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AMSAT-F / Electrolab

SPINO Communication System

Technical specifications

Reference : 2117-001 – Version 1B
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History :

Date	Version	Author	Comment
27/02/2021	1A	Y. Avelino / C. Mercier	Préliminary
27/04/2021	1B	A. Kovalchuk	First review

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1 Introduction

SPINO is a versatile telecommunication solution suitable for nanosatellites and Cubesats.

Operating in UHF and VHF bands, it features tight integration with amateur radio service and the worldwide amateur radio community.

The development of the SPINO SC board was initiated by enthusiats involved in non-profit / educational space projects. Since 2019, the project is supported by the joint efforts of two non-profit organizations: AMSAT-Francophone (site.amsat-f.org) and the hackerspace Electrolab (electrolab.fr).

Thanks to the support provided to "UVSQ-SAT" mission by the amateur radio community (data collection, ground segment support, spectrum coordination support...), LATMOS offered to integrate this experimental board into its new satellite "UVSQ-SAT+" as an additional payload.

In this context, SPINO SC receives since 2021 the academic support of the LATMOS laboratory, and the industrial support of the Adrelys company.

The SPINO SC board features functions dedicated to the spacecraft infrastructure :

- Receiver function for remote control commands from ground…
- Managed or Autonomous beacon (support for OBC failure)
- Data stream (uplink and downlink)
- Antenna deploy support

And functions dedicated to the amateur radio community :

- a versatile digital transponder
- a digital mailbox service

The SPINO SC board will be a pre-validated open source brick available off the shelf for any nanosatellites mission.

By the way, the goal is to maximize compatibility (standardized interfaces with UART, I2C, SPI, CAN FD, and standardizerd PC-104 "like" form factor), and maximize reliability (wide supply voltage range, fail-safe on key points, low power consumption, especially in idle to face failure situations).

SPINO SC operates in the Amateur Radio service bands, and features two full transceivers :

- VHF : TX (+30dBm) and RX 144-146MHz

- UHF : TX (+27dBm) and RX 430-440MHz

2 Project licenses

Documents, parts drawings, manufacturing files and software are gathered on Electrolab's GIT repository:

https://code.electrolab.fr/SPINO/cubesat_cs

2.1 Hardware and documents

The SPINO project led by the ELECTROLAB non profit organization, and all documents produced through the development process are under Creative Commons license:

CC BY-SA 4.0

Attribution-ShareAlike 4.0 International

https://creativecommons.org/licenses/by-sa/4.0/,

2.2 Software

The software developed for the needs of the SPINO project led by the ELECTROLAB non profit organization is under the GNU GPL version 3 license.

https://www.gnu.org/licenses/gpl-3.0.txt

3 System environment

3.1 Overall system architecture

[CDC-SPINO-2.1.1] The SPINO board is a subsystem seen as a telecommunication interface (modulator / demodulator) regarding the CubeSat payload.

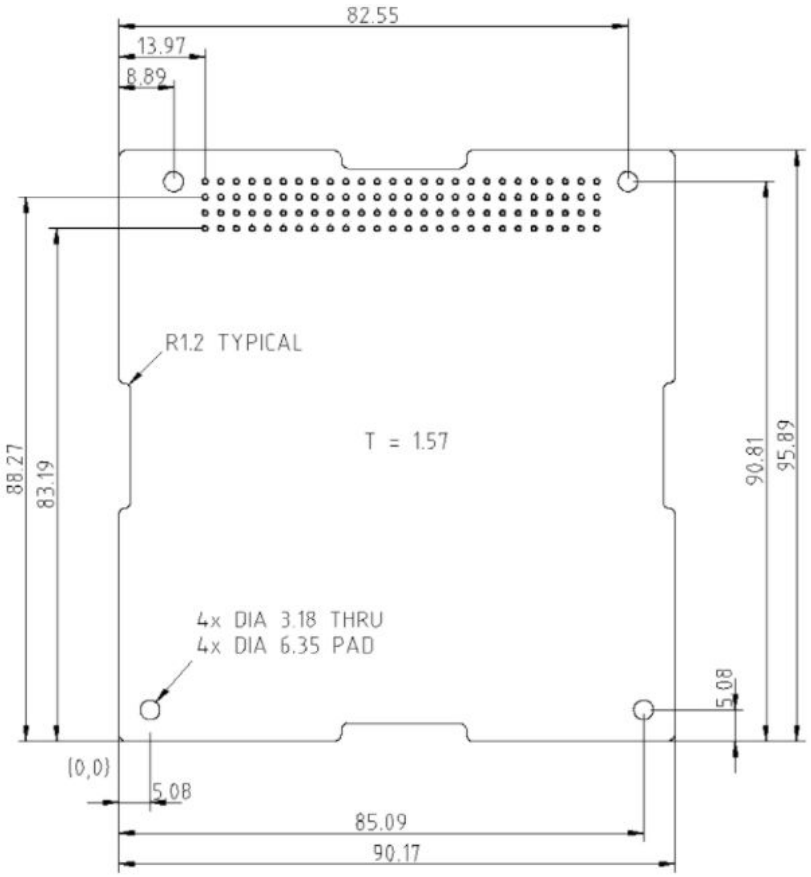
[CDC-SPINO-2.1.2] The board embeds a communication protocol layer.

[CDC-SPINO-2.1.3] It can operate autonomously.

[CDC-SPINO-2.1.4] The goal of this design is to maximize operational safety.

3.2 Form factor

[CDC-SPINO-2.2.1] In order to maximize compatibility the board will use the form factor standardized by the "Librecube" project :



3.3 Operating conditions

[CDC-SPINO-2.3.1] The board will be deployed in a micro-satellite designed for LEO (Low Earth Orbit, <1000 km).

[CDC-SPINO-2.3.2] The temperature range is -30°C to +40°C.

[CDC-SPINO-2.3.3] Silicon surfaces will be minimized to maximize resistance to SEU (Single-event upset).

4 Functional requirements

4.1 External interfaces

4.1.1 Power supply

[CDC-SPINO-3.1.1.1] The board will accept a power supply ranging from 2.5V to 15V.

[CDC-SPINO-3.1.1.2] Power consumption of the board less than 4W (with radio transmitter in operation).

[CDC-SPINO-3.1.1.3] Power will be supplied via the main interface connector CSKB (aka PC104).

[CDC-SPINO-3.1.1.4] The minimum power consumption is less than 50 mW (with receiver only).

[CDC-SPINO-3.1.1.5] In case of undervoltage (<2.5V) the board is automatically deactivated.

4.1.2 Bus CSKB / PC104

[CDC-SPINO-3.1.2.1] The pinout is specified in a dedicated document

4.1.3 Communication interface

[CDC-SPINO-3.1.3.1] Different interfaces will be supported on the hardware side:

- CAN FD (CAN 2.0 compatible)
- SPI
- UART
- I2C

[CDC-SPINO-3.1.3.2] Development efforts will focus on the UART interface.

4.1.4 Antenna deployment

[CDC-SPINO-3.1.4.1] Antenna deploy can be performed by the Spino board. Engagement can be done through external control signals or an instruction on the communication bus.

[CDC-SPINO-3.1.4.2] These signals will be accessible either on a specific connector (Hirose DF11-8DP-2DS or Hirose DF11-8DP-2DSA) or on the CSKB / PC104 connector.

Pin	Function
1	Deploy-1
2	Detect-1
3	Deploy-2
4	Detect-2
5	GND
6	GND

3.1.4 Antenna deploy connector pinout

[CDC-SPINO-3.1.4.3] The deployment supervision signals will be in Open Drain configuration with protective series resistors (330 ohms).v

[CDC-SPINO-3.1.4.4] Control signals will be 3.3 V pull up inputs (Zener diode protection, 330 ohm resistors)

4.2 Radio interface

[CDC-SPINO-3.2.1] The board features two complete transmitter/receiver systems:

- 144-146 MHz (VHF)
- 430-440 MHz (UHF)

In the standard operating mode, the system is configured with VHF uplink (ground to satellite) and UHF downlink (satellite to ground).

[CDC-SPINO-3.2.2] The connectors will be of type SMA or MCX.

4.2.1 Caractéristiques techniques

[CDC-SPINO-3.2.1.1] VHF transceiver :

- Output power is 1W, adjustable between 10 mW and 1 W
- Sensitivity at 1200 bits/s: better than -120 dBm
- RX power consumption less than 50 mW
- Blocking >90 dB (offset 20 MHz)
- ACR (Adjacent Channel Rejection) >60dB
- Supported modulations :
    - 2/4GFSK 0.1 à 360 Kbits/s
    - CW (TX only)

[CDC-SPINO-3.2.1.2] UHF transceiver :

- Output power is 0.5W, adjustable between 10 mW and 0.5 W
- Sensitivity at 1200 bits/s: better than -120 dBm
- RX power consumption less than 50 mW
- Blocking >90 dB (offset 20 MHz)
- ACR (Adjacent Channel Rejection) >60dB
- Modulations supportées :
    - 2/4GFSK 0.1 à 360 Kbits/s
    - CW (TX only)

4.2.2 Operating modes

TBC