The International Amateur Radio Union

Since 1925, the Federation of National Amateur Radio Societies
Representing the Interests of Two-Way Amateur Radio Communication

AMATEUR SATELLITE FREQUENCY COORDINATION REQUEST

(Make a separate request for each space station to be operated in the amateur-satellite service.)

Administrative information:

0	**DOCUMENT CONTROL**	
0a	Date submitted	**April 2011**
0b	Expected launch date	**First quarter of 2012**
0c	Document revision number	
1	**SPACECRAFT (published)**	
1a	Name before launch	NANOSATC-BR
1b	Proposed name after launch	NANOSATC-BR 1
1c	Country of license	Brazil
2	**LICENSEE OF THE SPACE STATION (published)**	
2a	First (given) name	Nelson Jorge
2b	Last (family) name	Schuch
2c	Call sign	PY3EB - Lauro Barbosa Alves
2d	Postal address	National Institute for Space Research Southern Regional Space Research Center – CRS/CCR/INPE-MCT – P.O. Box 5021 97110-970 - Santa Maria, RS - Brazil
2e	Telephone number (including country code)	Phone: +55 (55)-3301 2026 Fax: +55 (55) 3301-2030
2f	E-mail address	njschuch@lacesm.ufsm.br
2g	Skype name (if available)	nelson.jorge.schuch
2h	Licensee's position in any organisation referenced in item 3a.	Senior Researcher National Institute for Space Research – INPE/MCT
2i	List names and e-mail addresses of those who should receive copies of correspondence.	Dr. Otávio Santos C. Durão <durao@dir.inpe.br> Dr Pawel Rozenfeld <pawel@ccs.inpe.br> Prof. Dr. Natanael Gomes <natanael@lacesm.ufsm.br> Lauro Barbosa Alves <lauro_lauroalves@yahoo.com.br>
3	**ORGANISATIONS (published) — complete this section for EACH participating organization**	
3a	Name of organisation	National Institute for Space Research – INPE/MCT
3b	Physical address	Av. dos Astronautas, 1758, CEP: 12227-010 São José dos Campos (SP) Brasil
3c	Postal address	Av. dos Astronautas, 1758, CEP: 12227-010 São José dos Campos (SP) Brasil
3d	Telephone number (including country code)	+55-12-39456000

3e	E-mail address	webmaster@inpe.br
3f	Web site URL	http://www.inpe.br/
3g	National Amateur Radio Society (including contact information)	1 - Liga de Amadores Brasileiros de Rádio Emissão – LABRE http://www.labre.org.br/ 1.1 - Federação Sul-Rio-Grandense de Radioamadorismo - LABRE-RS 1.1.1 - UNIÃO SANTAMARIENSE DE RADIOAMADORES - USRA-SANTA MARIA – RS e-mail: ps7ahr@yahoo.com.br Address: Rua Venâncio Aires, 2025, Santa Maria, RS, Brasil Obs.: The USRA - SANTA MARIA – RS is a member of the Federação Sul-Rio-Grandense de Radioamadorismo - LABRE-RS
3h	National Amateur Satellite organisation (including contact information)	Liga de Amadores Brasileiros de Rádio Emissão – LABRE http://www.labre.org.br/
3i	Have you involved your National Amateur Satellite organization and/or National Amateur Radio Society? Please, explain.	Yes We contacted the USRA in Santa Maria and we had several meetings for starting cooperation between our organizations: USRA – INPE/MCT and LACESM/CT-UFSM.

Space station information:

4	**SPACE STATION (published)**	
4a	Mission(s). *Describe in detail what the space station is planned to do. Use as much space as you need.*	The NANOSATC-BR – CubeSats space station communication subsystem will make the radio down and up data links with the cubesat NANOSATC-BR ground station. The NANOSATC-BR – CubeSats small satellite communication ground stations is specifically designed for small satellites in Low Earth Orbit – LEO using radio amateur frequencies, such as CubeSats for use in university environments, as UFSM and INPE in Brazil. It is a compact turnkey setup, designed for Leo tracking applications, and Global Educational Network for Satellite Operations (GENSO) initiative ready, and is a full Azimuth and Elevation tracking station. The NANOSATC-BR – CubeSats development Project, consists of an INPE-UFSM Capacity Building Integrated Program on space science, engineering and computing sciences for the development of space technologies through a CubeSat satellite, the first Brazilian Scientific Nanosatellite. The Capacity Building Program was conceived at the Southern Regional Space Research Center, (CRS), from the Brazilian National Institute for Space Research – INPE/MCT, by Dr. Nelson Jorge Schuch, who is the Mission's General Manager and PI, having technical collaboration and management from Dr. Eng. Otávio Santos Cupertino Durão, the Mission's General Coordinator for Engineering and Space Technology at INPE's Headquarter (HQ), in São José dos Campos, São Paulo, with the involvement of undergraduate students from the Federal University of Santa Maria – UFSM[1]. The NANOSATC-BR concept was developed to: i) monitor, in real time, the Geospace, the particle precipitation and the disturbances at the Earth's magnetosphere over the Brazilian Territory, and ii) the determination of their effects on regions such as the South Atlantic Magnetic Anomaly (SAMA), Fig. 1, and the Brazilian sector of the Ionosphere Equatorial Electrojet.

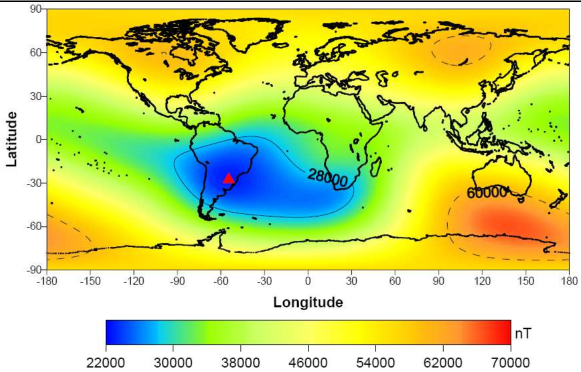


Fig. 1: Magnetic field intensity, year 2000, where the 28000nT isopleth shows the SAMA region[2].

The NANOSATC-BR satellite, Fig. 2 is a scientific and technological cooperation basically between the CRS/CCR/INPE-MCT with the Santa Maria Space Science Laboratory – LACESM/CT-UFSM and other departments from the UFSM, in Santa Maria, Rio Grande do Sul, South of Brazil.

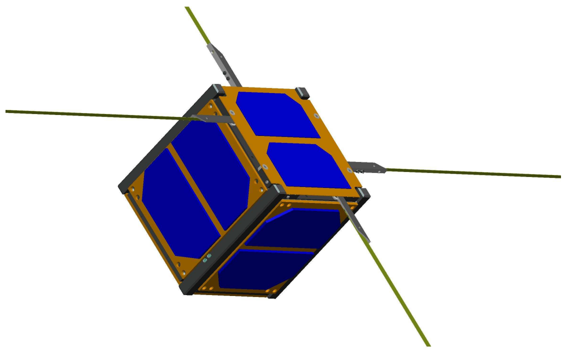
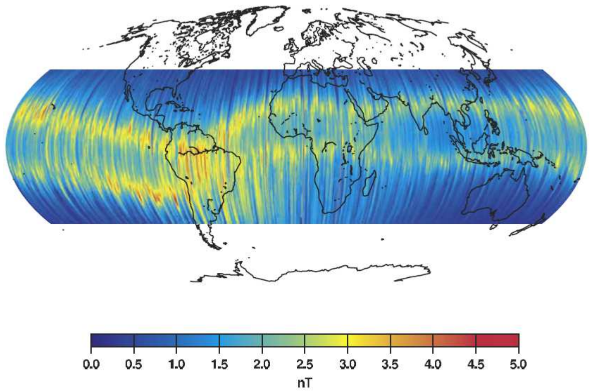


Fig. 2: The NANOSATC-BR's 3D model.

The development of technologies, scientific instrumentation, manufacturing, qualification, launch of the satellite, study of collected data and post analyzes of the NANOSATC-BR Project will provide for the Brazilian institutions technical and scientific base for the development and manufacturing of this satellites class and associated sensors.

The general management and the PI supervision are located at the CRS and the project technical supervision for the mission and payload specification, subsystems design and analysis, ground operations, sensors specification and acquisition, are provided by engineers and scientists from INPE's Headquarter (HQ) and from the UFSM and the CRS. The UFSM also participates with its undergraduate students (Scientific & Technologic Initiation Students) and faculty members as well.

The payload instruments of the NANOSATC-BR consists of: i) a magnetometer to measure the intensity of the Earth Magnetic Field at the South Atlantic Magnetic Anomaly (SAMA) region and on the Brazilian sector of the Ionosphere Equatorial Electrojet, Fig. 3, and ii) a particle precipitation chip dosimeter.

		 Fig. 3: Ionosphere Equatorial Electrojet representation[3]. [1] "Projeto NANOSATC-BR – Desenvolvimento de CubeSats". Document – Basic Project. First Version. Southern Regional Space Research Center - CRS/CCR/INPE-MCT, Santa Maria – RS, Brazil, June 2010. [2] Heirtzler, J. R., "The Future of the South Atlantic Anomaly and implications for radiation damage in space". Journal of Atmospheric and Solar-Terrestrial Physics, pp.1701-1708. 2002. [3] Lühr, H., S. Maus, & M. Rother, "Noon-time equatorial electrojet: Its spatial features as determined by the CHAMP satellite", J. Geophys. Res., 109, A01306, doi:10.1029/2002JA009656. 2004.
4b	Planned duration of each part of the mission.	About two years total
4c	Proposed space station transmitting frequency[1] plan. *List each frequency or frequency band (e.g. 435-438 MHz) with output power, ITU emission designator,[2,3] and associated antenna gain and pattern.*	Band :144-148MHz Bandwidth : 5kHz Satellite Output power : 0.2W Modulation 1k2 or 9k6 BPSK ITU Designator: 8k0G1DAN - BPSK 50HA1AAN –CW Satellite antenna gain : 0dBi Satellite antenna pattern : near omnidirectional Groundstation antenna gain : 10dBi Groundstation antenna pattern : 40deg beamwidth The intention is to have an FM to DSB amateur radio transponder function incorporated in the radio transceiver, which will can then be used as an end-of-mission mode for radio amateur communication.
4d	Proposed space station receiving frequency[4] plan. *List each frequency or frequency band with output power, ITU emission designator,[5,6] noise temperature,*	Band :430-440MHz Bandwidth : 15kHz Groundstation Output power : 50W Modulation: 1k2 AFSK ITU Designator: 16K0F1EJN Satellite antenna gain : 0dBi

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[1] Show all frequencies numerically in Hz, kHz, MHz, or GHz.

[2] ITU emission designators are explained at: http://life.itu.int/radioclub/rr/ap01.htm. (Thank you, 4U1ITU.) Effect of Doppler shift is NOT included when determining bandwidth.

[3] If using a frequency changing transponder, indicate the transmitting bandwidth. Effect of Doppler shift is NOT included when determining bandwidth.

[4] Show all frequencies numerically in Hz, kHz, MHz, or GHz.

[5] ITU emission designators are explained at: http://life.itu.int/radioclub/rr/ap01.htm. Effect of Doppler shift is NOT included when determining bandwidth.

	and associated antenna gain and pattern.	Satellite antenna pattern : omnidirectional Groundstation antenna gain : 12dBi Groundstation antenna pattern : 40deg beamwidth
4e	Physical structure. *General description, including dimensions, mass, antennas and antenna placement, whether stabilized or tumbling, etc. Give URL's for drawings.*	1U CubeSat, weighing no more than 1.0 kg, with deployable antennas for UHF/VHF (2 dipoles on one end). The satellite is actively stabilized (detumbled).
4f	Functional Description. *Describe each sections function within the satellite.*	The satellite will be used for a technology demonstration / scientific mission, with a magnetometer on board to measure the Earth's magnetic field.
4g	Power budget. *Describe each power source, power consuming section, power storage, and overall power budget.*	To be created. Typical power as available on a 1U CubeSat with body-mounted solar panels (ROM 2.5 Watt orbit average - TBC).
5	**TELECOMMAND (NOT published)**	
5a	**Telecommand** frequency plan. *Provide space station telecommand frequencies or frequency bands[7], ITU emission designator(s), link power budget(s), and a general description of any cipher system, etc.*	Band :430-440MHz Bandwidth : 15kHz Groundstation Output power : 50W ITU Designator: 1 16K0F1EJN Satellite antenna gain : 0dBi Satellite antenna pattern : near omnidirectional Groundstation antenna gain : 12dBi Satellite antenna pattern : 40deg beamwidth Telecommand uplink is done using AX25 frames transmitted with a 1k2 AFSK modem.
5b	Positive space station transmitter control. *Explain how telecommand stations will turn off the space station transmitter(s) immediately, even in the presence of user traffic and/or space station computer system failure.* ***NOTE:*** *Transmitter turn off control from the ground is absolutely required. Good engineering practice is to make this capability independent of all other systems.* Be sure to read the paper available at: http://www.iaru.org/satellite/ControllingSatellites v27.pdf.	The satellite incorporates a UHF/VHF radio transceiver of which the transmitter part can be switched on and off by internal command or by ground command. The receiver is always on and *can not* be switched off. Actual implementation of the 'turn off control' depends on the final software architecture, but will be tolerant to failures of other systems such as the OBC by design. The default state of the transmitter is non-transmitting. When the transmitter is placed in the transmitting state the flight software will monitor the time it is in this state and be able to return to the default non-transmitting state under ground control. In the case where the flight software fails while in the transmitting state a watchdog timer has been included in the system bus design to reset all components to the original default state.
5c	Telecommand stations. *List telecommand stations, including contact details, for sufficient Earth command stations to be established before launch to*	Primary Ground Station at Federal University of Santa Maria, Brazil. Backup Command Ground Station in Delft. The use of GENSO as a distributed network is intended.

[6] If using a frequency changing transponder, indicate the receiving bandwidth numerically in kHz or MHz. Effect of Doppler shift is NOT included when determining bandwidth.

[7] Show all frequencies and frequency bands numerically in Hz, kHz, MHz, or GHz.

	insure that any harmful interference caused by emissions from a station in the amateur-satellite service can be terminated immediately. See RR 25.11 and RR 22.1	
5d	Optional: Give the complete space station turn off procedure. *As a service, the IARU Satellite Advisor will keep the space station turn off procedure as a backup for your operation. Only the space station licensee may request the information. If interference occurs and the licensee cannot be located, the licensee grants the Satellite Advisor permission to use the turn off procedure. Please note that the Satellite Advisor will use his best efforts, but cannot guarantee success. The space station licensee is still held responsible for the space station transmitter(s) by the licensing administration.*	
6	**Telemetry (published)**	
6a	Telemetry frequencies *List all telemetry frequencies or frequency bands[8], ITU emission designators, and link budgets. Give the URL with telemetry decoding information.*	Band :145.8-146.0 MHz Bandwidth : 8kHz Satellite Output power : 0.2W ITU Designator: 8k0G1DAN Satellite antenna gain : 0dBi Satellite antenna pattern : near omnidirectional Groundstation antenna gain : 10dBi Groundstation antenna pattern : 40deg beamwidth Beacon transmission is a carrier modulated with morse code at 10words per minute. Telemetry downlink is an AX25 datastream modulating a BPSK modulator in a variable bitrate of between 1.2 and 9.6kbps
6b	Telemetry formats and equations. *Describe telemetry format(s), including telemetry equations. NOTE: Final equations must be published as soon as available.*	Telemetry is transmitted as the payload of AX25 frames between the satellite and groundstation. The raw databytes will represent an analoque telemetry state on the satellite by means of a simple linear equation or in more complex situations a look-up table. Examples of telemetry values transmitted are battery voltages, temperatures, current consumption etc. For the linear equations the telemetry may be calculated as follows Y=mX+k where Y is the required telemetry value in the required unit of measurement, m is the gain of the linear 1st order equation, X is the raw telemetry value and k is the offset value of the 1st order linear equation. Full telemetry channel list and calibration data will be incorporated in the design of the flight software will be made available as soon as possible.
6c	Is the telemetry transmission format commonly used by radio amateurs? If not, describe how and where it will be published.	Common formats used; the aim is to use telemetry formats that may be decoded by existing means or to develop and release a set of telemetry decoder software to the amateur radio community (e.g. AX.25 Unnumbered Information).

[8] Show all frequencies and frequency bands numerically in Hz, kHz, MHz, or GHz.

	Be sure to read: RR 25.2A. Text is included in the paper available at: http://www.iaru.org/satellite/sat-freq-coord.html.	
7	**Launch plans (published)**	
7a	Launch agency	Not yet confirmed
7b	Launch location	Not yet confirmed
7c	Planned orbit. *Include planned orbit apogee, perigee, inclination, and period.*	Target: 400 – 850 km, Polar/Sun Synchronous Orbit preferred
7d	List other amateur satellites expected to share the same launch.	Not determined yet, preferred timeframe first half 2012.

Earth station information:

8	**Typical Earth station — transmitting**	
8a	Describe a typical Earth station used to transmit signals to the planned space station.	See overall specification at: http://www.isispace.nl/brochures/ISIS_SmallSatGroundStations_Brochure_v.10.0.pdf
8b	Link power budget. *Show complete link budgets for all Earth station transmitting frequencies[9], except telecommand.*	<to be created>
9	**Typical Earth station — receiving**	
9a	Describe a typical Earth station to receive signals from the planned satellite.	See overall specification at: http://www.isispace.nl/brochures/ISIS_SmallSatGroundStations_Brochure_v.10.0.pdf
9b	Link power budget. *Show complete link budgets for all Earth station receiving frequencies[10].*	<to be created>

Additional information:

Do not attach large files. Indicate the URL where the information is available.

10	Please, supply any additional information that may assist the Satellite Advisor to

[9] Show all frequencies numerically in Hz, kHz, MHz, or GHz.

[10] Show all frequencies numerically in Hz, kHz, MHz, or GHz.

	coordinate your request(s).

Certification:

11	[ ] The licensee of the planned space station has reviewed all relevant laws, rules, a*****nd regulations, and certifies that this request complies with all requirements to the best of his/her knowledge.
	[ ] The licensee of the planned space station has reviewed all relevant laws, rules, and regulations and disagrees with IARU interpretations of Treaty requirements. The IARU Satellite Advisor is asked to consider the following interpretation. Explanation follows.

* Please tick appropriate box.

Signature:

12	**Nelson J. Schuch, M.Sc., Ph.D.** **Senior Researcher** Southern Regional Space Research Center National Institute for Space Research Signature of space station licensee.	**Santa Maria, April 06, 2011** Date submitted for coordination.