodal period)
aa	Altitude in hundreds and tens of kilometers
La	Latitude (tens)
1a	Latitude (tenths)

Table A-2 contains the numbers used in TBUS bulletins to identify the satellite.

Table A-2. Satellite Identifier in TBUS Bulletins.	
Numbers	**Meaning**
10 - 19	ITOS series satellites
20 - 29	SMS/GOES series satellites
30	TIROS-N
31	NOAA-6
32	NOAA-7
33	NOAA-8
34	NOAA-9
35	NOAA-10
36	NOAA-11
37	NOAA-12
38	NOAA-14
34	NOAA-15
36	NOAA-16
37	NOAA-17
39	NOAA-18
40	NOAA-19

A.1 THE TBUS-1 CODE FORM

U.S. NATIONAL PRACTICE CODE TBUS-1 FOR SATELLITE EPHEMERIS PREDICT MESSAGE (DAYLIGHT DESCENDING SATELLITES)

TBUS 1 KWBC
APT PREDICT
MMDDSS

PART I

$0N_rN_rN_rN_r$ $0D_rD_rH_rH_r$ $0m_rm_rs_rs_r$ $Q_rL_oL_ol_ol_o$ Tmmss $LL_oL_ol_ol_o$

$N_4N_4N_4N_4H_4$ $H_4h_4h_4s_4s_4$ $Q_4L_oL_ol_ol_o$

$N_8N_8N_8N_8G_8$ $H_8h_8h_8s_8s_8$ $Q_8L_oL_ol_ol_o$

$N_{12}N_{12}N_{12}N_{12}H_{12}$ $H_{12}h_{12}h_{12}s_{12}s_{12}$ $Q_{12}L_oL_ol_ol_o$

NIGHT PART II

$02a_{02}a_{02}Q_{02}$ $L_aL_al_aL_oL_ol_o$ $04a_{04}a_{04}Q_{04}$ $L_aL_al_aL_oL_ol_o$

$06a_{06}a_{06}Q_{06}$ $L_aL_al_aL_oL_ol_o$ $08a_{08}a_{08}Q_{08}$ $L_aL_al_aL_oL_ol_o$ .....

...and continuing north, at two-minute intervals, to day/night terminator in N. Hemisphere.

NIGHT PART III

$02a_{02}a_{02}Q_{02}$ $L_aL_al_aL_oL_ol_o$ $04a_{04}a_{04}Q_{04}$ $L_aL_a1_aL_oL_ol_o$

$06a_{06}a_{06}Q_{06}$ $L_aL_al_aL_oL_ol_o$ $08a_{08}a_{08}Q_{08}$ $L_aL_a1_aL_oL_ol_o$

...and continuing south, at two-minute intervals, to day/night terminator in S. Hemisphere.

DAY PART II

...begins near day/night terminator in N. Hemisphere, two minutes after last position given in NIGHT PART II, continuing south at two-minute intervals and ending close to and north of the equator, repeating the code form:

.....$mma_{mm}a_{mm}Q_{mm}$ $L_aL_a1_aL_oL_ol_o$ .....

DAY PART III

...begins two minutes after last position given in DAY PART II. First two code groups give

satellite time, altitude, octant, and latitude/longitude of the first position south of the equator; following groups give the same information at two-minute intervals until spacecraft reaches day/night terminator in S. Hemisphere; repeating code form:

.....$mma_{mm}a_{mm}Q_{mm}$ $L_aL_al_aL_oL_ol_o$ .....

PART IV

AAAAAAAAA BBBBB CCCCCCCCCCCC DDEEFFGGHHIIIII JJJJJJ
KKKKKKKK LLLLLLLL MMMMMMMM NNNNNNNN OOOOOOOO PPPPPPPP
QQQQQQQQ RRRRRRRR SSSSSSSSS TTTTTTTTTT UUUUUUUUUU
VVVVVVVVV WWWWWWWWW XXXXXXXXX YYYYYYYYY ZZZaaabbb cccc
ddddddddddd eeeeeeeee fffffffff ggggggggg hhhhhhhh
iiiiii jjjjjj kkkkkk llllll mmmmmm nnnnnn oooooo
APT TRANSMISSION FREQUENCY XXX.XX MHZ
HRPT TRANSMISSION FREQUENCY XXXX.XX MHZ
BEACON (DSB) TRANSMISSION FREQUENCY XXX.XX MHZ
APT DAY X/X APT NIGHT X/X
DCS CLK TIME YR/DA/TIM XXXX XXX XXXXX.XXX
(ADDITIONAL PLAIN LANGUAGE REMARKS WHEN NEEDED)

A.2 THE TBUS-2 CODE FORM

U.S. NATIONAL CODE TBUS-2 FOR SATELLITE EPHEMERIS PREDICT MESSAGE (DAYLIGHT ASCENDING SATELLITES)

TBUS 2 KWBC
APT PREDICT
MMDDSS

PART I

$0N_rN_rN_rN_r$ $0D_rD_rH_rH_r$ $0m_rm_rs_rs_r$ $Q_rL_oL_ol_ol_o$ Tmmss $LL_oL_ol_ol_o$

$N_4N_4N_4N_4H_4$ $H_4m_4m_4s_4s_4$ $Q_4L_oL_ol_ol_o$

$N_8N_8N_8N_8H_8$ $H_8m_8m_8s_8s_8$ $Q_8L_oL_ol_o1_o$

$N_{12}N_{12}N_{12}N_{12}H_{12}$ $H_{12}m_{12}m_{12}s_{12}s_{12}$ $Q_{12}L_oL_ol_ol_o$

DAY PART II

$02a_{02}a_{02}Q_{02}$ $L_aL_al_aL_oL_ol_o$ $04a_{04}a_{04}Q_{04}$ $L_aL_al_aL_oL_ol_o$

$06a_{06}a_{06}Q_{02}$ $L_aL_al_aL_oL_ol_o$ $08a_{08}a_{08}Q_{08}$ $L_aL_al_aL_oL_ol_o$ .....

...and continues north, at two-minute intervals, to day/night terminator in N. Hemisphere.

DAY PART III

$02a_{02}a_{02}Q_{02}$ $L_aL_al_aL_oL_ol_o$ $04a_{04}a_{04}Q_{04}$ $L_aL_al_aL_oL_ol_o$

$06a_{06}a_{06}Q_{02}$ $L_aL_al_aL_oL_ol_o$ $08a_{08}a_{08}Q_{08}$ $L_aL_al_aL_oL_ol_o$ .....

...and continuing south, at two-minute intervals, to day/night terminator in S. Hemisphere.

NIGHT PART II

...beginning near day/night terminator in N. Hemisphere, two minutes after last position given in DAY PART II, continuing at two-minute intervals and ending close to and north of the equator, repeating code form:

... $mma_{mm}a_{mm}Q_{mm}$ $L_aL_al_aL_oL_ol_o$ .....

NIGHT PART III

...beginning two minutes after last position given in NIGHT PART II. First two code groups give satellite time, altitude, octant, and latitude/longitude of the first position south of the equator; following groups give the same information at two-minute intervals until spacecraft reaches day/night terminator in S. Hemisphere; repeating code form:

... $mma_{mm}a_{mm}Q_{mm}$ $L_aL_al_aL_oL_o1_o$ .....

PART IV

... identical to the TBUS-1 code form

A.3 EXPLANATION OF CODE SYMBOLS

Table A.3-1 contains an explanation of the code symbols used for all parts of the TBUS-1 and TBUS-2 Predict messages.

Table A.3-1. Explanation of Code Symbols.	
Symbol	**Explanation**
TBUS-1 (or TBUS-2)	APT Bulletin originating in the United States: TBUS-1 is North to South (descending) daylight orbit. TBUS-2 is South to North (ascending) daylight orbit.
KWBC	Traffic entered at Washington, D.C.
APT PREDICT	Identifies message content.
MMDDSS	Message serial number MM - Month DD - Day of Month SS - Number of spacecraft to which predict applies (See Table A-1).
PART I - Equator crossing reference information follows:	
0	Code group indicator for first three groups
NrNrNrNr	Number of reference orbit. (Note: Information in Parts II and III also are related to this reference orbit.)
DrDrHrHrmrmrsrsr	Reference orbit equator crossing time (GMT), satellite northbound: DrDr - Day of Month HrHr - Hour mrmr - Minute srsr - Second
Note: In TBUS-1, northbound equator crossing takes place on NIGHT side of orbit. In TBUS-2, northbound equator crossing takes place on DAY side of orbit.	
Qr	Octant satellite is entering after crossing equator on reference orbit (See Appendix B).
LoLololo	Reference orbit equator crossing longitude in degrees and hundredths.
T	Indicator: nodal period follows (will always be shown as "T").
mm	Nodal period, minutes
ss	Nodal period, seconds. [Note: Hundreds group will not be included. example: 100 minutes 13 seconds will be coded as 0013.
L	Indicator, nodal longitude increment follows (always shown as "L").
LoLololo	Degrees and hundredths of degrees longitude between successive equator crossings.
N4N4N4N4	Orbit number of fourth orbit following reference orbit.
H4H4	Hour of northbound satellite equator crossing four orbits after reference orbit.
m4m4	Minute
s4s4	Second
Q4	Octant satellite is entering after crossing equator on fourth orbit after reference orbit.
LoLololo	Equator crossing longitude of fourth orbit after reference orbit.
Above information is repeated for eighth (N8N8N8N8) and twelfth (N12N12N12N12) orbits following reference orbit.	
NIGHT PART II (TBUS-1) or DAY PART II (TBUS-2): Contains satellite altitude and	

subpoint coordinates at two-minute intervals after time of equator crossing; satellite northbound.	
02	Indicator; satellite altitude and subpoint coordinates at two minutes after time of equator crossing.
a02a02	Altitude, in hundreds and tens of kilometers, at two minutes after equator crossing. Thousands figure understood; hence 1440 km is encoded as 44.)
Q02	Octant of globe at two minutes after equator crossing.
LaLala	Latitude of satellite subpoint in degrees and tenths of degrees at two minutes after equator crossing.
LoLolo	Longitude of satellite subpoint in degrees and tenths of degrees at two minutes after equator crossing.
Above information is repeated at two-minute intervals over the NIGHT portion of the orbit north of the equator for TBUS-1, and DAY portion of the orbit north of the equator for TBUS-2.) Note: Should the time after ascending node become greater than 99, the hundreds will be assumed (example, minute 102 will be encoded as 02).	
NIGHT PART III (TBUS-1) or DAY PART III (TBUS-2): Satellite altitude and subpoint coordinates at two-minute intervals south or equator on the ascending side of the orbit.	
02	Indicator; satellite altitude and subpoint coordinates at two minutes after time of equator crossing follows.
a02a02	Satellite altitude in hundreds and tens of kilometers at two minutes after equator crossing.
Q02	Octant of globe at two minutes after equator crossing.
LaLala	Latitude of satellite subpoint in degrees and tenths of degrees at two minutes after crossing.
L0L0l0	Longitude of satellite subpoint in degrees and tenths of degrees at two minutes after equator crossing.
Above information is repeated at two-minute intervals over the night portion of the orbit south of the equator for TBUS-1, and sunlight portion of the orbit north of the equator for TBUS-2.	
DAY PART II (TBUS-2) NIGHT PART II (TBUS-1): Satellite altitude and subpoint coordinates at two-minute intervals after time of equator crossing follows.	
02	Information pertinent to 02 minutes after equator crossing follows.
a02a02	Satellite altitude in hundreds and tens of kilometers at 02 minutes after equator crossing.
Q02	Octant of globe at 02 minutes after equator crossing.
LaLala	Latitude of satellite subpoint in degrees and tenths of degrees at 02 minutes after equator crossing.
L0L0l0	Longitude of satellite subpoint in degrees and tenths of degrees at 02 minutes after equator crossing.
Above information is repeated at two-minute intervals over the sunlit portion of the orbit north of the equator for TBUS-2, and night portion of the orbit north of the equator for TBUS-1.	
DAY PART III (TBUS-1) or NIGHT PART III (TBUS-2): Satellite altitude and subpoint coordinates at two-minute intervals south of the equator on the descending side of the orbit.	
02	Indicator: satellite altitude and subpoint coordinates at two minutes after

	time of equator crossing.
a02a02	Satellite altitude in tens of kilometersat two minutes after equator crossings.
Q02	Octant of globe at two minutes after equator crossing.
LaLala	Latitude of satellite subpoint in degrees and tenths of degrees at two minutes after equator crossing.
L0L0l0	Longitude of satellite subpoint in degrees and tenths of degrees at two minutes after equator crossing.
Above information is repeated at two-minute intervals over the sunlit portion of the orbit south of the equator for TBUS-1 and night portion of the orbit south of the equator for TBUS-2. Note: Should the time after ascending node become greater than 99, the hundreds will be assumed (example, minute 102 will be encoded as 02).	
PART IV: Contains high precision orbital elements transmission frequencies, and remarks - See Table A.3-2.	

In Table A.3-2, the classical elements (Keplerian) from MMMMMMMM to RRRRRRRR are Brouwer mean (BM) elements expressed in the form of Keplerian elements. The position and velocity components SSSSSSSSS to XXXXXXXXX are instantaneous. The Greenwich Hour Angle is apparent sidereal time.

Table A.3-2. Part IV Code Symbols.

Symbol	Explanation
AAAAAAAAA	Spacecraft identification (International designator)
BBBBB	Orbit number at epoch.
CCCCCCCCCCCC	Time of the first ascending node, in days, from the beginning of the year, to nine decimal places.
DD	Epoch year
EE	Epoch month
FF	Epoch day
GG	Epoch hour
HH	Epoch minute
IIIII	Epoch second, to three decimal places
JJJJJJ	Apparent Greenwich Hour Angle at Aries at epoch, to four decimal places.
KKKKKKKK	Anomalistic period (minutes), to four decimal places.
LLLLLLLL	Nodal period (minutes), to four decimal places.
MMMMMMMM	BM Eccentricity, eight decimal places.
NNNNNNNN	BM Argument of perigee (degrees), five decimal places.
OOOOOOOO	BM Right Ascension of the ascending node (degrees), five decimal places.
PPPPPPPP	BM Inclination (degrees), five decimal places.
QQQQQQQQ	BM Mean anomaly (degrees), five decimal places.
RRRRRRRR	BM Semi-major axis (km), three decimal places.
Note: All signed values in Part IV are preceded by a "P" or "M" to denote a plus (+) or minus	

(-) value.	
SSSSSSSSS	Sign and epoch X position component (km), to four decimal places.
TTTTTTTTTT	Sign and epoch Y position component (km), to four decimal places.
UUUUUUUUUU	Sign and epoch Z position component (km), to four decimal places.
VVVVVVVVV	Sign and epoch X velocity (Xdot) component (km/sec), to six decimal places.
WWWWWWWW	Sign and epoch Y velocity (Ydot) component (km/sec), to six decimal places.
XXXXXXXXX	Sign and epoch Z velocity (Zdot) component(km/sec), to six decimal places.
YYYYYYYYY	Ballistics coefficient CD-A/M (m2/kg), to eight decimal places.
ZZZ	Daily solar flux value (10.7 cm) 10-7 W/m2.
aaa	90-day running mean of solar flux 10-7 W/m2.
bbb	Planetary magnetic index (2x10-5 gauss).
cccc	Drag modulation coefficient, to four decimal places.
ddddddddd	Radiation pressure coefficient (m2/kg), to ten decimal places.
eeeeeeeee	Sign and perigee motion (degrees/day), to five decimal places.
fffffffff	Sign and motion of Right Ascension of the ascending node (degrees/day), to five decimal places.
ggggggggg	Sign and rate of change of mean anomaly at epoch (degrees/day), to two decimal places.
hhhhhhhh	Equator crossing longitude of the epoch reference orbit measure as East longitude, to five decimal places.
iiiiii	Month, date and year (MMDDYY) of last TIP clock correction.
jjjjjj	Sign and clock error after last correction measured in seconds, to three decimal places. *
kkkkkk	Month, date and year (MMDDYY) of current clock error.
llllll	Sign and current clock error measured in seconds, to three decimal places. *
mmmmmm	Month, date and year (MMDDYY) of the measured clock error rate.
nnnnnn	Sign and clock error rate expressed as milliseconds/day. *
oooooo	Month, date and year (MMDDYY) of next TIP clock correction. (000000 if unknown.)
* These will be set to 99999 if the value is unknown. Note: All signed values in Part IV are preceded by a “P” or “M” to denote a plus (+) or minus (-) value.	

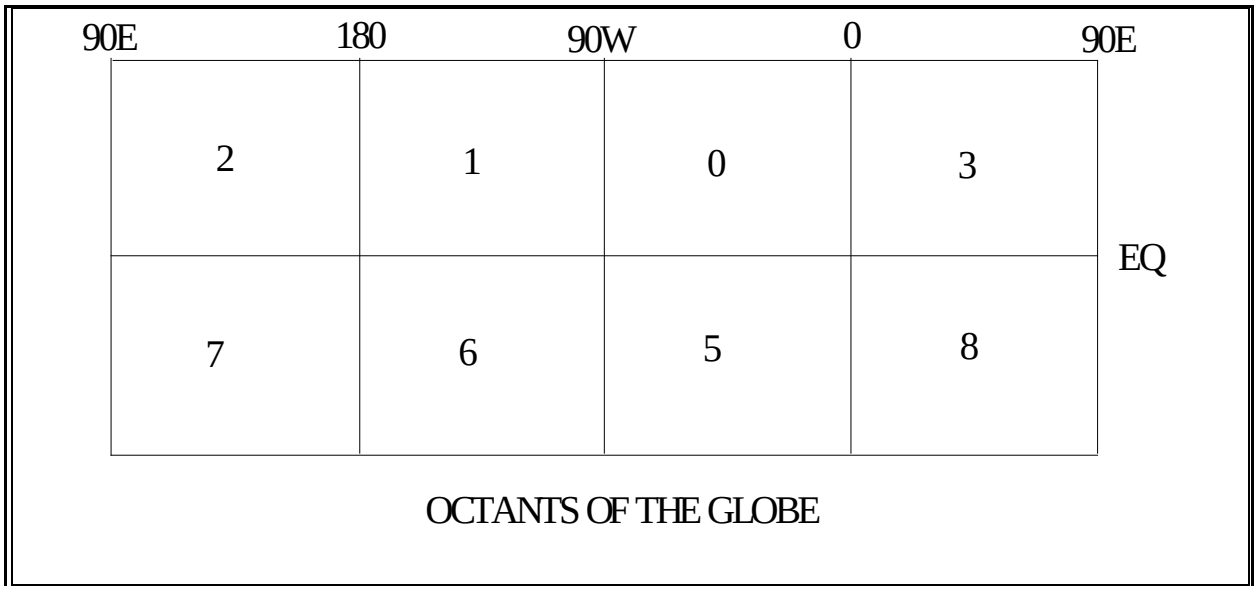


Figure A.3-1. Global Octant Map

A.4 SAMPLE APT PREDICT (TBUS) BULLETIN

The following encoded APT Predict (TBUS) Bulletin example is referred to throughout the remaining sub-appendices. The major features of the message are decoded in Table A.5-1.

```
TBUS 2 KWBC 271900
APT PREDICT
022737  NOAA   12
PART I
05271 02718 05148 01022 T0115 L2531
52750 13652 11149
52790 82156 24723
52831 50700 34596
NIGHT  PART II
02810 070117  04820 141133  06820 211150  08820 282168
10820 352187  12820 422210  14830 491236  16830 560270
18830 628316  20830 694386  22830 755511  24830 803772
26831 811225  28831 773557  30831 714712
NIGHT  PART III
02815 070086  04815 141070  06825 212054  08825 282036
10825 352016  12828 422005  14828 492032  16838 560066
18838 628112  20838 694182  22838 755307
DAY    PART II
32831 649795  34832 582752  36832 514715  38822 444687
40822 375663  42822 304643  44822 234624  46822 164607
48812 093591  50812 022576
```

DAY PART III
52817 048560 54817 118544 56827 189528 58827 259511
60827 330492 62827 400470 64827 469445 66827 538414
68837 607373 70837 673312 72837 736211 74837 790006
76838 815596 78838 788195 80835 734001
PART IV
1991 032A 35260 058012410488 980227001752266 1611059
01012050 01012668 00124135 27260918 06938332 09853018
08737459 07191220 P025340217 P067357065 P000000000
P01033198 M00387576 P07361891 003003246 094096008 9449
0000500000 M00312884 P00096864 P00512228 26827739
123195 M00100 020998 M00100 020198 M00002 000000
APT 137.50 MHZ, HRPT 1698.0 MHZ, BCN DSB 136.77 MHZ. APT DAY/NIGHT
CH 2,4/3,4. VIS CH 2 /0.725 TO 1.0/ AND IR CH 4 /10.5 TO 11.5/ XMTD
DURING S/C DAY. IR CH 3 /3.55 TO 3.93/ AND IR CH 4 /10.5 TO 11.5/
XMTD DURING S/C NIGHT. DCS CLK YR/DAY/TIME 1994 185 69079.016
LAST TIP CLK CORR 12/31/95 CLK ERR AFTER CORR MINUS 0.1 SEC. CLK ERR AS
OF 02/09/98 MINUS 0.1 SEC. ERR RATE AS OF 02/01/98
MINUS 2 MS/DAY(ESTIMATED). NO CLK CORRECTION SCHEDULED.
NNNN

A.5 DECODING EXERCISE

Table A.5-1. Decoding Exercise of Sample APT Predict (TBUS) Bulletin from Section A.4.

Line from TBUS	Explanation
TBUS2 KWBC 271900	
TBUS2	Bulletin heading--identifies bulletin for satellite northbound in daylight
KWBC	Bulletin source--Washington, D.C. Communications Center
271900	27 -Day of the month (21st) 1900 -Bulletin time (1900 UTC)
APT PREDICT	Bulletin identifier
022737 NOAA 12	
022737	0227 - Date for which bulletin applies, Feb. 27 37 - Satellite identifier (Table A-2)
NOAA 12	Plain language satellite identifier
PART I	Identifies reference orbit information and the equator crossing time and equator crossing longitude for the fourth, eighth and twelfth orbits after the reference orbit.
05271 02718 05148 01022 T0115 L2531	
05271	0 - Group indicator 5271 - Reference orbit number

02718	0 - Group indicator 27 - Day of month of equator crossing 18 - Hour
05148	0 - Group indicator 51- Minute 48 - Seconds (equator crossing 18:51:48 UTC)
01022	0 - Octant 0 (0 to 90W degrees), N. Hemisphere 1022 - 010.22W (equator crossing)
T0115	T - Group indicator 0115 - Orbital period 101 minutes 15 seconds
L2531	L - Group indicator 2531 - Nodal longitudinal increment 25.31 degrees
52750 13652 11149	
52750 13652	5275 - Orbit number 5275 (4th orbit after reference orbit) 013652 - Time (01:36:52Z) of ascending node for orbit 5275
11149	1 - Octant 1 (90W to 180 degrees) 1149 - 111.49W (equator crossing for orbit 5275 in octant 1)
52790 82156 24723	Decoded in same manner as previous line of data
52831 50700 34596	Decoded in same manner as previous line of data
NIGHT PART II	Satellite altitude and subpoint coordinates at two-minute intervals beginning at the day/night terminator in the N. Hemisphere and continuing southward toward the equator.
02810 070117 04820 141133	
02810	02 - Minute 02 after northbound equator crossing 81 - Spacecraft altitude 810 km 0 - Octant 0 (0 - 90W degrees) N. Hemisphere
070117	070 - Latitude 7.0N 117 - Longitude 11.7E
04820	04- Minute 04 after equator crossing 82 - Spacecraft altitude 820 km 0 - Octant 0 (0 - 90W degrees) N. Hemisphere
141133	141 - Latitude 14.1N 133 - Longitude 13.3E
Remainder of NIGHT PART II decoded in same manner. Data continues at 2 minute intervals.	
NIGHT PART III	Satellite altitude and subpoint coordinates at two-minute intervals south of the equator on the descending side of the orbit.
02815 070086 04815 141070	
02815	02 - Minute 02 after Northbound equator crossing 81 - Spacecraft altitude 810 km 5 - Octant 5 (0 - 90W degrees) S Hemisphere
070086	070 - Latitude 07.0S 086 - Longitude 08.6E

04815	04 - Minute 04 after equator crossing 81 - Spacecraft altitude 810 km 5 - Octant 5 (0 -90W degrees) S Hemisphere	
141070	141 - Latitude 14.1S 070 - Longitude 7.0E	
Remainder decoded in same manner. Data continues at 2-minute intervals from first point South of equator to Southern terminator.		
DAY PART II	Contains satellite altitude and subpoint coordinates at two-minute intervals after time of Northbound (ascending) equator crossing.	
	32831 649795 34832 582752	
32831	32 - Minute 32 after Northbound equator crossing 83 - Spacecraft altitude 830 km 1 - Octant 1 (90W to 180W degrees) N. Hemisphere	
649795	649 - Latitude 64.9N 795 - Longitude 079.5W	
34832	34 - Minute 34 after Northbound equator crossing 83 - Spacecraft altitude 830 km 2 - Octant 2 (90E to 180E) N. Hemisphere	
582752	582 - Latitude 058.2N 752 - Longitude 75.2W	
Remainder of DAY PART II decoded in same manner. Data for DAY PART II are continuous at 2-minute intervals from equator North to Northern terminator.		
DAY PART III	Satellite altitude and subpoint coordinates at two-minute intervals south of the equator. Satellite Northbound in the Southern hemisphere (points are plotted Southward from the equator).	
	52817 048560 54817 118544	
52817	52 - Minute 52 before Northbound equator crossing 81 - Spacecraft altitude 810 km 7 - Octant 7 (90E to 180E degrees) S. Hemisphere	
048560	048 - Latitude 04.8S 560 - Longitude 056.0W	
54817	54 - Minute 54 after equator crossing 81 - Spacecraft altitude 810 km 7 - Octant 7 (90E to 180E degrees) S. Hemisphere	
118544	118 - Latitude 11.8S 544 - Longitude 54.4W	
Remainder of DAY PART III decoded in same manner		
PART IV	Indicator -- orbital elements, transmission frequencies, and remarks follow.	
AAAAAAAAA	1991 032A	1991-032A International designator for NOAA-12
BBBBB	35260	revolution 35260

CCCCCCCCCCCC	058012410488	058.012410488 days
DDEEFFGGHHIIIII	980227001752266	98--1998 year 02-02 months 27-27 days 00-00 hours 17-17 minutes 52266--52.266 seconds
JJJJJJJ	1611059	161.1059 degrees
KKKKKKKK	01012050	101.2050 minutes
LLLLLLLL	01012668	101.2668 minutes
MMMMMMMM	00124135	0.00124135 no units
NNNNNNNN	27260918	272.60918 degrees
OOOOOOOO	06938332	69.38332 degrees
PPPPPPPP	09853018	98.53018 degrees
QQQQQQQ	08737459	87.37459 degrees
RRRRRRRR	07191220	7191.220 km
SSSSSSSSS	P025340217	+2534.0217 km
TTTTTTTTTT	P067357065	+06735.7065 km
UUUUUUUUUU	P000000000	+0.0000 km
VVVVVVVVV	P01033198	+1.033198 km/sec
WWWWWWWWW	M00387576	-0.387576 km/sec
XXXXXXXXX	P07361891	+7.361891 km/sec
YYYYYYYYY	003003246	0.03003246 m2/kg
ZZZaaabbb	094096008	094--94 x 10-7 W/m2 096--96 x 10-7 W/m2 008-- 8 x 10-5 gauss
cccc	9449	0.9449 no units
ddddddddd	0000500000	0.0005000000 m2/kg
eeeeeeeee	M00312884	- 3.12884 degrees/day
fffffffff	P00096864	+0.96864 degrees/day
ggggggggg	P00512228	+5122.28 degrees/day
hhhhhhhh	26827739	268.27739 degrees East longitude
iiiiii	123195	12-month, 31-date, 95-year
jjjjjj	M00100	-0.100 seconds
kkkkkk	020998	02-month, 09-date, 98-year
llllll	M00100	-0.100 seconds
mmmmmm	020198	02-month, 01-date,

		98-year
nnnnnn	M00002	-2 milliseconds/day
oooooo	000000	Date of next clock correction is unknown.
PLAIN LANGUAGE PART OF MESSAGE: APT 137.50 MHZ, HRPT 1698.0 MHZ, BCN DSB 136.77 MHZ. APT DAY/NIGHT CH 2,4/3,4. VIS CH 2 /0.725 TO 1.0/ AND IR CH 4 /10.5 TO 11.5/ XMTD DURING S/C DAY. IR CH 3 /3.55 TO 3.93/ AND IR CH 4 /10.5 TO 11.5/ XMTD DURING S/C NIGHT. DCS CLK YR/DAY/TIME 1994 185 69079.016 LAST TIP CLK CORR 12/31/95 CLK ERR AFTER CORR MINUS 0.1 SEC. CLK ERR AS OF 02/09/98 MINUS 0.1 SEC. ERR RATE AS OF 02/01/98 MINUS 2 MS/DAY(ESTIMATED). NO CLK CORRECTION SCHEDULED.		
NNNN	NNNN	Indicates end of message

A.6 NASA TWO LINE ORBITAL ELEMENTS (TLE)

A description of the NASA prediction bulletin's two line, orbital element set format is explained in the following example.

Data for each satellite consists of three lines (two of which contain actual orbital elements) in the following format:

AAAAAAAAAAAAAAAAAAAAA

1 NNNNNU NNNNNAAA NNNNN.NNNNNNNN +.NNNNNNNN +NNNNN-N +NNNNN-N N NNNNN

2 NNNNN NNN.NNNN NNN.NNNN NNNNNNN NNN.NNNN NNN.NNNN NN.NNNNNNNNNNNNN

Line 0 is a twenty-two-character name. Lines 1 and 2 are the standard Two-Line Orbital Element Set Format identical to that used by USSC and NASA. The format is described in Table A.6-1.

Table A.6-1. Format of Standard Two-Line Orbital Element Set.	
Column	**Description**
Line 1	
01-01	Line Number of Element Data
03-07	Satellite Number
10-11	International Designator (Last two digits of launch year). See Table A.6-2.
12-14	International Designator (Launch number of the year). See Table A.6-2.
15-17	International Designator (Piece of launch). See Table A.6-2.
19-20	Epoch Year (Last two digits of year)
21-32	Epoch (Julian Day and fractional portion of the day)
34-43	First Time Derivative of the Mean Motion or Ballistic Coefficient (depending on ephemeris type)
45-52	Second Time Derivative of Mean Motion (decimal point assumed; blank if N/A)
54-61	BSTAR drag term if GP4 general perturbation theory was used. Otherwise, radiation pressure coefficient. (Decimal point assumed)
63-63	Ephemeris type
65-68	Element Number
69-69	Check Sum (Modulo 10)
Line 2	
01-01	Line Number of Element Data
03-07	Satellite Number
09-16	Inclination (degrees)
18-25	Right Ascension of the Ascending Node (degrees)
27-33	Eccentricity (decimal point assumed)
35-42	Argument of Perigee (degrees)
44-51	Mean Anomaly (degrees)
53-63	Mean Motion (revolutions per day)
64-68	Revolution number at epoch (revolutions)
69-69	Check Sum (Modulo 10)
Note: All other columns are blank or fixed.	

Table A.6-2. Definition of Satellite ID and International Designator.		
Satellite name	**Satellite ID (USSC)**	**International Designator (Launch year and day)**
NOAA-1	04793	7∈1∈6
NOAA-2	06235	72∈82
NOAA-3	06920	73∈86
NOAA-4	07529	74∈89
NOAA-5	09057	76∈77
TIROS-N	11060	78096
NOAA-6	11416	79057

NOAA-7	12553	81059
NOAA-8	13923	83022
NOAA-9	15427	84123
NOAA-10	16969	86073
NOAA-11	19531	88089
NOAA-12	21263	91032
NOAA-13	22739	93050
NOAA-14	23455	94089
NOAA-15	25338	98030
NOAA-16	26536	00055
NOAA-17	27453	02032
NOAA-18	28654	05018
NOAA-19	33591	09005
∈ indicates a blank		

A.7 EXAMPLE OF DECODED TWO LINE ORBITAL ELEMENT MESSAGE

The following is an example of a two-line orbital element message:

NOAA 14
1 23455U 94089A 95222.82483495 .00000053 00000-0 53646-4 0 2755
2 23455 98.9047 164.9161 0010620 42.0812 318.1174 14.11526152 31526

This example has been decoded in Table A.7-1.

Table A.7-1. Example of Decoded Two-Line Orbital Element Message.

NOAA-14	Satellite name ANOAA-14"
1 23455U	1 - Message line 1 23455 - Satellite number 23455
94089A	94 - Launch year 1994 089 - Launch number 89 A - Launch piece A (not in multiple pieces)
95222.82483495	95 - Epoch year 1995 222.82483495 - Julian day 222 and fraction
.00000053	First time derivative of the mean motion (plus sign implied)
00000-0	Second time derivative of the mean motion
53646-4	BSTAR drag term
0	Ephemeris type zero
2755	Element number 275 5 - Check sum
2 23455	2 - Message line 2 223455 - Satellite number 23455 (repeated)
98.9047	Orbit inclination 98.9047 degrees
164.9161	Right ascension of ascending node 164.9161 degrees

0010620	Eccentricity .0010620
42.0812	Argument of perigee 042.0812 degrees
318.1174	Mean anomaly 318.1174 degrees
14.11526152	Mean motion 14.11526152 revolutions per day
31526	3152 - Satellite revolution 3152 at epoch 6 - Check sum