## *5.3. Communications Subsystem.*

The communications system consists of two redundant VHF transponder systems, two redundant S-band transmitters with four S-band power amplifiers, and associated antenna systems. The communications system interfaces with the power supply subsystem, telemetry encoder output, and command decoder input. Functionally, this system provides the means for transmission of telemetry data, reception of ground generated commands, and a way of tracking the spacecraft using the Goddard Range & Range Rate (R&RR) system.

### *5.3.1. S-band system.*

Characteristics of the S-band system include the following,

- Transmitter frequency 2249.80 MHZ
- Power output 6 w
- Output modulation Phase modulation (pm)
- Antenna polarization Circular

The S-band system consists of two redundant transmitters and four power amplifiers with individual antennas. The S-band system is used for transmission of telemetry data. Both of the transmitters are connected to each of the power amplifier/antenna combination. Only one transmitter and one power amplifier/antenna are activated by command at any one time. Selection of a particular power amplifier depends upon a favourable view of the Earth tracking station by its associated antenna.

The IUE S-band antenna sensitivity plot for the four power amplifiers is show in the figure 5-19.

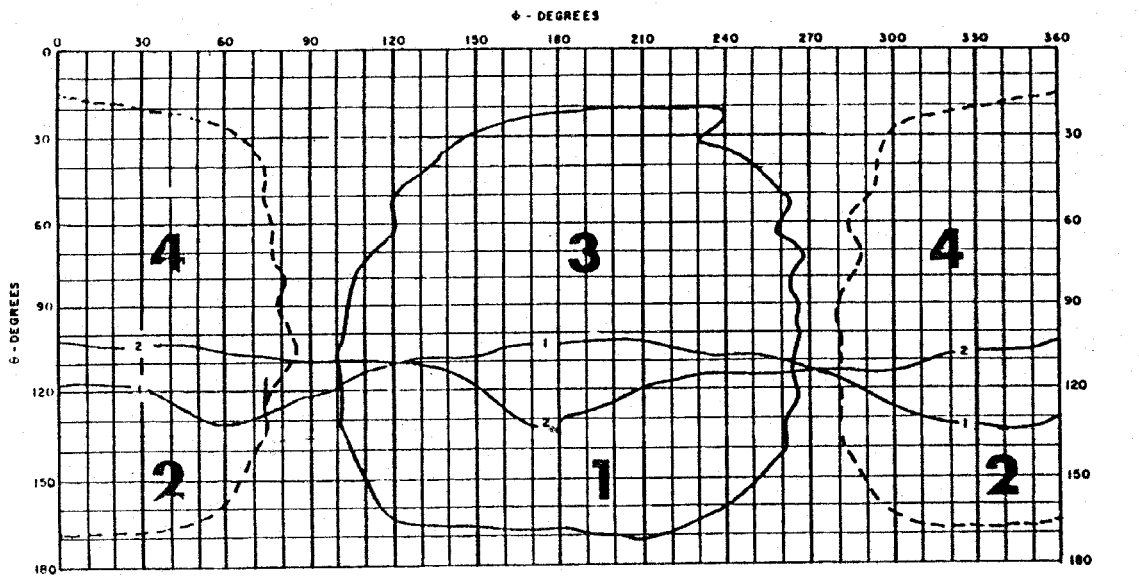


*Figure 5-19. IUE S-Band antenna sensitivity plot.*

The angles theta ($\theta$) and phi ($\Phi$) are the spacecraft look angles from the tracking stations. The contours plotted on figure are -6 dbi curves found during prelaunch thermal vacuum testing.

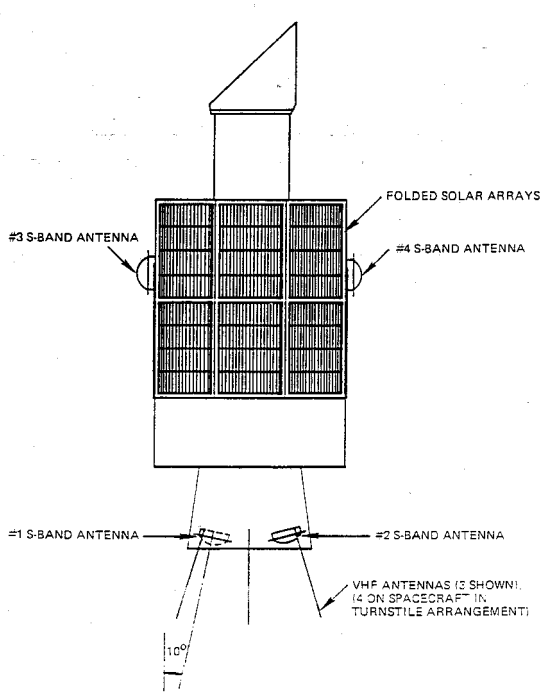


*Figure 5-20. Antenna locations on the S/C.*

Antennas 1 and 2 are located on the bottom of the spacecraft on the anti-Sun and Sun side (figure 5-20), respectively, so they are more useful when the telescope is pointing away from the Earth. Antennas 3 and 4 are located higher up on the body of the spacecraft, above 1 and 2, respectively.

The table below shows approximately the load of each power amplifier.

| S-band P.A. | Power load (watts) |
|---|---|
| P.A.#1 | 16 w |
| P.A.#2 | 21 w |
| P.A.#3 | 23 w |
| P.A.#4 | 27 w |

The figure 5-21 compares the antenna radiation pattern for each PA at the end of the IUE. The AGC (automatic gain control) is the combiner output voltage in the reception chain.

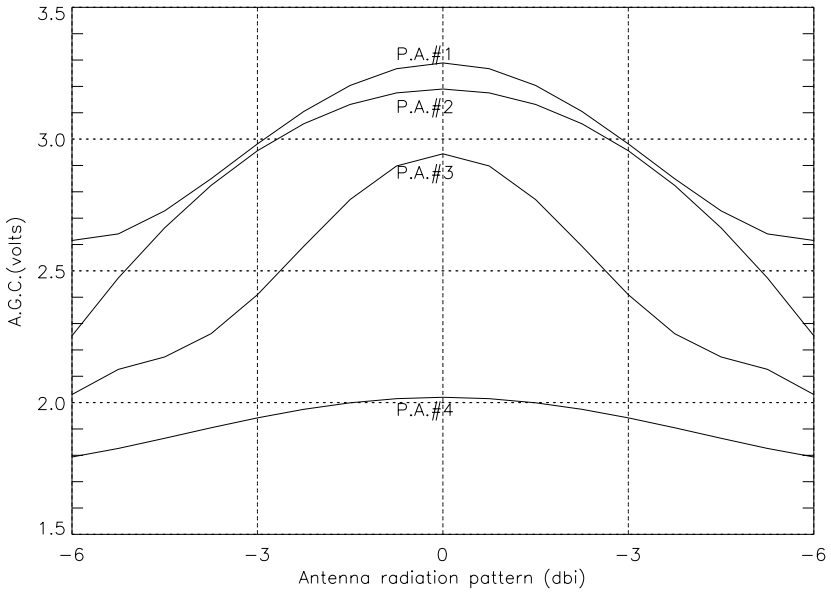


*Figure 5-21. Comparison between the output of the four power amplifiers.*

### *5.3.1.1. S-band power amplifier 4 anomaly.*

A sudden drop in the S-band power amplifier 4 down-link signal strength was observed twice along the spacecraft life, the first time was on the 24th of September of 1984 and, the second time, the 5th of August of 1995. Both times the measured drops were around 10 dbm. The data analysis, in 1995, showed a corresponding drop in the spacecraft bus current of approximately 0.16 amps and, also, a rapid drop in the S-band power amplifier temperature from 26.2°C to 23.2°C.

PA 4 was anticipated to become more susceptible to become degraded over the years. It was located on the Sun side of the s/c, so that solar radiation degraded PA 4 more than the other PAs.

## *5.3.2. VHF system.*

Characteristics of the VHF transponder system include the following,

- Receiver frequency 148.980 MHZ
- Transmitter frequency 136.860 MHZ
- Power output 6 w
- Output modulation Phase modulation (pm)
- Receiver sensitivity -106 dbm
- Antenna polarization Turnstile
- Antenna pattern Omnidirection

The VHF transponder system consists of a turnstile antenna system, antenna distribution system and two VHF transponders. The VHF system provides for the transmission of telemetry data, reception of ground generated commands, and the turnaround transmission of R&RR signals. The VHF downlink is essentially an omnidirectional antenna; therefore, it is possible to pick up the VHF signal from any spacecraft attitude. This makes it very useful for use during emergencies where a loss of attitude control condition exists. The VHF system cannot be used effectively at data rates greater than 5 kilobits per second. As the VHF system uses less power than the S-band system, it has been used for data during shadow periods to minimize battery drain.

### *5.3.2.1. Ranging.*

The Goddard R&RR system is used to determine the location and rate of motion of the IUE spacecraft throughout its orbit. This ranging information is used by the tracking stations to locate the satellite accurately for the best possible reception of data and to monitor orbit drift. Three tracking stations are capable of performing rangings: Greenbelt (BLT)/Wallops (WPS), Santiago, Chili (AGO) and Ascension Island (ACN).

Ranging was done at 1 hour intervals covering the entire orbit around twice a month. To range with the IUE, the VHF system was turned on and placed in the ranging mode. The station uplinked ranging tones which are fed back to the station by the VHF system. The Doppler shift in these tones was used to calculate the spacecraft radial motion.