Technical Information to Supplement Schedule S

1 SCOPE AND PURPOSE

The purpose of this Attachment is to provide the Commission with the technical characteristics of the WINDS satellite. This attachment contains the information required by 47 C.F.R. §25.114 and other sections of the FCC's Part 25 rules that cannot be entered into the Schedule S submission.

2 GENERAL DESCRIPTION

The Wideband InterNetworking engineering test and Demonstration Satellite ("WINDS") is operated by the Japan Aerospace Exploration Agency ("JAXA") at the 143° E.L. orbital location. It operates under the authority of the Japanese Government and operates under the WINDS-A ITU network. The WINDS-A network has been notified under Article 11 of the ITU Radio Regulations and is recorded in the ITU's Master Register. The network has been successfully coordinated with the USA. This application seeks Commission authorization to communicate between Japan and Hawaii, and more specifically, with an earth station located on the premises of the University of Hawaii.

On a demonstration / experimental basis, the WINDS satellite will be used in conjunction with the University of Hawaii's Pan-Pacific Education and Communication Experiments by Satellite ("PEACESAT") program. This collaborative effort between Japan's National Institute of Information and Communications Technology and the University of Hawaii has two primary objectives:

1) Demonstrate and verify the flexibility of the WINDS satellite to provide Ka-band FSS services within its serviceable area, especially at low elevation angles (e.g., Hawaii) through a hopping beam steered towards Hawaii;

2) Provide long-distance education experiments in conjunction with the PEACESAT network.

The WINDS satellite is quite complex in that it has a multi-beam antenna ("MBA") which provides multiple fixed spot beams within ITU Region 3, an active phased array antenna ("APAA") that can provide up to four spot beams (two uplink and two downlink) and which are steered on a hopping basis to virtually anywhere towards the visible Earth and it has both on-board regenerative capabilities as well as a bent-pipe mode. For this application, Commission authorization is only sought for transmission from Japan (MBA) to Hawaii (APAA), and vice versa, using bent-pipe mode and for a limited amount of Ka-band spectrum. Accordingly, only those aspects of the satellite's payload to be used during the demonstration experiment are described herein and in the associated Schedule form.

The access technique is SS-TDMA, with the primary communications taking place between two 1.2 meter antennas (compact VSAT or "C-VSAT", for short); one located in Kashima, Japan and the other in Hawaii. A Network Reference Burst ("NRB") from Japan to Hawaii will also be transmitted for TDMA timing purposes using a 4.5 meter uplink antenna.

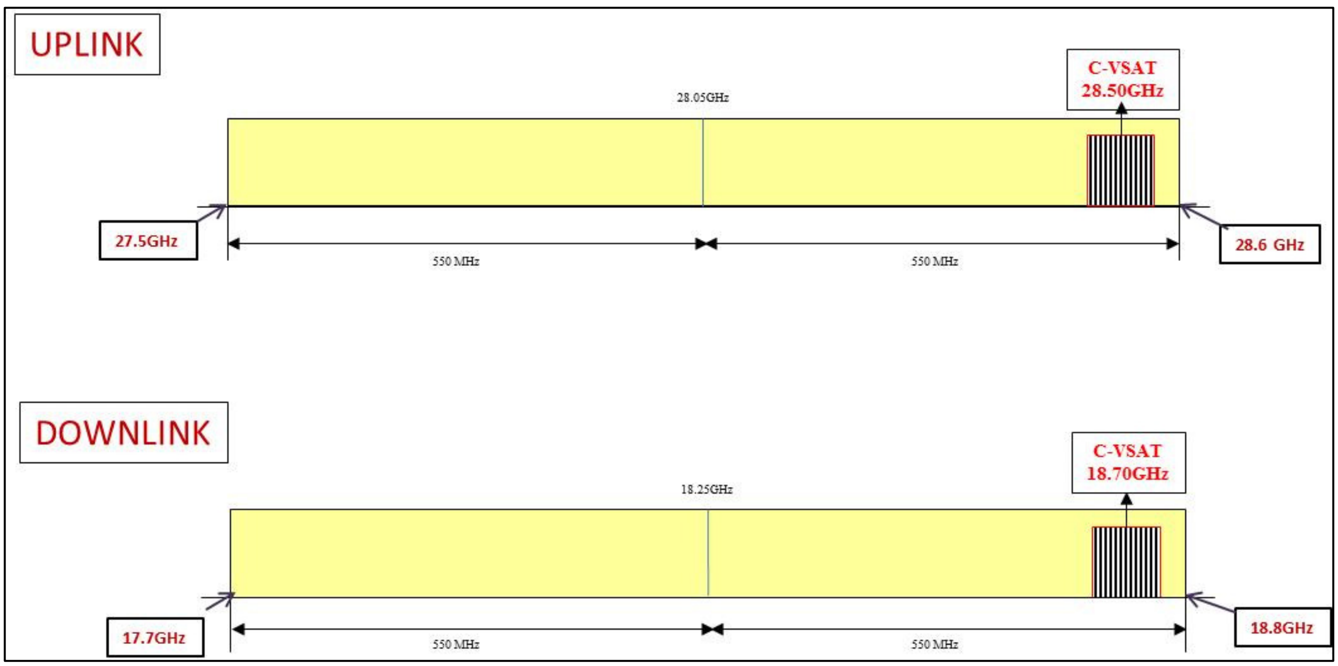
3 FREQUENCY AND POLARIZATION PLAN

The WINDS satellite's frequency plan and beam inter-connectivity for use in the demonstration experiment is provided in the associated Schedule S forms. Figure 3-1 shows the satellite's frequency plan when operated in bent-pipe mode, which is the only mode to be used during the experiment. Figure 3-1 also highlights the only frequencies that will be used for transmissions to-and-from Hawaii (C-VSAT block of spectrum). Specifically, Commission authorization is sought for 107 MHz, in both uplink and downlink directions, centered on 28.5 GHz and 18.7 GHz, respectively. Although the satellite has the capability of receiving and transmitting outside of these two bands, no transmissions from-and-to Hawaii will occur outside of the 107 MHz C-VSAT block of spectrum.

The bent-pipe mode has two possible channelizations: a 1.1 GHz wide transponder, or one 600 MHz transponder that uses the upper part of the band. Either mode may be used during the demonstration experiment.

Transmissions to-and-from Hawaii will use vertical polarization, while transmissions to-and-from Japan will use horizontal polarization. The MBA provides 19 spot beams over ITU Region 3, with different beams using either HPOL or VPOL. The APAA can provide up to four spot beams (two uplink beams and two downlink beams). Therefore, the satellite is capable of providing a minimum of dual frequency reuse, which satisfies the requirements of §25.210(d) of the Rules.

Figure 3-1. WINDS satellite frequency plan for bent-pipe mode.



4 SPACE STATION TRANSMIT AND RECEIVE CAPABILITY

The WINDS satellite's antenna gain contours for the receive and transmit beams, as required by §25.114(d)(3), are provided in GXT format and are embedded in the associated Schedule S form.

5 SERVICES TO BE PROVIDED

During the period of the demonstration experiment, digital carriers will be transmitted with data rates ranging between 1.6 Mbps and 104 Mbps. In addition, a non-modulated test signal will be transmitted. Representative link budgets, which include details of the transmission characteristics, performance objectives and earth station characteristics, are provided in the associated Schedule S submission.

6 TT&C INFORMATION

The WINDS satellite uses the 2 GHz band for its TT&C functions. Specifically, the command frequency is centered on 2090 MHz (RHCP) and the telemetry frequency is centered at 2269.68 MHz (RHCP). Both the uplink and downlink TT&C beams are global beams.

No TT&C transmissions will occur from U.S. soil and accordingly, Commission authorization for TT&C operation is not sought. The JAXA Tsukuba Space Center, located in Japan, controls the satellite. The Center's address and contact details are provided in the Schedule S form.

7 KA-BAND POWER FLUX DENSITY AT THE EARTH'S SURFACE

§25.208(c) contains PFD limits that apply in the 18.3-18.8 GHz band. The PFD limits of §25.208(c) are as follows:

- -115 dB(W/m^2) in any 1 MHz band for angles of arrival between 0 and 5 degrees above the horizontal plane;
- $-115+(\delta-5)/2$ dB(W/m^2) in any 1 MHz band for angles of arrival δ (in degrees) between 5 and 25 degrees above the horizontal plane; and
- -105 dB(W/m^2) in any 1 MHz band for angles of arrival between 25 and 90 degrees above the horizontal plane.

In addition, §25.208(d) contains PFD limits that apply in the 18.6-18.8 GHz band produced by emissions from a space station under assumed free-space propagation conditions as follows:

- -95 dB(W/m^2) for all angles of arrival. This limit may be exceeded by up to 3 dB for no more than 5% of the time.

The maximum downlink EIRP density that the WINDS satellite will transmit towards Hawaii is 40.6 dBW/MHz. The spreading loss between the satellite and the peak gain of the Hawaii beam is 162.9 dB. Therefore, the maximum PFD that can occur within the Hawaii beam is -122.3 dBW/m^2/MHz (i.e., 40.6 – 162.9). This PFD level is less than the -115 dBW/m^2/MHz PFD limit value that applies at elevation angles of 5° and below. Therefore compliance with the PFD limits is assured.

In addition, §25.208(d) requires an aggregate PFD limit of -95 dBW/m^2 within the 200 MHz of the 18.6-18.8 GHz band. In the worst case, this would correspond to a PFD limit of -118 dBW/m^2/MHz (i.e., -95-10*log(200)), assuming transmissions to Hawaii used the entire 200 MHz, which will not be the case. As demonstrated in the previous paragraph, downlink transmissions from the WINDS satellite towards Hawaii will not exceed -122.3 dBW/m^2/MHz at any angle of arrival and therefore compliance with §25.208(d) is also assured.

8 KA-BAND TWO DEGREE COMPATIBILITY

All uplink transmissions from Hawaii and downlink transmissions to Hawaii will not exceed the uplink off-axis EIRP density and downlink PFD levels of §25.138.

Compliance with the Commission’s two-degree spacing policy is assured provided:

1) The uplink off-axis EIRP density levels of §25.138(a)(1) of the Rules for blanket licensing are not exceeded;

2) The maximum PFD levels are lower than the PFD values given in §25.138(a)(6) of the Rules.

The clear sky uplink off-axis EIRP density limits of §25.138(a)(1) are equivalent to a maximum uplink input power density of -56.5 dBW/Hz. Table 8-1 compares the uplink input power densities derived from the Hawaii-to-Japan link budgets that are contained in the Schedule S form with the clear sky limits of §25.138 (a)(1) of the Rules. It can be seen that in all cases the clear sky uplink power limits are met. No uplink transmissions from Hawaii towards the WINDS satellite will exceed the clear sky uplink off-axis EIRP density limits of §25.138(a)(1). In addition, the Hawaii transmitting earth station antenna meets the requirements of §25.209(a) and (b).

Table 8-1. Demonstration of Compliance with the Uplink Power limits of §25.138 (a)(1).

Uplink Antenna Size	Emission	Maximum Clear Sky Uplink Input Power Density (dBW/Hz)	Clear Sky Uplink Input Power Density Limit of §25.138 (a)(1) (dBW/Hz)	Excess Margin (dB)
1.2 m	1M67G7W	-56.7	-56.5	0.2
1.2 m	6M66G7W	-56.7	-56.5	0.2
1.2 m	26M7G7W	-58.7	-56.5	2.2
1.2 m	53M3G7W	-61.7	-56.5	5.2

The non-modulated test signal (25K0N0N) has a smaller bandwidth than the 40 kHz bandwidth upon which the off-axis EIRP spectral densities of §25.138(a)(1) are predicated. For this carrier, and for transmissions from Hawaii, the maximum uplink input power will not exceed -10.6 dBW/ 40 kHz (-0.6 dBW/ 4 kHz). This input power provides 0.1 dB margin against the spectral densities of §25.138(a)(1).

Section 7 above demonstrates that the maximum PFD that will be transmitted by the WINDS satellite towards Hawaii is -122.3 dBW/m^2/MHz and therefore the PFD levels at other elevation angles will be necessarily lower. This demonstrates that transmissions from the WINDS satellite towards Hawaii will always be lower than that of §25.138(a)(6).

9 CHANNEL FILTER RESPONSE CHARACTERISTICS

The frequency responses of the 1.1 GHz and 600 MHz channels, as measured between the receive antenna input and transmit antenna, fall within the limits shown in Table 9-1 below. In addition, the frequency tolerances of §25.202(e) and the out-of-band emission limits of §25.202(f) (1), (2) and (3) are met.

Table 9-1: Channel Frequency Responses

Channel Bandwidth	Frequency offset from channel center	Gain relative to channel center frequency(dB)	Comments
1.1 GHz	CF±550 MHz	-3.0	In-Band
	CF±700 MHz	-26	Out-of-Band
	CF±800 MHz	-38	
	CF±900 MHz	-20	
600 MHz	CF±300 MHz	-3.0	In-Band
	CF±442 MHz	-37	Out-of-Band
	CF±450 MHz	-26	
	CF±500 MHz	-38	
	CF±600 MHz	-20	

10 SPACECRAFT CHARACTERISTICS

The spacecraft's physical characteristics are embedded in the associated Schedule S form.

The WINDS satellite was designed for a 5 year lifetime. The probability of the entire satellite successfully operating throughout this period is at 0.56 with the probability of the payload and bus being of 0.7 and 0.8, respectively. These numbers are based on predicted failure rates of all critical components in the satellite bus and payload.

11 ORBITAL DEBRIS MITIGATION PLAN

11.1 Spacecraft Hardware Design

The WINDS satellite is designed such that no debris will be released during normal operations. JAXA has assessed the probability of collision with meteoroids and other small debris (<1 cm diameter) and has taken the following steps to limit the effects of such collisions: (1) critical satellite components are located inside the protective body of the satellite and properly shielded; and (2) all satellite subsystems have redundant components to ensure no single-point failures. The satellite will not use any subsystems for end-of-life disposal that are not used for normal operations.

11.2 Minimizing Accidental Explosions

JAXA has assessed and limited the probability of accidental explosions during and after completion of mission operations. The satellite has been designed to ensure that debris generation will not result from the conversion of energy sources on board the satellite into energy that fragments the satellite. The propulsion subsystem pressure vessels have been designed with high safety margins. All pressures, including those of the batteries, are monitored by telemetry. At end-of-life and once the satellite has been placed into its final disposal orbit, JAXA will remove all stored energy from the spacecraft by depleting any residual fuel, leaving all fuel line valves open, venting the pressure vessels and the batteries will be left in a permanent state of discharge.

11.3 Safe Flight Profiles

In considering current and planned satellites that may have a station-keeping volume that overlaps the WINDS satellite, the list of FCC licensed satellite networks, as well as those that are currently under consideration by the FCC within ±0.2° of 143° E.L. have been researched. In addition, networks for which a coordination request has been published by the ITU within ±0.2° of 143° E.L. have also been reviewed.

Based on this review, there are no satellites that have Commission authorization to operate at an orbital location ±0.2° from 143° E.L and there are no pending applications before the Commission seeking to use an orbital location within this range. There are no operational satellites that have an overlapping station-keeping volume with the WINDS satellite, nor are we aware of any satellite with an overlapping station-keeping volume with the WINDS satellite that is the subject of an ITU filing and which is being progressed towards launch.

Based on the preceding, it is concluded that physical coordination of the WINDS satellite with another party is not required at the present time.

11.4 Post-Mission Disposal

At the end of the operational life of the WINDS satellite, JAXA will maneuver the satellite to a disposal orbit with a minimum perigee of 258.6 km above the normal GSO operational orbit. The post-mission disposal orbit altitude is based on the following calculation, according to §25.283:

Total Solar Pressure Area “A” = 43.4 m^2

“M” = Dry Mass of Satellite = 2422 kg

“C_R” = Solar Pressure Radiation Coefficient = 1.319

Therefore the Minimum Disposal Orbit Perigee Altitude is calculated as:

= $36,021 \text{ km} + 1000 \times C_R \times A/m$

= $36,021 \text{ km} + 1000 \times 1.319 \times 43.4/2422$

= 36044.6 km

= 258.6 km above GSO (35,786 km)

This will require approximately 12.2 kg of propellant, taking account of all fuel measurement uncertainties, which will be allocated and reserved in order to perform the final orbit raising maneuver.

12 WAIVER REQUESTS

12.1 East-West Station-Keeping

Part 25.201(j) of the Commission's Rules require that geostationary space stations be operated with an east-west station-keeping tolerance of ±0.05 degrees. The WINDS satellite is operated with an east-west station-keeping tolerance of ±0.1 degrees.

The Commission may waive its Rules where good cause is shown. As stated in section 11.3, there are no operational or known, planned satellites that have a station-keeping volume overlap with the WINDS satellite. The WINDS satellite is a demonstration satellite, not a commercial one, and in the context of this application, will be used to promote the goals of the University of Hawaii's non-profit PEACESAT program. Among other things, the PEACESAT program assists organizations in providing cultural exchanges, long-distance education, research and accessing health care resources. Further, the WINDS satellite has been recorded in the ITU's Master Register and coordination with the USA has been completed. There are no operational Ka-band satellites within ±6 degrees from 143° E.L., other than those that operate under the authority of the Administration of Japan.

For the preceding reasons, there is good cause to grant the requested waiver.

12.2 TT&C

The WINDS satellite uses the 2 GHz bands for TT&C purposes.

Part 25.202(g) states in part that:

> Telemetry, tracking and telecommand functions for U.S. domestic satellites shall be conducted at either or both edges of the allocated band(s).

Since the WINDS satellite is not a "U.S. domestic satellite", this phrase implies there is no requirement to conduct TT&C at the edge of the allocated band (i.e., Ka-band in this case). However, one interpretation of Parts 25.137(b) and (d) is that non-U.S. satellites are required to conform to all technical requirements of Part 25. Accordingly, and to the extent required, a waiver is requested for operation of TT&C outside of the Ka-band for the reasons given below.

The satellite was not designed to adhere to all of the Commission's rules, but it was however designed to adhere to all of the ITU's rules. The 2 GHz bands were selected to take advantage of JAXA's existing 2 GHz TT&C ground segment infrastructure. The WINDS satellite has been recorded in the ITU's Master Register. Coordination of the 2 GHz bands with the USA was not required. At the Article 11 notification stage, the ITU's harmful interference examination determined that there was the potential for harmful interference only to the Administration of Brunei's LARKSAT networks and only for the telecommand transmissions. All of Brunei's LARKSAT networks have since been suppressed by the ITU, so there is no possibility of harmful interference into any adjacent 2 GHz network. The WINDS satellite has operated at 143° E.L. since mid-2008 with no complaints of harmful interference or even unacceptable interference. For the preceding reasons, there is good cause to grant the requested waiver.

CERTIFICATION OF PERSON RESPONSIBLE FOR PREPARING ENGINEERING INFORMATION

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

/s/

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