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May 29, 1997

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MAY 2 9 1997

Federal Communications Commission
Office of Secretary

William Caton, Acting Secretary
Federal Communications Commission
1919 M Street, N.W.
Washington, DC 20554

RE: Notice of Ex Parte Presentation
in CC Docket 92-297

Dear Mr. Caton:

Today representatives of Motorola Satellite Communications, Inc. met with the following individuals of the Commission's staff: Tom Tcyz, Chief, Satellite and Radiocommunication Division, International Bureau; Harry Ng, Engineeering Advisor; Fern Jarmulnek, Chief, Satellite Policy Branch; Steve Sharkey, Chief, Satellite Engineering Branch; Karl Kensinger, Legal Advisor; Julie Garcia, Staff Engineer; Tom Boasberg, Senior Legal Advisor to Chairman Hundt; Rudy Baca, Legal Advisor to Commissioner Quello; David Siddall, Legal Advisor to Commission Ness; and Jane Mago and Suzanne Toller, Legal Advisors to Commissioner Chong.

In these meetings Motorola presented arguments in support of its Petition for Partial Reconsideration in the above-captioned proceeding. Specifically, Motorola explained that the technical requirements created for NGSO MSS systems use of the 29.25-29.5 GHz bands for feeder-link operations, set forth at 47 C.F.R. § 25.252(c), will not have the intended impact.

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During these presentations, Motorola distributed the enclosed written materials. Please do not hesitate to contact the undersigned if you have any questions.

Sincerely,

Brent H. Weingardt/wz

Brent H. Weingardt
Counsel for Motorola Satellite
Communications, Inc.

Enclosure

cc (w/o enclosures): Tom Tcyz
Harry Ng
Tom Boasberg
Rudy Baca
David Siddall
Suzanne Toller
Jane Mago
Fern Jarmulnek
Steve Sharkey
Karl Kensinger
Julie Garcia

Meeting With The

FEDERAL COMMUNICATIONS COMMISSION

Reconsideration Of Section 25.258(c) "Node Regression for NGSO MSS Systems"

29 May 1997

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MAY 29 1997
Federal Communications Commission
Office of Secretary

Objective

Provide Additional Technical Discussions Detailing Motorola's Position On:

§25.258 Sharing between NGSO MSS Feeder Link Stations and GSO FSS services in the 29.25 - 29.5 GHz Bands

(a) Operators of ...

(b) Licensed GSO FSS ...

(c) NGSO MSS satellites operating in this frequency band shall compensate for nodal regression due to the oblate shape of the Earth, and thus maintain constant successive sub-satellite ground tracks on the surface of the Earth.

(d) NGSO MSS systems ...

Analysis Of Rule §25.258(c)

Action Required

.. compensate for nodal regression ..

Implied Result Achieved

..thus maintain constant successive sub-satellite ground tracks ..

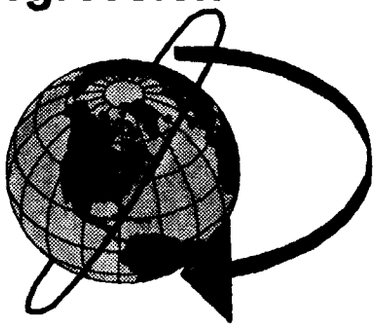
Dynamics Involved

1) Earth Rotation (West To East)
2) Precession Of Orbit Node (Longitude Crossing On Equator) [East To West For Most Orbits]

Satellite ground track follows the same "paint stripe" on the surface of the Earth

Earth Rotation

Nodal Regression



Applicable Equations

Earth Rotation Rate

0.004178 Deg / Sec
0.25068 Deg / Min
15.0411 Deg / Hour

Nodal Regression Rate

$$\dot{\Omega} = \frac{-1.5 \cdot J_2 \cdot \cos(I) \cdot R_E^2 \cdot \sqrt{\mu_E}}{\left(a^{3.5}\right) \cdot \left(1 - e^2\right)^2}$$

where:

J_2 = 1.08263E-3
I = Inclination
R_E = Earth Radius
u_E = Gravity constant of Earth
a = Orbit Semi-major Axis
e = Orbit Eccentricity

Technical Discussion Of Rule §25.258(c)

- **Rule As Written Does NOT Achieve The Stated Objective (i.e., Repeat Ground Tracks)**
  - Repeat Ground Tracks NOT Produced By Compensating For Nodal Regression
  - The Repeat Track Timeframe NOT Specified
    - Repeat Daily, Weekly or Monthly??
    - Industry Standard Is <u>Daily</u>
- **Rule's Original Intent Was To Reduce Interference Opportunities Between NGSOs & GSOs**
  - This Is NOT Possible For All NGSO Combinations Of Inclination and Altitude
  - ITU Studies Show <u>Increased</u> Interference Opportunities Occur Using Repeat Ground Tracks

    (Guaranteed Opportunities)

Methods Which Compensate For Nodal Regression

- **Orbit Adjust Maneuver**
  - Perform Once Each Orbit
  - Uses Extremely Large Quantities Of Fuel
  - Impossible For Any NGSO System To Maintain
  - Performed Out-Of-Plane .. Requires Yaw Attitude Change

- **Compensate By Producing Repeat Ground Tracks**
  - Use Knowledge Of Nodal Regression Rate
  - Combine With Earth Rotation Rate
  - Select Mission Inclination & Adjust Altitude

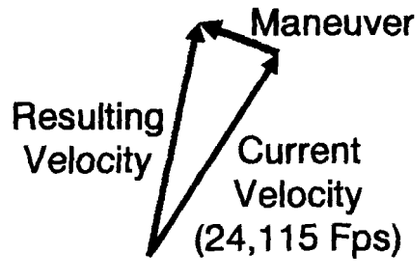
Compensation For Nodal Regression By Maneuver

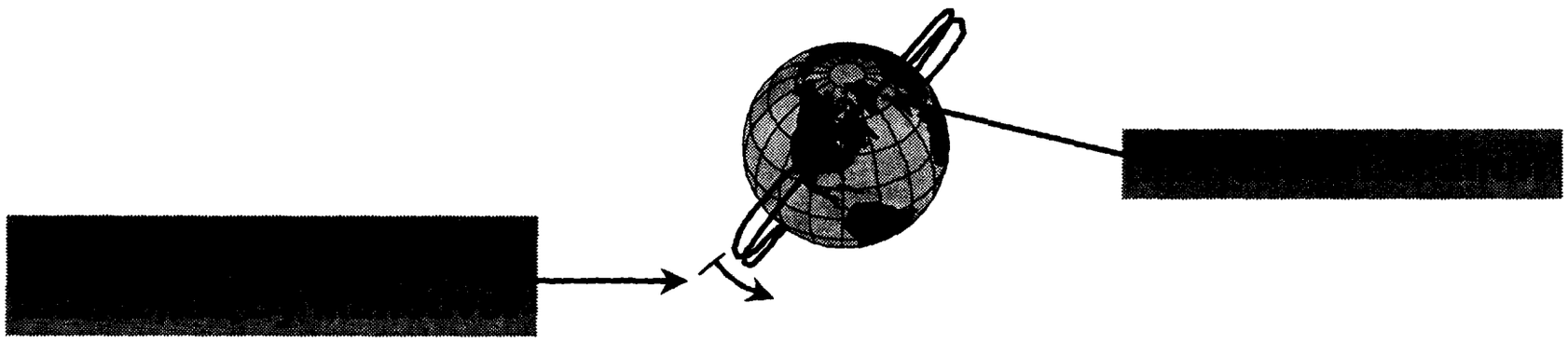
Example Satellite Orbit

Orbit Altitude = 1000 km
Inclination = 50°
Period = 6306.2 seconds (~105.1 minutes)
Regression Rate = -0.281 Deg/Rev (To The West)

Maneuver Data

Size = 118.3 Fps
Location = Northern Most Latitude
Direction = Out-Of-Plane





Result Of Nodal Compensation Maneuver

- **Longitude Movement**

Before Maneuver = 26.63° Per Orbit
After Maneuver = 26.35° Per Orbit

- **Resulting Orbits Per Day:** $\frac{360^\circ}{26.35^\circ} = 13.66$ (Not Repeating Track)

- **Orbits Per Day Must Be An Integer (i.e., 12, 13, 14 etc) For Repeat Ground Tracks To Occur**

Equation To Achieve "Repeat Ground Tracks"

$$\text{OrbitsPerDay} \times \text{Period} \times [\text{EarthRate} - \text{NodeRate}] = 360°$$

OrbitsPerDay	Period	EarthRate	NodeRate
integer	f(altitude)	constant	f(altitude & inclination)

Orbits Per Day	Altitude (km)	Inclination
1	35,786	0°
4	10,348	50°
12	1,624	50°
13	1,200	50°
14	826	50°
15	492	50°

NGSO Demonstration Constellations

- **Repeat Ground Tracks Using 4 x 3 Constellation**
  - 10,348 Km Altitude @ 50° Inclination
  - Minimum Number Of "Paint Stripes" (4)
  - Maximum Sharing Capability With GSOs

FCC_DEMO1

- **Repeat Ground Tracks Using 4 x 3 Constellation**
  - 10,348 Km Altitude @ 50° Inclination
  - Moderate Number Of "Paint Stripes"
  - Questionable Sharing Capability With GSOs

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- **Repeat Ground Tracks Using 3 x 4 Constellation**
  - 10,348 Km Altitude @ 50° Inclination
  - Large Number Of "Paint Stripes"
  - Unlikely Sharing Capability With GSOs

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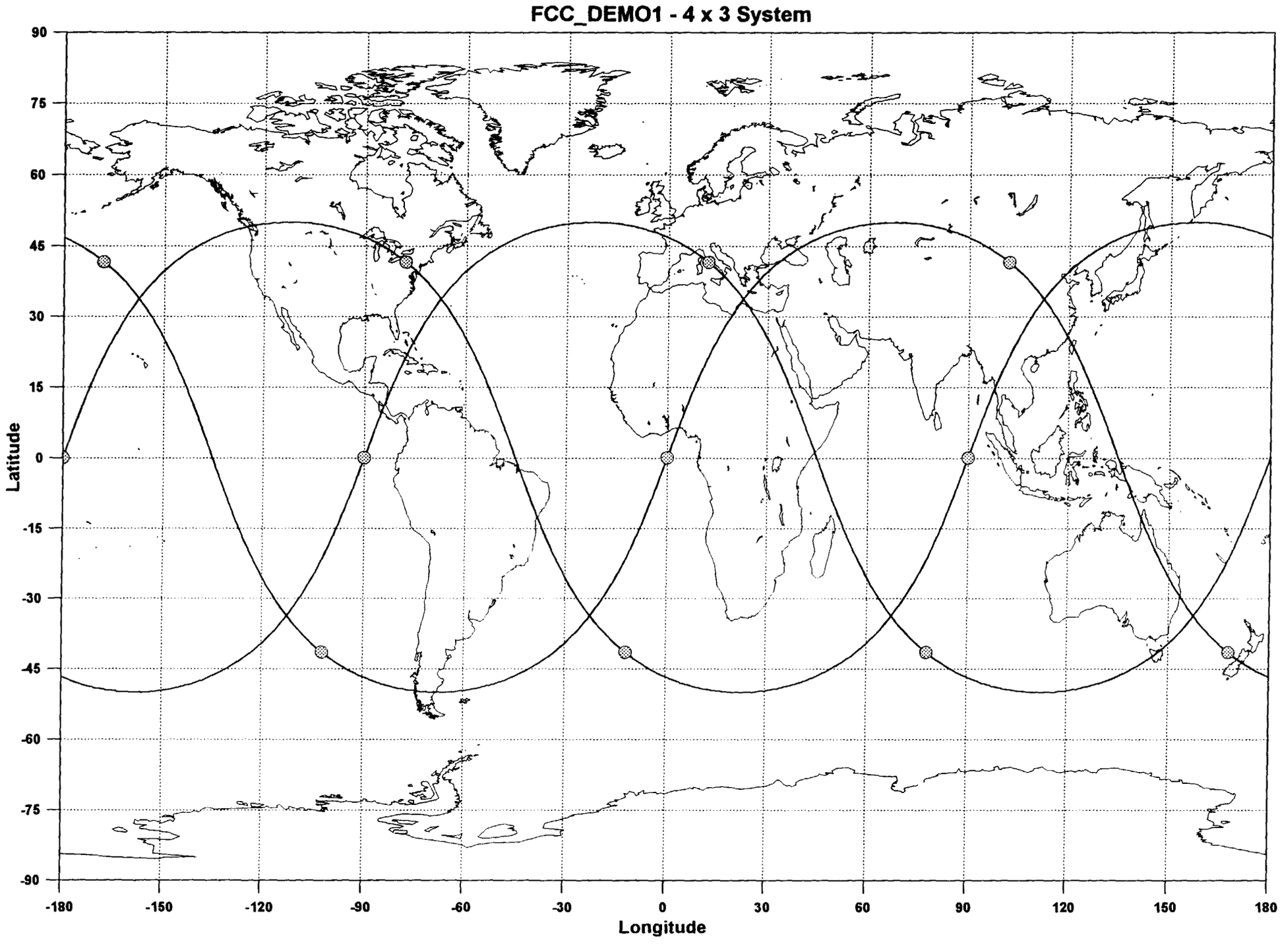
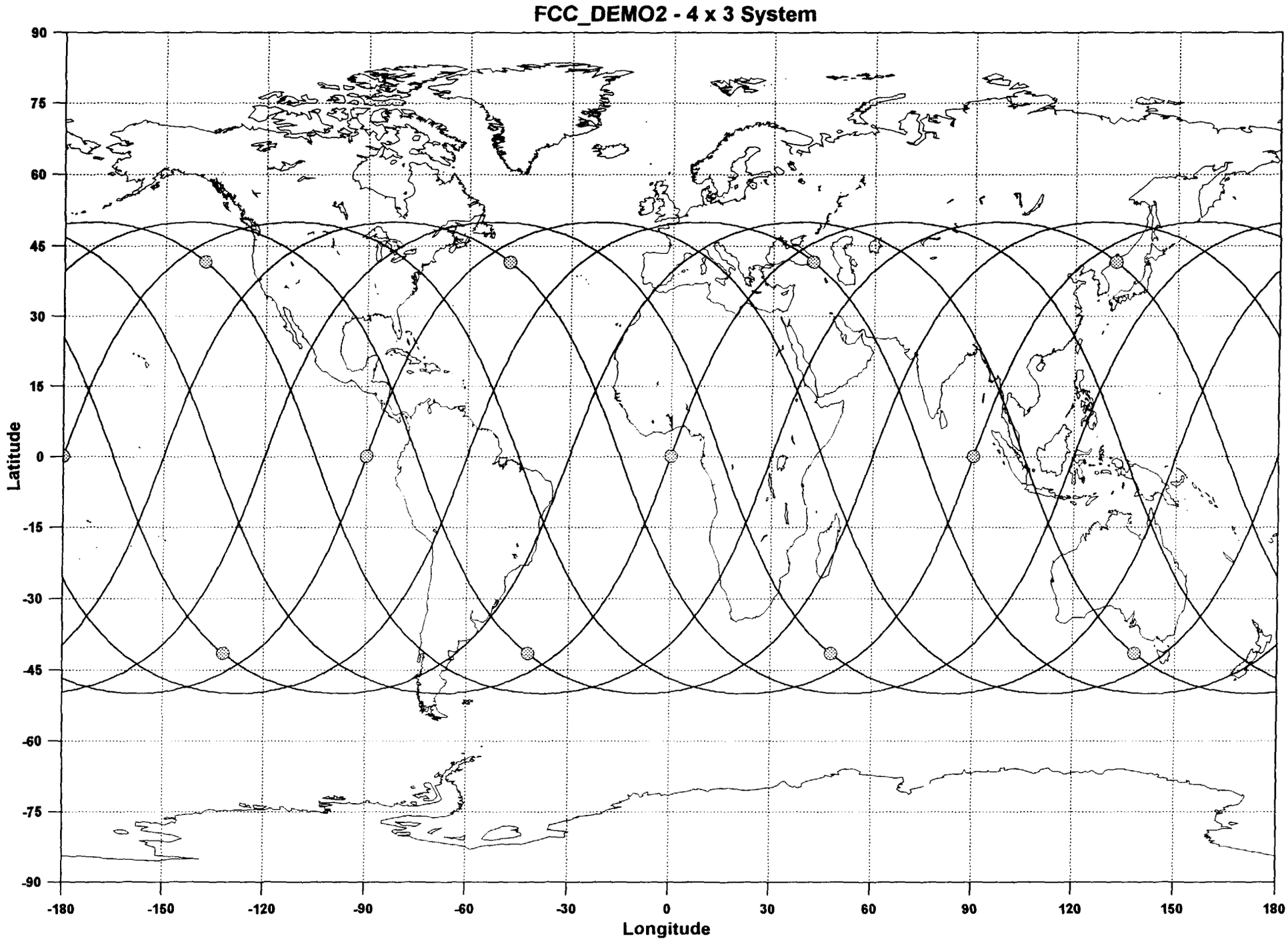
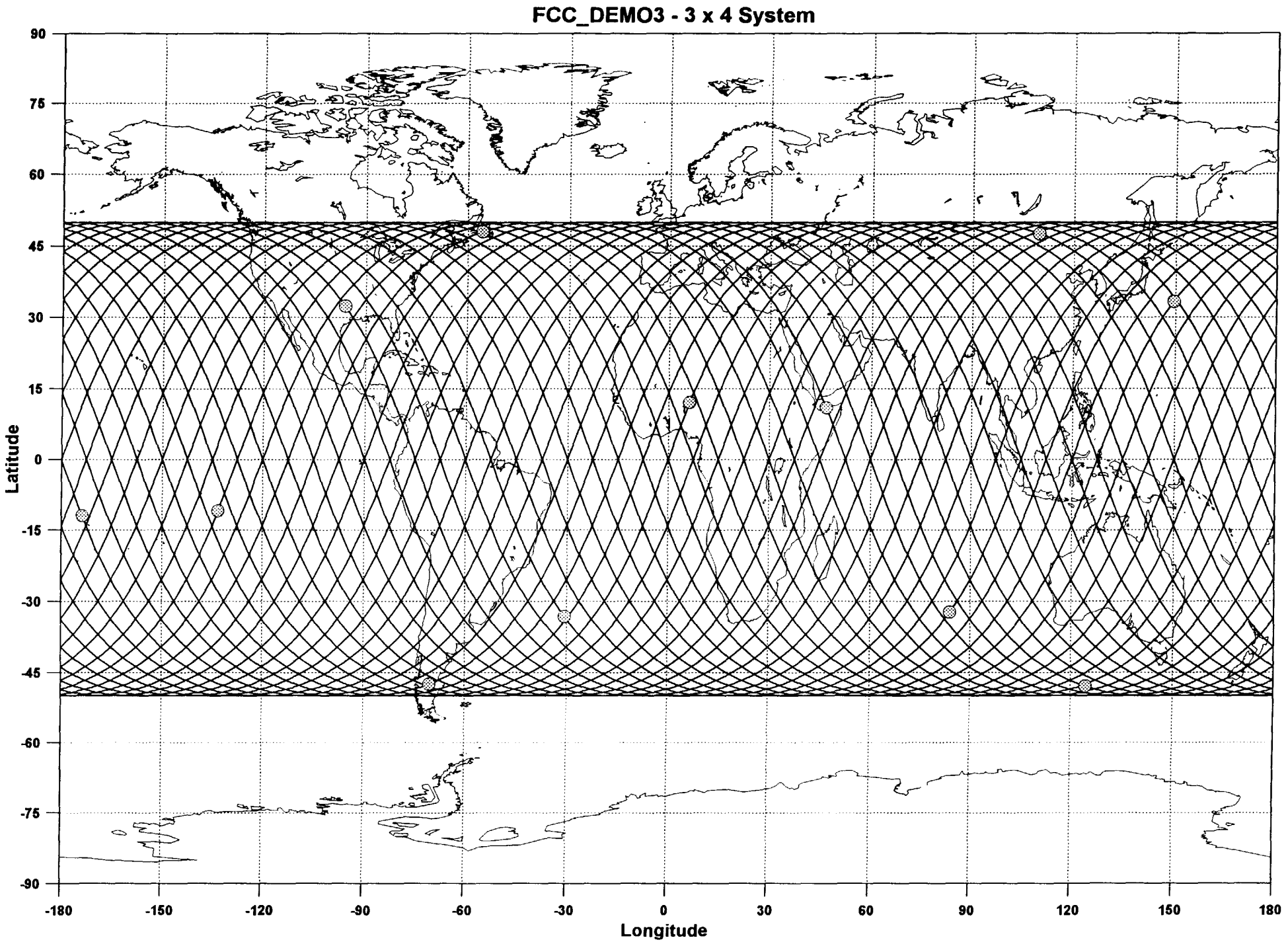
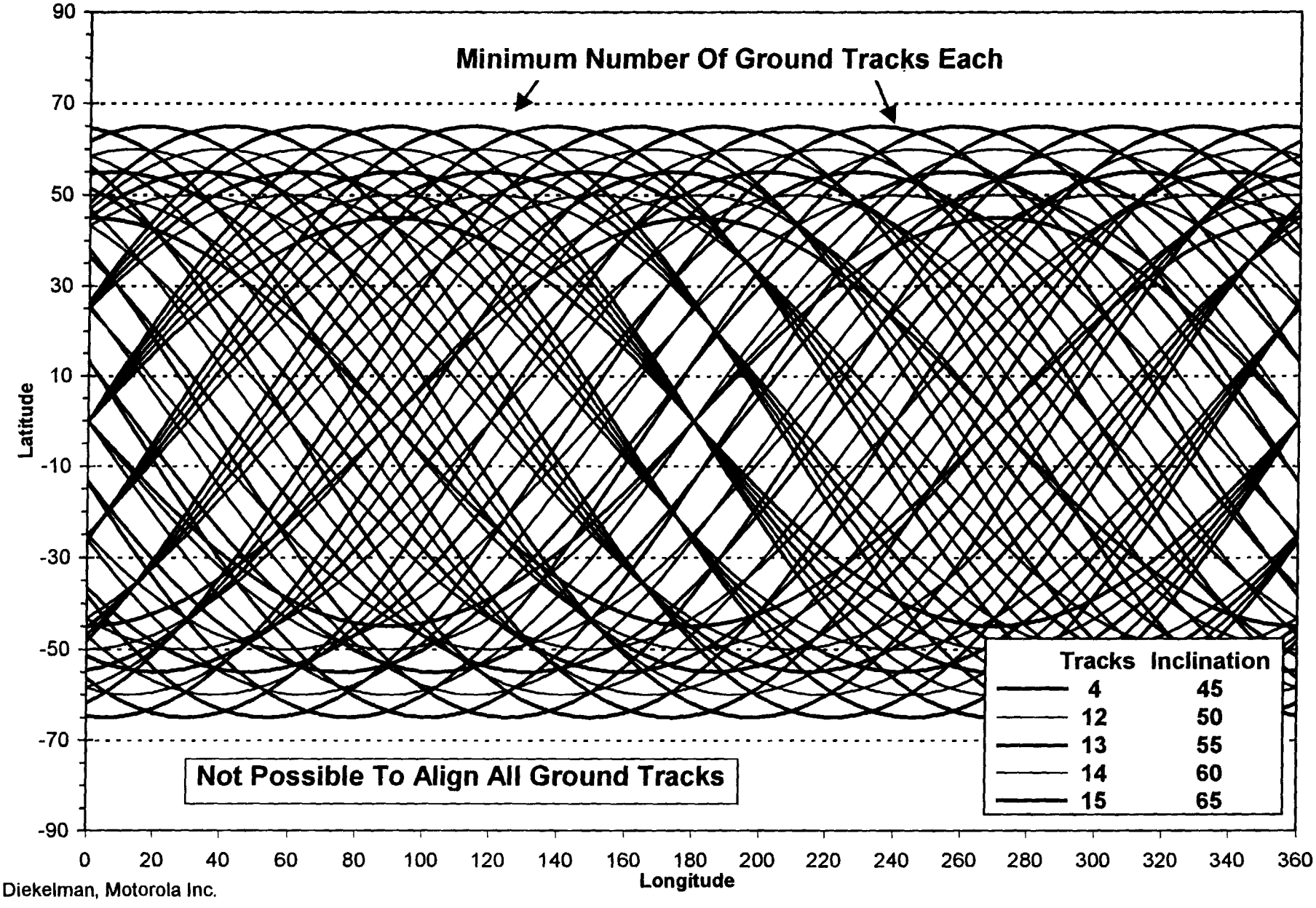

FCC_DEMO1 - 4 x 3 System
Latitude
Longitude
90
75
60
45
30
15
0
-15
-30
-45
-60
-75
-90
-180
-150
-120
-90
-60
-30
0
30
60
90
120
150
180


FCC_DEMO2 - 4 x 3 System
Latitude
Longitude
90
75
60
45
30
15
0
-15
-30
-45
-60
-75
-90
-180
-150
-120
-90
-60
-30
0
30
60
90
120
150
180


FCC_DEMO3 - 3 x 4 System
Latitude
Longitude
90
75
60
45
30
15
0
-15
-30
-45
-60
-75
-90
-180
-150
-120
-90
-60
-30
0
30
60
90
120
150
180

NGSO Combinations Of Altitudes & Inclinations



Summary

- Compensating For Nodal Regression Does NOT Produce Repeating Ground Tracks
  - Maneuver Method Is Not Practical
  - Only An Altitude Change Will Yield Repeat Tracks
  - Altitude Changes Destroy Current NGSO System Designs
  - Severely Restrict Future NGSO System Design
- Interference Reduction Should Be Accomplished By Other Means