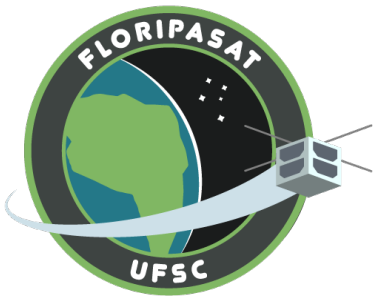
FLORIPASAT - TTC-DOC - REV1



Telemetry, Tracking and Command Module of the FloripaSat Project

Module Documentation
GSE, Federal University of Santa Catarina, Florianópolis - Brazil

December 2017

FloripaSat Project, Telemetry, Tracking and Command Module Documentation

December, 2017

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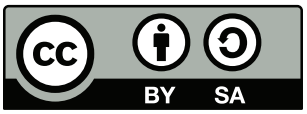

Abstract

This document...
Keywords: Cubesats. Embedded systems. Telecomunications.

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Nomenclature

ADC Analog-To-Digital Converter.

BSL Bootstrap Loader.

CPU Central Processing Unit.

DMA Direct Memory Access.

GPIO General Purpose Input/Output.

HAL Hardware Abstraction Layer.

I^2C Inter-Integrated Circuit.

ISR Interruption Service Routine.

PCB Printed Circuit Board.

RAM Random Access Memory.

SPI Serial Peripheral Interface.

TTC Telemetry, Tracking and Command.

UART Universal Asynchronous Receiver/Transmitter.

USB Universal Serial Bus.

CHAPTER 1

Introduction

INTRODUCTION... [1].

Module Requirements

CHAPTER 2

Hardware

The TTC board is composed by the following main components:

- MSP430F6659, as the beacon microcontroller.
- RF4463F30, as the radio module for the beacon and the telemetry link.

In the figure 2.1, ...

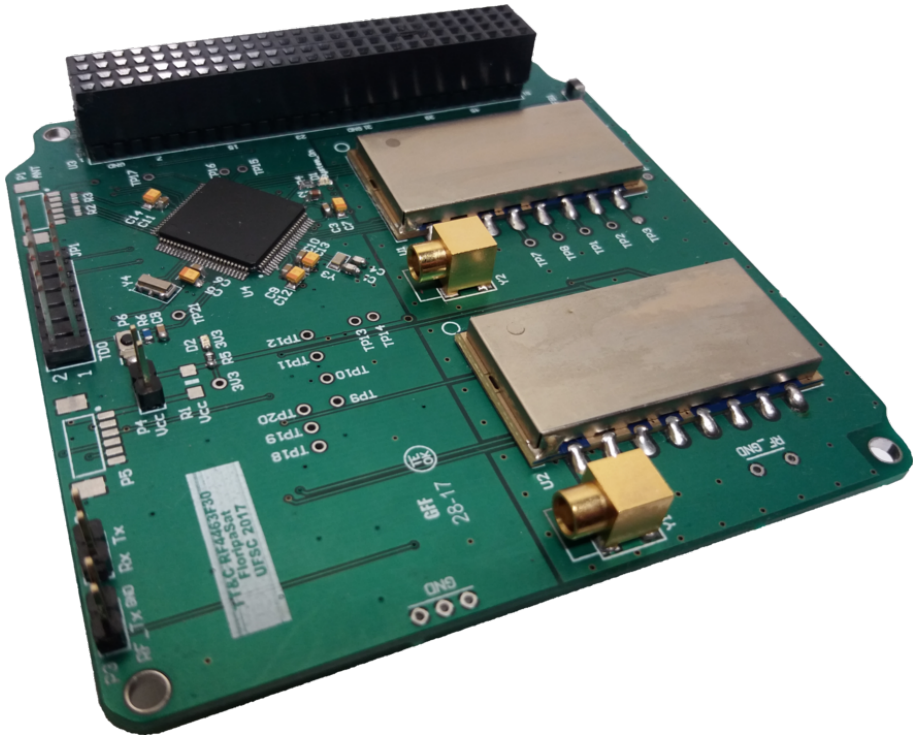

Figure 2.1: TTC PCB.

General Diagram

In the figure 2.2, a general hardware diagram can be seen.

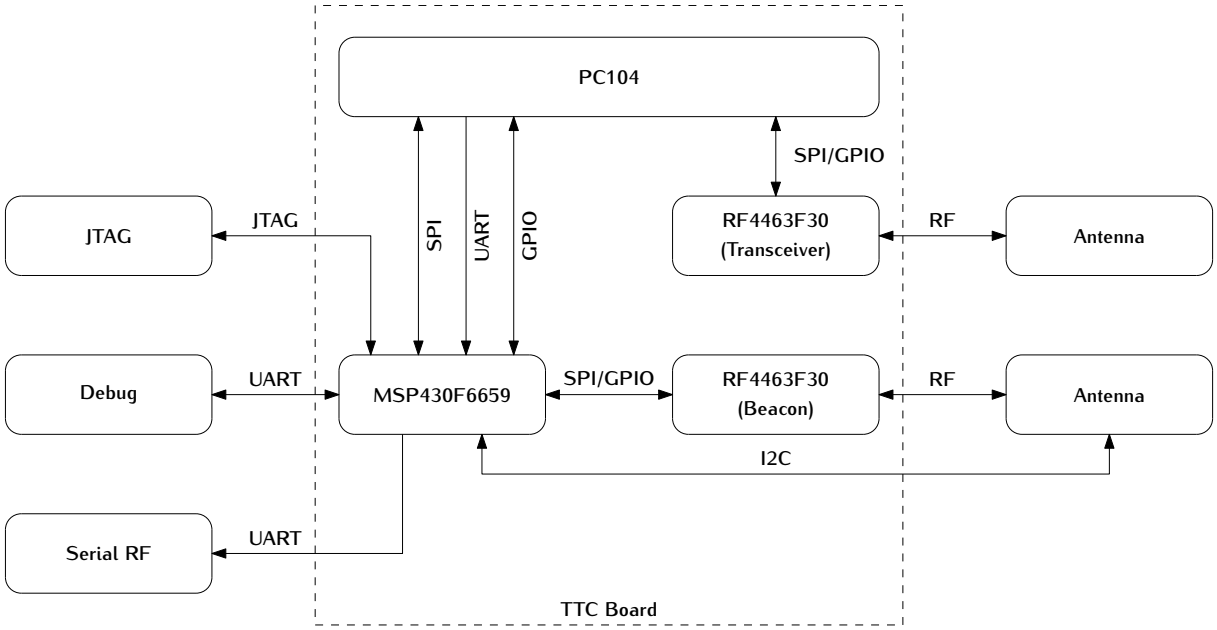

Figure 2.2: Hardware diagram of the TTC module.

Main Components

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Microcontroller

The beacon microcontroller is the MSP430F6659IPZR [**?**]. Its main characteristics can be found in the table 2.1.

Radio Modules

The NiceRF RF4463F30 [**?**] is a transceiver module based on the Silicon Labs Si4463 [**?**] radio. This module also contains a PA module to increase the output power up to 31 dBm.

Si4463

External Connections

This section describes the external available connections of the TTC module.

In the figure 2.3, all the external connections are enumerated.

A brief description of each connection is presented in the table 2.3.

The connections 1, 2, 4 and 6 were designed to be used during the software development stage, and not during the satellite operation.

Characteristic	*Value*
CPU	MSP430
Frequency	Up to 20 MHz
Non-volatile memory	512 kB
RAM	66 kB
GPIO pins	74
I^2C	3
SPI	6
UART	3
DMA	6
ADC	ADC12-12ch
Comparators	12 inputs
Timers - 16-bit	4
Multiplier	32×32
BSL	USB
Min V_{cc}	1,8 V
Max V_{cc}	3,6 V
Active Power	360 $\mu A/MHz$
Standby Power (LMP3)	$2,6$ μA
Wakeup Time	3 μs
Operating Temperature Range	-40 to 80 $°C$

Table 2.1: MSP430F6659 features.

Characteristic	*Value*	*Unit*
Frequency range	119-1050	MHz
Receiver sensitivity	-126	dBm
Modulation	(G)FSK, 4(G)FSK, (G)MSK and OOK	-
Max. output power	+20	dBm
PA support	+27 to 30	dBm
Ultra low current powerdown modes	30 (shutdown), 50 (standby)	nA
Data rate	100 bps to 1 Mbps	-
Power supply	1,8 to 3,6	V
TX and RX FIFOs	64 bytes for each or 129 bytes shared	-

Table 2.2: Si4463 features.

PCI-104 Pins

The table 2.4 describes the PCI-104 connector used pins. The first column is the row number of the connector, and the remaining columns are the respective columns (Named as H1A, H1B, H2A and H2B respectively). If the pin has no description, it is not connected to the TTC board.

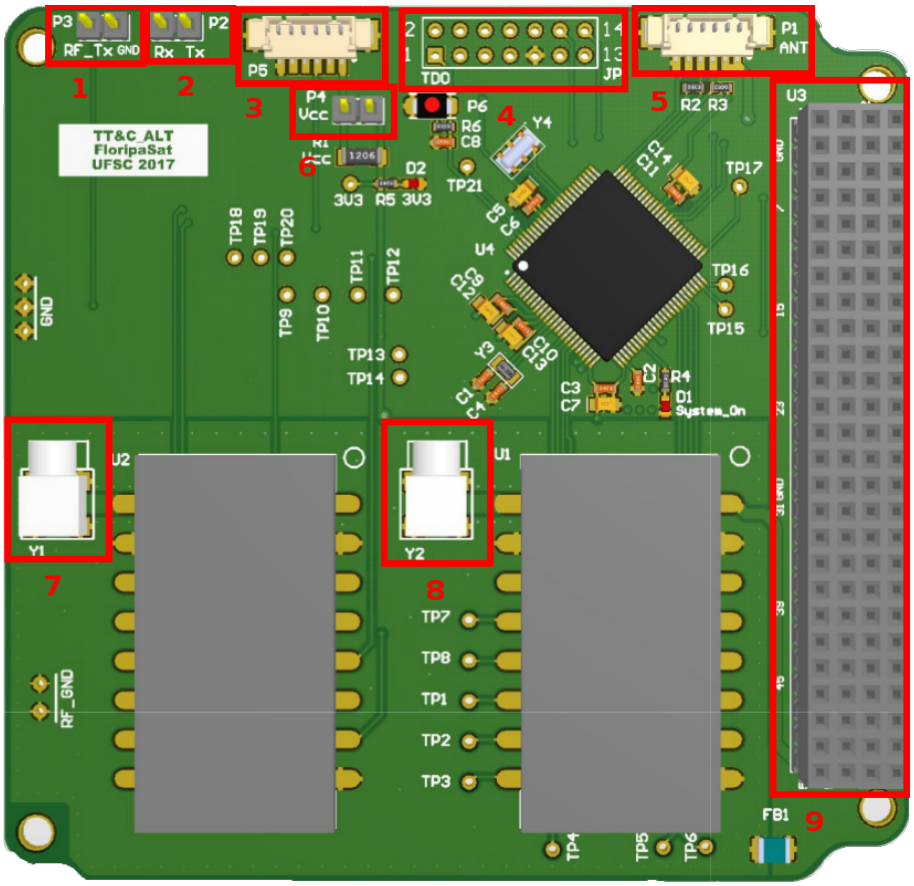


Figure 2.3: External connections on the board.

Number	*Connector*	*Description*
1	Male pin header (1×2)	UART TX @4800 bps. These pins transmit the beacon packets over a serial connection (It is enable in the configuration file, setting the BEACON_RADIO variable as UART_SIM).
2	Male pin header (1×2)	Debug UART TX/RX @115200 bps. These pins transmit a description of the main events of the beacon software during it's execution. This feature is only available in DEBUG_MODE.
3	Male PicoBlade^{TM} ($\times 6$)	JTAG and Debug. This connection contains the relevant pins of the connectors 2 and 4.
4	Male pin header (2×2)	MSP430 JTAG. This connection is for programming the uC code, using a MSP-FET debugger.
5	Male PicoBlade^{TM} ($\times 6$)	Antenna I2C. I2C bus for a communication channel with the antenna module.
6	Male pin header (1×2)	Power supply jumper. With a jumper, the beacon microcontroller power source comes from the JTAG connector. Without a jumper, the uC power supply comes from a pin of the PC104 connector.
7	Female Angled MCX	437 MHz band RF signal (Goes to the antenna module).
8	Female Angled MCX	145 MHz band RF signal (Goes to the antenna module).
9	Male/Female PCI-104	PCI-104. Power supply and communication buses with others stacked up modules.

Table 2.3: External connections description.

Row	*H1A*	*H1B*	*H2A*	*H2B*
1	GND	GND	GND	GND
2	GND	GND	GND	GND
3	-	-	UART RX @4800 bps from the EPS module.	-
4	Telemetry radio GPIO0	Telemetry radio GPIO1	-	-
5	Telemetry radio GPIO2	Enable beacon radio power supply	-	-
6	Telemetry radio SDN	-	OBDH communication (SPI MOSI)	OBDH communication (SPI clock)
7	-	-	OBDH communication (SPI chip select)	OBDH communication (SPI MISO)
8	-	-	-	-
9	-	-	-	-
10	-	-	-	-
11	-	-	-	-
12	-	-	-	-
13	-	-	-	-
14	-	-	Beacon uC power supply (3,3 V/50 mA)	3,3 V beacon uC power supply (3,3 V/50 mA)
15	GND	GND	GND	GND
16	GND	GND	GND	GND
17	-	-	-	-
18	Telemetry radio SPI clock	-	-	-
19	Telemetry radio SPI MISO	-	-	-
20	Telemetry radio SPI MOSI	Telemetry radio SPI chip select	-	-
21	-	-	-	-
22	-	-	-	-
23	-	-	-	-
24	-	-	-	-
25	Telemetry radio power supply (5 V/500 mA)	-	-	-
26	Beacon radio power supply (5 V/500 mA)	-	-	-

Table 2.4: PCI-104 connector reference.

CHAPTER 3

Software

SOFTWARE...

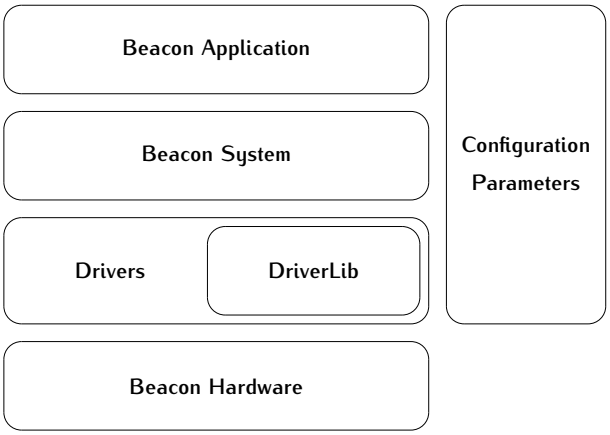


Figure 3.1: Beacon software stack-up.

Flowcharts

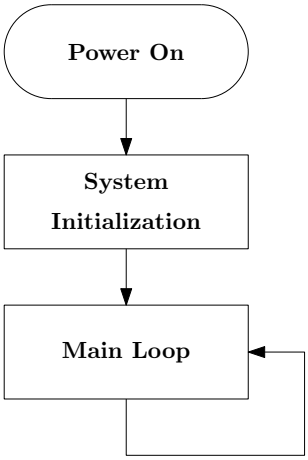
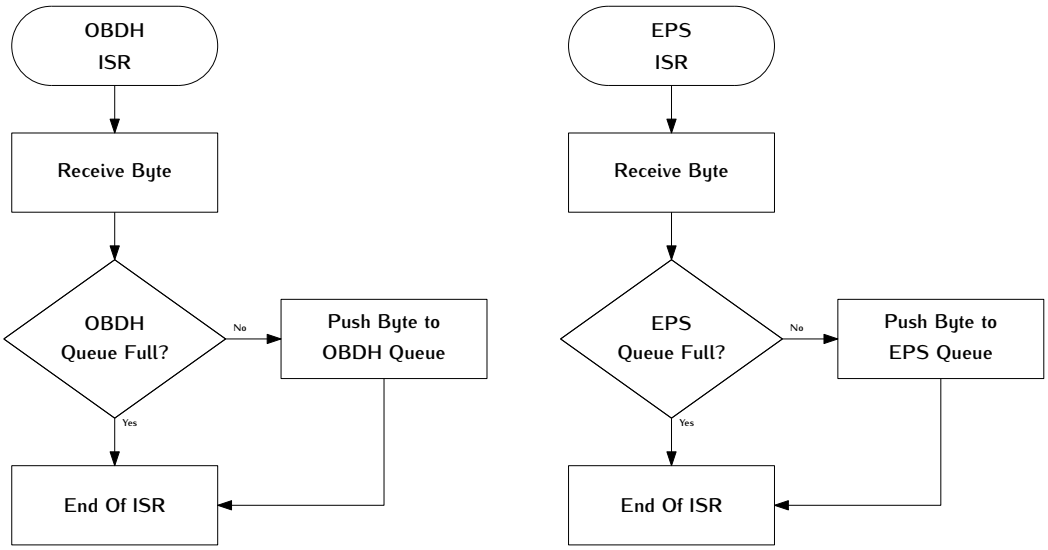


Figure 3.2: Main flowchart of the beacon software.



(a) OBDH communication ISR flowchart. (b) EPS communication ISR flowchart.

Figure 3.3: OBDH and EPS modules comunication ISRs routines.

CHAPTER 4

Tests

THIS...

RF Signal Power

P...

CHAPTER 5

Conclusion

Conclusion...

Bibliography

[1] Rafael P. Alevato. Floripasat project, 2017.