HOGAN & HARTSON

COLUMBIA SQUARE
555 THIRTEENTH STREET NW
WASHINGTON, DC 20004-1109
202/637-5600

WRITER'S DIRECT DIAL NUMBER
202/637-5793

6701 ROCKLEDGE DRIVE
BETHESDA, MARYLAND 20817
301/493-0030

111 SOUTH CALVERT STREET
BALTIMORE, MARYLAND 21202
301/659-2700

8300 GREENSBORO DRIVE
McLEAN, VIRGINIA 22102
703/848-2600

November 19, 1990

BY HAND

Ms. Donna R. Searcy, Secretary
Federal Communications Commission
1919 M Street, N.W. - Room 222
Washington, D.C. 20554

Re: Ge American Communications, Inc.
Application for Modification of
Authorization of Satcom H-1

Dear Ms. Searcy:

On behalf of GE American Communications, Inc., we enclose an amendment to its application filed on October 31, 1990 to modify the authorization of Satcom H-1. This amendment consists of the Technical Description of the H-1 satellite as modified, which could not be filed in final form at the time the application was submitted.

Acceptance of this amendment will serve the public interest by providing a full description of the manner in which GE Americom proposes to modify its satellite in response to customer requirements.

If any questions arise in connection with the foregoing please contact the undersigned.

Respectfully

HOGAN & HARTSON

By *Gerald E. Oberst*
Peter A. Rohrbach
Gerald E. Oberst, Jr.

Attorneys for GE American Communications, Inc.

GEO/csj
Enclosure
cc: Fern Jarmulnek
5388p.61

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Federal Communications Commission
Office of the Secretary

GE AMERICAN COMMUNICATIONS, INC.

Application for Modification of Authorization of Satcom H-1

TECHNICAL EXHIBIT

SECTION 1.0
INTRODUCTION AND SUMMARY

TABLE OF CONTENTS

SECTION 1.0
INTRODUCTION AND SUMMARY

1.1 INTRODUCTION

The Satcom Hybrid Spacecraft satisfies the requirement to deliver C-band service to the continental United States (CONUS) simultaneously with Ku-band service to the CONUS. The spacecraft optimizes the communications capacity of a satellite configured for launch by either of two launching systems: the Ariane 4 or the Atlas IIAS.

The baseline Ku-band communications package consists of 24 active 50-watt traveling wave tube amplifiers, (TWTAs) arranged in 16-for-12 redundancy. The baseline C-band communications package consists of 24 active 17-watt solid state power amplifiers (SSPAs) with 4 spare SSPAs arranged in 7-for-6 redundancy. The 24 active Ku-band channels and the 24 active C-band channels may all be operated simultaneously without restrictions. All active channels operate at full output during eclipse. A summary of the key performance characteristics of the proposed spacecraft is given in Table 1-1.

The spacecraft design life is 12 years; the propulsion load is based on this mission with launch weights listed in Table 1-2, including Liquid Apogee Engine.

TABLE 1-1. SPACECRAFT PERFORMANCE SUMMARY

Parameter	Value
Launch Vehicles	Ariane 4/Atlas IIAS
Launch Weight (kg)	3116/3503
On-Orbit Dry Weight (kg)	1580/1580
Propellant (kg)	1536/1922
Stationkeeping (deg)	±0.05° N-S & E-W
Transfer Orbit Stabilization	Active Damping Spin
Beam Pointing Circular Error (deg)	0.15 (3σ)
EOL Array Power (equinox - W)	4807
Battery Capacity (Ah)	100
Battery Depth of Discharge (eclipse - %)	76
Eclipse Channel Capability TWTA/SSPA	24/24
Receive Frequency Band (GHz) (Ku-Band/C-Band)	14.0 to 14.5 & 5.925 to 6.4235
Transmit Frequency Band (GHz) (Ku-Band/C-Band)	11.7 to 12.2 & 3.7 to 4.2
Active Transponder Channels (Ku-Band/C-Band)	24/24
Total Installed TWTAs/SSPAs	32/28
Output Power (W) TWTAs/SSPAs	50/17
Communications Receiver Redundancy K-Band/ C-Band	4-for-2/4-for-2
Channel Bandwidth (MHz) Ku-Band	8 channels @ 54 MHz, 16 channels @ 27 MHz
Channel Bandwidth (MHz) C-Band	36 MHz

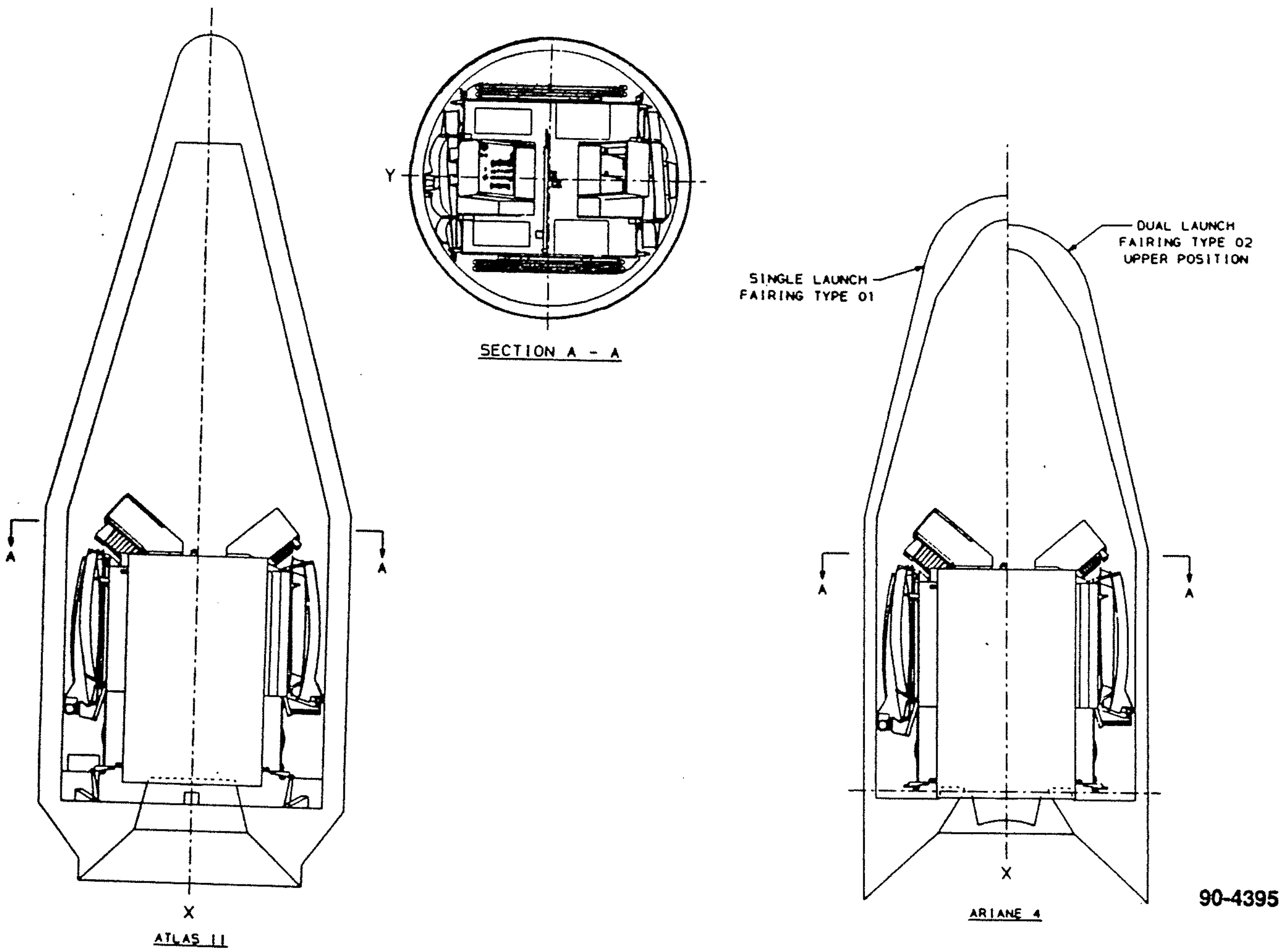


Figure 1-1. Launch Vehicle Envelope Compatibility

SECTION 2.0
COMMUNICATIONS SUBSYSTEMS

SECTION 2.0
COMMUNICATIONS SUBSYSTEMS

2.1 COMMUNICATIONS PAYLOAD SUMMARY

Communications performance to the required coverage zones is achieved with the combination of C-band and Ku-band gridded reflectors, each employing its own multifeed horn array together with its respective transponders. Table 2-1 is a summary of C-band and Ku-band uplink and downlink performance. Figure 2-1 is a block diagram of the Ku-band communications subsystem. Figure 2-2 is a block diagram of the C-band communications subsystem.

The horizontally and vertically polarized C-band and Ku-band reflectors are deployed after the spacecraft is placed in its geosynchronous orbit. Feed horn geometries, power divisions, and relative phase delays are optimized for gain and coverage, including consideration for spacecraft longitude position, attitude pointing, and antenna thermal distortion.

Thirty-two 50-watt traveling wave tube amplifiers (TWTAs) are combined with 4-for-2 redundant receivers to provide eight operating wideband channels on one polarization and sixteen narrowband channels on the other. The Ku-band feed array is configured to optimize CONUS coverage for dual-polarized reception and transmission. As shown, in Figure 2-1, dual mode networks are used to combine two groups of four channels on H-Pol and two groups of eight channels on V-Pol.

Twenty-eight solid state power amplifiers (SSPAs) are combined with 4-for-2 redundant receivers to provide 12 operating channels on each polarization. The C-band feed array provides dual-polarized reception and transmission over CONUS. As shown in Figure 2-2, dual-mode networks are used to combine two groups of six channels for transmission on each polarization. Separate networks are used to combine the received signals from the diplexers into a single port on each polarization.

2.2 KU-BAND COMMUNICATIONS SUBSYSTEM

The baseline Ku-band communications subsystem shown in Figure 2-1 contains 32 transponders (24 active), each with a 50-watt TWTA. Communications subsystem performance is summarized in Table 2-1. The patterns are shown in Figures 2-3 through 2-8 for both polarizations for a 79°W longitude position.

The frequency plan for the proposed Ku-band communications subsystem is shown in Figure 2-9. As shown in the frequency plan, the Ku-band satellite system operates in the 14.0-to-14.5-GHz band on the uplink and in the 11.7-to-12.2-GHz band on the downlink. There are 24 transponder channels having a frequency spacing of 60 MHz for the wideband channels so that eight channels span the 500-MHz band and 30 MHz for the narrow channels so that sixteen channels span the 500-MHz band. Narrowband channels are received at the satellite on horizontal polarization and transmitted on vertical polarization; wideband channels are received on vertical polarization and transmitted on horizontal polarization. Cross-polarization isolation of at least 33 dB ensures adequate immunity to interference.

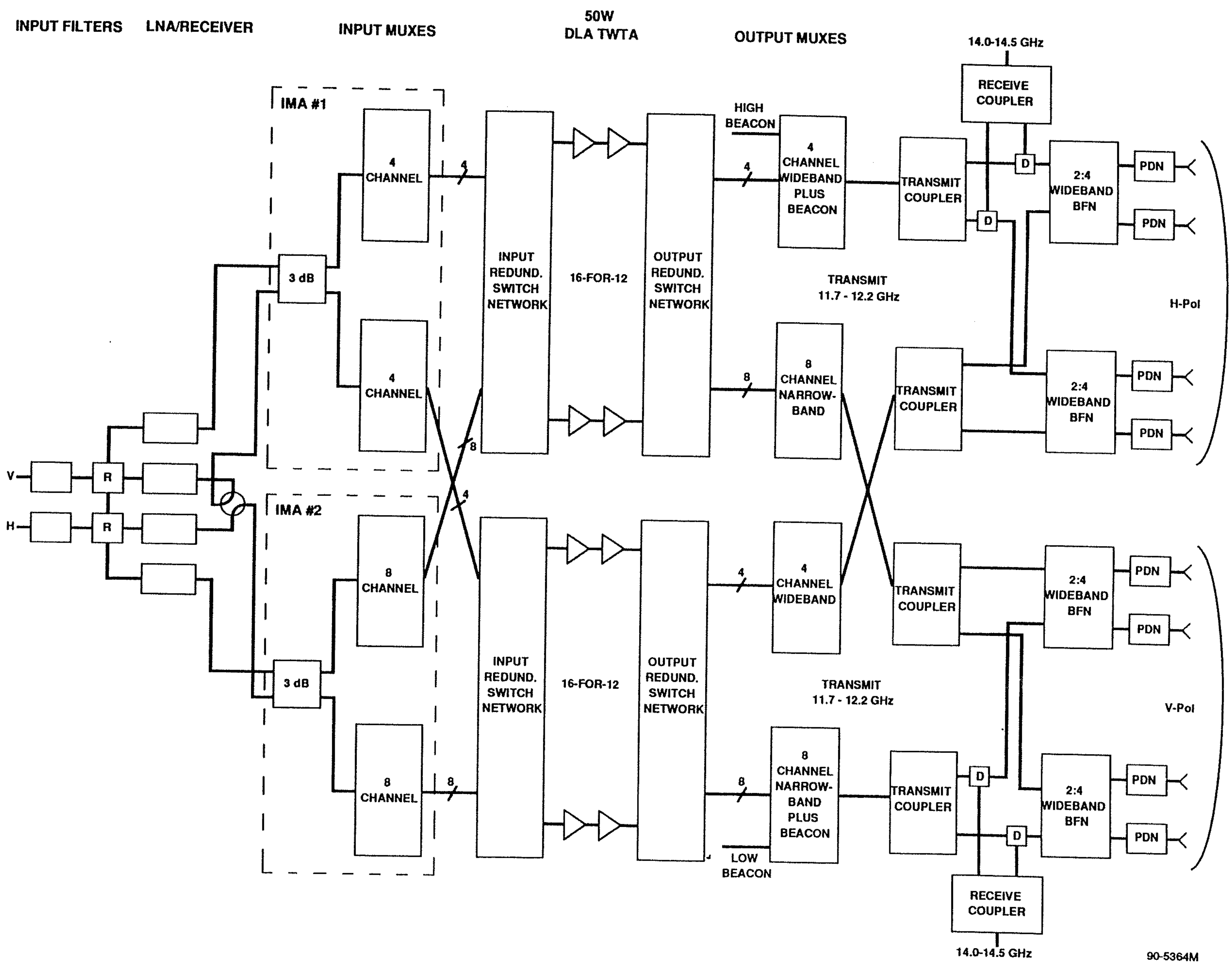


Figure 2-1. Ku-Band Communications Subsystem Block Diagram

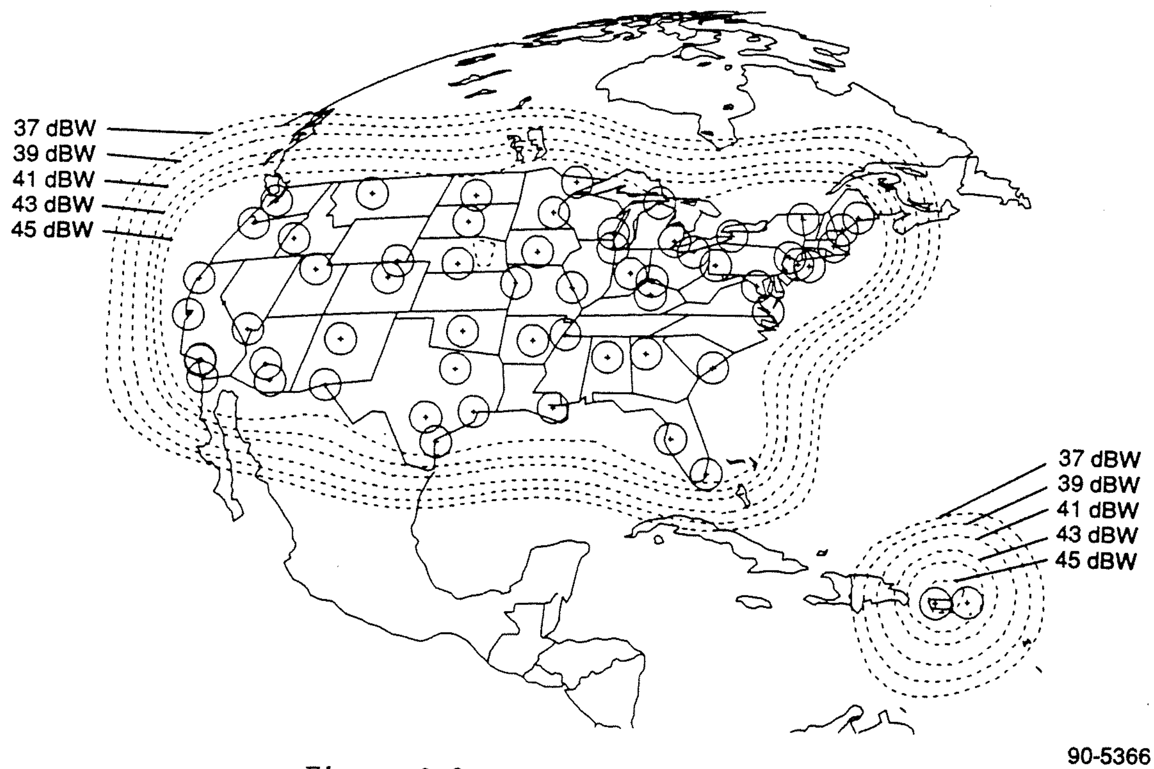


Figure 2-3. Ku-Band EIRP, HP, Mode 1

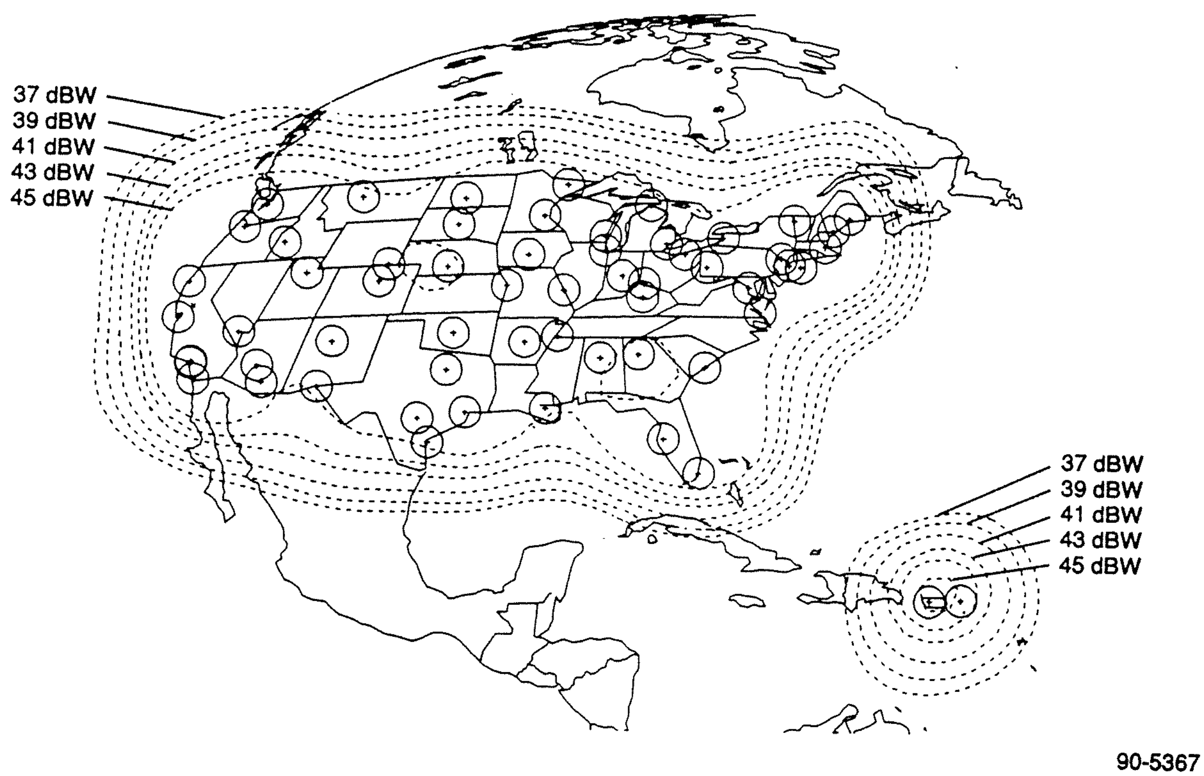


Figure 2-4. Ku-Band EIRP, HP, Mode 2

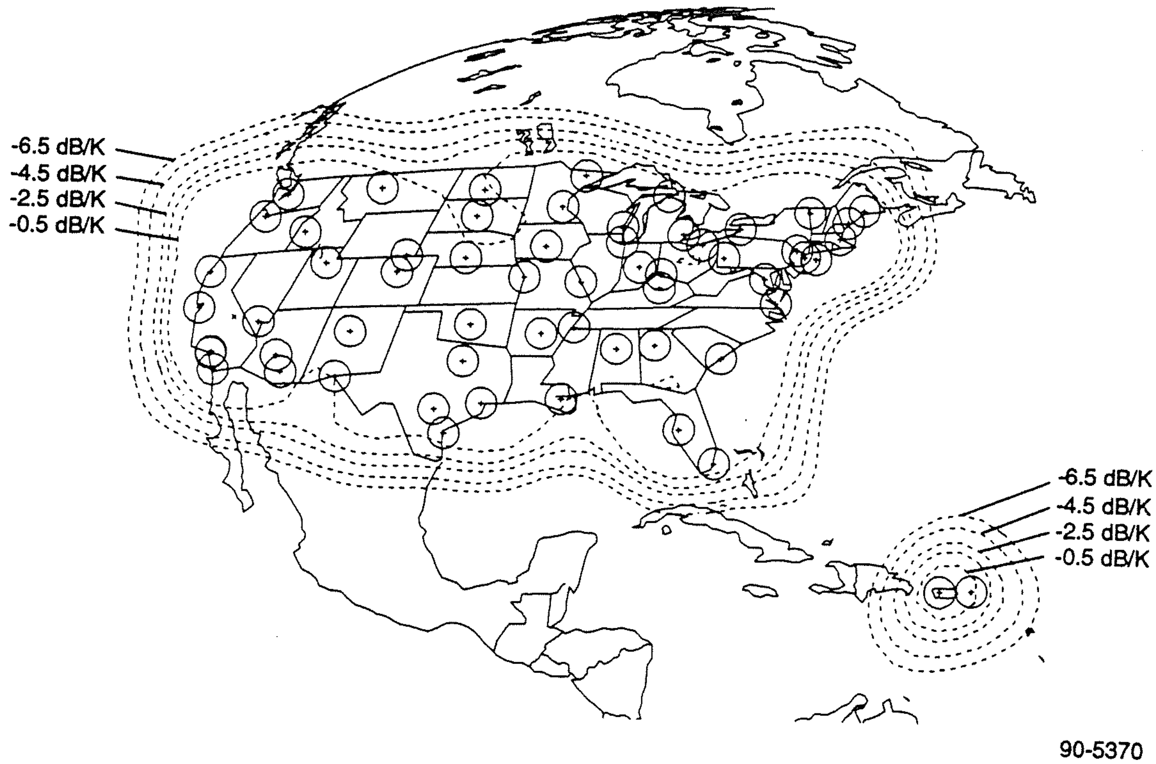


Figure 2-7. Ku-Band Receive Beam G/T, HP

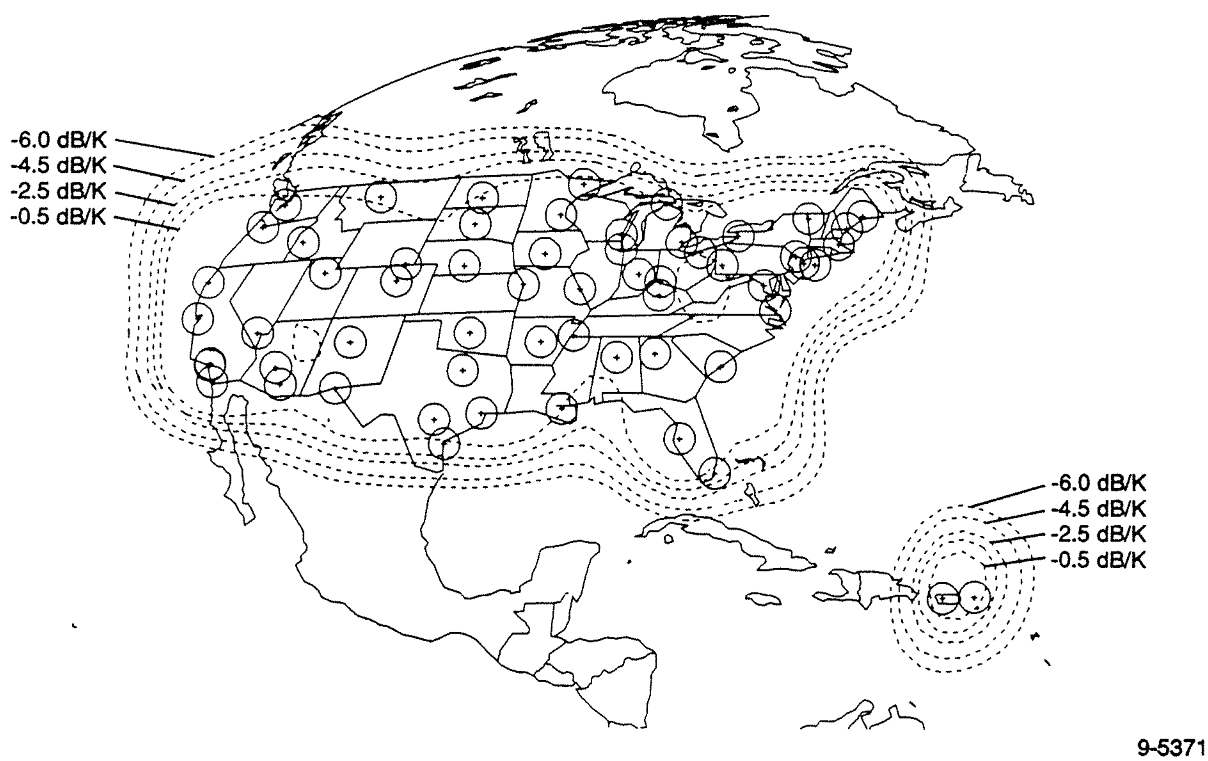


Figure 2-8. Ku-Band Receive Beam G/T, VP

amplifier and TWTA. The payload contains 24 active transponders and 8 spare transponders. These transponders are connected in two redundant configurations that provide 16-for-12 redundancy. The output from the TWTA is fed through a redundancy switch to the output multiplexer assembly which combines half the channels associated with one polarization. The signal is then combined with the second half of the polarization in the dual mode beamforming networks. The beamforming networks distribute the signal to the regional feed horns in the antenna assembly, which generates the transmit beams.

2.3 C-BAND COMMUNICATIONS SUBSYSTEM

The C-Band communications subsystem contains 28 transponders (24 active), each with a 17-watt SSPA. The C-band subsystem, through frequency reuse, provides coverage of CONUS with 12 vertically polarized 36-MHz bandwidth channels plus 12 horizontally polarized 36-MHz bandwidth channels.

The block diagram and frequency plan for the proposed communication subsystem are shown in Figures 2-2 and 2-10, respectively. As shown in the frequency plan, the C-band system operates in the 5,925-to-6,425-MHz band on the uplink and in the 3,700-to-4,200-MHz band on the downlink. There are 24 transponder channels having a frequency spacing of 40 MHz, such that 12 channels span the 500-MHz band. Odd channels are received at the satellite on horizontal polarization and transmitted on vertical polarization; even channels are received on vertical polarization and transmitted down on horizontal polarization. The cross-polarization isolation of at least 33 dB across CONUS, excluding Thule and Panama, ensures adequate immunity to interference. The vertical polarization axis of the proposed antenna design is aligned nominally north-south, whereas the horizontal polarization axis is oriented nominally parallel to the equatoral plane.

Each of the horizontal and vertical antenna assemblies contains multiple feed horns and a gridded reflector. This reflector operates as both a transmit and a receive antenna. An uplink signal received on either the vertical or horizontal antenna is fed through the diplexer to the combining network and then to the wideband receiver, where it is amplified and translated to the downlink frequency. One receiver serves vertical polarization; a second receiver serves the horizontal polarization. Two redundant receivers are available to be switched in should either of the primary receivers fail. The signal from the receiver is fed through a power splitter to the input multiplexer. There are two input multiplexers for each polarization. The input multiplexer divides the total spectrum into individual transponder channels. The output of each channel filter is fed through a 7-for-6 redundancy network to a SSPA. The C-band payload contains 24 active transponders and four spare transponders interconnected in four 7-for-6 redundant groups. The output from the SSPA is fed through a switch network to the output multiplexer, and then to the dual-mode antenna transmit feed network. Two sets of six channels are combined in each dual-mode network to provide a CONUS beam containing 12 channels on each polarization. The uplink signal out of each horn is coupled through a diplexer to the receiver combining network, where they are combined into a single port for each polarization.

Typical EIRP and G/T contours for a 79°W longitude satellite position are shown in Figures 2-11 through 2-16. Table 2-1 summarizes the performance of the C-band payload.

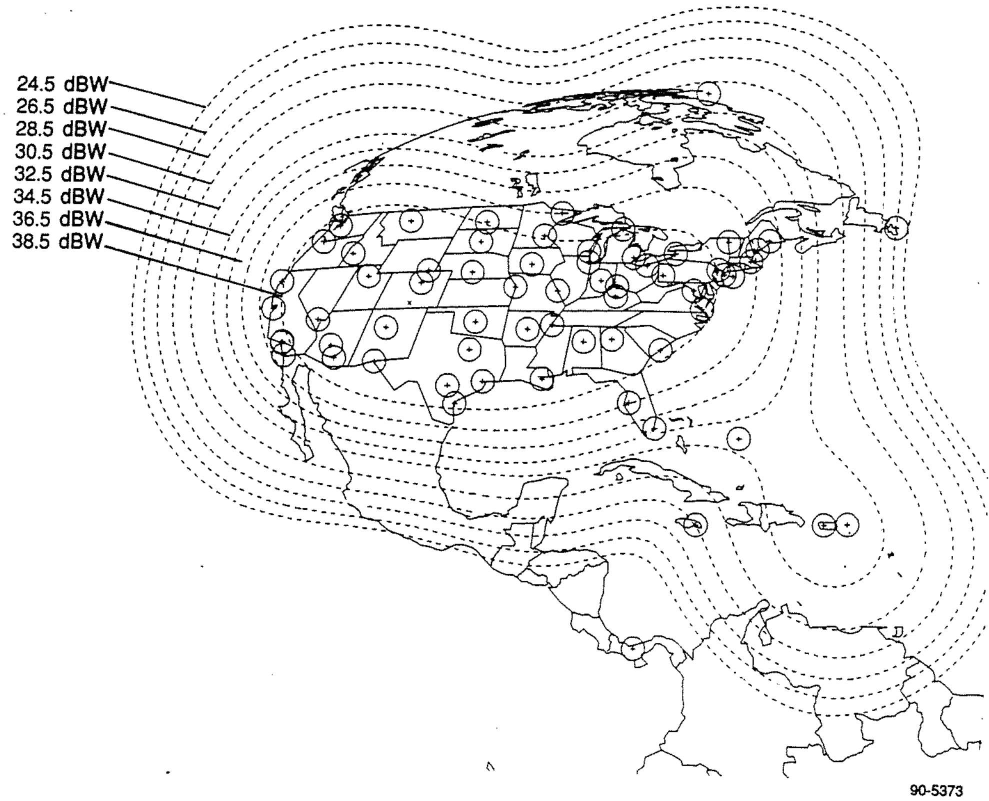


Figure 2-12. C-Band EIRP, VP, Mode 2

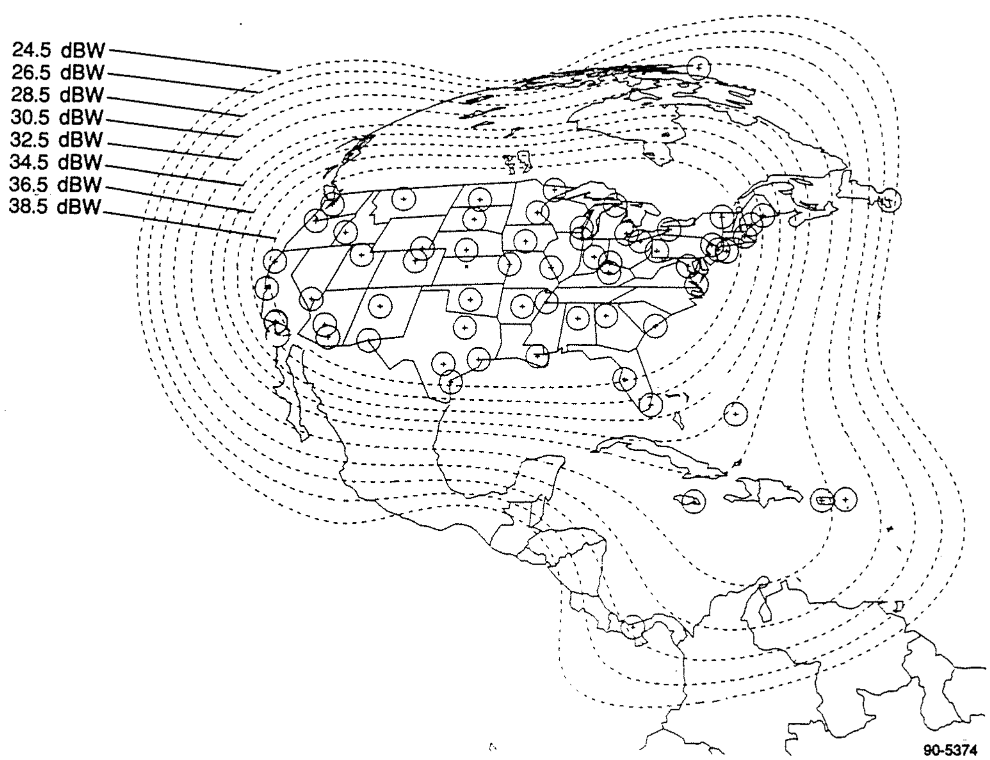


Figure 2-13. C-Band EIRP, HP, Mode 1

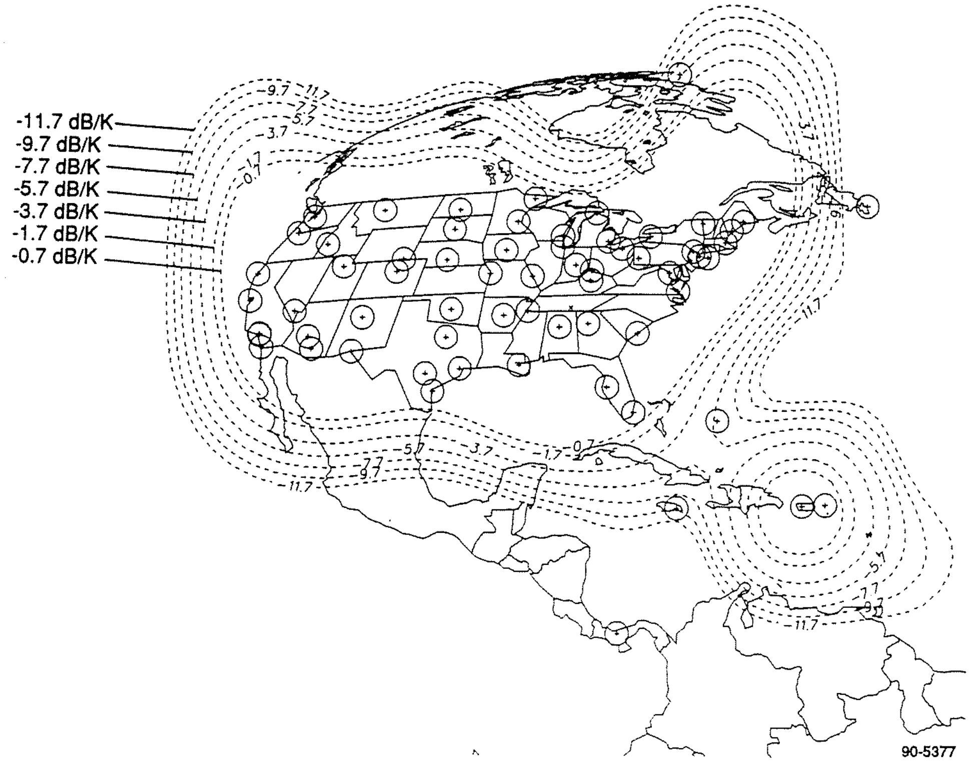


Figure 2-16. C-Band Receive Beam G/T, HP

SECTION 3.0
BUS SUBSYSTEM

SECTION 3.0
BUS SUBSYSTEM

3.1 STRUCTURE

Figures 3-1 and 3-2 illustrate the deployed and launch configurations of the Series 7000-based Satcom H1 satellite. Series 7000 is the largest in the GE Astro-Space Division (Astro) family of geosynchronous 3-axis stabilized momentum bias spacecraft. The Series 7000-unique modular design, with dedicated payload bay, provides the maximum flexibility in adapting the spacecraft to mission-unique communications needs. The Satcom heritage is evident in the efficient rectangular structure with its large north/south area, side-mounted solar array panels, compact launch arrangement, and orientation in which the upper surface during launch coincides with the earth-facing direction in geosynchronous orbit. The C- and Ku-band reflectors are side-mounted on the west and east sides respectively, leaving the space on the earth-facing (nadir) panel free for antenna feed assemblies, input multiplexers, the CR&T omni antenna, and attitude reference sensors. An exploded view is shown in Figure 3-3.

A truly modular arrangement is basic to the Series 7000 design. The bus, payload, and antenna modules are separate assemblies that allow parallel integration, test, and alignment, thereby maximizing the activity time available to each module with no jeopardy to the system schedule. Figure 3-4 illustrates the satellite modularity and identifies the panels that permit access to the interior, even after the major modules have been joined.

The payload module itself consists of a U-shaped arrangement, which allows 100% access to all transponder components as the assembly is being integrated and tested. With the payload module and antenna modules installed on the spacecraft, the interior of the payload region of the spacecraft remains unobstructed to allow efficient radiative thermal interchange among all panels.

Each antenna module includes a platform, which is the center panel of the east or west side, plus its feed assembly and reflector/hinge assembly. The platform overlaps both the payload and bus modules, and it is partly recessed into the east or west surface to ensure no interference with rf energy transmission paths. The graphite composite platform is thermally stable and sufficiently stiff to allow the antenna elements to be integrated and aligned as a module.

The bus module contains all housekeeping components, except attitude sensors. Battery cells are mounted directly to north and south corner panels rather than in a conventional two-tier "wine rack" configuration, as on previous communications satellites. This configuration provides highly efficient thermal interchange with the structure, reduces thermal gradients, and minimizes packaging weight of the cells. The battery packs are, in fact, submodules of the spacecraft itself. The north/south center panels support the momentum wheels and other bus components. A center tank contains all of the oxidizer, and four tanks surrounding a center cylinder contain the hydrazine propellant. An upper deck and a base panel close the ends of the bus module. These two panels are connected by bulkheads that transfer shear loads from the outer panels to the center cylinder.

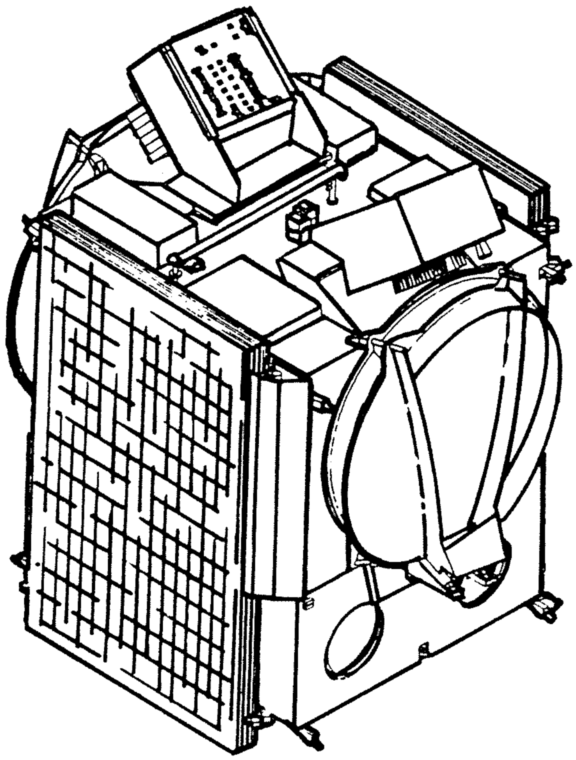


Figure 3-2. Satcom H1 Launch Configuration

Access to the fully assembled spacecraft is easily facilitated by readily removable east and west panels that surround the antenna modules and support no components themselves.

A final important feature of the configuration, is that all sensitive electronic equipment is housed within the structural enclosure. This ensures complete protection against environmental effects, particularly electrostatic discharge (ESD).

The spacecraft has a direct, identical interface with the adapters of Ariane 4 and Atlas IIAS. Figure 1-1 illustrates the compatibility of the satellite with the candidate launch vehicles.

3.2 PROPULSION SUBSYSTEM

The Series 7000 propulsion subsystem incorporates the dual-mode design presently completing integration and test for Astro's Series 5000 satellites. The subsystem uses highly efficient and redundant bipropellant Liquid Apogee engines (LAEs) for the main velocity change maneuvers and a simple, flight-proven, monopropellant reaction control subsystem (RCS) for stationkeeping and on-orbit attitude control. This approach offers high performance for the large throughput ΔV maneuvers, along with a well-characterized low-thrust stationkeeping RCS. Fuel (hydrazine) is supplied to all components from

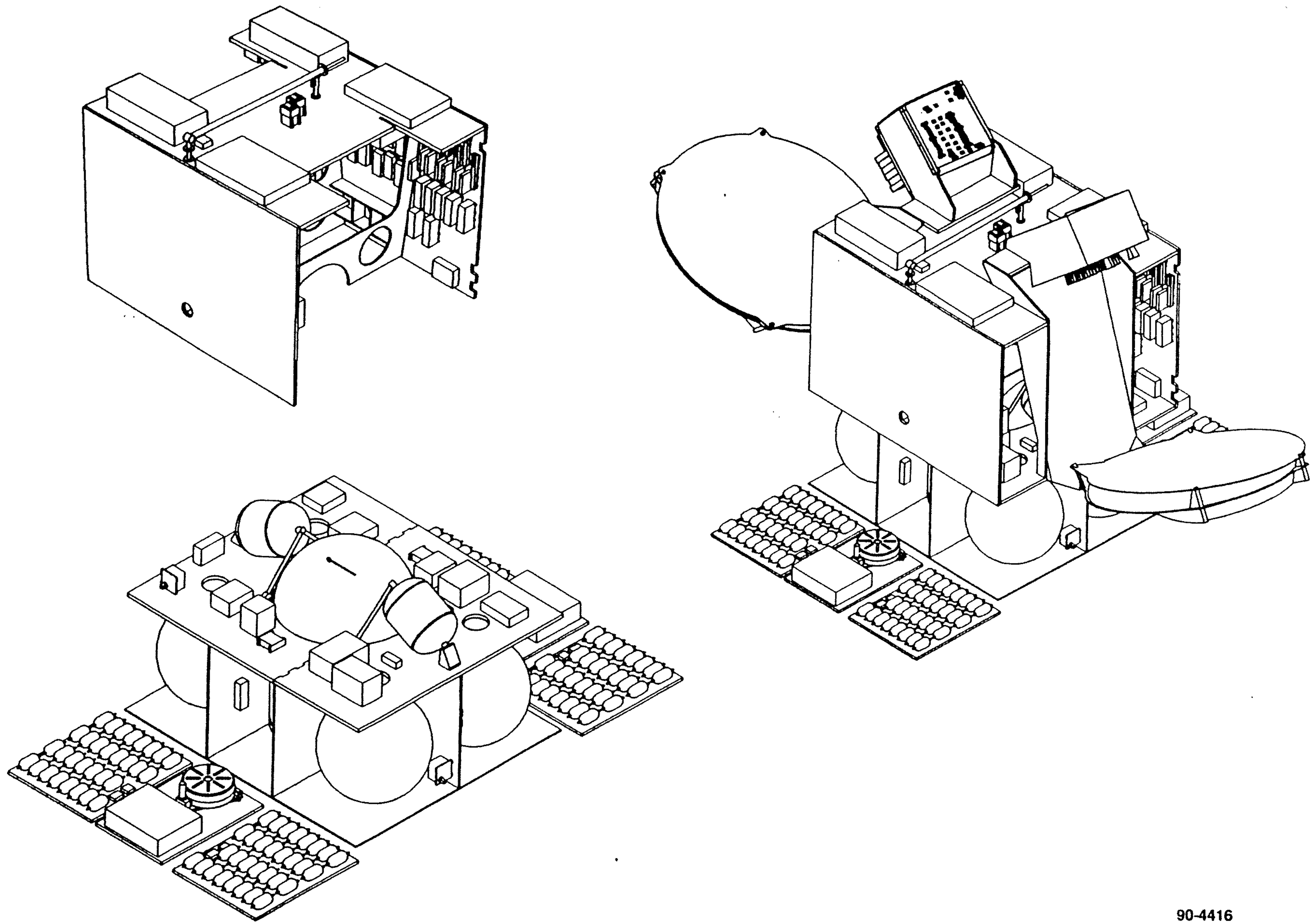
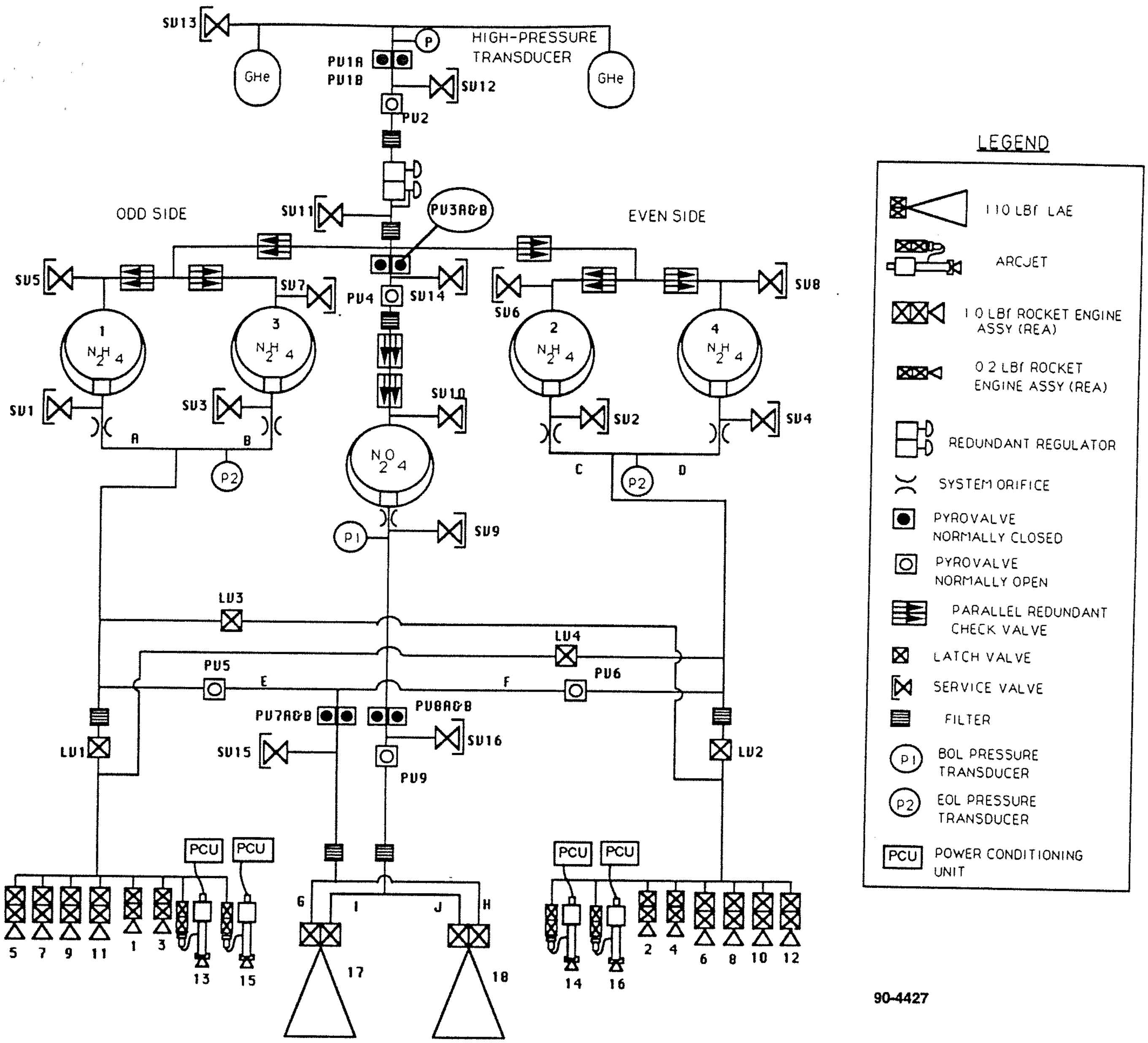
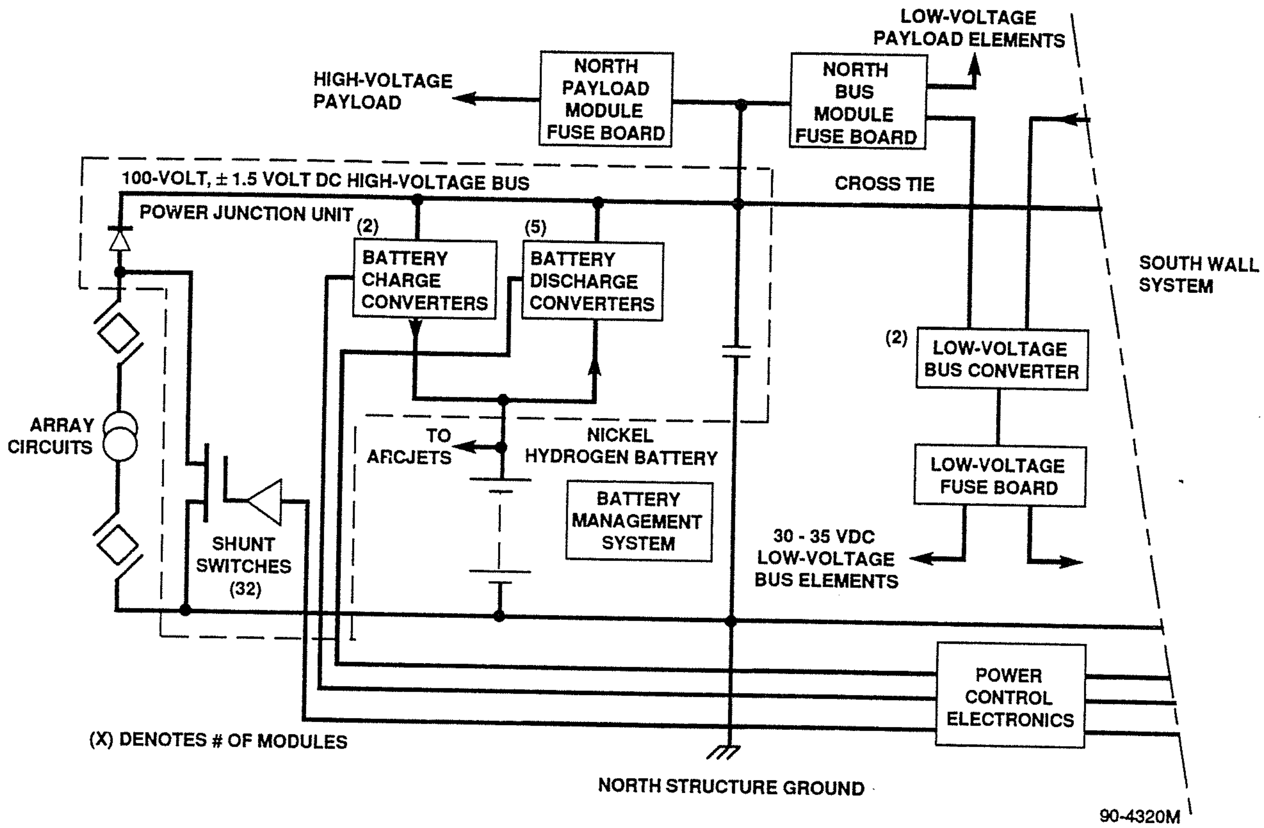


Figure 3-4. Satcom H1 Assembly Sequence



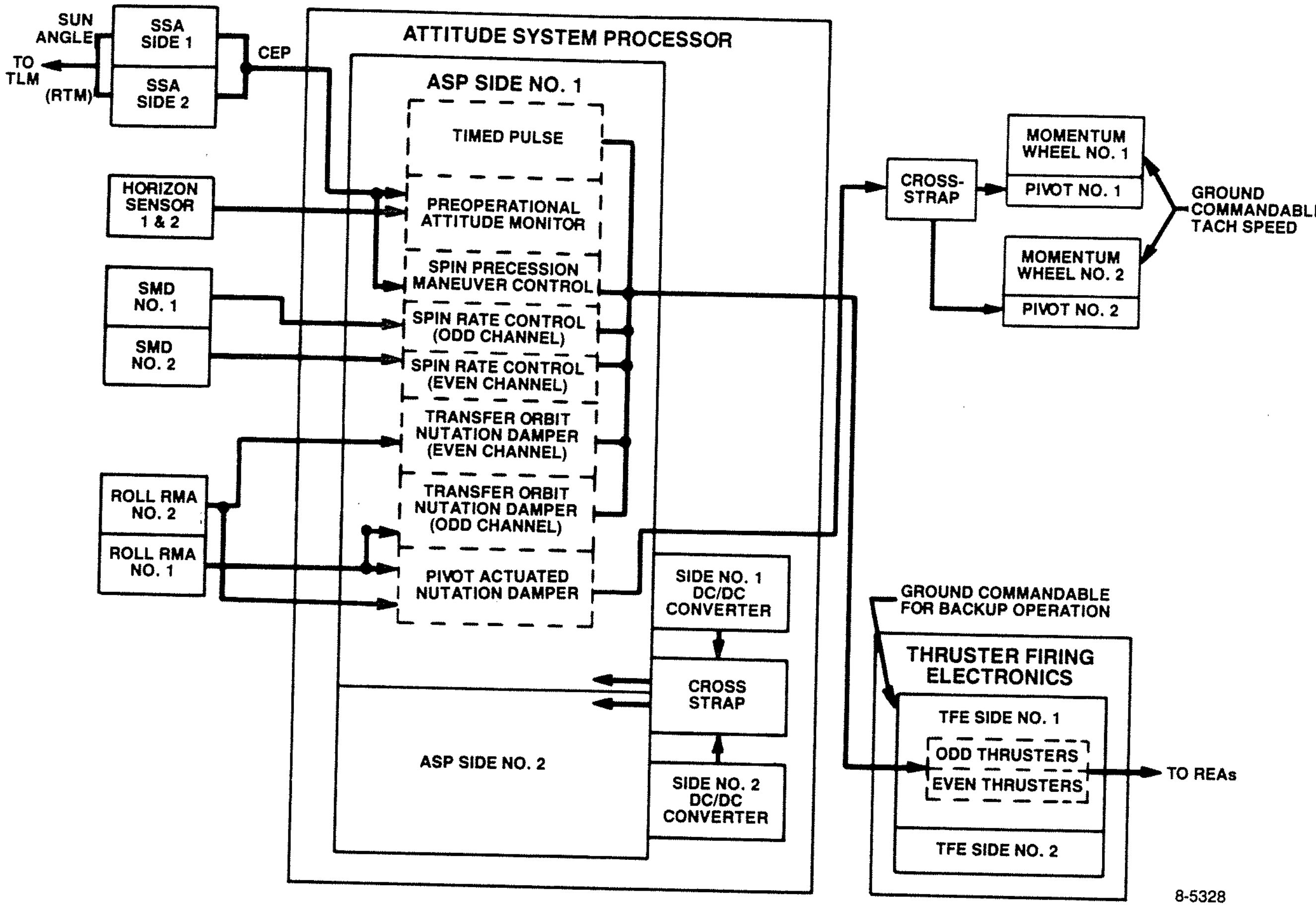
- **A LIQUID 'DUAL-MODE' PROPULSION SUBSYSTEM PROVIDING ALL REQUIRED PROPULSION FUNCTIONS FOLLOWING L.V. SEPARATION**
- **APOGEE INSERTION: BIPROPELLANT MODE (UNTIL OXIDIZER DEPLETION)**
- **ALL OTHER FUNCTIONS: MONOPROPELLANT MODE**
- **PROPELLANTS: N_2H_4 AND N_20_4**
- **PROPELLANT STORAGE: 4 X 0.86M DIA. N_2H_4 TANKS**
  (CAPACITY: 1240 KG)
  1 X 1.07M DIA. N_20_4 TANK
  (CAPACITY: 847 KG)
- **SYSTEM OPERATES IN BLOWDOWN FOLLOWING APOGEE INSERTION**
- **REDUNDANT 445N THRUSTERS FOR APGOEE INSERTION (ISP: 313 SECS)**
- **HYDRAZINE 0.2N THRUST FOR ARCJETS FOR N/S STATIONKEEPING (ISP: 502 SECS)**
- **HIGH EFFICIENCY MULTIPLE BURN PVA AND APOGEE INSERTION SCENARIO**
- **ALL ENGINES TESTED PRIOR TO LAUNCH**

Figure 3-5. Propulsion Subsystem



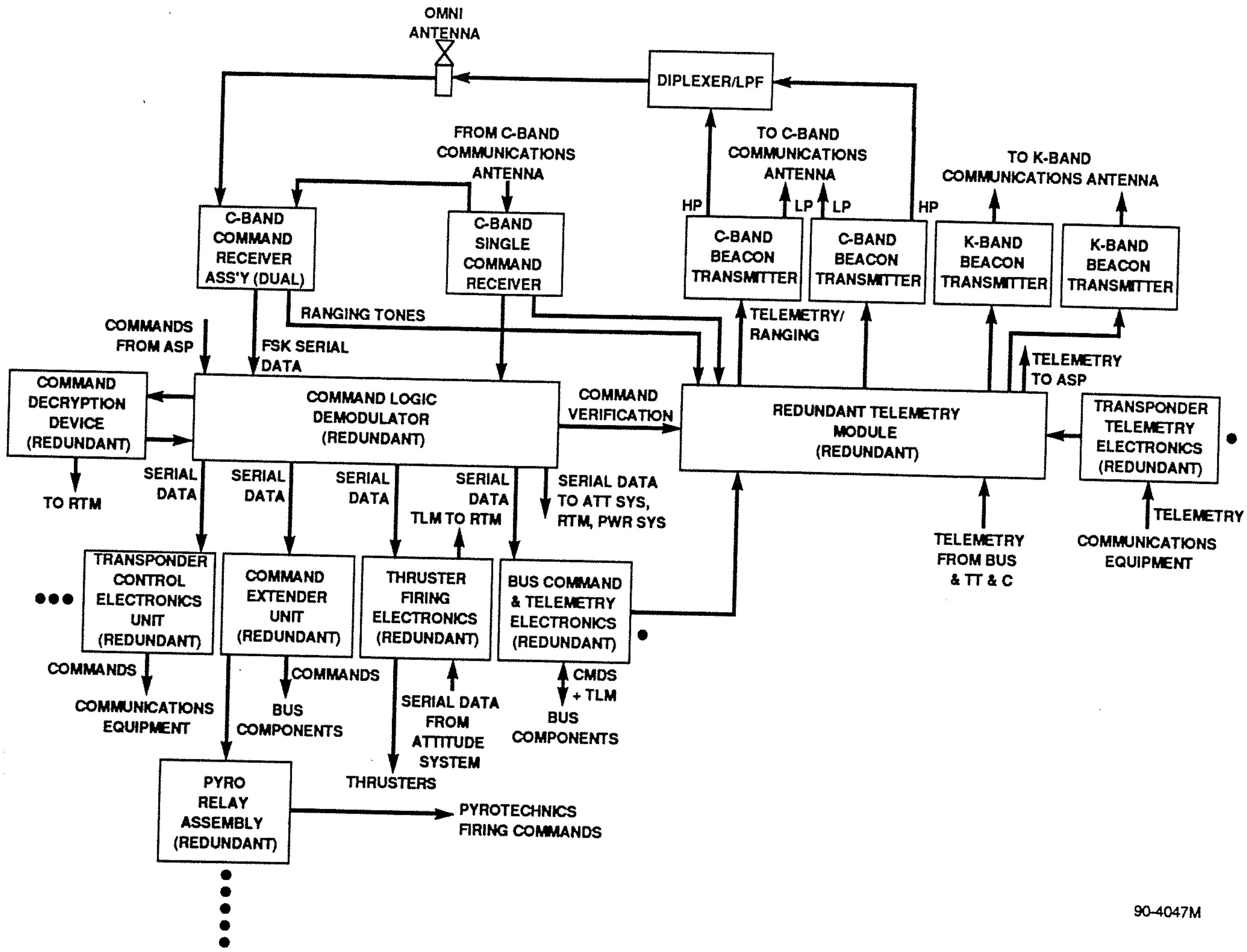
- SINGLE-AXIS ORIENTED ARRAY, ECLIPSE CAPABILITY (NIH_2 BATTERIES), REGULATED DET SUPPLY
- SOLAR ARRAY AREA: $38M^2$ (3 PANELS PER WING)
- LOAD POWER CAPABILITY: 4 KW AT 12 YEARS
- ARRAY BUS: 100 VOLTS
- LOW VOLTAGE BUS: 30 TO 35 VOLTS
- ENERGY STORAGE: 2 X 50 AH NIH_2 BATTERIES (58 CELLS EACH)

Figure 3-7. Electrical Power Subsystem



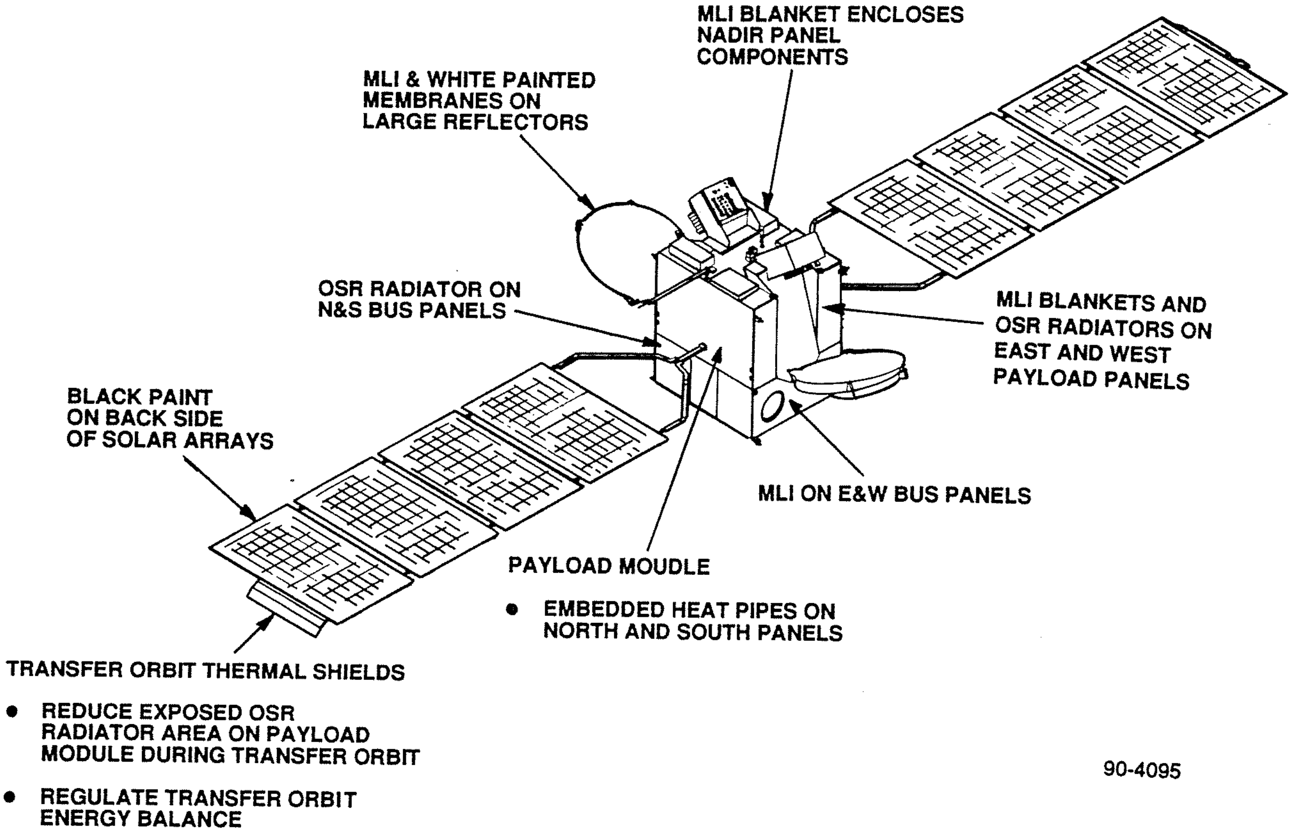
- 3-AXIS MOMENTUM BIAS SYSTEM. MAGNETICS ROLL/YAW CONTROL WITH PROPULSION BACKUP (54 NMS BIAS MOMENTUM)
- POINTING ACCURACY: ±0.1 PITCH & ROLL, ±0.25 YAW
- STATIONKEEPING: ±0.05 BOX
- PITCH BIAS CAPABILITY: ±6.0° IN 0.01° INCREMENTS
- ROLL BIAS CAPABILITY: ±2.5° IN 0.01° INCREMENTS
- AUTOMATIC ROLL YAW STEERING CAPABILITY
- ALLOWS INCLINED ORBIT OPERATION
- EXTENDED OFFSET CAPABILITY UNDER GYRO CONTROL FOR SINGLE POINT ANTENNA MEASUREMENTS
- GROUND COMMAND OVERRIDE OF ALL AUTONOMOUS FUNCTIONS
- AUTONOMOUS STATIONKEEPING MANEUVERS AND REDUNDANCY MANAGEMENT

Figure 3-9. Attitude Control Subsystem



- DUAL BAND SYSTEM PROVIDING COMMAND/ TELEMETRY AND TURN AROUND NONCOHERENT RANGING FUNCTIONS
- COMMAND RATE 100 BPS (32-BIT FORMAT)
- TELEMETRY RATE 1024 BPS (256 WORD FRAME)
- TELEMETRY DWELL CAPABILITY
- SECURE COMMAND CAPABILITY
- C-BAND UPLINKS AND DOWNLINKS AVAILABLE THROUGH EITHER THE TT&C OMNI ANTENNA OR THROUGH THE COMMUNICATIONS ANTENNA SYSTEM WHILE ON STATION
- KU-BAND DOWNLINK AVAILABLE THROUGH THE COMMUNICATIONS ANTENNA

Figure 3-10. CR&T Subsystem



- FULLY PASSIVE DESIGN AUGMENTED BY HEATERS
- EMBEDDED HEAT PIPES IN N/S PAYLOAD PANELS
- OPEN PAYLOAD MODULE STRUCTURE ALLOWS MAXIMUM RADIATIVE COUPLING BETWEEN NORTH/ SOUTH SURFACES
- CONDUCTIVELY COATED OSR's AND MLI FOR MAXIMUM ESD PROTECTION
- FLAT-FACK BATTERY DESIGN MINIMIZES THERMAL GRADIENTS
- FULLY MODULAR DESIGN FOR EASE OF INTEGRA– TION AND ACCESS
- COMPATBILE WITH STANDARD LAUNCH VEHICLE INTERFACES
- COMPOSITE ANTENNA SUPPORT STRUCTURE MINIMIZES THERMAL DISTORTION
- COMPATIBLE WITH 4 LAUNCH VEHICLE ENVIRONMENTS

Figure 3-11. Thermal Control Subsystem