GEOSTAR®
Positioning Corporation

SERVICE: Satellite Space Station
Type of Application: Construction and Launch
Number of Stations: One

May 18, 1990

47-DSS-P/LA-90
RDSS 2B
(52107)

Donna R. Searcy, Secretary
Federal Communications Commission
1919 M Street, N.W.
Washington, D.C. 20554

Attention: Ms. Cecily C. Holiday, Chief
Satellite Radio Branch
Room 6324

Re: Application for authority to construct, launch and operate an RDSS transmit/receive payload on a host satellite

Dear Ms. Holiday:

Enclosed is an original and nine copies of an application requesting authority to construct, launch and operate a new transmit/receive payload in the radiodetermination satellite service (RDSS). GPC is engaged in detailed negotiations with a satellite operator to have this payload incorporated into a host satellite presently scheduled for launch in 1992.

Pursuant to §1.1105 of the Commission's rules and regulations, a filing fee in the amount of $19,800 is attached.

Please contact Ronald J. Lepkowski at (202)-778-6008 if you have any questions concerning this filing.

Sincerely,

Robert D. Briskman

Robert D. Briskman
General Manager

1001 22nd Street, NW • Washington, DC 20037 • 202/887-0870 • FAX: 202/223-6154

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of the Application of	)	
	)	
GEOSTAR POSITIONING CORPORATION	)	File No.
	)	
For Authority to Construct, Launch and	)	
Operate a Transmit/Receive RDSS	)	
Payload to be Carried on a Host Satellite	)	

APPLICATION

Pursuant to Sections 308, 309 and 319 of the Communications Act of 1934, as amended, 47 USC §§ 308, 309 and 319, Geostar Positioning Corporation (GPC) requests authority to construct, launch and operate a transmit/receive communications payload in the radiodetermination satellite service (RDSS) to be carried on a host satellite.

A general description of GPC's RDSS system is provided in the *Geostar Satellite System Compendium of Application and Technical Information* that was filed on April 5, 1985, and which is incorporated by reference into this application. The following information is submitted in support of this application in accordance with Section III of Appendix B of *Space Station Application Filing Procedures*, 93 FCC 2d 1260, 1265 (1983). Additional details are provided in the attached Technical Description.

(A) The name and address of the applicant is:

Geostar Positioning Corporation
1001 22nd Street, N.W. - Suite 500
Washington, D.C. 20037

(B) Correspondence concerning this application should be addressed to:

Geostar Positioning Corporation
1001 22nd Street, N.W. - Suite 500
Washington, D.C. 20037

Attention: Robert D. Briskman
General Manager
(202)-778-6002

with a copy to applicant's counsel:

Michael Yourshaw, Esquire
Wiley, Rein & Fielding
1776 K Street, N.W.
Washington, D.C. 20006
(202)-429-7028.

(C) In this application, GPC proposes to construct, launch and operate a transmit/receive communications payload to be carried on a host satellite. This communications package will include two inbound channels and two outbound channels, and will have two 3.5° by 7° coverage patterns which independently serve user terminals located in the continental United States or in portions of Central and South America.

The following frequency bands will be used by the transmit/receive RDSS payload.

Center Frequency	Bandwidth	Polarization	Link Description
1618.25 MHz	16.5 MHz	LHCP	user-to-satellite
2491.75 MHz	16.5 MHz	RHCP	satellite-to-user
(TBD) MHz	1.0 MHz	Horiz	telemetry/beacon
(TBD) MHz	16.5 MHz	Horiz	satellite-to-control center
(TBD) MHz	1.0 MHz	Horiz	telemetry/beacon
(TBD) MHz	3.0 MHz	Vert	telecommand
(TBD) MHz	16.5 MHz	Vert	control center-to-satellite

Note: TBD = to be determined by host satellite.

The proposed transmit/receive RDSS payload operates at a significantly lower EIRP compared to the EIRP specified for the multibeam satellite design in the *Compendium*, and will not increase the potential for interference to any other user of the spectrum. The payload will still be capable of supporting handheld user terminals (although at a lower outbound information transmission rate) and providing position determination by range measurements obtained through two satellites and altitude information obtained from a digitized terrain map or on board altimeter.

(D) The orbital location at which the transmit/receive RDSS package will operate will be determined by the host satellite into which it is incorporated. It is expected that the links between the satellite and central control station, as well as TT&C, will be provided in the regular communications bands employed by the host spacecraft.

(E) Space station antenna gain contours are provided in the Annex to the attached Technical Description.

(F) The physical stationkeeping characteristics of the transmit/receive RDSS payload will be determined by the host satellite. The characteristics of the communications payload are described in the attached Technical Description. An operating lifetime of four years is projected for the transmit/receive payload.

(G) Spurious emissions will be attenuated below the mean power output of the transmitter under actual electrical conditions of operation by at least the following amounts:

1. On any frequency removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: 25 dB.

2. On any frequency removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: 35 dB

3. On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: 59 dB.

(H) The costs of the construction and integration of the transmit/receive RDSS payload, including the first year of operation, is estimated as follows ($000):

	L-2	L-1	L	L+1	Total
Construction/integration	10,000	10,000	10,000	0	30,000
Launch insurance	0	0	6,000	0	6,000
In-orbit insurance	0	0	0	600	600
Total	10,000	10,000	16,000	600	36,600

GPC is currently engaged in detailed negotiations with a satellite operator to have this payload incorporated into a host satellite presently scheduled for launch in 1992. Subject to review after reaching a final agreement with the host spacecraft operator and finalizing a launch and integration schedule, GPC tentatively proposes that the transmit/receive RDSS payload be placed into service in accordance with the following schedule of milestones:

Construction begins:	June 1990
Construction completed:	June 1992
Launch:	to be determined by host satellite
In-service:	August 1993.

Applicant Qualifications

The qualifications of the applicant are a matter of record before the Commission. See *Geostar Corporation*, Mimeo 6144 (released August 7, 1986). GPC filed its most recent *Common Carrier and Satellite Radio Qualifications Report* (FCC Form 430) with the Commission on March 28, 1990, and that filing is incorporated into this application by reference.

Public Interest Considerations

By separate applications filed today, GPC is requesting (a) modification of its authorizations for the first two dedicated RDSS satellites to allow a pair of dedicated RDSS satellites to be launched simultaneously from the shuttle on a single payload assist module at the end of 1993 and at the end of 1994, (b) authority to construct two additional dedicated RDSS satellites to be paired with the first two dedicated satellites as part of the 1993 and 1994 dual-satellite launches, and (c) authority to construct and operate an RDSS transmit/receive package on board a host satellite.

In *Geostar Corporation*, *supra*, the Commission determined that the public interest would be served by the construction, launch and operation of GPC's RDSS system. By its applications filed today, GPC is proposing a revised but comprehensive implementation plan for its RDSS system.

GPC is currently engaged in detailed negotiations with a satellite operator to have a transmit/receive RDSS payload incorporated into a host satellite presently scheduled for launch in 1992. With this two-way package and the existing RDSS relays on board the GTE Spacenet III and GSTAR III satellites, GPC will be able to provide full RDSS service, including satellite ranging and support of handheld user terminals, by the August 1993 date currently specified by the Commission for full RDSS system implementation.

With the technically innovative approach of launching two RDSS satellites simultaneously with the same payload assist module from the shuttle, GPC will incrementally increase the service capacity and reliability of its RDSS system in an economical manner. This is a financially prudent approach to system implementation that better matches in-orbit capacity with actual market development.

Finally, GPC is proposing to launch its multibeam Geostar-3 satellite at the end of 1995. At that time, traffic levels should have risen to the point where the most effective use can be made of the investment required for such a high capacity satellite.

GPC believes that the public interest will be served by this proposed RDSS implementation plan because it incrementally matches in-orbit capacity with the expected level of service demanded. Moreover, this implementation plan allows GPC to provide full RDSS service to its subscribers in a timely and economical manner without any loss in service quality or reliability.

Conclusion

This application is a minor action which is categorically excluded from environmental processing under §1.1306 of the Commission's rules and regulations because the facilities:

(1) do not involve a site location specified under §§1.1307(a)(1)-(5);

(2) do not involve high intensity lighting under §1.1307(a)(6); and

(3) do not result in human exposure to radio frequency radiation in excess of the applicable safety standards specified in §1.1307(b).

The Applicant waives any claim to the use of any particular frequency or of the electromagnetic spectrum as against the regulatory power of the United States because of the previous use of the same, whether by license or otherwise, and requests a space station authorization in accordance with this application. The undersigned, individually and for the Applicant, certifies that the statements made in this application are true, complete and accurate to the best of his knowledge and belief, and are made in good faith.

Respectfully submitted,

GEOSTAR POSITIONING CORPORATION
Robert D. Briskman
General Manager

Attachments: Technical Certification
Technical Description

May 18, 1990.

TECHNICAL CERTIFICATION

I hereby certify that I am the technically qualified person responsible for the preparation of this application; that I am familiar with Part 25 of the Commission's Rules and Regulations; that I have either prepared or reviewed the technical information contained in this application; and that it is complete and accurate to the best of my knowledge and belief.

Paul A. Locke
Vice President, Systems Engineering

Date: May 18, 1990

GEOSTAR SINGLE BEAM RDSS SPACE STATIONS

TECHNICAL DESCRIPTION

(May 18, 1990)

Geostar Positioning Corporation
1001 22nd Street, N.W. - Suite 500
Washington, D.C. 20037

(202)-887-0870

TABLE OF CONTENTS

GEOSTAR SINGLE BEAM RDSS SPACE STATIONS TECHNICAL DESCRIPTION

1. INTRODUCTION

Geostar is currently authorized to construct and operate three satellites in the radiodetermination satellite service (RDSS), *Geostar Corporation*, Mimeo 6144, (August 7, 1986). Geostar is currently providing interim service using RDSS relays on board the GTE Spacenet III and GSTAR III satellites, *GTE Spacenet Corporation*, 1 FCC Rcd 1163 (1986), Mimeo 5175 (June 16, 1986), DA 88-1265 (August 15, 1988) and DA 89-1506 (December 6, 1989), and 4/6 GHz transponders on conventional domestic fixed satellites, *Geostar Positioning Corporation*, FCC 89-142 (May 25, 1989).

Geostar satellites are currently manifested for three shuttle flights. For its first two Shuttle launches, Geostar is proposing the innovative use a single payload assist module (PAM-D2) upper stage to insert two RDSS satellites simultaneously into the geostationary satellite orbit. Geostar is also engaged in detailed negotiations with a satellite operator to incorporate a transmit/receive RDSS payload into a host satellite presently scheduled for a 1992 launch.

Each of these dedicated RDSS satellites, as well as the RDSS transmit/receive payload, will have a 3.5° by 7° coverage pattern centered on the continental United States, and/or on another point in the western hemisphere depending on customer requirements. All of these satellites will be capable of supporting miniaturized handheld user terminals.

In accordance with Section 25.392(a) of the Commission's Rules and Regulations governing the radiodetermination satellite service (RDSS), this appendix provides the detailed information required for individual space station applications by Appendix B of *Space Station Application Filing Procedures*, 93 FCC 2d 1260, 1265 (1983). Additional information concerning the overall Geostar RDSS system proposal and description is contained in the April 5, 1985 *Geostar Satellite System Compendium of Application and Technical Information*.

2. RADIO FREQUENCY PLAN

2.1 RDSS OPERATIONS

A detailed description of the operation of Geostar's RDSS system is provided in the *Compendium*. Figure 1 is an illustration of the radio links used in the system.

Geostar current operations are focused on the transportation industry and employ vehicle installed equipment. However, a miniaturized terminal is currently under development for government customers which will measure 5.6 x 3.1 x 1.6 inches and weigh 22 ounces, excluding battery pack. This user terminal includes a keyboard display containing a 2-line by 39 character display and 3-row by 10-column alphanumeric keypad. The unit also includes the L-band transmitter, S-band receiver, omnidirectional patch antennas, and internal processor module. Geostar expects that similar user terminals will also be commercially available to the general public.

Many other applications of RDSS service already have been demonstrated in practice. For example, Geostar's current system is being used by the Bureau of Land Management for aircraft tracking and emergency reporting. With Geostar's dedicated RDSS satellites, users will be able to receive a fully independent radiolocation and radionavigation service, coupled with ancillary two-way messaging.

In the RDSS system, a continuous outbound signal from the central earth station to mobile users is transmitted to provide time reference marks and an outbound time division multiplex data stream. To determine the position of a mobile unit, the mobile unit retransmits one of the time reference marks, adding its unique identification code and other information to this inbound transmission burst, through two or more geosynchronous RDSS satellites. The position of the mobile unit is calculated at the central earth station from the round trip propagation times through three satellites, or by the round trip propagation times through two satellites and altitude information obtained from a digitized terrain map or on-board altimeter. The calculated position and any other information addressed to the user is transmitted back on the outbound data stream between the system time reference marks. The positioning accuracy of Geostar's dedicated RDSS system will be better than fifty meters.

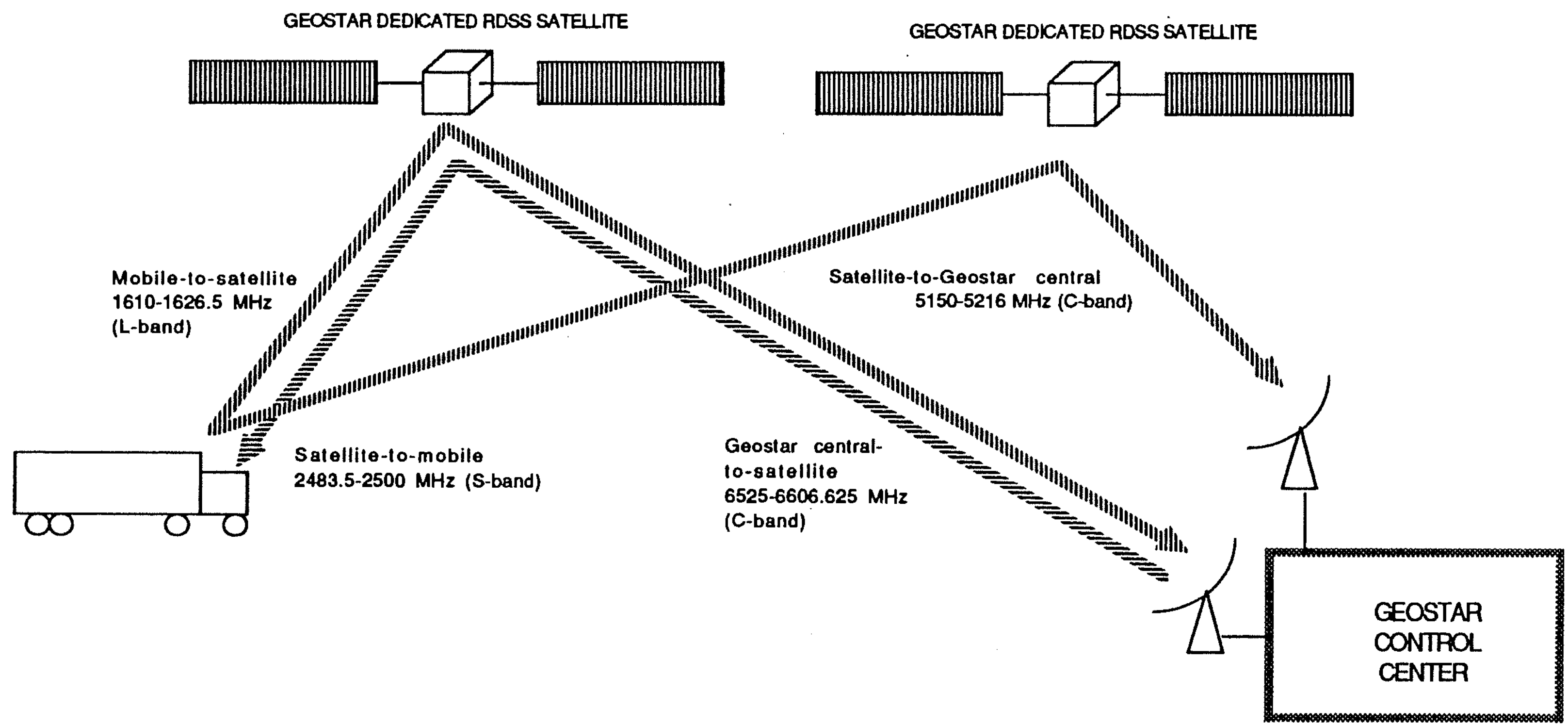


FIGURE 1. FREQUENCY PLAN FOR GEOSTAR DEDICATED RDSS SATELLITES

2.2 PARTICULARS OF OPERATION

The frequencies available for RDSS are set forth in Section 25.202(a)(2), as modified by the Commission's *Report and Order* in Gen. Docket No. 89-103, FCC 89-282 (October 19, 1989) to reflect the change in the satellite-to-control center link from 5117-5183 MHz to 5150-5216 MHz band as a result of the Final Acts of the 1987 World Administrative Radio Conference for the Mobile Services. In addition, Geostar was granted authority to utilize the band 6525-6606.625 MHz for its control center-to-satellite link in *Geostar Positioning Corporation,* FCC 90-88 (March 14, 1990).

The following table identifies the particulars of operation for the Geostar single beam dedicated RDSS satellites.

Center Frequency	Bandwidth	Polarization	Link Description
1618.25 MHz	16.5 MHz	LHCP	user-to-satellite
2491.75 MHz	16.5 MHz	RHCP	satellite-to-user
5141.5 MHz	1.0 MHz	Horiz	telemetry/beacon
5183 MHz (or 5174.25 MHz)	16.5 MHz	Horiz	satellite-to-central earth station
5224.5 MHz	1.0 MHz	Horiz	telemetry/beacon
6226.5 MHz 6536.5 MHz	3.0 MHz	Vertical	central earth station-to-satellite
6562.875 MHz (or 6555.5 MHz)	16.5 MHz	Vertical	telecommand

Table 1. Particulars of Operation for Geostar RDSS Space Stations

In order to be able to independently command each of the two RDSS satellites being launched at the same time on the PAM-D2, different telecommand frequencies are needed for each satellite. Two alternative frequencies are also being considered for the feeder links between the satellite and central earth station, and both are specified in Table 1.

With respect to the transmit/receive payload, the feeder links between the satellite and central earth station, and the TT&C frequencies, will be determined by the host satellite on which the payload is carried.

2.3 MODULATION AND SIGNAL FORMAT

The inbound transmission from a mobile user is in a spread spectrum format, consisting of a transmission burst, approximately 20 to 80 milliseconds in duration, transmitted at a chip rate of 8 million chips per second (8 mcps). This signal consists of 15.625 kilobit per second data, rate-1/2 encoded for forward error correction, spread by a direct sequence pseudo-random noise code. The spread signal is BPSK modulated. The emission designator for this signal is 16M5G1D.

As illustrated in Figure 2, the transmission burst is divided into the following fields:

- an acquisition sequence to allow the central earth station to lock onto the incoming packet
- a length field to indicate the length of the data portion of the packet
- a routing address for preprocessing control and routing of incoming packets
- the user identification code (physical address)
- format and protocol control fields
- a variable length data field
- a cyclic redundancy check (CRC) for error detection, and
- forward error correction (FEC) flush bits.

The data field contains an internal diad required for position determination and an application packet of other data as required.

The RDSS central control earth station transmits a continuous signal, which is framed and contains message packets addressed to mobile users. This outbound signal is also spread. This signal consists of 125 kilobit per second data, rate-1/2 encoded for forward error correction. The data rate for the transmit/receive RDSS payload will be lower. The data transmission is spread by a direct sequence pseudo-random noise code operating at 8.000

megabits per second. The spread signal is BPSK modulated. The emission designator for this signal is 16M5G1D.

The outbound signal consists of a continuous transmission of fixed length frames, with the beginning of each frame constituting a time reference mark for the RDSS system. As illustrated in Figure 2, each frame consists of:

- an acquisition aid
- the frame number
- a beam number, and
- standard outbound packets addressed to a particular user or group of users.

Each outbound packet is delimited by HDLC flags, and contains the following fields:

- an address (individual or group user identification code)
- format and protocol control fields, and
- an application packet containing the calculated user position and other data, and
- a frame check sequence (FCS) for error detection.

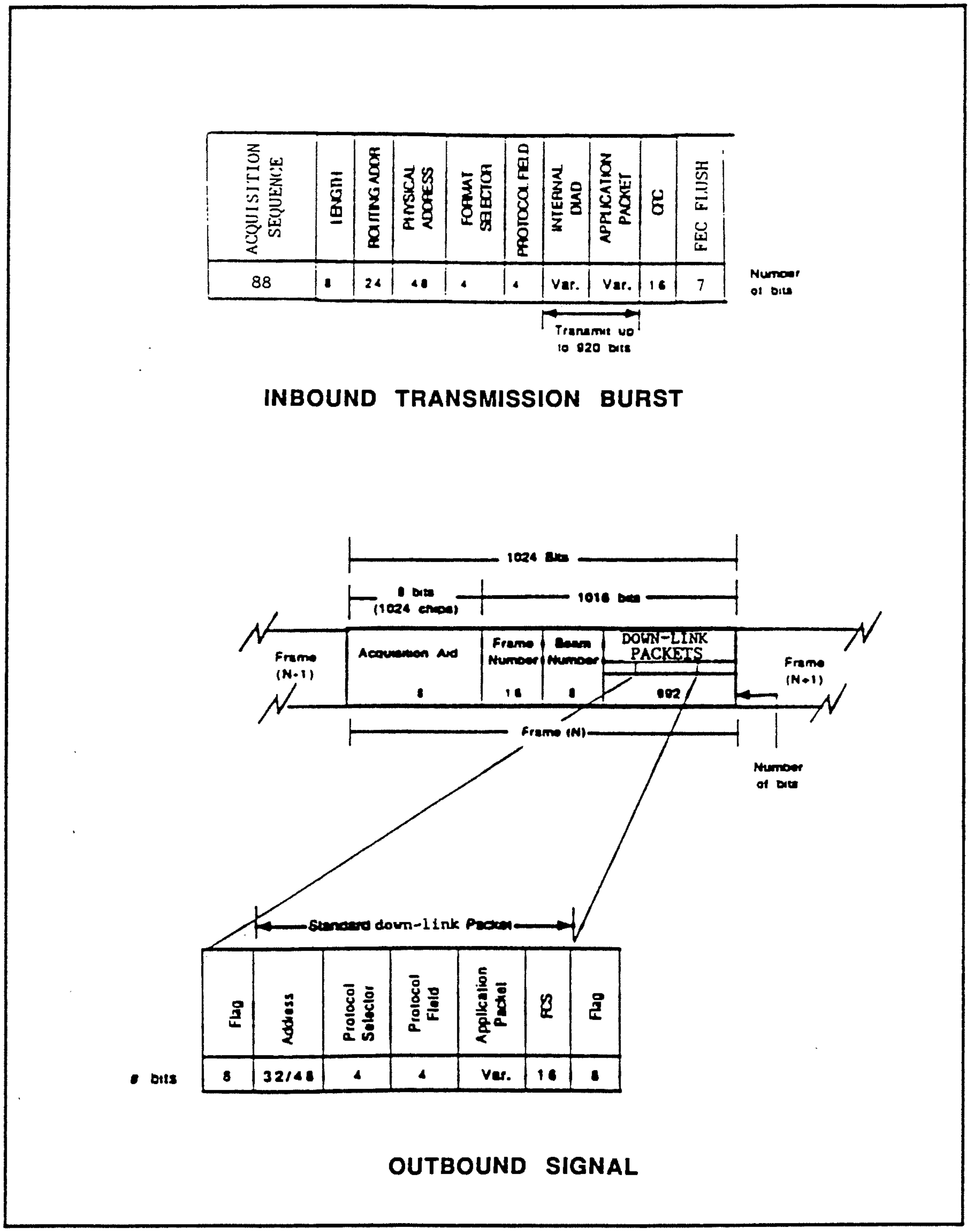


Figure 2. RDSS Signal Structure

3. ORBITAL LOCATIONS

In *Geostar Corporation*, *supra*, the Commission assigned Geostar the orbital locations of 70°, 100° and 130° West Longitude for its RDSS satellites. Geostar is unaware of any other companies holding Commission authorizations to operate satellites at these locations in the RDSS bands licensed to Geostar.

No changes are proposed in the currently authorized orbital locations of 70° and 100° West Longitude that were assigned to GPC in *Geostar Corporation*, Mimeo 6144 (released August 7, 1986). However, GPC does request that the westernmost orbital location assigned to its RDSS system be changed from 130° to 120° West Longitude. This change in assigned orbital location will not affect any other satellite operator and will improve service reliability by affording users on the east coast of the United States a higher elevation angle to the satellite. Any decrease in positioning accuracy from a reduction in spacing between the western and central satellite will be negligible.

The orbital location of the transmit/receive RDSS payload will be determined by the location assigned to the host satellite.

The following table illustrates Geostar's currently proposed satellite deployment plan. As is the case in other satellite services, Geostar may deploy specific satellites in a different sequence among the three orbital locations of 70°, 100° and 120° West Longitude assigned to its RDSS system as warranted by customer service requirements and the status of the satellites in its system at the time.

DATE	120° WL	100° WL	70° WL
1990		• 93° WL: GSTAR III	• 87° WL: Spacenet III
1992		T/R payload	
12/93		Geostar-1A	Geostar-1B
12/94	Geostar-2A		Geostar-2B
12/95		Geostar-3	

Table 2. Geostar RDSS Satellite System Deployment Plan

4. SPACE STATION COVERAGE PATTERNS

The Geostar RDSS satellites use a single 3.5° by 7.0° antenna beam (nominal edge of coverage). The L and S band antennas are roll-pointable to cover all elevations, with a spacecraft pitch offset capability for pointing in azimuth (±6.2° pitch offset capability). This will allow Geostar to alter the in-orbit coverage of these satellites to meet customer demand throughout the western hemisphere over the lifetimes of the satellites.

The Annex to this Technical Description contains space station antenna gain patterns with the contours plotted at 2 dB intervals down to 12 dB below the peak gain and at 4 dB intervals between 12 and 20 dB below the peak gain. A -30 dB contour is also included. Since each of the satellites will be functionally identical, the Annex contains a set of contours for each of the 70°, 100° and 120° West Longitude orbital locations, and for boresights in the United States and a typical Caribbean coverage. The transmit/receive payload will have two channels, one of which will provide coverage of the continental United States and the other will provide coverage of South America. For the purposes of developing contours for the transmit/receive payload, an orbital location of 100° West Longitude was assumed. The actual orbital location for the transmit/receive payload will be that assigned to the host satellite.

Table 3 summarizes the characteristics of the space station antenna transmission parameters. No saturation flux density (SFD) is specified for the 1.6 GHz receiver because a single user spread spectrum transmission burst is approximately 18 dB below the satellite receiver noise floor. It is necessary to specify an aggregate power flux density (in lieu of an SFD) at the orbit as part of the inter-system coordination process to protect the 1.6 GHz receiver from unacceptable interference. That level will be substantially below the flux density level that would saturate the transponder.

		Maximum	Edge of Coverage
1.6 GHz:	gain G/T SFD	23.8 -3.6 * *	22.9 -4.5 * *
2.5 GHz:	gain EIRP	29.9 50.9	27.0 48.0
5.1 GHz:	gain EIRP	28.0 38.0	25.0 33.0
6.5 GHz:	gain G/T SFD	25.0 -2.0 -88.0	22.0 -5.0 -91.0

Table 3. Space Station Antenna Transmission Parameters

The power flux density produced by the satellites is calculated in Table 4 below.

	2.5 GHz	5.1 GHz
Maximum satellite EIRP (dBW)	50.9	38.0
-10 log (16.5 MHz/4 kHz)	-35.4	-35.4
Maximum satellite EIRP density	15.5	2.6
Spreading factor	-162.4	-162.4
Power flux density (dBW/m^2-4 kHz)	-146.9	-159.8

Table 4. Calculation of Power Flux Densities at the Earth's Surface

5. SATELLITE CHARACTERISTICS

The Geostar dedicated single beam RDSS satellites will be manufactured by GE-Astro Space Division, and take advantage of subsystems from previous satellite designs in the 3000 and 4000 series of satellites. By relying to the maximum extent on flight proven hardware and designs, Geostar expects to achieve a high reliability, economical satellite design.

5.1 COMMUNICATIONS PAYLOAD

Figure 3 is a functional block diagram of the communications payload. The satellite carries a 16.5 MHz transponders in each of the inbound (mobile user-to-central control earth station) and outbound (central control earth station-to-mobile user) directions. Each transponder is of a simple frequency translating design (either L-to-C band or C-to-S band). Two for one redundancy is provided in each transponder for all active components. The transmit/receive payload will have a three for two redundancy design for its active components.

The S-band (2.5 GHz) transmitters are 180 watt travelling wave tube amplifiers (TWTAs), and the C-band (5.1 GHz) transmitters are 12 watt solid state power amplifiers (SSPAs). For the transmit/receive payload, the TWTA is rated at 42 watts. In each case, there is about 1 dB of loss between the output of the TWTA or SSPA and the input to the transmitting antenna.

The L-band and S-band antennas are planar arrays and are independently steerable over a ±6° angle to provide coverage of both the continental United States as well as South and Central America. The axial ratios will be 2.5 dB or less.

The L-to-C band transponder has 8 gain step settings ranging from +2 to -9 dB with respect to the nominal SSPA output.

GEOSTAR Dual-Launch Transponder Block Diagram

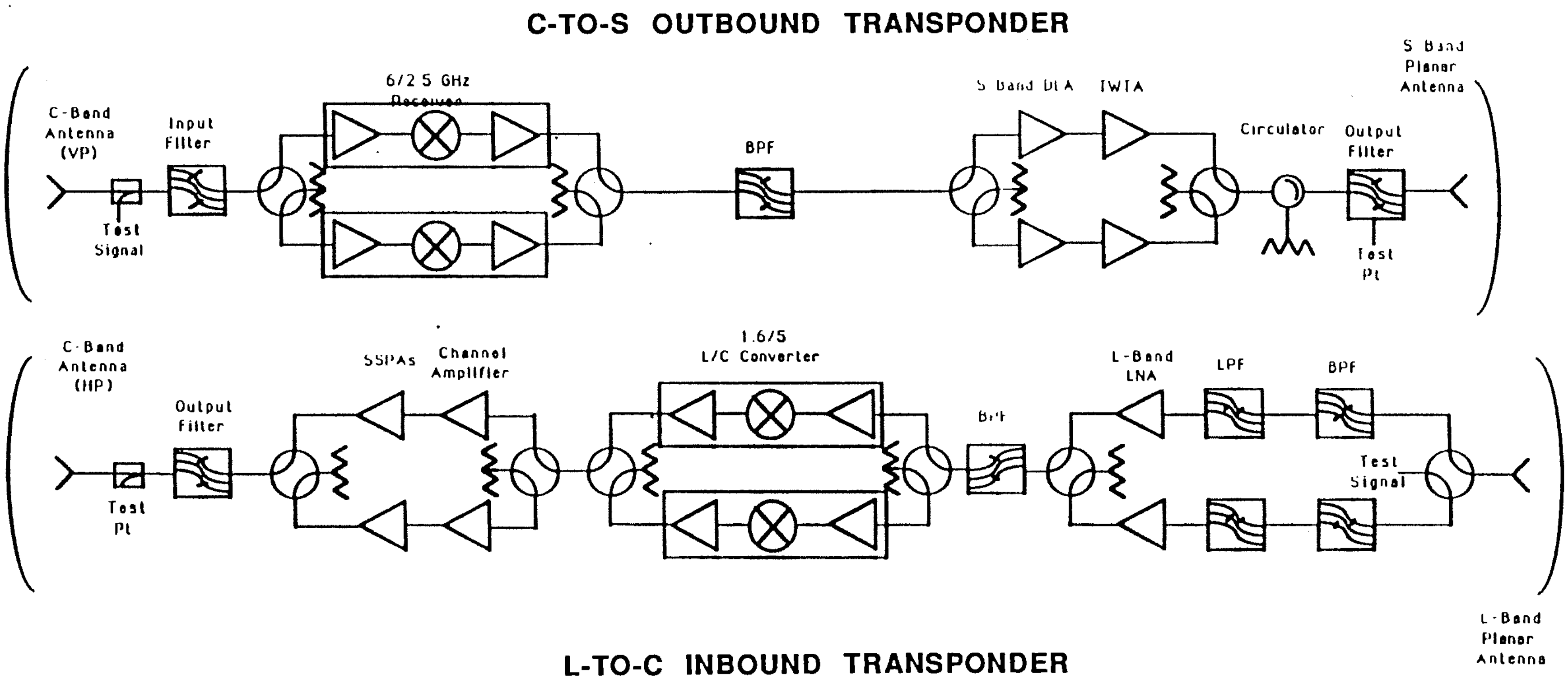


Figure 3. Dedicated RDSS Satellite Functional Block Diagram

Spurious emissions from the dedicated RDSS satellites will be attenuated below the mean power output of the transmitter under actual electrical conditions of operation by at least the following amounts:

1. On any frequency removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: 25 dB.

2. On any frequency removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: 35 dB

3. On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: 65 dB (2.5 GHz); 54 dB (5.1 GHz).

5.2 TELEMETRY, TRACKING AND COMMAND

The telemetry tracking and command (TT&C) system provides the functional and hardware redundancy required for (a) the reception, processing and distribution of command signals, (b) the reception, accumulation, multiplexing and transmission of housekeeping telemetry, and (c) the reception, detection and retransmission of ranging signals.

The TT&C system consists of three command receivers and redundant demodulators and processors. The telecommand signal will be located within a 3 MHz band centered at 6526.5 MHz on one satellite and at 6536.5 MHz on the other of the dual launch pair.

The two telemetry and beacon systems are also redundant, with two separate beacon normally being transmitted. Each beacon will be assigned a different frequency. Each of the beacon signals have a nominal bandwidth of 100 kHz and are located within a 1 MHz band centered at 5141.5 and 5224.5 MHz. The beacon/telemetry bands are outside of the 66 MHz satellite-to-control center feeder link allocated for the inbound transmission from mobile users. However, as was the case in the *Compendium* and the Commission's authorization in *Geostar Corporation, supra,* these telemetry beacons will be used on a secondary non-interference basis and are transmitted at a power level that provides a protection ratio of at least 30 dB N/I to any microwave landing systems that might operate on these frequencies. See *Compendium* at page 31.

Two antennas are provided for the TT&C signals. One antenna provides an omnidirectional toroidal pattern, for transfer orbit operations with a gain of 0 dBi over a ±20° toroid and 2.5 dBi over a ±9° toroid. The other TT&C antenna is a 15 dBi earth coverage horn antenna for on station operations. The beacon EIRP is -1.0 dBW during transfer orbit and 4.0 dBW when on station. Consideration is also being given to the use of the normal C-band communications antennas for TT&C while the satellite is on station. Additional details on the TT&C transmission format is provided in the *Compendium*.

5.3 PHYSICAL AND ELECTRICAL CHARACTERISTICS

The structure of the Geostar single beam satellites utilizes GE-Astro Series 3000 and 4000 heritage components. The basic structure consists of a monocoque center cylinder with aluminum honeycomb panels on which the bus and communications equipment is mounted. Figure 4 is a sketch of the satellite configuration.

The satellites are designed to be stacked together with a single apogee kick motor within the satellite structure. The following table provides a weight summary (weights are specified in terms of pounds).

Subsystem	Upper	Lower	Combined
Structure	182.1	182.0	364.1
Attitude control	118.8	114.7	233.5
TT&C	65.4	65.4	130.8
Power	239.4	239.4	488.8
Thermal	31.3	40.3	71.6
Communications	187.7	187.7	375.4
AKM/separation	49.3	145.7	195.0
Margin			89.9
Total(dry)	873.9	975.0	1848.9
Propellant	114.1	95.3	209.4
AKM expendables		1911.9	1911.9
Total (liftoff)			4060.0

Table 5. Geostar Dedicated RDSS Satellite Weight Summary

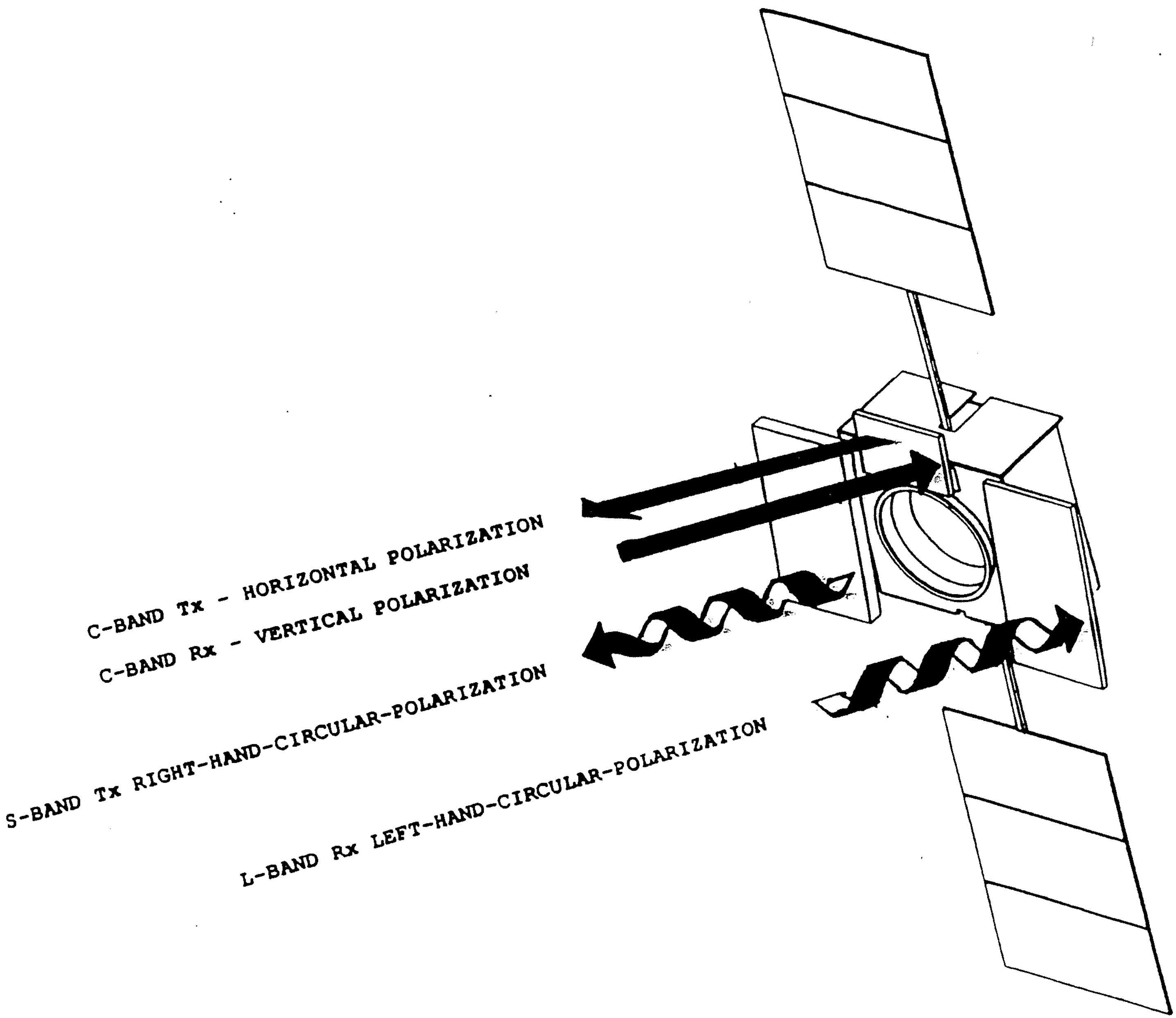


Figure 4. Geostar Single Beam Dedicated RDSS Satellite Design

Prime DC power is provided by a solar panel array that is rated at 810 watt end of lifetime (EOL). The batteries carried on board are rated at 48 ampere hours to provide full eclipse operation. The following table summaries the electrical power budget.

Subsystem	watts
communications	458.0
TT&C	28.7
Attitude control/propulsion	43.4
battery charge (equinox)	85.2
thermal	39.8
power conditioning/losses	19.3
Peak and load margins	47.0
Total peak load	720.4
Array capability (10 years)	810.4
Margin	90.0

Table 6. Geostar Dedicated RDSS Satellite Electrical Power Summary

The satellite is designed to achieve an operating lifetime of ten years or more.

The three-axis attitude control system uses momentum wheels and magnetic torquer for normal on-orbit operations. The satellite carries redundant sun and earth sensors for attitude determination, as well as a redundant reaction control system for east-west stationkeeping and orbital maneuvers.

The satellite will be controlled to the following parameters:

$\pm$ 0.1° E-W
$\pm$ 5.0° N-S
$\leq$ 0.15° antenna pointing

Roll and pitch offsets for the dedicated RDSS satellites are controlled by reprogramming uplinked from the satellite operations center and will be used to maintain space station antenna pointing over a 24 hour period.

5.4 LAUNCH ARRANGEMENTS

The Geostar single beam RDSS satellites are designed to be stacked and launched on a single launch vehicle, and transferred to the geostationary satellite orbit with a single apogee kick motor (AKM). The satellite stack will be spin stabilized during transfer orbit. After the AKM burn, the satellites are despun and separated using a spring loaded separation mechanism. The satellites are allowed to drift to their assigned orbital locations where the on board thrusters are used to stop the drift and maintain the satellite on station.

The Geostar dedicated RDSS satellites will be launched from the space shuttle, using a PAM-D2 upper stage to achieve transfer orbit. The satellites are also compatible with an Ariane IV launch vehicle.

6. INTERFERENCE CONSIDERATIONS

Typical link budgets for the inbound transmissions from the mobile units and for the outbound link from the central control station are presented in Tables 8 and 9, respectively. In addition, a supplemental link budget is given in Table 10 for the transmit/receive payload which will have a lower EIRP than Geostar's dedicated RDSS satellites.

Operations of Geostar's RDSS system will conform to the sharing criteria specified in the international Radio Regulations. The criteria are summarized in Table 7.

- POWER FLUX DENSITY LIMITS ON SATELLITE POWER:
  - -144 TO -154 dBW/m^2-4 kHz at 2.5 GHz
    (Article 28: RR 2556-2558)
  - -159 dBW/m^2-4 kHz at 5 GHz
    (Article 8: RR 797A)
- EIRP DENSITY LIMITS ON EARTH STATION TRANSMITTERS
  - -3 dBW/4 kHz at 1.6 GHz (mobiles)
    (Article 28: RR 2548A)
  - 40+3Ø dBW/4 kHz at 6.5 GHz (hub station)
    (Article 28: RR 2541 [existing FSS limit])
- UNIFORM COORDINATION DISTANCES FOR MOBILE UNITS
  (Article 11: RR 1107.1)
  - 100 km for ground-based units
  - 400 km for airborne units

Table 7. Summary of International RDSS Sharing Criteria

The Commission has established basic technical characteristics for RDSS in order to insure multiple entry by several RDSS system operators with only minimal coordination of technical parameters between them. In particular, Section 25.392(f) requires RDSS licensees to coordinate with each other to avoid harmful interference through power flux density limits, use of pseudo-random noise codes and random access, time division multiplex techniques. During the period of time in 1986-1987 when several companies held RDSS system authorizations, Geostar had worked with the other permittees to coordinate system parameters to insure compatible use of the geostationary satellite orbit and spectrum by the different RDSS systems. At this point in time, however, there are no other licensed RDSS systems or other pending applicants for new RDSS systems. Thus, Geostar necessarily complies with the requirements of Sections 25.392(a) and (f) with respect to compatibility with other potential RDSS systems. It should be noted, moreover, that Geostar's system will conform to all of the requirements identified in the earlier RDSS inter-system coordination, and Geostar stands ready to cooperate fully with any new RDSS system applicant in this band.

Term	Value		Units
Constants			
Spacecraft Longitude	70.0		Deg W
Uplink Center Frequency	1.61825		GHz
Down Link Center Freq.	5.15000		GHz
Uplink Channel BW	16.5		MHz
Information Rate	15.625		kbps
Down Link Channel BW	16.5		MHz
	Earth Station	User	
Gnd Location		6 City	
Lat	38.46	Average	Deg N
Long	107.77		Deg W
Az	128.75		Deg
El	30.77		Deg
Range	38541	37552	km
Uplink	**Clear Sky**	**Faded**	
User Transmitter Powei	16.00	16.00	dBW
User Unit Feed Loss	-0.70	-0.70	dB
User Unit Antenna Gain	3.00	3.00	dBi
	------	------	
User EIRP	18.30	18.30	dBW
Free Space Loss	-188.12	-188.12	dB
Polarization Loss	-0.50	-0.50	dB
Random Path Losses	0.00	-2.00	dB
Gaseous Loss	-0.05	-0.05	dB
Rain Losses (99.99 %)	0.00	-0.02	dB
	------	------	
Power at Sat. (Iso Ant.)	-170.37	-172.39	
Satellite G/T	-4.50	-4.50	dB/K
C/No up	53.73	51.71	dB/Hz
C/N up	-18.44	-20.46	dB
Flux @ Satellite	-144.73	-146.75	dBW/m2
	Clear Sky	**Faded**	

Table 8. Dedicated RDSS Satellite Inbound Link Budget

Down Link	Clear Sky	Faded	
Satellie EIRP	33.00	33.00	dBW
C/N up	-18.44	-20.46	dB
Intermodulation Loss	-1.20	-1.20	dB
	------	------	
Satellite EIRP/Carrier	13.36	11.34	dBW
Path Loss	-198.40	-198.40	dB
E. S. Antenna Gain	51.50	51.50	dBi
Feed Loss	-1.00	-1.00	dB
Pointing Loss	-0.20	-0.20	dB
Polarization Loss	-0.30	-0.30	dB
Gaseous Absorption	-0.08	-0.08	dB
Rain Losses (99.999 %)	0.00	-1.48	dB
1 Sigma Scintillation	-0.09	-0.08	dB
	------	------	
Received Power/Carrier	-135.20	-138.69	dBW
E. S. Noise Power	-136.13	-133.73	dBW
	------	------	
C/N down	0.93	-4.96	dB
C/No down	73.10	67.21	dB Hz
C/No up	53.73	51.71	dB Hz
	------	------	
C/No Total	53.68	51.59	dB Hz
Eb/No	11.75	9.66	dB
Implementation	-2.50	-2.50	dB
Coding Gain	5.20	5.20	dB
	------	------	
Resultant Eb/No	14.45	12.36	dB
Required Eb/No	9.60	9.60	dB @ 1:10^5
	------	------	
Margin	4.85	2.76	dB
Power Flux Density	-162.6		dBW/m2 4KHz
	Clear Sky	Faded	

Table 8. Dedicated RDSS Satellite Inbound Link Budget

Term	Value		Units
Constants			
Spacecraft Longitude	70.00		Deg W
Uplink Center Frequency	6.533		GHz
Uplink Transmission BW	16.500		MHz
Down Link Center Freq.	2.49175		GHz
Down Link Trans. BW	16.50		MHz
Down Link Information Rate	125.00		kbps
	Earth Station	User	
Gnd Location		6 City	
Lat	38.46	Average	Deg N
Long	107.88		Deg W
Az	128.64		Deg
El	30.70		Deg
Range	38548	37552	km
Uplink	**Clear Sky**	**Faded**	
Transmitter Ant Gain	50.05	50.05	dBi
Transmitter Power	23.00	23.00	dBW
Transmit Feed losses	-1.00	-1.00	dB
Pointing Losses	-0.20	-0.20	dB
Polarization Losses	-0.30	-0.30	dB
	----------	----------	
Uplink EIRP	71.55	71.55	dBW
Path Loss	-200.46	-200.46	dB
Atmos. Gaseous Losses	-0.08	-0.08	dB
Rain Losses (99.999 %)	0.00	-2.75	dB
1 Sig Tropo Scintillation	-0.09	-0.09	dB
	----------	----------	
Signal Level @ Satellite	-129.09	-131.84	dBW
Satellite G/T	-7.00	-7.00	dB/K
	----------	----------	
Received C/No up	92.51	89.76	dB Hz
Received bandwidth	72.17	72.17	dB Hz
	----------	----------	
Received S/N	20.34	17.59	dB
Flux @ Satellite	-91.33	-94.08	dBW/m^2
	Clear Sky	**Faded**	

Table 9. Dedicated RDSS Satellite Outbound Link Budget

Down Link	Clear Sky	Faded	
Sat. Transponder EIRP	48.00	48.00	dBW
Path Loss	-191.86	-191.86	dB
User Antenna Gain	3.00	3.00	dBi
Ant. Feed Losses	-0.30	-1.00	dB
Polarization Loss	-0.50	-0.50	dB
Atmos. Gaseous Losses	-0.06	-0.06	dB
Rain Loss (99.99 %)	0.00	-0.04	dB
Random Path Losses	0.00	-2.00	dB
	----------	----------	
Received Power	-141.72	-144.46	dBW
User Thermal Noise Power	-133.41	-133.35	dBW
	----------	----------	
C/N down	-8.31	-11.11	dB
C/N up	20.34	17.59	dB
	----------	----------	
C/N Total	-8.32	-11.12	dB
C/No down	63.86	61.05	dB Hz
Received Eb/No	12.89	10.09	dB
Implementation Margin	-2.50	-2.50	dB
Coding Gain	5.20	5.20	dB
	----------	----------	
Eb/No	15.59	12.79	dB
Required Eb/No	9.60	9.60	dB @ 1:10^-5
	----------	----------	
Margin	5.99	3.19	dB
	Clear Sky	Faded	

Table 9. Dedicated RDSS Satellite Outbound Link Budget

Term	Value	Units
Constants		
Spacecraft Longitude	100.00	Deg W
Uplink Center Frequency	6.533	GHz
Uplink Transmission BW	16.500	MHz
Down Link Center Freq.	2.49175	GHz
Down Link Trans. BW	16.50	MHz
Down Link Information Rate	31.25	kbps
	Earth Station	
Gnd Location		
Lat	38.00	Deg N
Long	77.00	Deg W
Az	214.58	Deg
El	39.83	Deg
Range	37791	km
Uplink	**Faded**	
Transmitter Ant Gain	53.57	dBi
Transmitter Power	20.00	dBW
Transmit Feed losses	-1.00	dB
Pointing Losses	-0.20	dB
Polarization Losses	-0.30	dB

Uplink EIRP	72.07	dBW
Path Loss	-200.29	dB
Atmos. Gaseous Losses	-0.70	dB
Rain Losses (99.999 %)	-5.10	dB
1 Sig Tropo Scintillation	-0.70	dB

Signal Level @ Satellite	-134.72	dBW
Satellite G/T	-5.00	dB/K

Received C/No up	88.88	dB Hz
Received bandwidth	72.17	dB Hz

Received S/N	16.70	dB
Flux @ Satellite	-96.97	dBW/m^2
	Faded	

Table 10. Transmit / Receive Payload Outbound Link Budget

Down Link	Faded	
HPA Power	42.00	Watts RF
RF Losses	-1.20	dB

Sat RF Power	15.03	dBW
Satellite S-Band Gain	27.40	dBi
Antenna Losses	-1.60	dB
Pointing Loss	-0.15	dB

Sat Antenna Gain	25.65	dBi
Sat. Transponder EIRP	40.68	dBW
Path Loss	-191.92	dB
User Antenna Gain	3.00	dBi
Ant. Feed Losses	-0.30	dB
Polarization Loss	-0.50	dB
Atmos. Gaseous Losses	-0.06	dB
Rain Loss (99.99 %)	-0.06	dB
Random Path Losses	0.00	dB

Received Power	-149.16	dBW
User Thermal Noise Power	-133.35	dBW

S/N down	-15.81	dB
S/N up	16.70	dB

S/N Total	-15.81	dB
C/(No) down	56.37	dB Hz
Received Eb/No	11.42	dB
Implementation Margin	-2.50	dB
Coding Gain	5.20	dB

Eb/No	14.12	dB
Required Eb/No	9.60	dB @ 1:10^-5

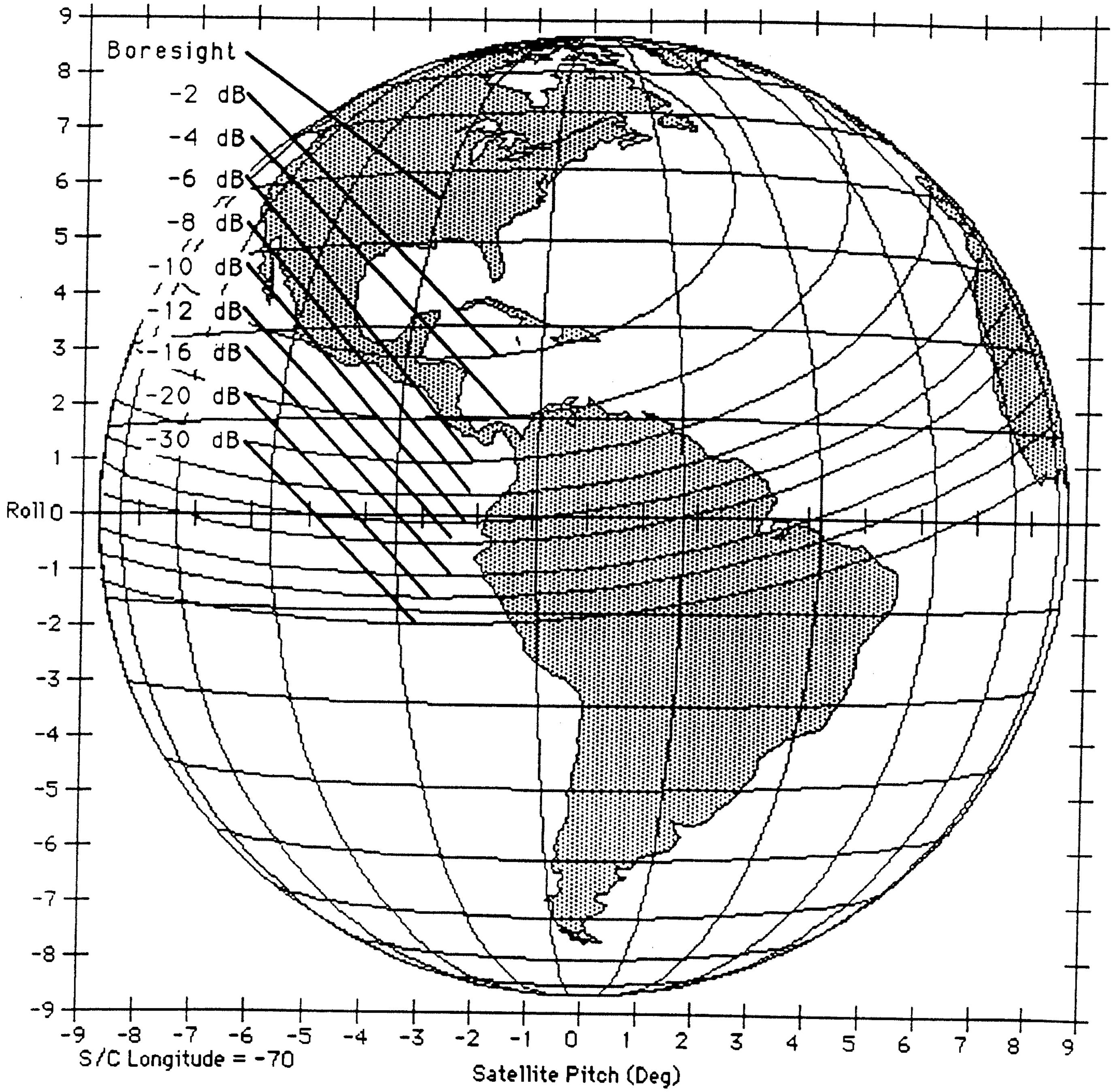
Margin	4.52	dB
Data Rate	31.25	kbps
	Faded	

Table 10. Transmit / Receive Payload Outbound Link Budget

ANNEX

GEOSTAR DEDICATED RDSS SATELLITES

SPACE STATION ANTENNA PATTERNS



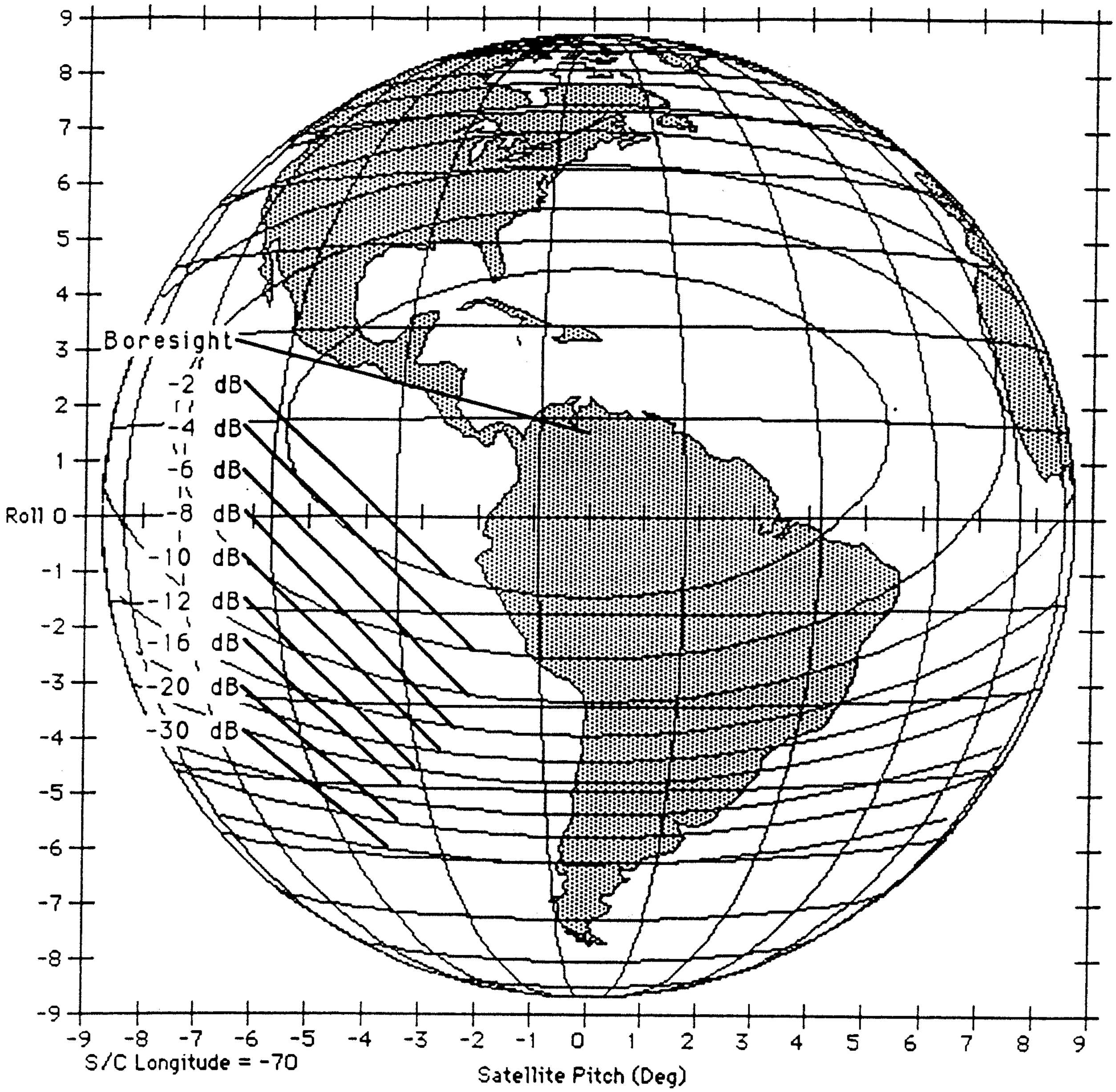
Output File : L 70 S Conus

Orbital Location : 70° W

Coverage Area : Conus

Peak Gain : 23.8 dBi

Frequency : 1.618 GHz



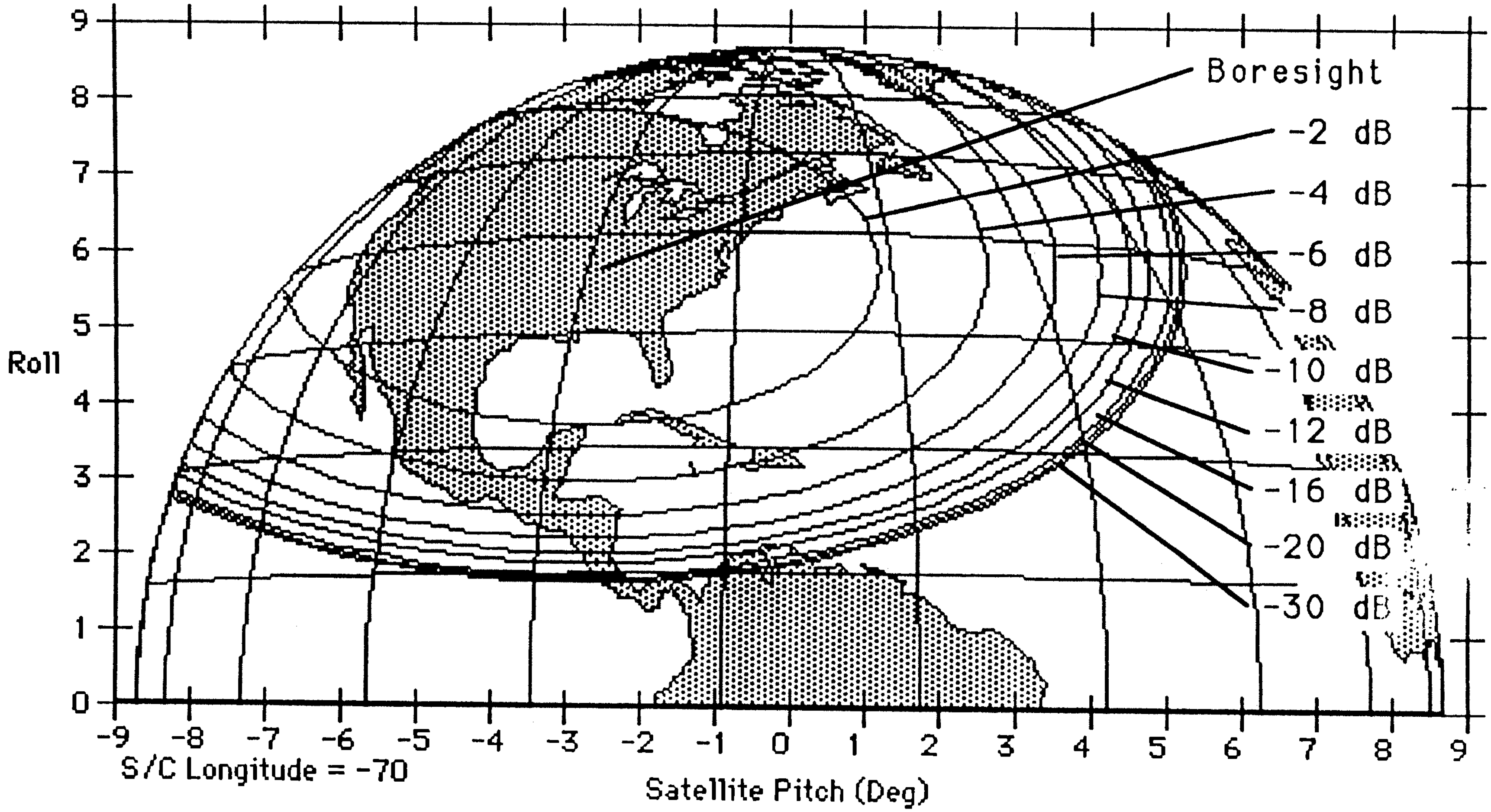
Output File : L 70 SA S

Orbital Location : 70° W

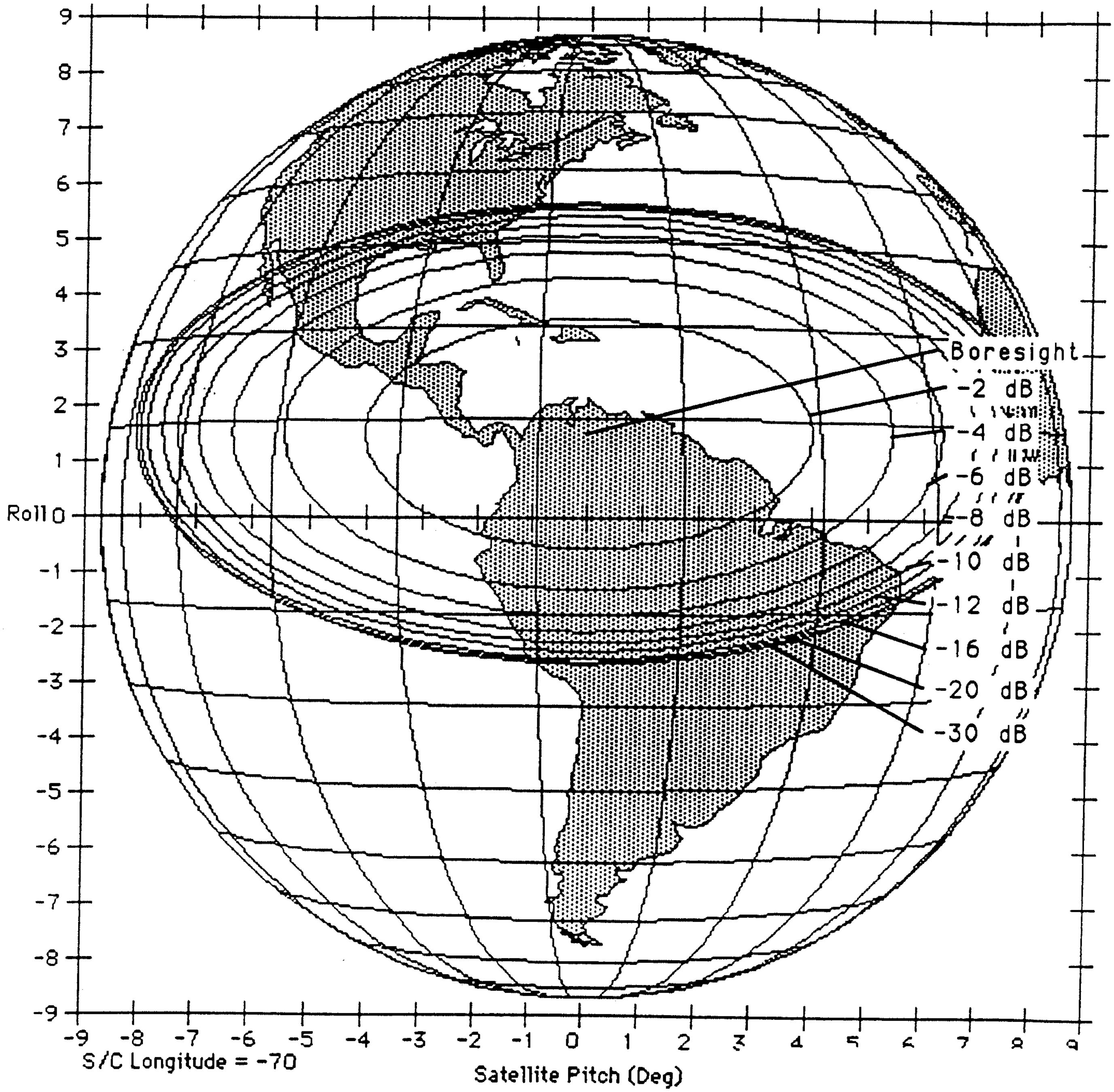
Coverage Area : Carribean

Peak Gain : 23.8 dBi

Frequency : 1.618 GHz

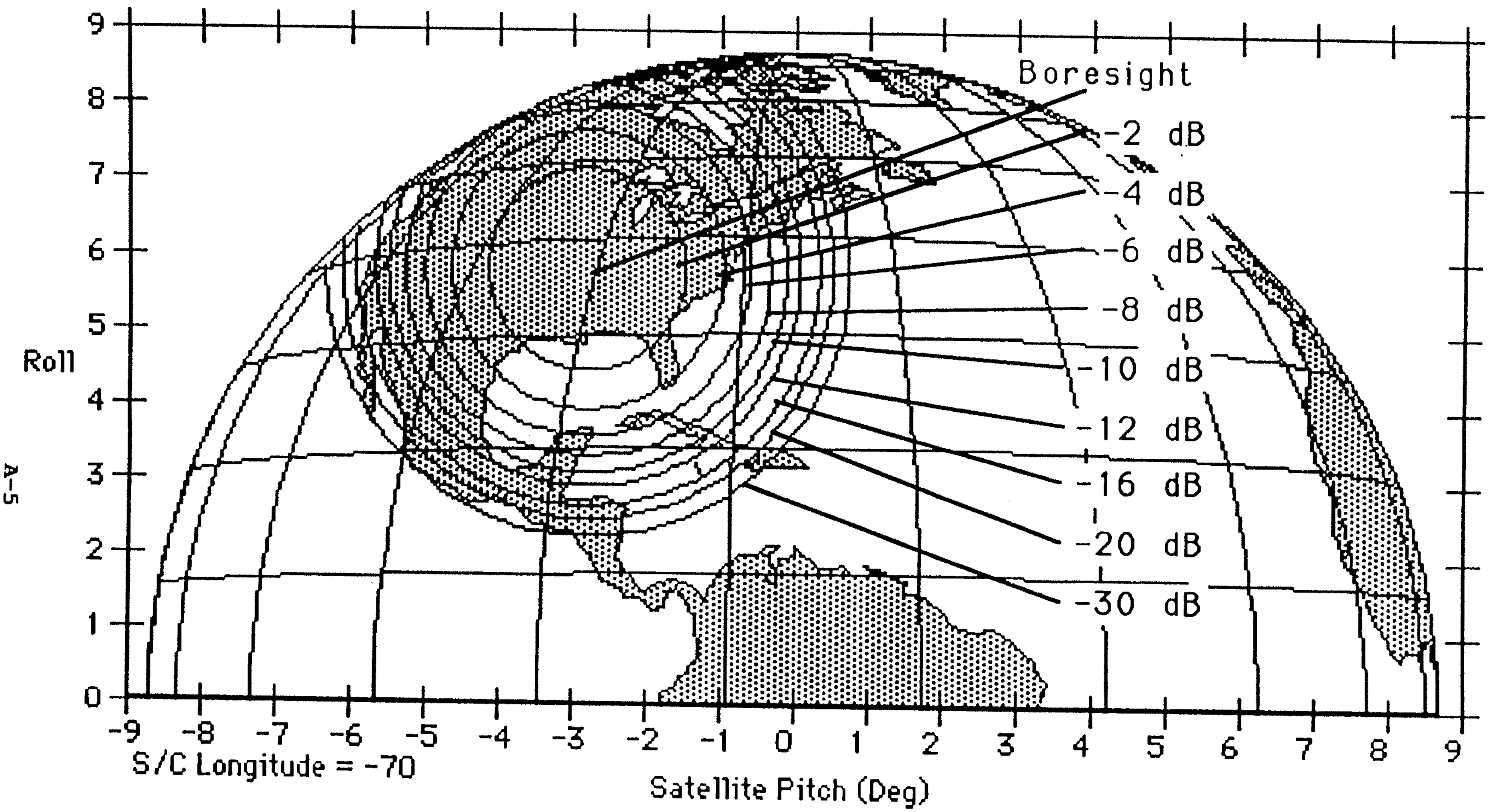


Output File : S 70 N
Orbital Location : 70° W
Coverage Area : Conus
Peak Gain : 29.9 dBi
Frequency : 2.499 GHz



Output File : S 70 S Carrib

Orbital Location : 70° W
Coverage Area : Carribean
Peak Gain : 29.9 dBi
Frequency : 2.499 GHz



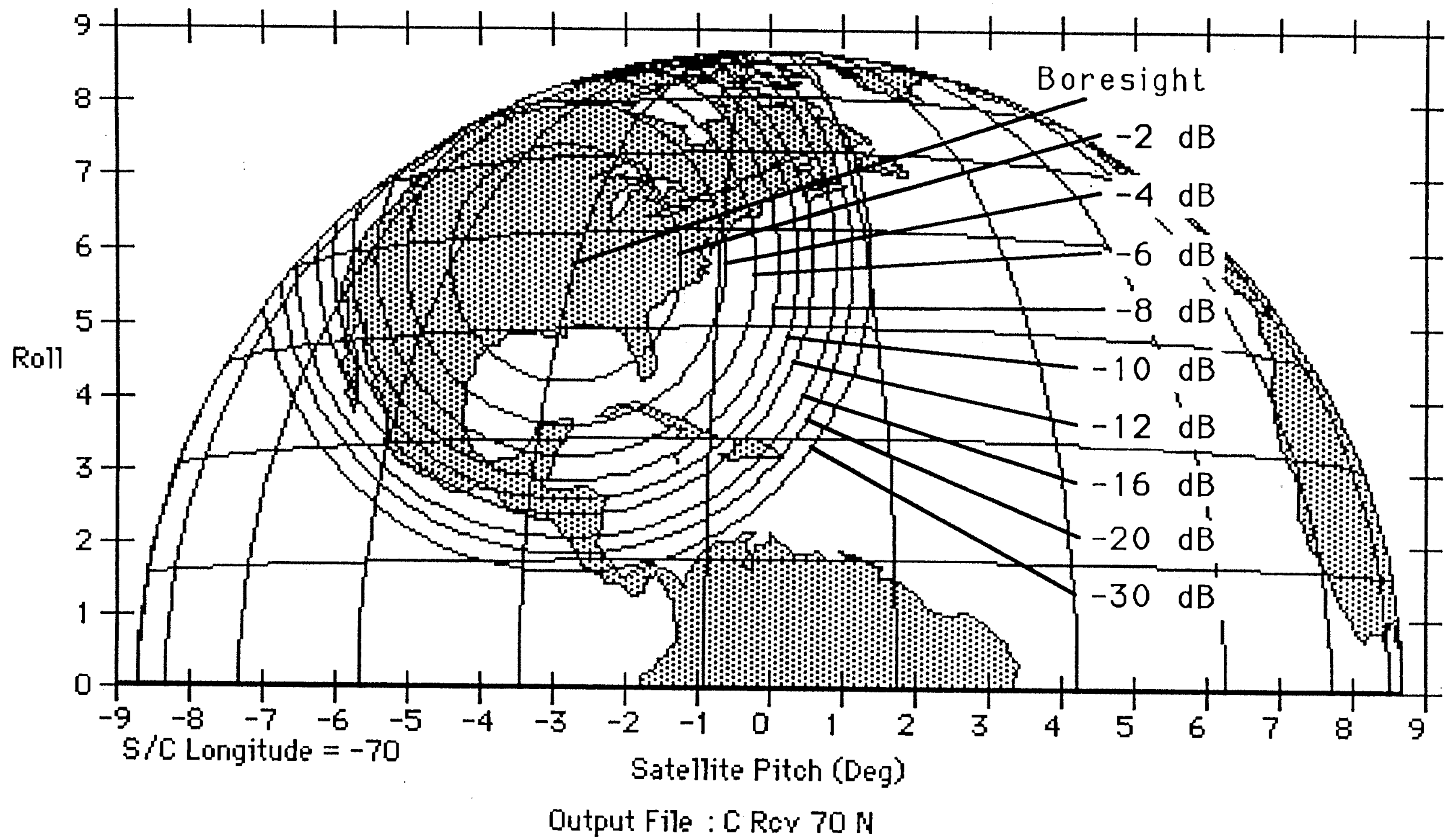
Output File : C Xtr 70 N

Orbital Location : 70° W

Coverage Area : U.S.

Peak Gain : 28 dBi

Frequency : 5.1 GHz

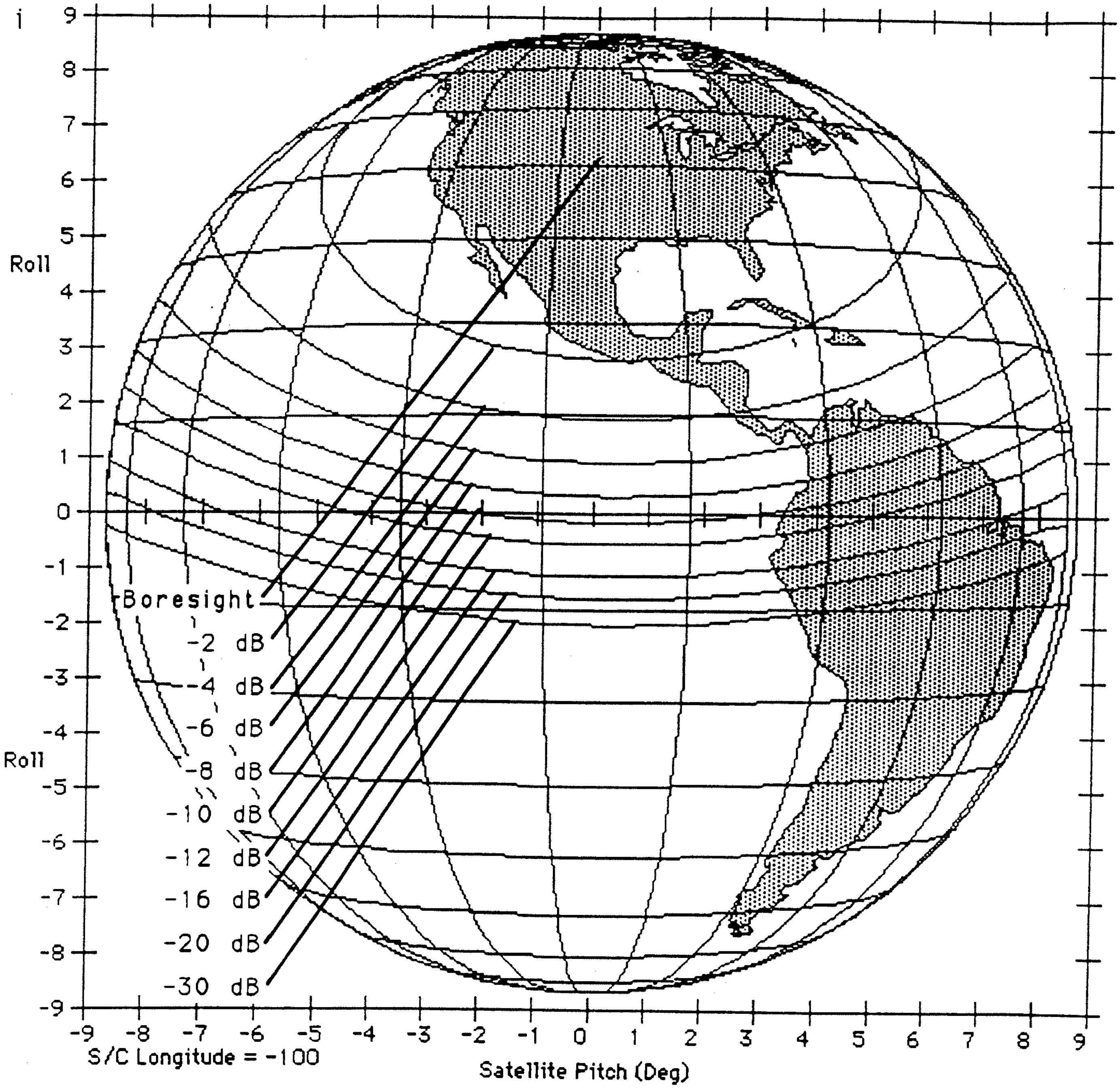


Orbital Location : 70° W

Coverage Area : U.S.

Peak Gain : 25.0 dBi

Frequency : 6.5 GHz



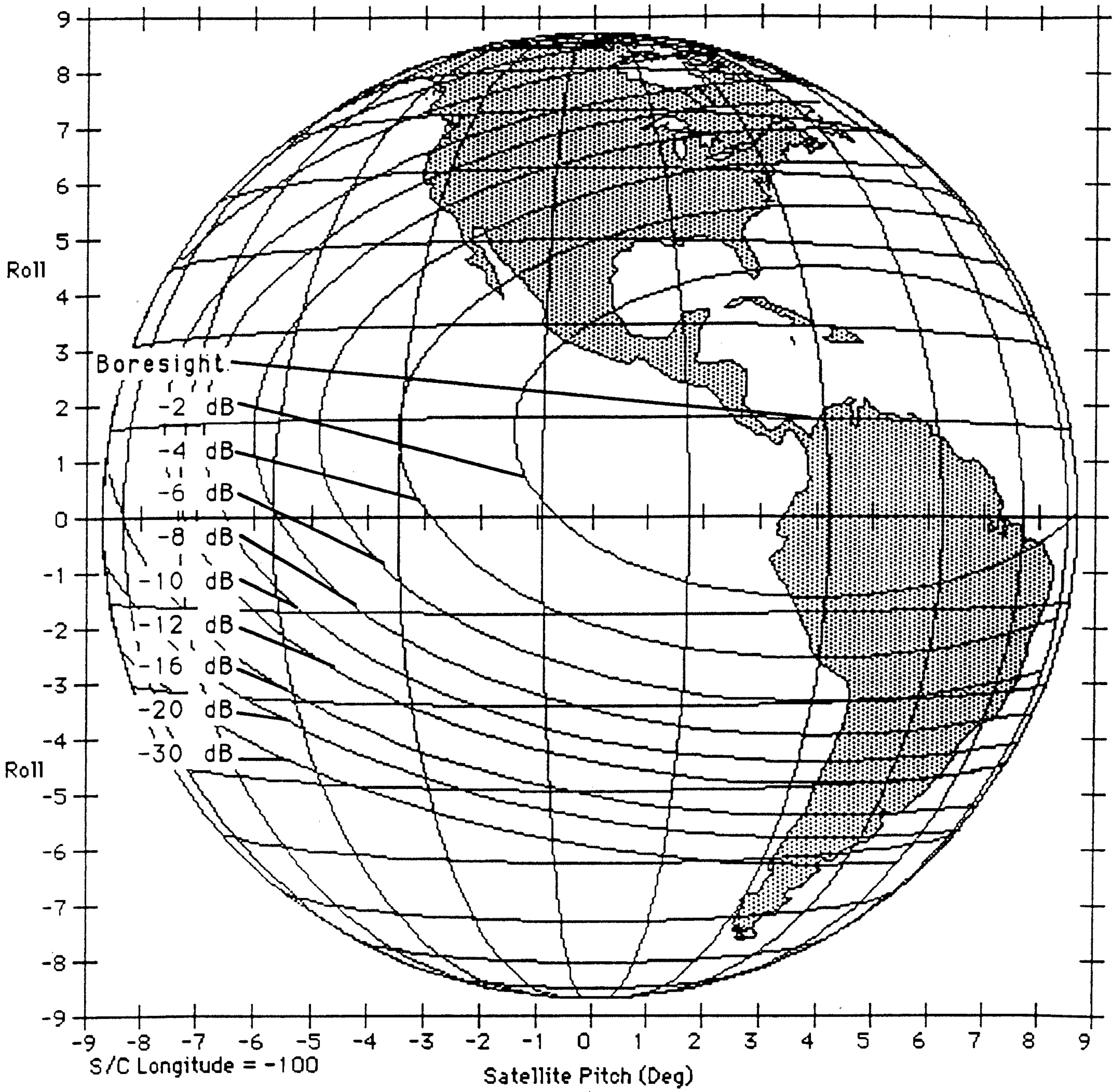
Output File : L 100 Conus S

Orbital Location : 100° W

Coverage Area : Conus

Peak Gain : 23.8 dBi

Frequency : 1.618 GHz



Output File : L 100 SA S

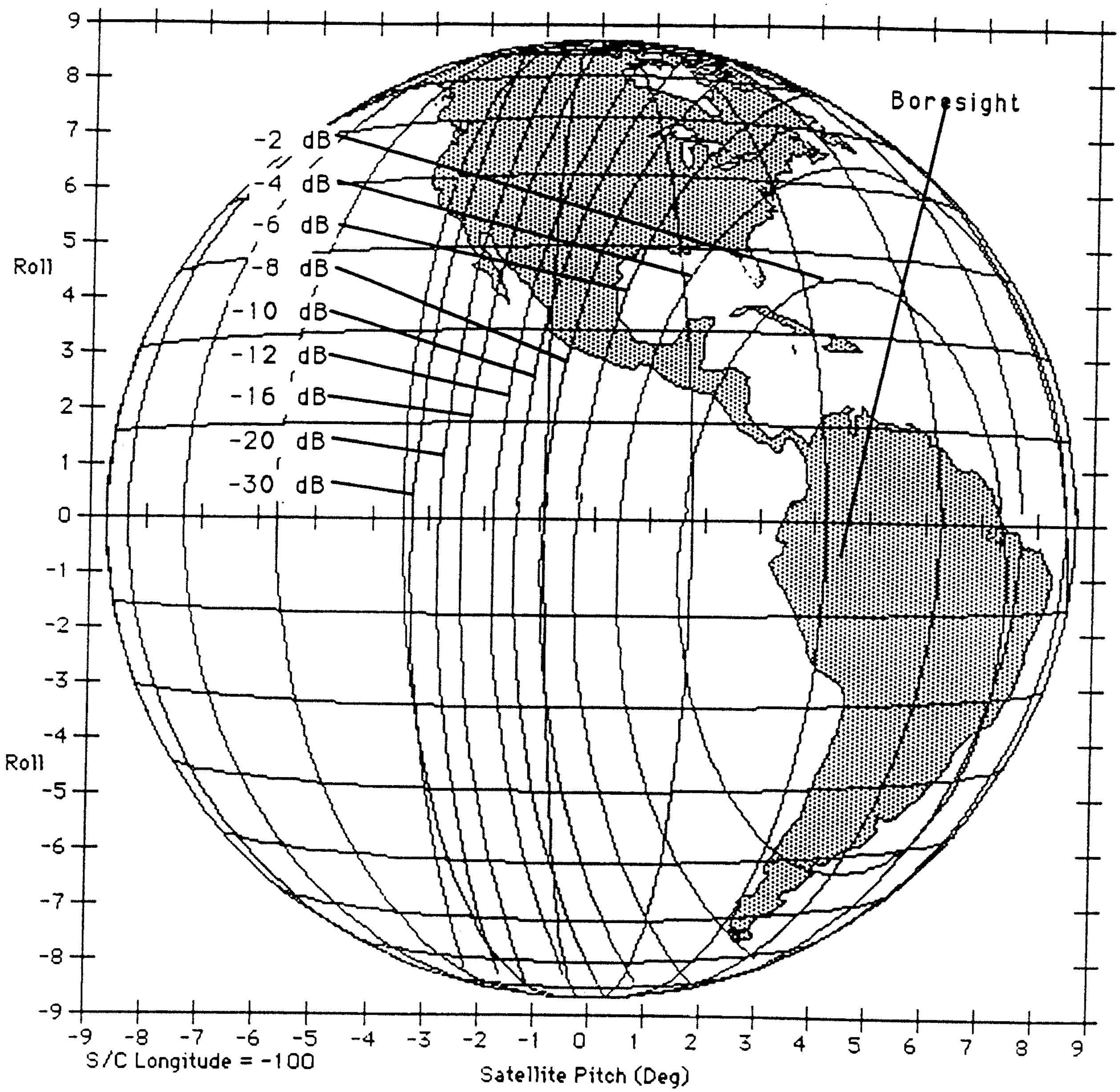
CCW

Orbital Location : 100° W

Coverage Area : Carribean

Peak Gain : 23.8 dBi

Frequency : 1.618 GHz



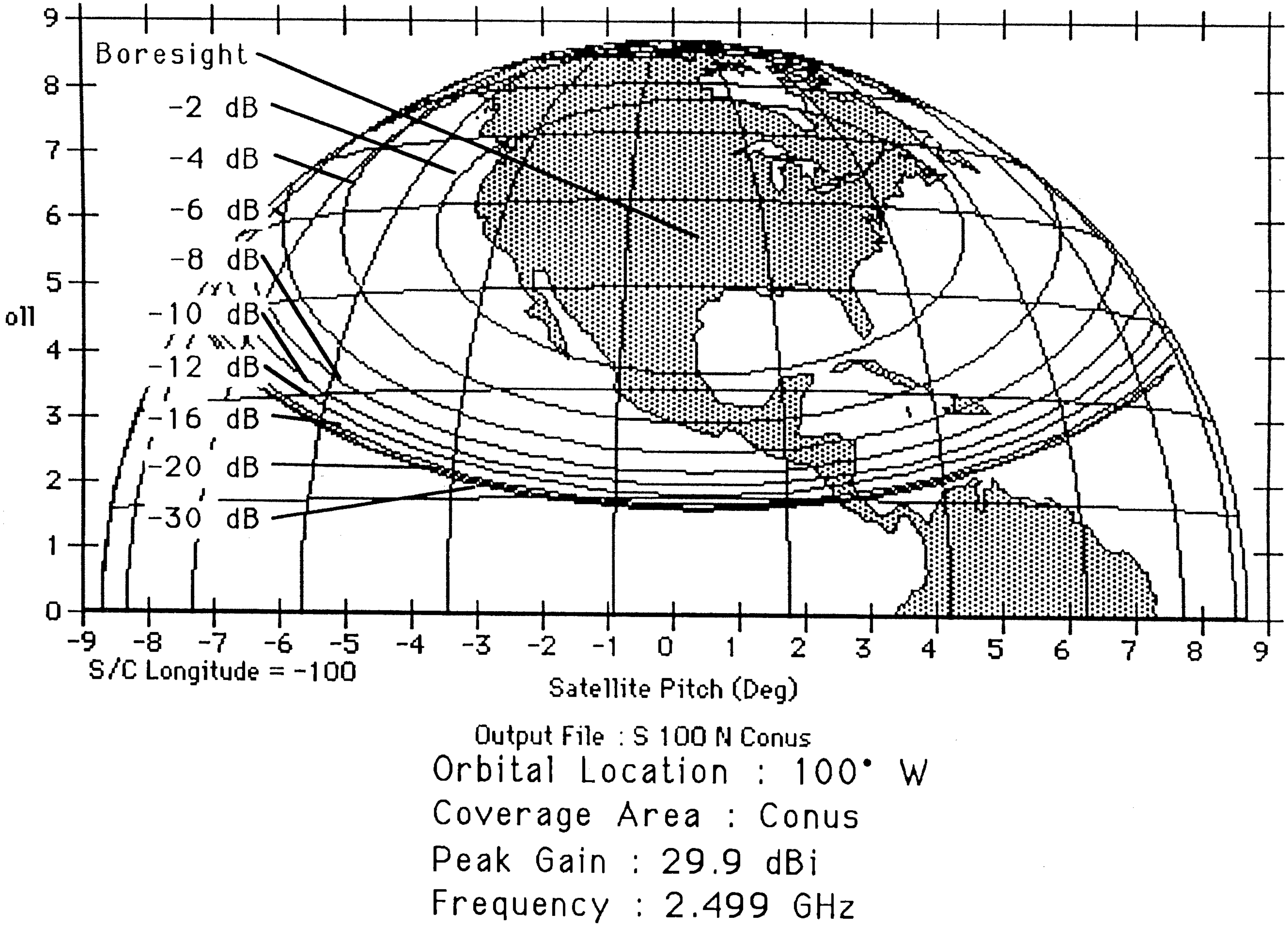
Output File : L 100 SA S

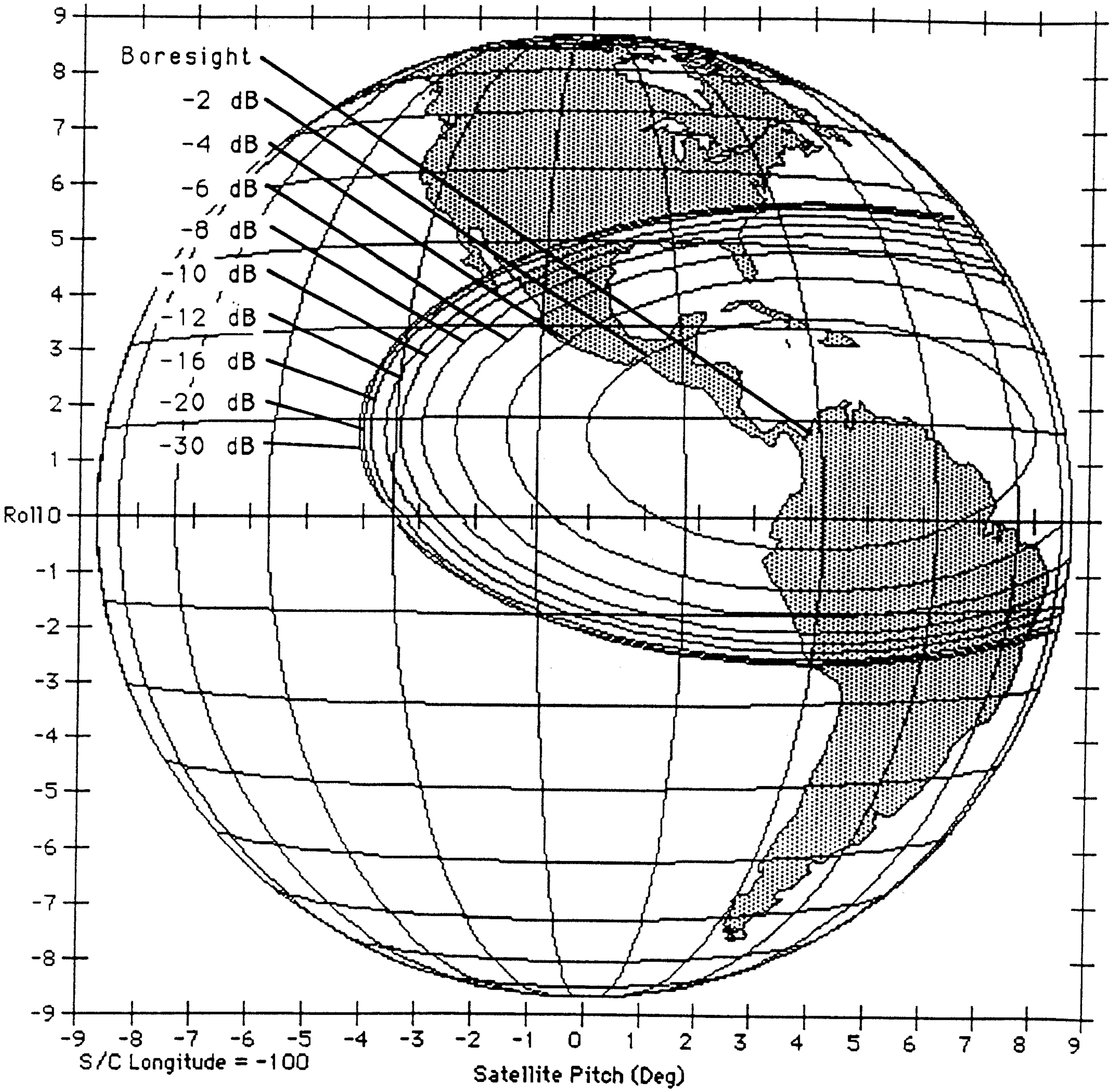
Orbital Location : 100° W

Coverage Area : South America

Peak Gain : 23.8 dBi

Frequency : 1.618 GHz


Boresight
-2 dB
-4 dB
-6 dB
-8 dB
-10 dB
-12 dB
-16 dB
-20 dB
-30 dB
oll
S/C Longitude = -100
Satellite Pitch (Deg)
Output File : S 100 N Conus
Orbital Location : 100° W
Coverage Area : Conus
Peak Gain : 29.9 dBi
Frequency : 2.499 GHz



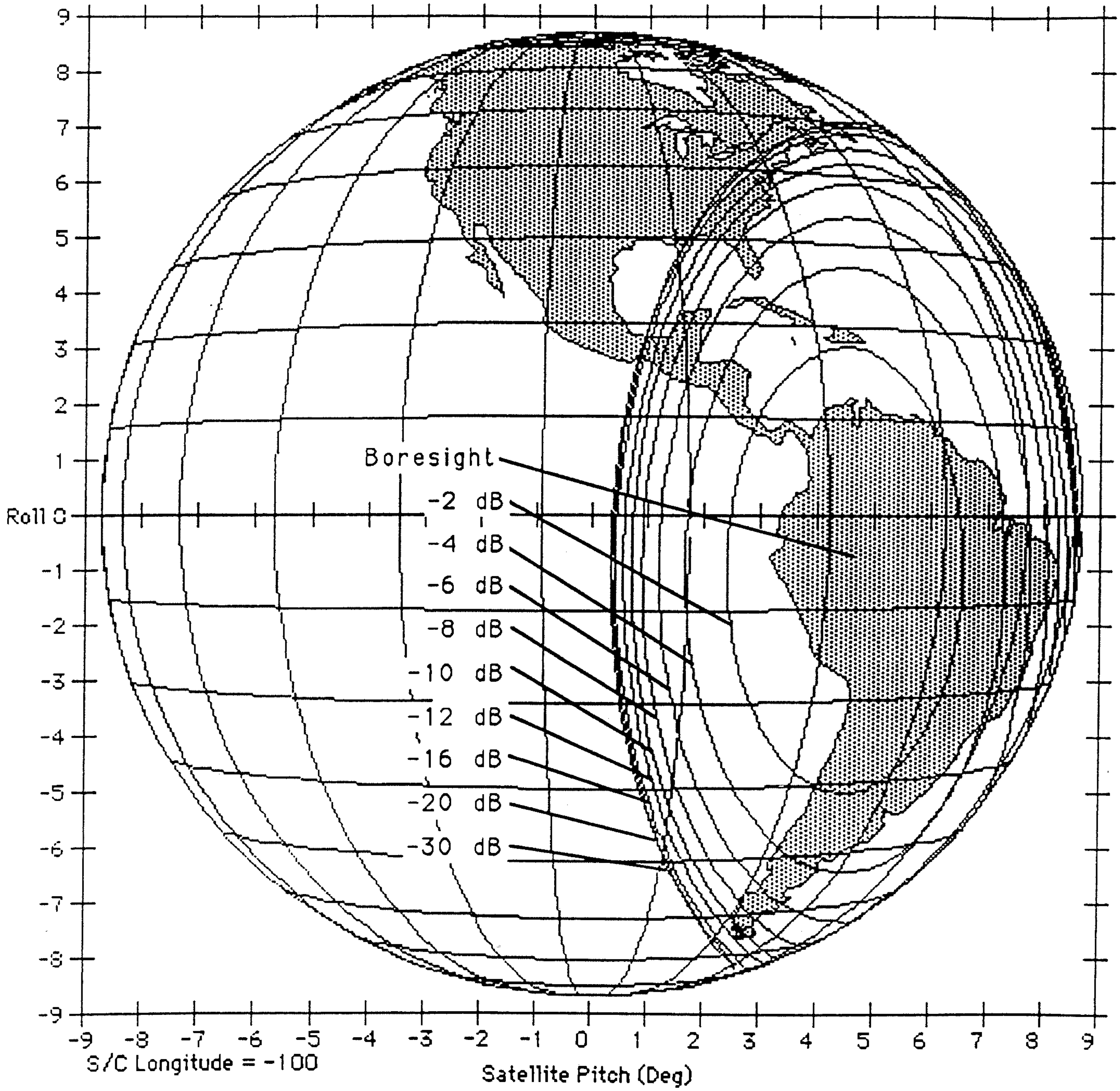
Output File : S 100 S Carrib

Orbital Location : 100° W

Coverage Area : Carribean

Peak Gain : 29.9 dBi

Frequency : 2.499 GHz



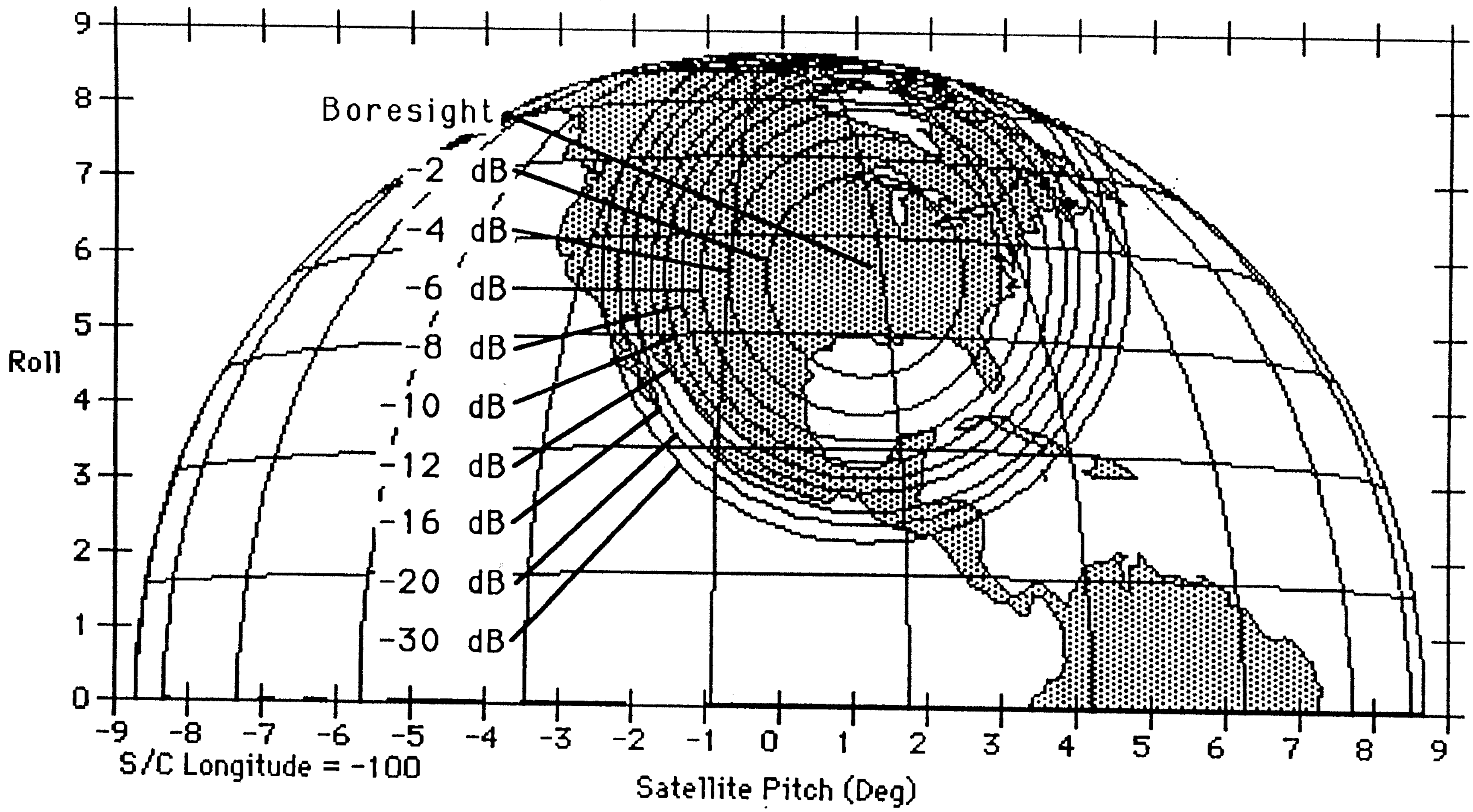
Output File : S 100 S SA

Coverage Area : South America

Orbital Location : 100° W

Peak Gain : 29.9 dBi

Frequency : 2.499 GHz



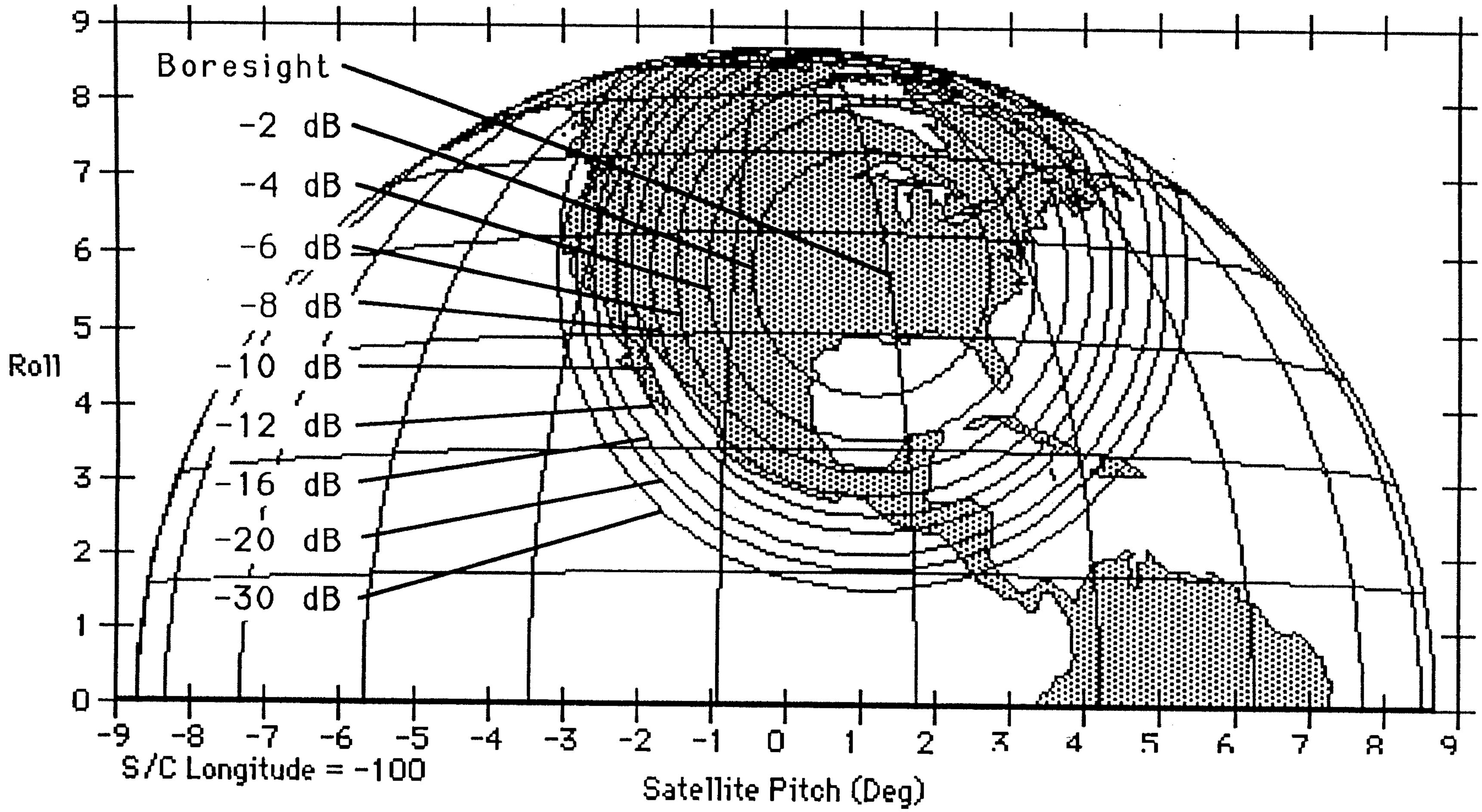
Output File : C Xtr 1 N

Orbital Location : 100° W

Coverage Area : U.S.

Peak Gain : 28 dBi

Frequency : 5.1 GHz



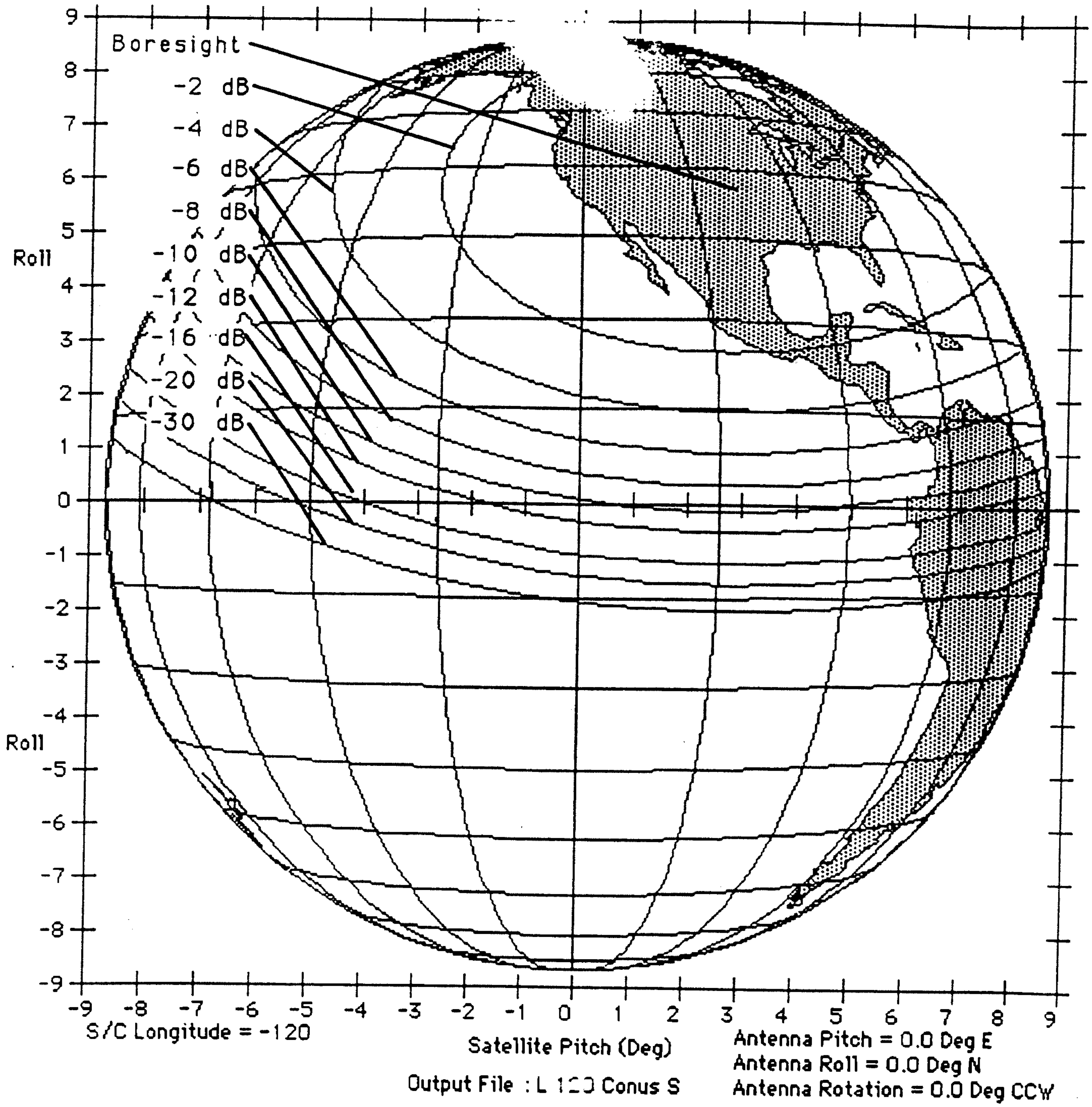
Output File : C Rcv 100 N

Orbital Location : 100° W

Coverage Area : U.S.

Peak Gain : 25.0 dBi

Frequency : 6.5 GHz

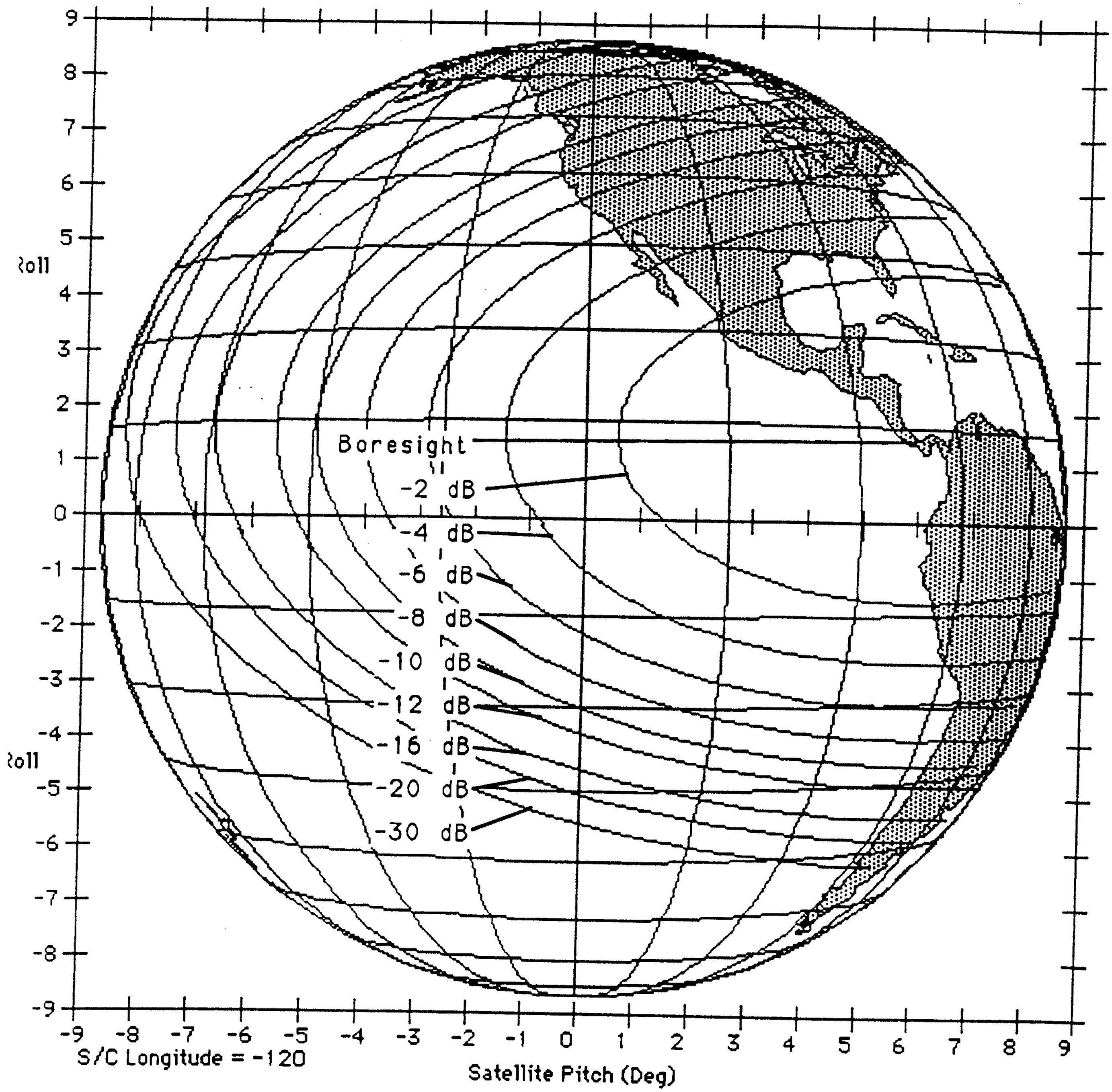


Orbital Location : 120° W

Coverage Area : Conus

Peak Gain : 23.8 dBi

Frequency : 1.618 GHz



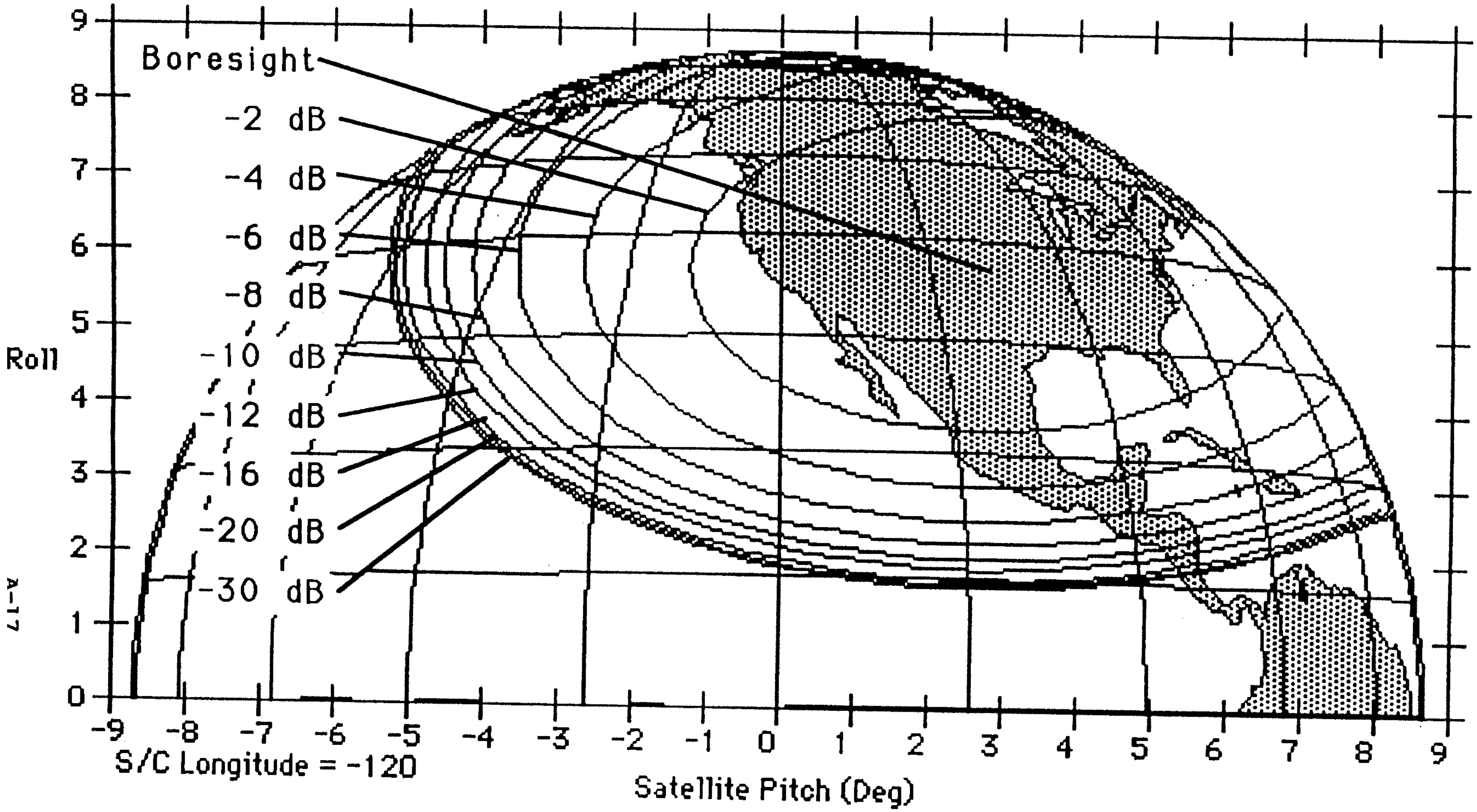
Output File : L 120 SA S

Orbital Location : 120° W

Coverage Area : Carribean

Peak Gain : 23.8 dBi

Frequency : 1.618 GHz



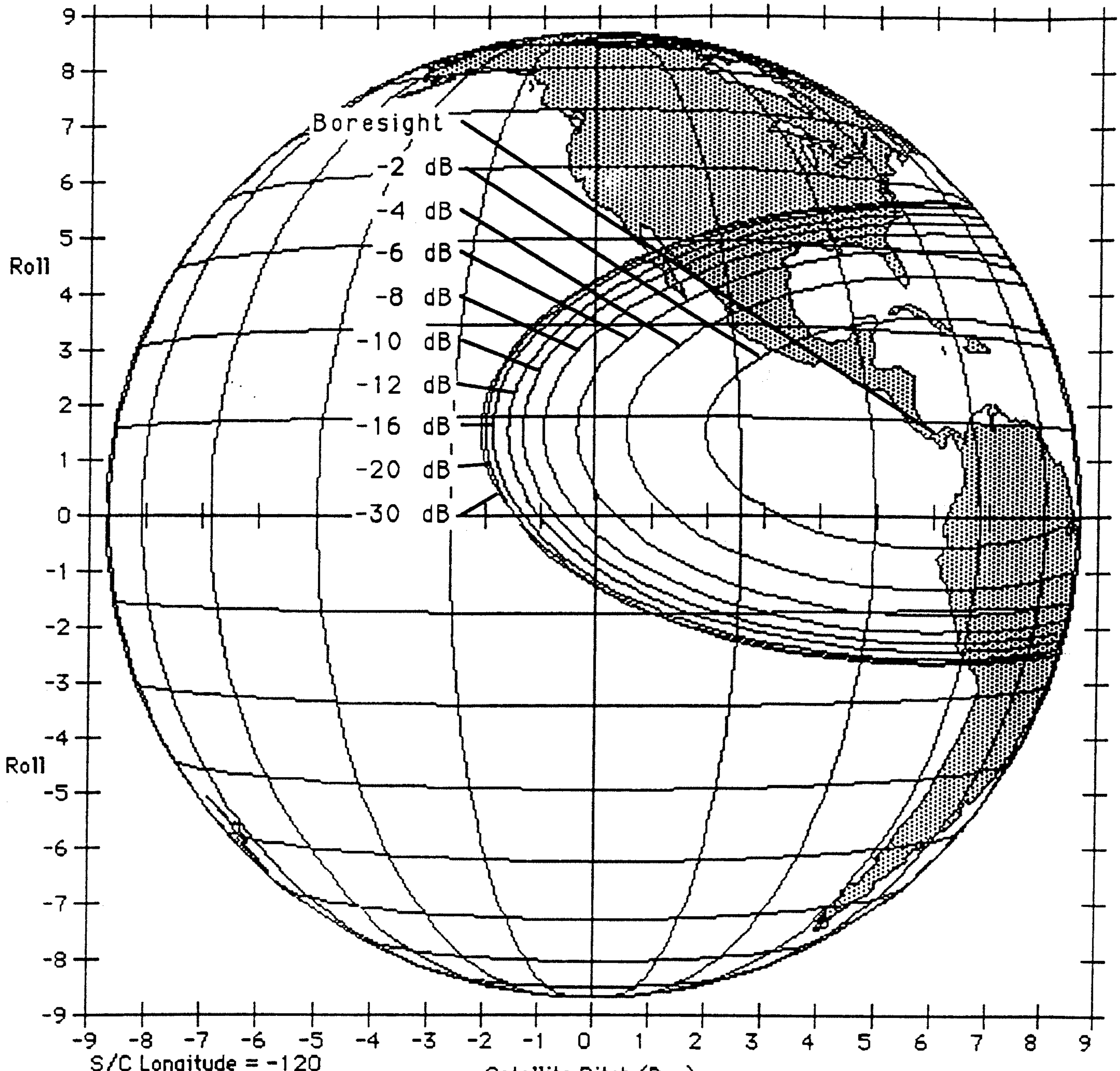
Output File : S 120 N Conus

Orbital Location : 120° W

Coverage Area : Conus

Peak Gain : 29.9 dBi

Frequency : 2.499 GHz



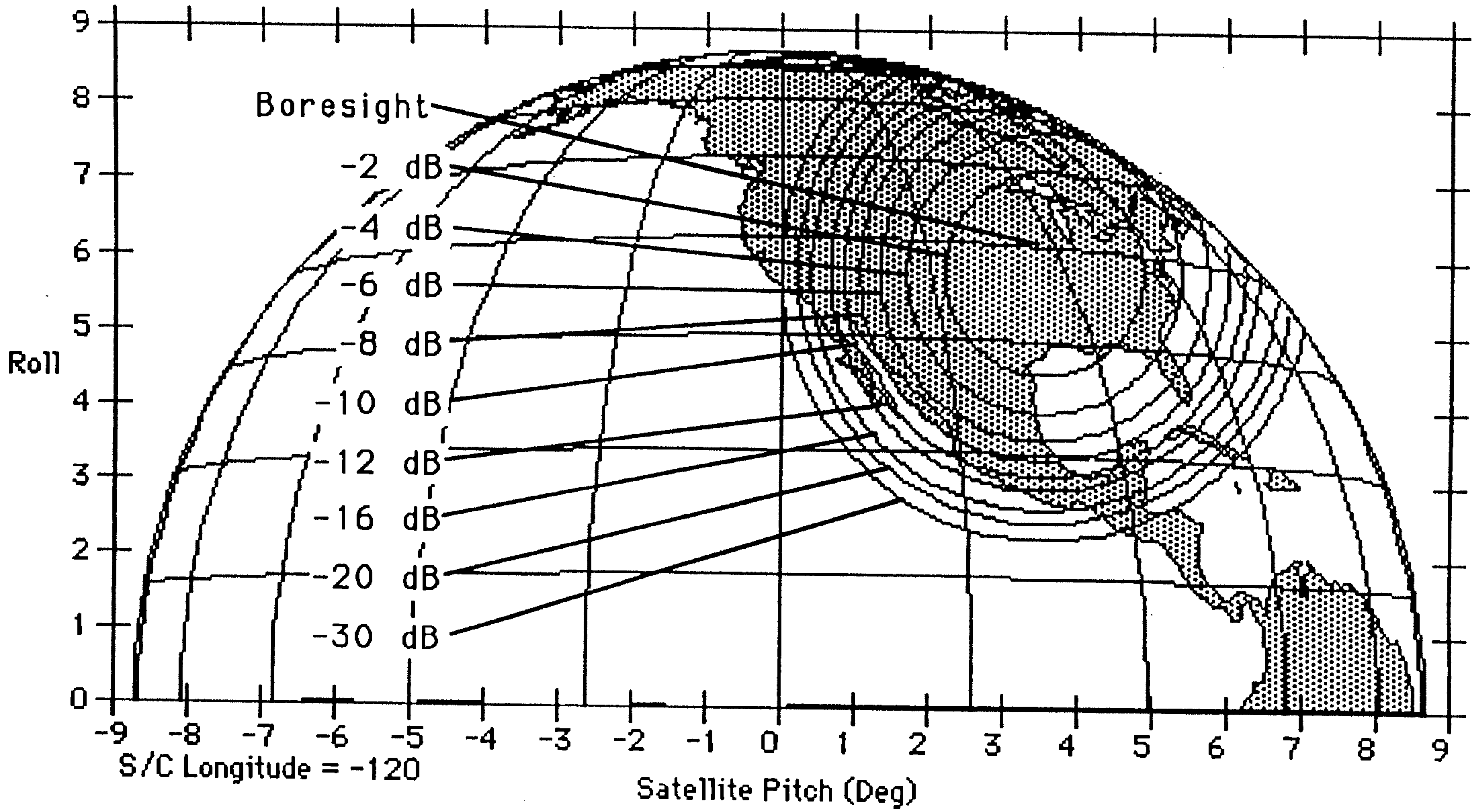
Output File : S120 S Carrib

Orbital Location : 120° W

Coverage Area : Carribean

Peak Gain : 29.9 dBi

Frequency : 2.499 GHz



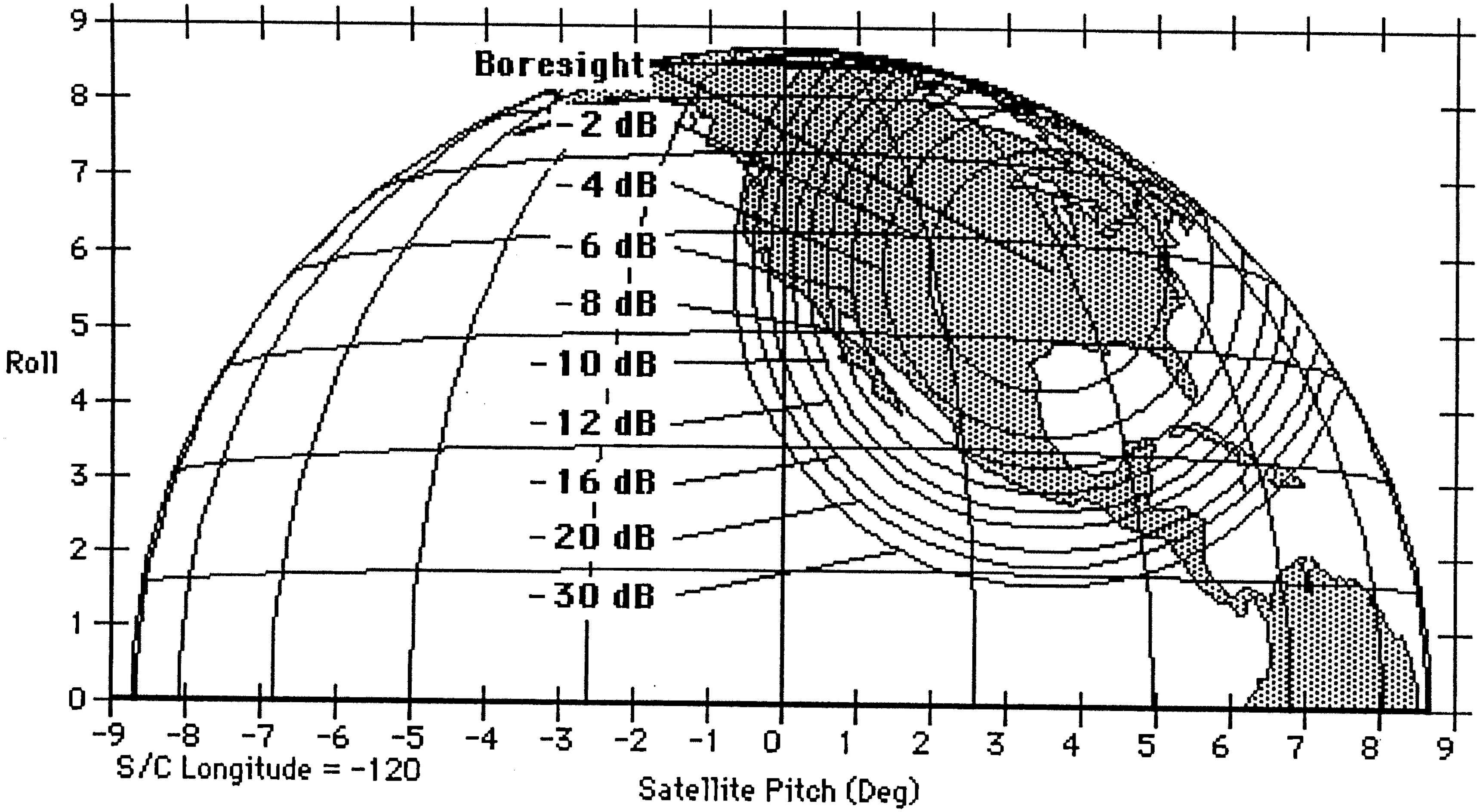
Output File : C Xtr 120 N

Orbital Location : 120° W

Coverage Area : U.S.

Peak Gain : 28 dBi

Frequency : 5.1 GHz



Output File : C 120 Rcv N

Orbital Location : 120° W

Coverage Area : U.S.

Peak Gain : 25.0 dBi

Frequency : 6.5 GHz