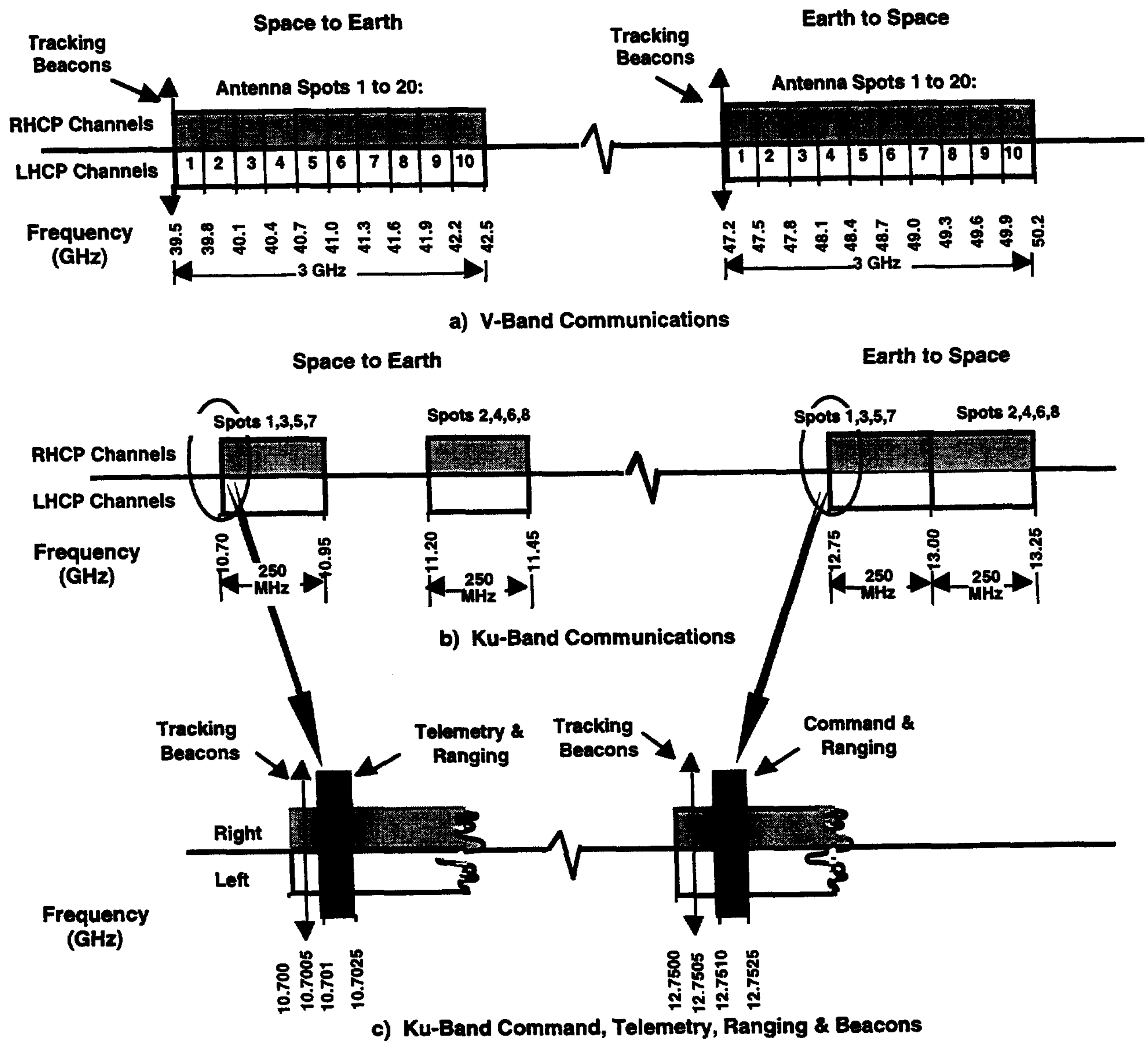

Figure 4.2-1. Illustrative Frequency & Polarization Plan

Figures 4.2-2 and 4.2-3 show the detailed frequency and polarization plans for V-band communications. The 3 GHz of spectrum will be used in each of two polarizations and will be channelized into ten 300-MHz wide frequency division multiplexed (FDM) channels, each of which are time division multiplexed (TDM) into 100 time channels or slots. Users will be assigned a unique time slot and FDM channel and will, in general, burst data at 155 Mbps. All uplink time slots and all downlink time slots are synchronized to a satellite clock that controls channel-to-channel switching and connectivity by means of a satellite TDMA switch. Because up to 40 beams will be active at any given time, and because each beam is capable of supporting 4,000 channels of compressed, 384 kbps video, the total V-band capacity is 160,000 channels of compressed, multiplexed 384 kbps video per satellite.

Ku-band communications will use an approach similar to that of V-band. Figures 4.2-4 and 4.2-5 show the detailed frequency and polarization plans for the Ku-band, using the planned Ku-band for illustrative purposes. Again, the bandwidth will be used in each of two polarizations[3] and 100 time slots will be time division multiplexed onto a single uplink or downlink carrier to provide a total Ku-band capacity of 6400 channels of compressed 384 kbps video.

[3] Thus, by employing dual polarization, SpaceCast™ effectively meets the full-frequency reuse requirements of Sections 25.210(c) and (e) of Commission's Rules. As is the case with the Ka-band, the Commission, in modifying its existing service rules to facilitate licensing in the V-band, should allow use of dual circular polarization, instead of dual linear polarization. In order to facilitate use of the same type of polarization for both the Ku-band and V-band on SpaceCast™ and to the extent necessary, HCI requests a waiver of the vertical and horizontal polarization requirements of Section 25.210(c).

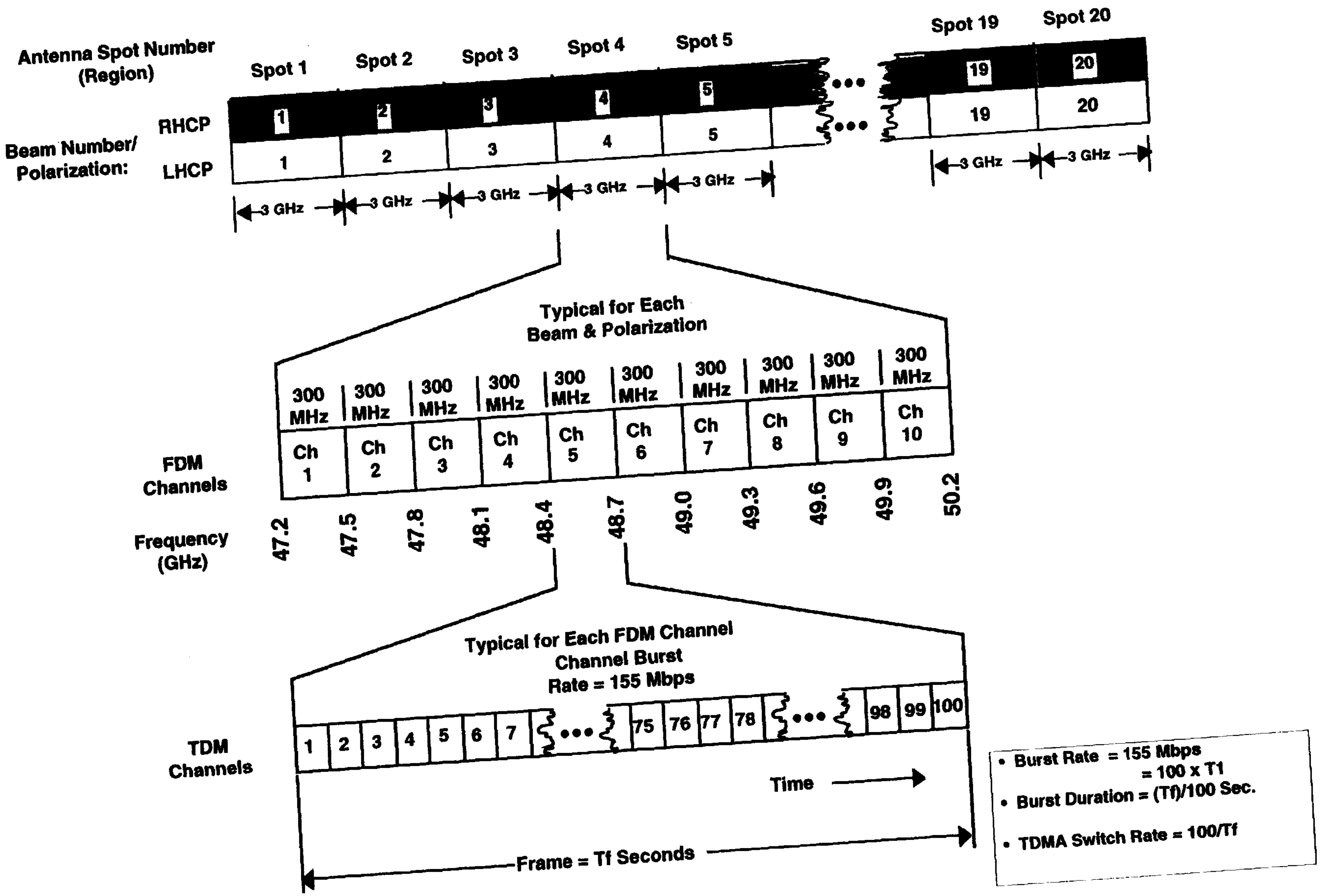

Figure 4.2-2. V-Band Uplink (Earth-to-Space) Frequency and Polarization Plan

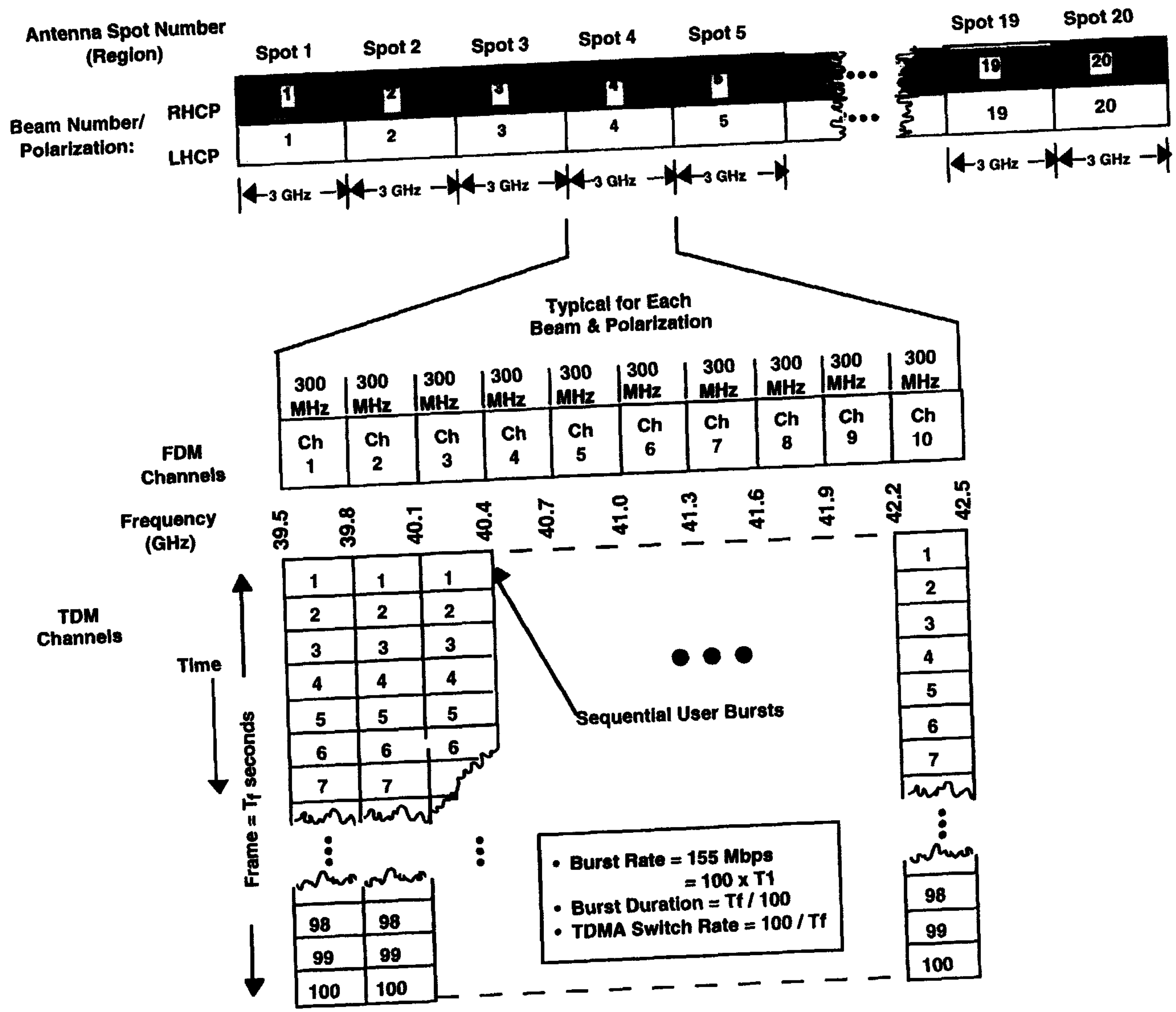

Figure 4.2-3. V-Band Downlink (Space-to-Earth) Frequency and Polarization Plan

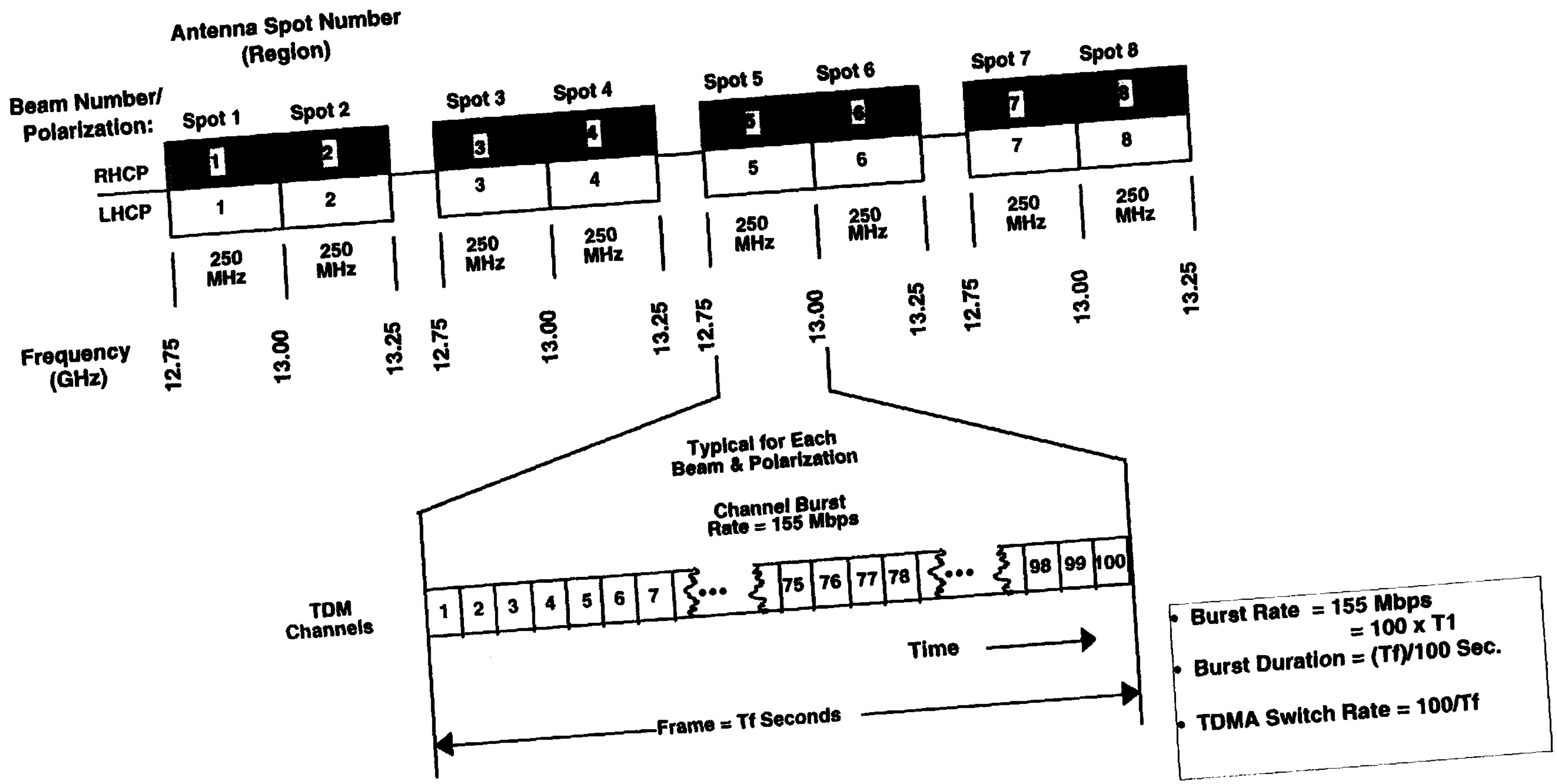

Figure 4.2-4. Ku-Band Communications Uplink (Earth-to-Space) Frequency and Polarization Plan (Specific Frequencies are Illustrative)

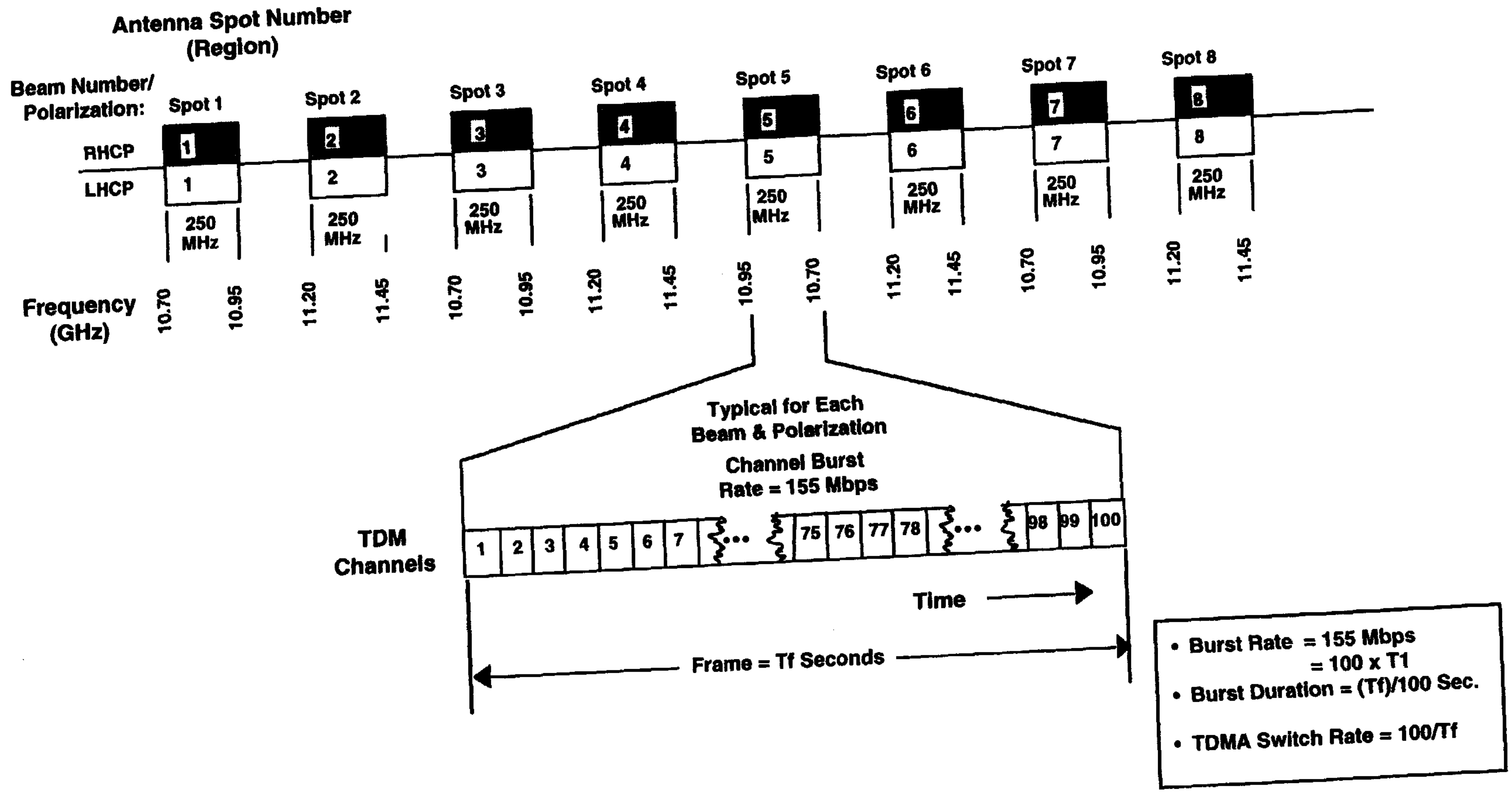

Figure 4.2-5. Ku-Band Communications Downlink (Space-to-Earth) Frequency and Polarization Plan (Specific Frequencies are Illustrative)

4.3. Emission Designators

Uplink V-band communications to SpaceCast™ satellites will use a Pulse Code Modulation, Differential Quadriphase Shift Keying (PCM/DQPSK) format. Each V-band beam will contain ten 300 MHz-wide frequency division multiplexed (FDM) channels. Each FDM channel will in turn be time shared (TDM) by 100 users with a burst rate as high as 155 Mbps. Downlink communications will also use a PCM/DQPSK format.

Each Ku-band uplink communications beam will have a single 250 MHz carrier time shared by users using the same PCM/DQPSK modulation format. Users will burst data to the satellite at a rate as high as 155 Mbps. Each downlink carrier will use the PCM/DQPSK format in a continuous, non-burst mode.

Commands to the satellites from the earth control segment will be performed at Ku-band using Non-Return-to-Zero/Frequency-Shift-Keying/Frequency Modulation (NRZ/FSK/FM) modulation. Range tones transmitted to the satellite on the Ku-band command carrier will be transponded and phase modulated onto the downlink Ku-band telemetry carrier. Telemetry data will be transmitted using a Pulse Code Modulation/Phase-Shift-Keying/Phase Modulation (PCM/PSK/PM) format. Unmodulated Ku-band and V-band beacons will also be transmitted to and from the satellites for attitude control and pointing. Command, telemetry, ranging, tracking, and beacons will occupy lower edges of the uplink and downlink Ku-bands. Table 4.3-1 lists the various signals as well as their emission designators.

Table 4.3-1 Emission Designators

Signal	Number Per Beam	Emission Designator
V-band Communications Uplink	10	257MG1DDT
V-band Communications Downlink	10	257MG1DDT
V-band Communications Uplink	10	43M7G1DDT
V-band Communications Downlink	10	43M7G1DDT
Ku-band Communications Uplink	1	214MG1DDT
Ku-band Communications Downlink	1	214MG1DDT
Ku-band Command	1	1M50F9DXF
Ku-band Telemetry	1	1M50G9DXF
Ku-band Receive Beacons	1	100KN0NXN
Ku-band Transmit Beacons	1	100KN0NXN
V-band Receive Beacons	1	100KN0NXN
V-band Transmit Beacons	1	100KN0NXN

4.4. Power Flux Density Compliance

4.4.1. V-Band Communications

At present, no power flux density (PFD) requirement is specified in the FCC Rules for emissions in the 39.5-42.5 GHz band used by SpaceCast™ for communications downlink. The international Radio Regulations (RR) have specified limits applicable to this band. Using these requirements, emissions from a satellite shall not exceed: (a) -115 dB (W/m^2) in any 1 MHz band for angles of arrival between 0 and 5 degrees above the horizontal plane; (b) -115 + 0.5(d-5) (W/m^2) in any 1 MHz band for angles of arrival d (degrees) between 5 and 25 degrees above the horizontal plane; (c) -105 dB (W/m^2) in any 1 MHz band for angles of arrival between 25 and 90 degrees above the horizontal plane.

Because signal burst rates range from 26.418 Mbps to 155.52 Mbps and because the satellite EIRP per carrier is constant regardless of the burst rate, the maximum PFD in any 1 MHz band is determined by the narrowest signal's bandwidth:

PFD (dBW/m^2/MHz) = Satellite Carrier EIRP (dBW) - 20 log(Slant Range in km) - 71 - 10 log (43.7 MHz/1 MHz)

Table 4.4.1-1 gives the SpaceCast™ V-band maximum PFD as a function of elevation angle. In all cases SpaceCast™ complies with the limits with at least 2 dB margin for all elevation angles above the horizon.

Table 4.4.1-1. V-Band Communications Maximum Power Flux Densities

Maximum PFD Requirement ($dBW/m^2/MHz$)	Elevation Angle (degrees)	Slant Range (km)	SpaceCast™ Power Flux Density ($dBW/m^2/MHz$)	Margin (dB)
-115	0	41,680	-117.8	2.8
-115	5	41,128	-117.7	2.7
-105	25	39,072	-114.2	9.2
-105	90	35,787	-113.5	8.5

4.4.2. Ku-Band Communications

4.4.2.1 FCC Rules

PFD at the earth's surface produced by a satellite for all methods of modulation shall not exceed: (a) -150 dB(W/m^2) in any 4 kHz band for angles of arrival between 0 and 5 degrees above the horizontal plane; (b) -150 + (d-5)/2 dB(W/m^2) in any 4 kHz band for angles of arrival (in degrees), between 5 and 25 degrees above the horizontal plane; and (c) -140 dB(W/m^2) in any 4 kHz band for angles of arrival between 25 and 90 degrees above the horizontal plane. A single Ku-band carrier will be used to support TDM data rates up to 155 Mbps in a 250 MHz beam. Because a 155 Mbps carrier occupies a bandwidth of 214 MHz, the Ku-band PFD in any 4 kHz band is given by:

PFD ($dBW/m^2/4$ kHz) = Satellite Carrier EIRP (dBW) - 20 log(Slant Range in km) - 71 - 10 log (214 MHz/4 kHz)

Table 4.4.2.1-1 gives the SpaceCast™ PFD as a function of elevation angle. In all cases, SpaceCast™ complies with the PFD limits with more than 4 dB margin for angles up to 25° above the horizon and with more than 10 dB for angles above 25°.

Table 4.4.2.1-1. FCC Ku-Band Communications Power Flux Densities

Maximum PFD Requirement (dBW/m²/4 kHz)	Elevation Angle (degrees)	Slant Range (km)	SpaceCast™ Power Flux Density (dBW/m²/4 kHz)	Margin (dB)
-150	0	41,680	-154.4	4.4
-150	5	41,128	-154.3	4.3
-140	25	39,072	-150.8	10.8
-140	90	35,787	-150.1	10.1

4.4.2.2 International Requirements

International PFD limits applicable to SpaceCast™'s Ku-band downlink transmission were taken from RR S21.16. The power flux densities at the Earth's surface produced by emissions from a satellite for all conditions and for all methods of modulation shall not exceed the following for frequencies between 10.7 GHz and 11.7 GHz: (a) -150 dB(W/m^2) in any 4 kHz band for angles of arrival between 0 and 5 degrees above the horizontal plane; (b) -150 + 0.5(d-5) dB(W/m^2) in any 4 kHz band for angles of arrival d (in degrees) between 5 and 25 degrees above the horizontal plane; and (c) -140 dB(W/m^2) in any 4 kHz band for angles of arrival between 25 and 90 degrees above the horizontal plane. Table 4.4.2.2-1 gives the SpaceCast™ Ku-band PFD in any 4 kHz band. As shown in this table, SpaceCast™ therefore complies with the international Radio Regulations by more than a 4 dB margin.

Table 4.4.2.2-1. International Ku-Band Communications Power Flux Densities (10.7-11.7 GHz)

Maximum PFD Requirement (dBW/m²/4 kHz)	Elevation Angle (degrees)	Slant Range (km)	SpaceCast™ Power Flux Density (dBW/m²/4 kHz)	Margin (dB)
-150	0	41,680	-154.4	4.4
-150	5	41,128	-154.3	4.3
-140	25	39,072	-150.8	10.8
-140	90	35,787	-150.1	10.1

Under RR S21.16, the power flux densities at the earth's surface produced by emissions from a satellite for all conditions and for all methods of modulation shall not exceed the following for frequencies between 12.2 and 12.75 GHz: (a) -148 $dB(W/m^2)$ in any 4 kHz band for angles of arrival between 0 and 5 degrees above the horizontal plane; (b) -148 + 0.5(d-5) $dB(W/m^2)$ in any 4 kHz band for angles of arrival d, between 5 and 25 degrees above the horizontal plane; and (c) -138 $dB(W/m^2)$ in any 4 kHz band for angles of arrival between 25 and 90 degrees above the horizontal plane. Table 4.4.2.2-2 gives the SpaceCast™ Ku-band PFD in any 4 kHz band. As shown in this table, SpaceCast™ complies with the international Radio Regulations by more than a 6 dB margin.

Table 4.4.2.2-2. International Ku-Band Communications Power Flux Densities (12.2-12.75 GHz)

Maximum PFD Requirement ($dBW/m^2/4$ kHz)	Elevation Angle (degrees)	Slant Range (km)	SpaceCast™ Power Flux Density ($dBW/m^2/4$ kHz)	Margin (dB)
-148	0	41,680	-154.4	6.4
-148	5	41,128	-154.3	6.3
-138	25	39,072	-150.8	12.8
-138	90	35,787	-150.1	12.1

4.4.3. Ku-Band Telemetry

4.4.3.1. FCC Rules

SpaceCast™ telemetry will take place in the lower 2 MHz of selected Ku-bands. The maximum EIRP for the telemetry downlink as given in Appendix A of this application is 8.0 dBW. Using the same criteria as that for Ku-band communications given in Section 4.4.2.1 above, the maximum telemetry PFD in any 4 kHz band is given by the expression below and tabulated in Table 4.4.3.1-1.

$$\text{PFD (dBW/m}^2\text{/4 kHz)} = \text{Satellite EIRP (dBW)} - 20\log(\text{Slant Range in km}) - 71 - 10\log(1.5\text{ MHz/4 kHz})$$

As shown in Table 4.4.3.1-1, the PFD for SpaceCast™ telemetry complies with the Commission limits with at least 30 dB of margin for all elevation angles above the horizon.

Table 4.4.3.1-1. FCC Ku-Band Telemetry Power Flux Densities

Maximum PFD Requirement ($dBW/m^2/4$ kHz)	Elevation Angle (degrees)	Slant Range (km)	SpaceCast™ ™ Power Flux Density ($dBW/m^2/4$ kHz)	Margin (dB)
-150	0	41,680	-181.0	31.0
-150	5	41,128	-180.9	30.9
-140	25	39,072	-180.4	40.4
-140	90	35,787	-179.7	39.7

4.4.3.2 International Requirements.

Using the same criteria as those for Ku-band communications given in Section 4.4.2.2 above, SpaceCast™ telemetry compliance with international PFD limits was determined and is given in Tables 4.4.3.2-1 and 4.4.3.2-2 below. As shown, SpaceCast™ telemetry complies with the international PFD limits with a margin of more than 30 dB for all elevation angles above the horizon in the 10.7-11.7 GHz band and more than 32 dB for all elevation angles above the horizon in the 12.2-12.75 GHz band.

Table 4.4.3.2-1. International Ku-Band Telemetry Power Flux Densities (10.7-11.7 GHz)

Maximum PFD Requirement ($dBW/m^2/4$ kHz)	Elevation Angle (degrees)	Slant Range (km)	SpaceCast™ ™ Power Flux Density ($dBW/m^2/4$ kHz)	Margin (dB)
-150	0	41,680	-181.0	31.0
-150	5	41,128	-180.9	30.9
-140	25	39,072	-180.4	40.4
-140	90	35,787	-179.7	39.7

Table 4.4.3.2-2. International Ku-Band Telemetry Power Flux Densities (12.2-12.75 GHz)

Maximum PFD Requirement ($dBW/m^2/4$ kHz)	Elevation Angle (degrees)	Slant Range (km)	SpaceCast™ ™ Power Flux Density ($dBW/m^2/4$ kHz)	Margin (dB)
-148	0	41,680	-181.0	33.0
-148	5	41,128	-180.9	32.9
-138	25	39,072	-180.4	42.4
-138	90	35,787	-179.7	41.7

4.4.4. Tracking Beacons

Two unmodulated Ku-band tracking beacons will be used for satellite attitude control and antenna pointing and will be located near lower edges of the Ku-band spectrum. Two beacons will also be provided near lower edges of the V-band spectrum. The satellite beacons will have a maximum EIRP of 12 dBW.

4.4.4.1 FCC Rules

Table 4.4.4.1-1 provides PFD levels for the Ku-band tracking beacons.

Table 4.4.4.1-1. FCC Ku-Band Beacon Power Flux Densities

Maximum PFD Requirement ($dBW/m^2/4$ kHz)	Elevation Angle (degrees)	Slant Range (km)	SpaceCast™ Power Flux Density ($dBW/m^2/4$ kHz)	Margin (dB)
-150	0	41,680	-151.4	1.4
-150	5	41,128	-151.3	1.3
-140	25	39,072	-150.8	10.8
-140	90	35,787	-150.1	10.1

4.4.4.2. International Requirements.

SpaceCast™ beacon compliance with international PFD regulations are shown in Tables 4.4.4.2-1, 4.4.4.2-2, and 4.4.4.2-3.

Table 4.4.4.2-1. International V-Band Beacon Power Flux Densities

Maximum PFD Requirement (dBW/m²/MHz)	Elevation Angle (degrees)	Slant Range (km)	SpaceCast™ Power Flux Density (dBW/m²/MHz)	Margin (dB)
-115	0	41,680	-151.4	36.4
-115	5	41,128	-151.3	36.3
-105	25	39,072	-150.8	45.8
-105	90	35,787	-150.1	45.1

Table 4.4.4.2-2. International Ku-Band Beacon Power Flux Densities (10.7-11.7 GHz)

Maximum PFD Requirement (dBW/m²/4kHz)	Elevation Angle (degrees)	Slant Range (km)	SpaceCast™ Power Flux Density (dBW/m²/4 kHz)	Margin (dB)
-150	0	41,680	-151.4	1.4
-150	5	41,128	-151.3	1.3
-140	25	39,072	-150.8	10.8
-140	90	35,787	-150.1	10.1

Table 4.4.4.2-3. International Ku-Band Beacon Power Flux Densities (12.2-12.75 GHz)

Maximum PFD Requirement (dBW/m²/4kHz)	Elevation Angle (degrees)	Slant Range (km)	SpaceCast™ Power Flux Density (dBW/m²/4 kHz)	Margin (dB)
-148	0	41,680	-151.4	3.4
-148	5	41,128	-151.3	3.3
-138	25	39,072	-150.8	12.8
-138	90	35,787	-150.1	12.1

4.5. SPACE SEGMENT

The Hughes high power spacecraft supports the power and antenna mounting area required for SpaceCast™. This satellite is a three-axis, body-stabilized satellite that uses a five panel solar array system, along with outboard radiator panels attached to the main body to dissipate heat generated from the high power TWTs. Table 4.5-1 gives satellite characteristics, and Figure 4.5.-1 is an illustration of the satellite.

Table 4.5-1. SpaceCast™ Satellite Characteristics

Satellite Bus	Hughes High Power Spacecraft
Mission Life	15 Years End-of-Life
Stabilization	3 Axis Earth Sensor and Beacon Tracking with the Use of Reaction Wheels and Thrusters
DC Power	17 kW Beginning-of-Life (5 Panel Design) 15 kW End-of-Life
Eclipse Capability	100%
Deployed Length	Approximately 144 Feet (5 Panel Design)
Approximate Weight	5500 kgs with Propellant 3500 kgs without Propellant
V-band Antennas	2 V-Band Reflectors 2 Feed Horn Packs
Ku-band Antennas	2 Reflectors 2 Feed Horn Packs
T&C Antennas	2 Ku Bicone Receive/Transmit 4 Pipe Antennas Receive/Transmit
Beacon Tracking	Command Planar Array and/or V-band Service Link
Number of V-band FDM Carriers	400
Number of V-band Antenna Footprints	204
V-band Cross-Polarization Isolation	30 dB
Number of Active, V-band Antenna Beams	Maximum of 40
Number of Ku-band FDM Carriers	16 active
Number of Ku-band Footprints	up to 16
Ku-band Cross-Polarization Isolation	30 dB
Number of CMD Carriers	2
Number of TLM Carriers	2
Number of Tracking Beacons	2 Transmit, 2 Receive at Ku-band 2 Transmit, 2 Receive at V-band
Number of Laser Carriers	2 Transmit, 2 Receive
V-Band Spectrum Reuse	40 times
Ku-Band Spectrum Reuse	8 times
Station Keeping North-South East-West	 ± 0.05° ± 0.05°
Antenna Pointing Normal (Precision Two Axis	 ± 0.03° N-S and E-W

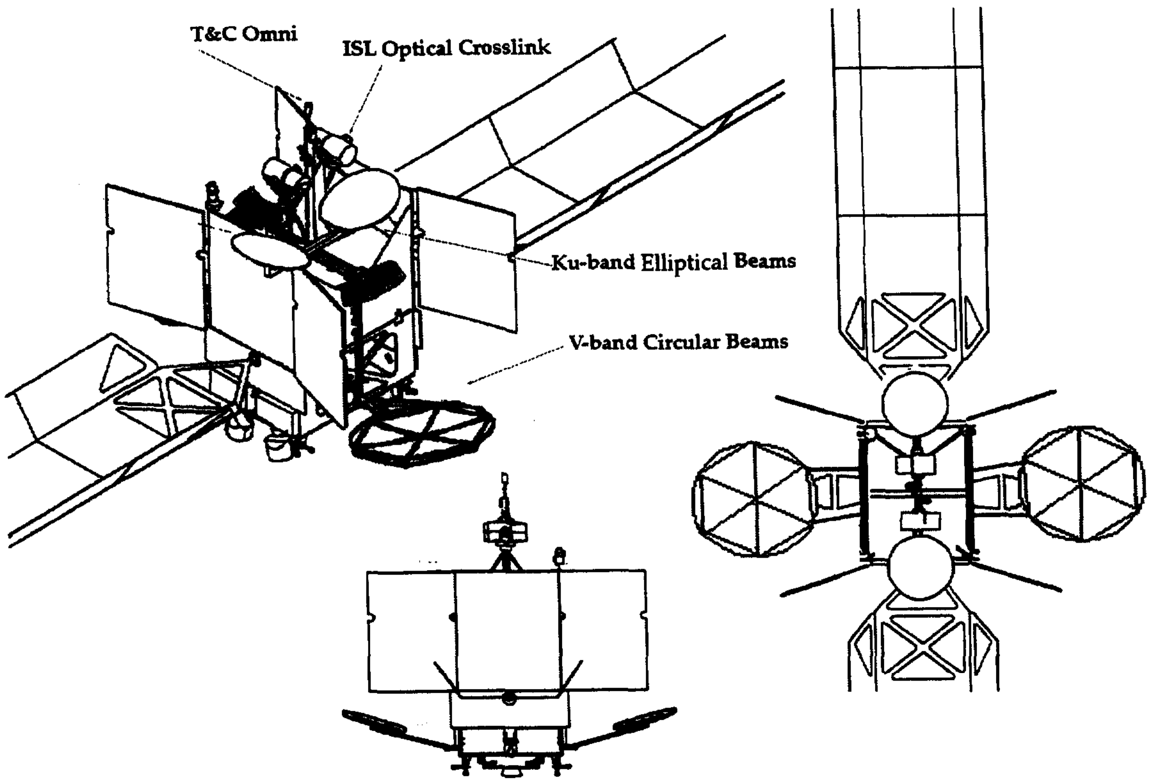

Figure 4.5-1 Hughes High Power Satellite

4.5.1. Communications Subsystem

The satellites contain both V-band and Ku-band payloads. Payload management and reconfiguration will be performed via SpaceCast™'s TT&C system operating in conjunction with the system's ground operations and control segment (See Section 4.10). Table 4.5.1-1 gives communication parameters, and Appendix A provides illustrative link budgets.

Table 4.5.1-1. Communication Parameters

Parameter Description	V-Band Payload	Ku-Band Payload	Crosslink Payload
Modulation Format	DQPSK	DQPSK	Intensity, Wavelength, Multiplexed
Coding Scheme	Convolutional Concatenated Reed Solomon	Convolutional Concatenated Reed Solomon	Convolutional Concatenated Reed Solomon
Target Bit Error Rate	1×10^{-9}	1×10^{-9}	1×10^{-9}
Max Data Rates/FDM Channel	155 Mbps	155 Mbps	3 Gbps
FDM Channel Bandwidth	300 MHz	250 MHz	N/A
Uplink / Downlink / Crosslink Total Bandwidth	3 GHz	500 MHz	N/A

4.5.1.1. V-Band Subsystem

The V-band subsystem will utilize 3 GHz of spectrum (47.2 to 50.2 GHz) for Earth-to-space communication and 3 GHz of spectrum (39.5 to 42.5 GHz) for space-to-Earth communication. The V-band antenna system will consist of multibeam feed horn arrays and reflectors. Appendix C contains V-band antenna coverage plots for satellites located at requested orbital positions. Any satellite in the constellation can independently select a maximum of 40 active beams out of an array of 204 possible spot beam footprints. The spectrum of a single beam will be divided into ten 300 MHz wide FDM channels, including guard bands. Each 300 MHz TDM channel will be time division multiplexed (FDM) by 100 channels or time slots. The overall format is PCM/DQPSK on each uplink and downlink beam. Figure 4.5.1.1-1 shows the V-band/Ku-band satellite payload block diagram.

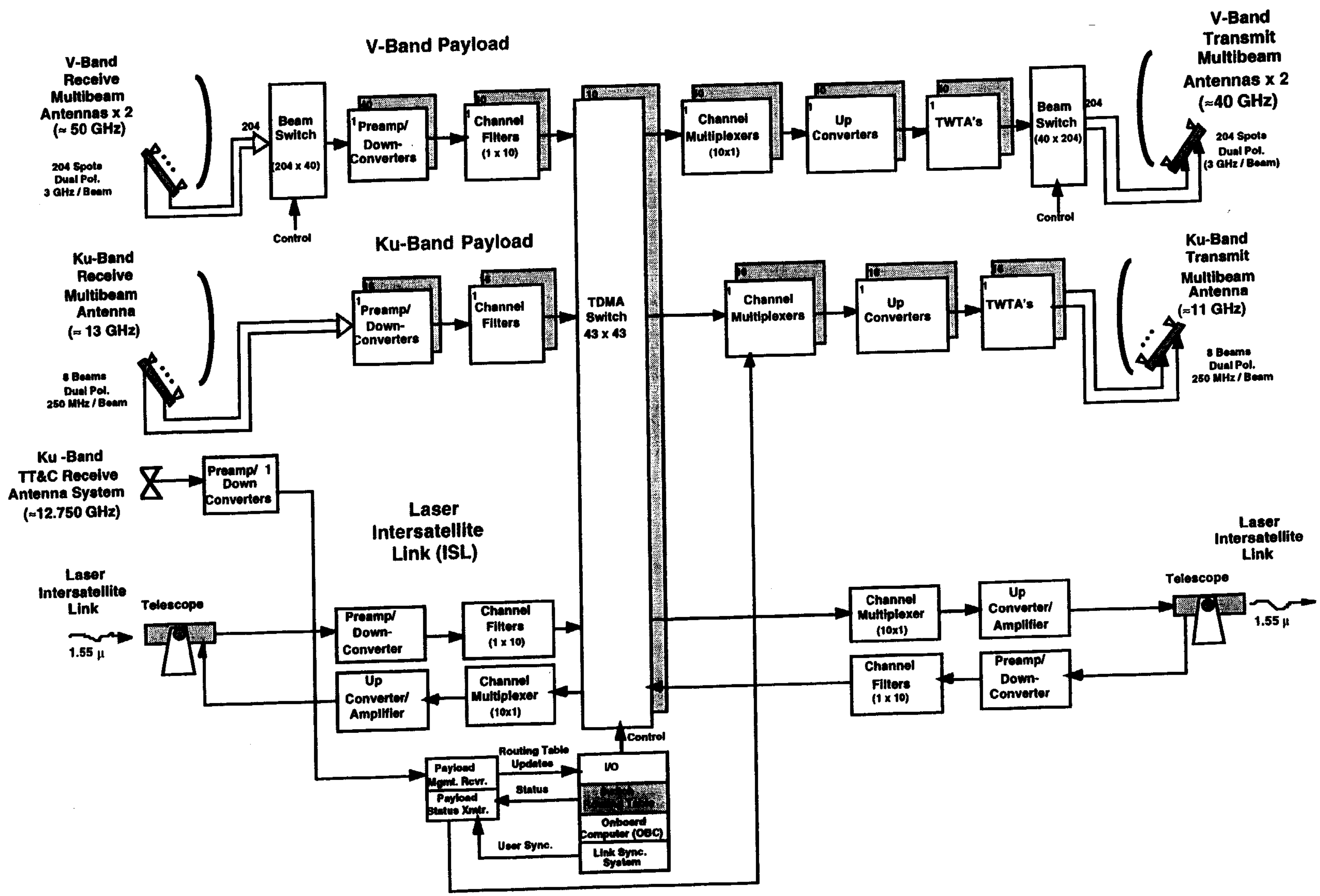

Figure 4.5.1.1-1. V/Ku-Band Repeater Block Diagram (Specific Ku-band Frequencies are Illustrative)

The V-band subsystem will be capable of routing V-band uplink traffic to a V-band downlink,. a Ku-band downlink, or a laser cross link via the on-board TDMA switch.

4.5.1.2. Ku-Band Subsystem

Ku-band coverage will be provided via up to 16 elliptical beams. Appendix C provides Ku-band coverage plots. An onboard Ku-band payload subsystem will use 250 MHz of bandwidth in each of two polarizations for each beam. These beams will be used to provide ubiquitous coverage to large service areas. The Ku-band subsystem will be capable of routing Ku-band uplink traffic to a Ku-band downlink, a V-band downlink, or a laser crosslink via the on-board TDMA switch.

4.5.2 TDMA Switch

The TDMA switch routes a particular TDM channel at a particular time in a particular FDM channel and uplink beam to the assigned downlink beams. The programmable TDMA switch time gates the uplink to downlink users. Synchronization information is transmitted to all user terminals. All user terminals will remain synchronized with one another so that satellite access can be made within the prescribed TDMA channel window.

4.6. Major Spacecraft Subsystems

4.6.1. Antennas

4.6.1.1. Uplink and Downlink Antennas

The SpaceCast™ antennas have been designed in conjunction with the communications and electrical power system to provide maximum coverage performance within an efficient system package. The system consists of the following antennas:

- One east-mounted parabolic reflector; dual circularly polarized V-band transmit and receive antenna, providing 102 of the 204 beams covering the satellite's field of view.
- One west-mounted parabolic reflector; dual circularly polarized V-band transmit and receive antenna, providing the other 102 of the 204 beams.
- Two nadir-mounted parabolic reflectors; dual circularly polarized Ku-band transmit and receive antennas, providing 16 beams.
- Two nadir-mounted optical crosslink telescope assemblies, providing east and west crosslink beams.
- An omnidirectional antenna system consisting of two bicone and four pipe antennas providing TT&C services.

4.6.1.1.1 Ku-Band Antennas

The Ku-band elliptical beam coverage is provided by two nadir-mounted reflector antennas. Each is illuminated by 16 feeds to provide up to 16 elliptically shaped area beams. Ku-band coverage plots for SpaceCast™ satellites are given in Appendix C.

4.6.1.1.2 V-Band Antennas

The V-band spot beam coverage is provided by one east-mounted and one west-mounted multi-feed antenna assembly. The offset parabolic reflectors are deployed from the east and west side of the satellite. The feeds are mounted on the nadir face and do not deploy. Each reflector is populated by a 102 feed horn, dual circularly polarized feed array. The feeds can be adjusted such that the 0.15° spot beams can be positioned anywhere within larger 0.3° footprints. Appendix C contains coverage plots for satellites at each orbital position requested. Each horn of the feed array is diplexed for both transmit and receive frequencies. In addition, each horn provides either a single sense of circular polarization or dual circular polarization as selected by command. Consequently there are 408 total input ports to the 204 horns that comprise the V-band antenna assembly. Up to 40 of the possible 408 inputs are selected for operation at any given time by a commandable beam switch.

4.6.1.2. TT&C Antennas

The telemetry and command omni antenna subsystem consists of two stacked bicone antennas and separate nadir and aft pipes. The bicone antennas provide toroidal radiation patterns and the pipe antennas, when used in conjunction with the bicones during transfer orbit, provide near 4π steradian coverage. On-orbit commanding is provided by the Ku-band planar array antenna.

4.6.1.3. Intersatellite Telescopes

The optical intersatellite service is provided by two laser-telescope assemblies. One assembly is pointed to the east and the other to the west. The optical crosslink will operate in the 1.55 micron wavelength region.

4.6.2. Thermal Control Subsystem

The majority of the on-board power consumption is used by the downlink high power traveling wave tube (TWT) amplifiers. The SpaceCast™ high power satellite thermal design allows for customized heat dissipation with the use of heat pipes and radiator panels. The bus design has additional out-board radiator panels that also contain heat pipes and are extended beyond the normal body of the satellite for maximum thermal dissipation. The size of the out-board radiator panels is governed by the launch vehicle dimensions, satellite antennas, and amount of thermal dissipation required. Satellite blankets and electrical heaters are also used to manage temperatures. On-board temperature sensors feed information to the telemetry subsystem, which, in turn, sends the information to the ground or the on-board Spacecraft Control Processor (SCP). Using the SCP, temperature critical units can be maintained autonomously for up to 30 days without any input from ground facilities.

4.6.3. Attitude Control Subsystem

4.6.3.1. Pointing

A SpaceCast™ high power satellite Attitude Control Subsystem (ACS) is capable of controlling the transfer orbit and on-station pointing with the following sensors: Sun Sensor, Earth Sensor Assembly (ESA), and RF beacons. Pointing accuracy is determined by the choice of pointing reference. The SpaceCast™ satellite has the capability to auto-track the spacecraft body and up to two reflectors when the ACS processes individual beacons. Pointing control is accomplished with the use of reaction wheels and pulsed firing of selected thrusters. With the use of the on-board Spacecraft Control Processor, the pointing can be maintained for up to 30 days autonomously without any commands from the ground facility.

4.6.3.2. Reaction Wheels

One of three different reaction wheel designs will be utilized depending on the momentum storage requirements of the spacecraft. The reaction wheel for SpaceCast™ will be sized accordingly and will support a five panel solar array, storage capability, and higher mass per wheel.

4.6.3.3. Sensor Suite Positioner

The Earth Sensor Assembly bias in pitch-and-roll can be increased with the addition of a Sensor Suite Positioner.

4.6.4. Propulsion Subsystem

A liquid bipropellant propulsion subsystem is used for the transfer orbit of a SpaceCast™ satellite. The liquid bipropellant subsystem is based on proven technology from previous programs. It uses hypergolic propellant: nitrogen-tetroxide (N_2O_4) oxidizer and monomethyl-hydrazine fuel. The Xenon Ion Propulsion System (XIPS) is used for control of the satellite orbit and attitude through the projected 15 year life.

4.6.5. Electrical Power Subsystem

A SpaceCast™ satellite is capable of supplying at least 15 kW for all of the on-board electronics. The fundamental components of the electrical subsystem include solar panels, batteries, and integrated power controllers (IPCs). For the SpaceCast™ application, a combination of the following items has been selected: five-panel solar array; 60 cells for 328 Amp hour battery service; and an IPC.

4.6.6. Telemetry, Tracking and Command Subsystem

The Ku-band TT&C subsystem will be used to control operations of the V-band and Ku-band communications payloads. Four beacons, two at Ku-band and two at V-band, will aid in ground system antenna pointing. Figure 4.6.6-1 shows the TT&C system block diagram.

The telemetry and command subsystem will use Ku-band for transfer orbit and on-station control and monitoring. The telemetry and command summary is given in Table 4.6.6-1. The normal on-station command and telemetry paths are through the planar array. This array is also used for tracking. The transfer orbit and backup on-station command and telemetry paths are through the omni antennas (pipes and bicones).

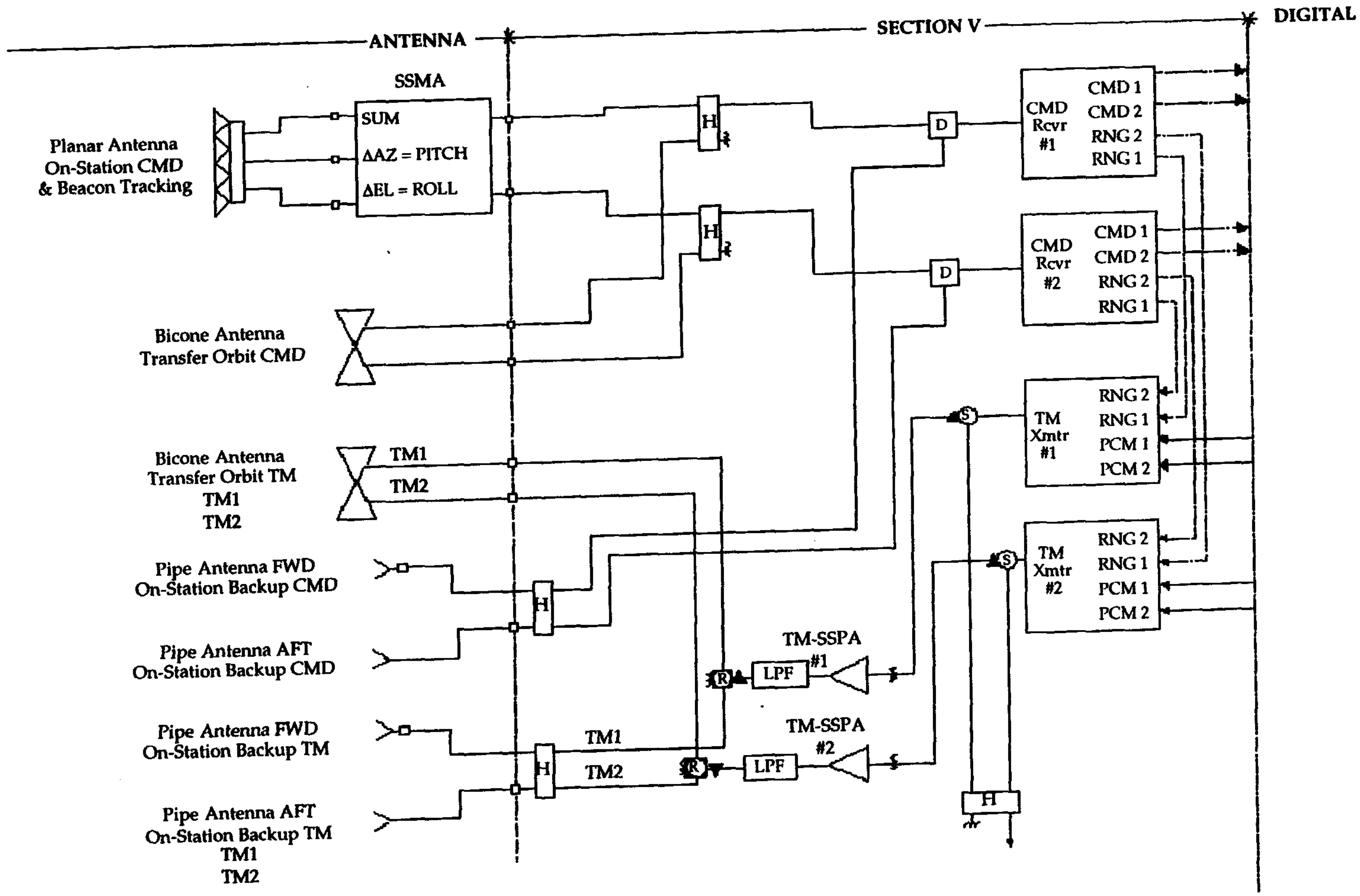

Figure 4.6.6-1. TT&C Subsystem Block Diagram