Introduction
to EduQube kit

INNOVA
SPACE

Index

1.0 – Overview

Hardware

EduQube includes three separated modules containing the OBC/COMMS, EPS and Payload subsystems. All units feature PQ-10-standard connections.

Software and data visualization

The kit features a modular code for both satellite and GND station and a dashboard for data visualization.

Optional features

A 1P pocketqube structure and a CubeSat standard-sized motherboard (*flatsat*) are available as optional features. The motherboard brings the possibility to include an additional payload and to perform specific tests.

1.1 – EduQube block diagram
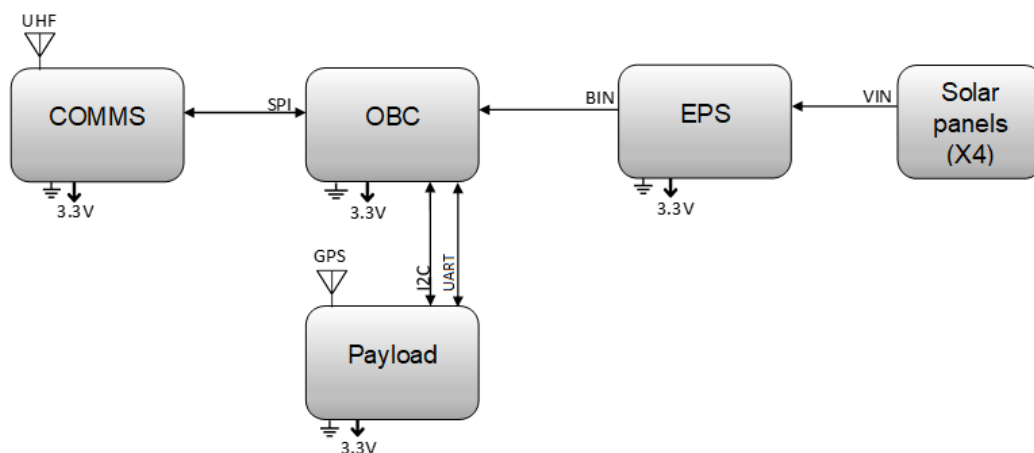
## 1.2 – EduQube data processing diagram
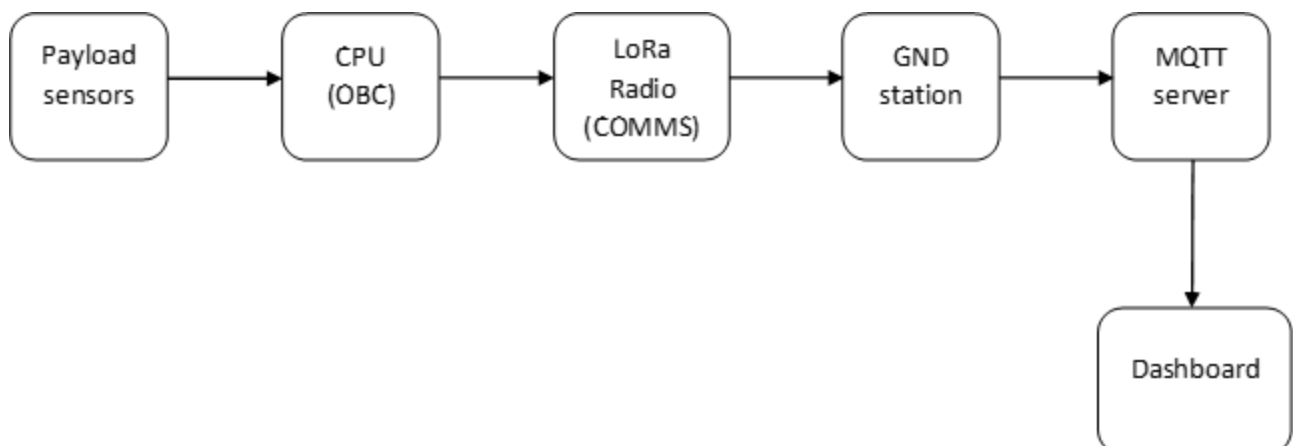
2.0 – OBC/COMMS

The OBC-v0X is an on-board computer and communications unit designed for EduQube educational kit. The board has been developed for data processing, telemetry functions and RF communication, hosting these subsystems in a unique board. Its architecture includes a 32-bit SAMD21 G microcontroller and a RFM95W 915MHz LoRa radio module (**OBC-v01**). The **OBC-v02** features a SX1262 1GHz LoRa radio module.

Main features:

- **Microchip SAMD21-G** 32-bit, 48MHz microcontroller.

- **PQ-10** Standard header.

- **4Mb** flash memory.

- Texas Instruments **current monitor**.

- **USB-C 2.0** receptacle.

- **SMA** and **UFL** connectors.

- Supports **Arduino** and **Python** programming.

2.1 – OBC/COMMS Pinout (*OBC_v01* and *OBC_v02*)
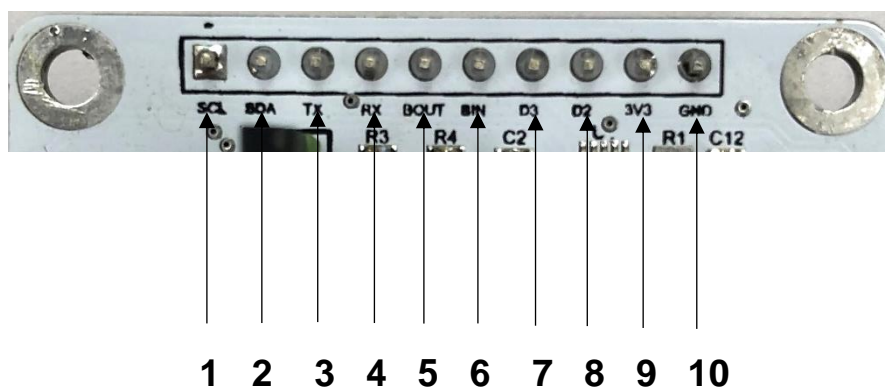
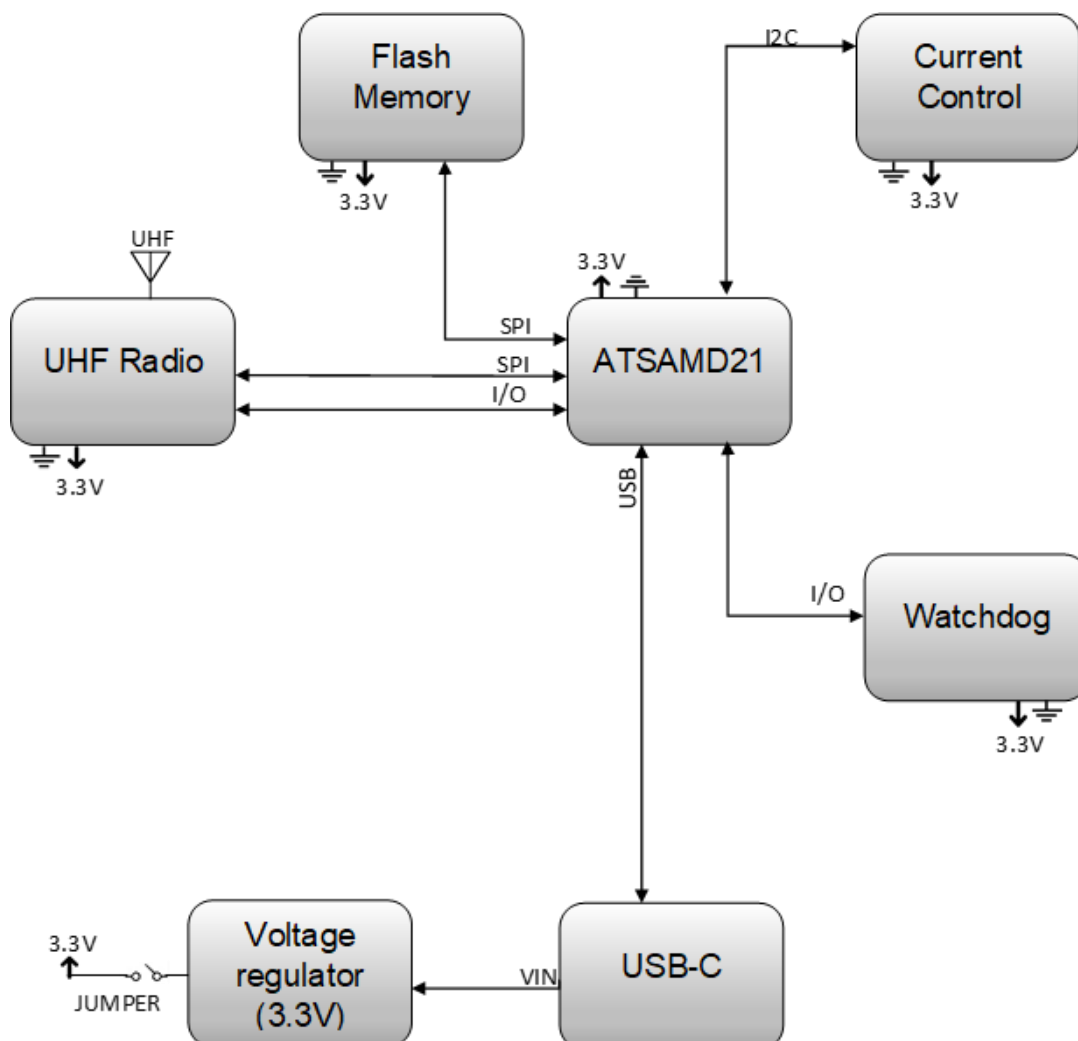| Pin number	Name	Pin functions
1	SCL	I2C communication SCL pin.
2	SDA	I2C communication SDA pin.
3	TX	UART communication TX pin.
4	RX	UART communication RX pin.
5	BOUT	Current control output.
6	BIN	Current control input.
7	D3	Digital I/O pin.
8	D2	Digital I/O pin.
9	3V3	+3.3v VDD
10	GND	VSS

2.1.1 – OBC/COMMS USB power source
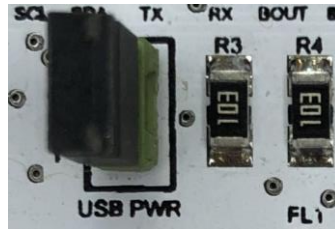
To enable the USB power source, the **USB PWR** jumper has to be connected. This is suggested when the OBC is being programmed, in order to avoid extra connections on the board.
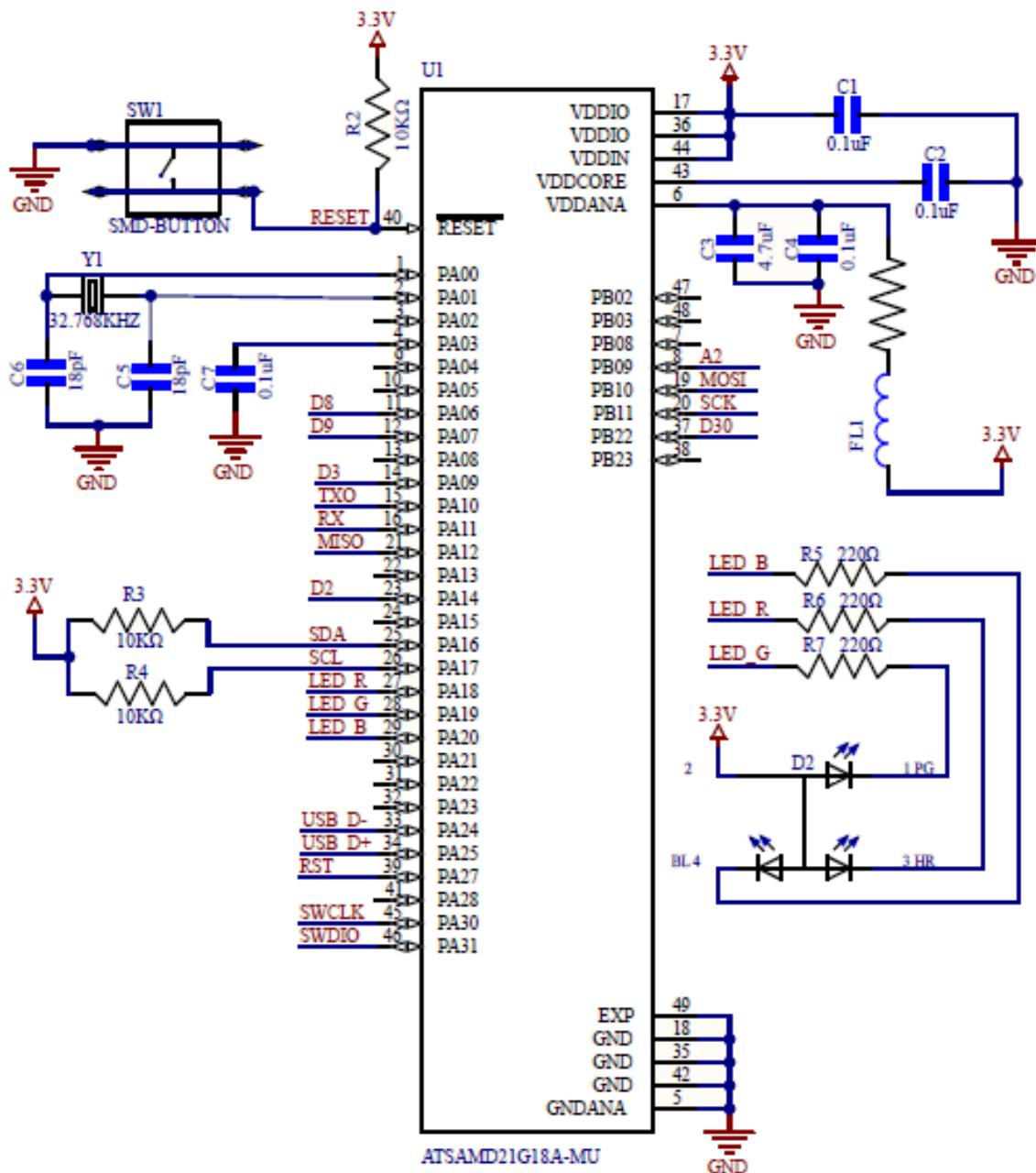
IMPORTANT: DO NOT CONNECT USB PWR JUMPER IF THE BOARD IS BEING POWERED EXTERNALLY (CONNECTED TO EPS OR CONNECTED TO AN EXTERNAL POWER SOURCE)
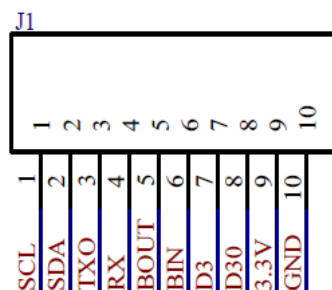
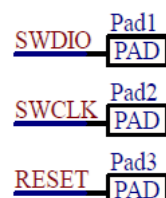# 2.2 – OBC/COMMS block diagram
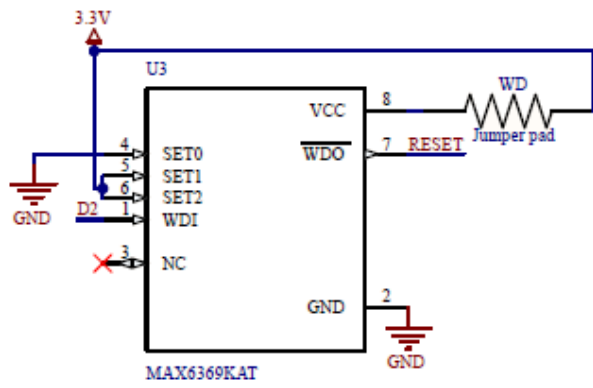
2.3 – OBC/COMMS schematic design

ATSAMD21G18A

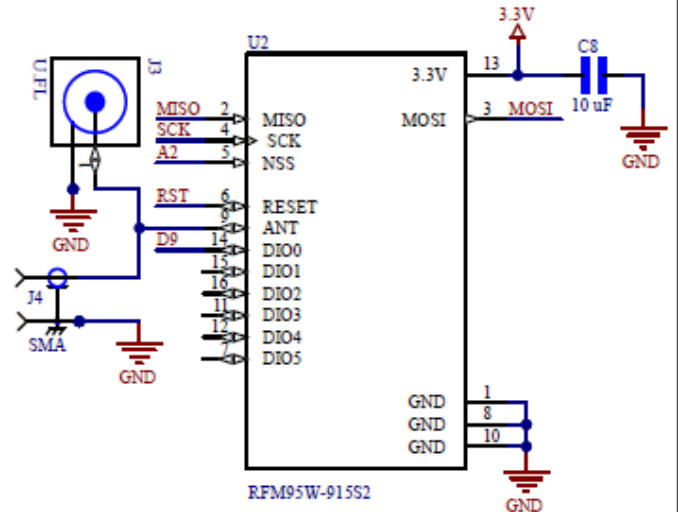ATSAMD21G18A-MU

HEADER

BOOTLOADER

WATCHDOG

U3

MAX6369KAT

SET0 4
SET1 5
SET2 6
WDI 1
NC 3
D2

VCC 8
WDO 7 RESET
GND 2

WD
Jumper pad

3.3V

GND

GND

CURRENT CONTROL

U5

INA226AIDGST

BOUT

R1 1.50KΩ

BIN

A0 2
A1 1
IN+ 10
IN- 9
SCL 5
SDA 4

VS 6
VBUS

ALERT 3

GND 7

3.3V

C12 0.1uF

GND

SCL
SDA

LoRa RFM95

U2

RFM95W-915S2

J3

U.FL

GND

J4

SMA

GND

MISO 2
SCK 4
A2 5

RST 6
D9 9
14
15
16
11
12

MISO
SCK
NSS

RESET
ANT
DIO0
DIO1
DIO2
DIO3
DIO4
DIO5

3.3V 13
MOSI 3 MOSI

GND 1
GND 8
GND 10

3.3V

C8 10 uF

GND

GND

FLASH MEMORY

U4

AT25DF041B-SSHN-T

3.3V

VCC 8

SI 5
CS 1
WP 3
HOLD 7
SCK 6

GND 4

SO 2 MISO

MOSI
D8

SCK

GND

USB / VOLTAGE REGULATOR

J2

USB4110-GF-A

R9 5.1KΩ

GND

USB D+ A6
USB D- A7

A5
A6
A7
A8

CC1
DP1
DN1
SBU1

VBUS A4/B9
VBUS B4/A9

CC2 B5
DP2 B6 USB D+
DN2 B7 USB D-
SBU2 B8

GND A1/B12
GND B1/A12
GND S1
GND S2
GND S3
GND S4

GND

D1 B5819W

R8 5.1KΩ

GND

C11 10uF

U6

MCP1703-4002E/DB

VIN 1

GND_(TAB) 2
GND_(TAB)_2 4

VOUT 3

J5

Jumper

1 1
2 2

3.3V

C9 10uF
C10 0.1uF

GND

7

3.0 – EPS

The EPS-v01 unit provides the EduQube kit an efficient power management. This module features two ST SPV1040, which includes an embedded MPPT, a high-efficiency solar battery charger and a built-in current control. The EPS-v01 supports up to four solar panels, reaching a maximum output power of 3.3W.

Main features:

- Two ST SPV1040 **high-efficiency solar battery chargers** and **MPPTs.**

- **PQ-10** Standard header.

- **1A** voltage regulator.

- **Current control.**

- **3.3W** max. Output power.

3.1 – EPS Pinout
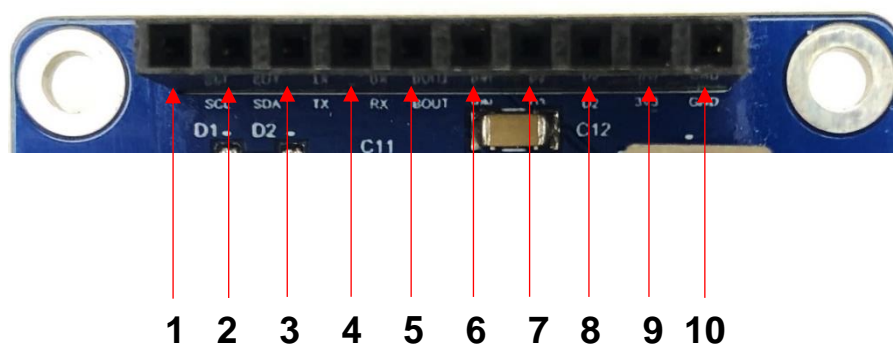
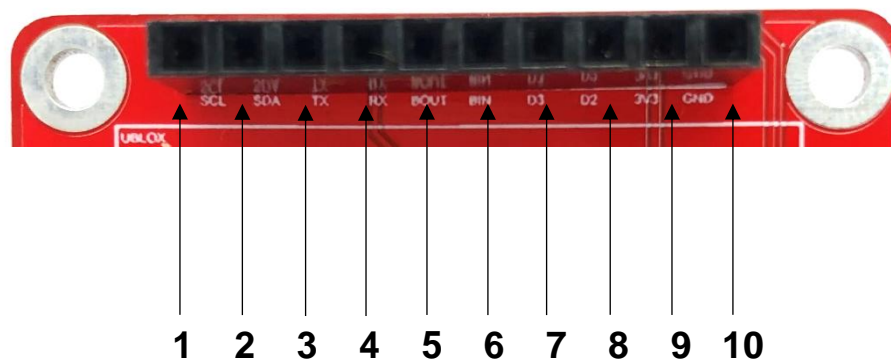| Pin number	Name	Pin functions
1		NC
2		NC
3		NC
4		NC
5	BOUT	Current control output.
6	BIN	Current control input.
7	D3	Digital I/O pin.
8	D2	Digital I/O pin.
9	3V3	+3.3v VDD
10	GND	VSS

3.2 – EPS block diagram
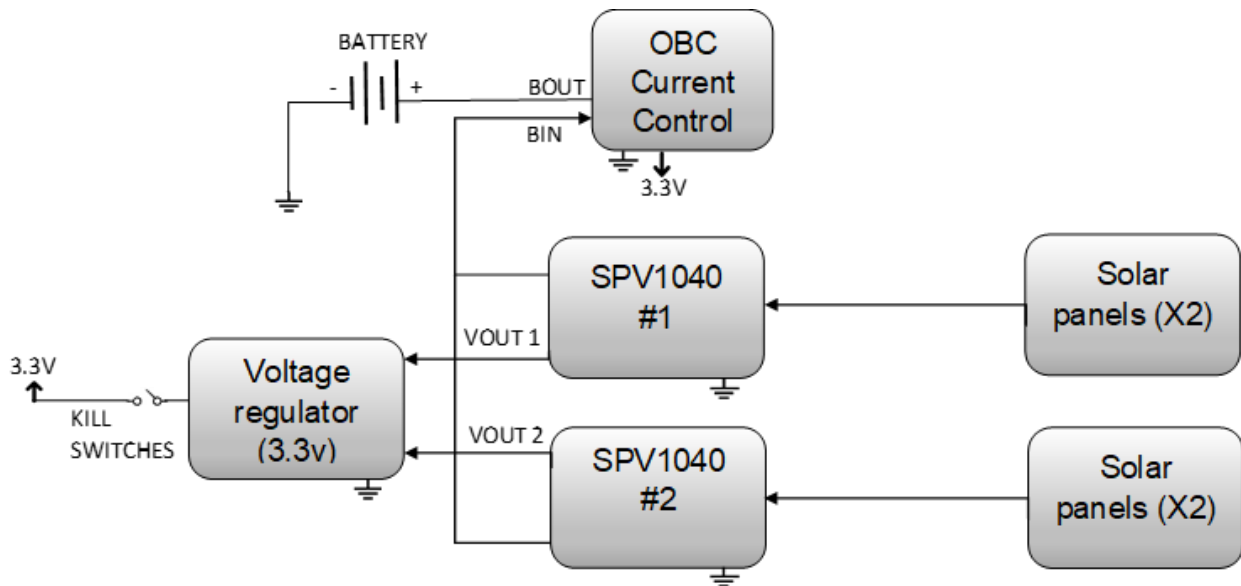
3.3 – EPS schematic design
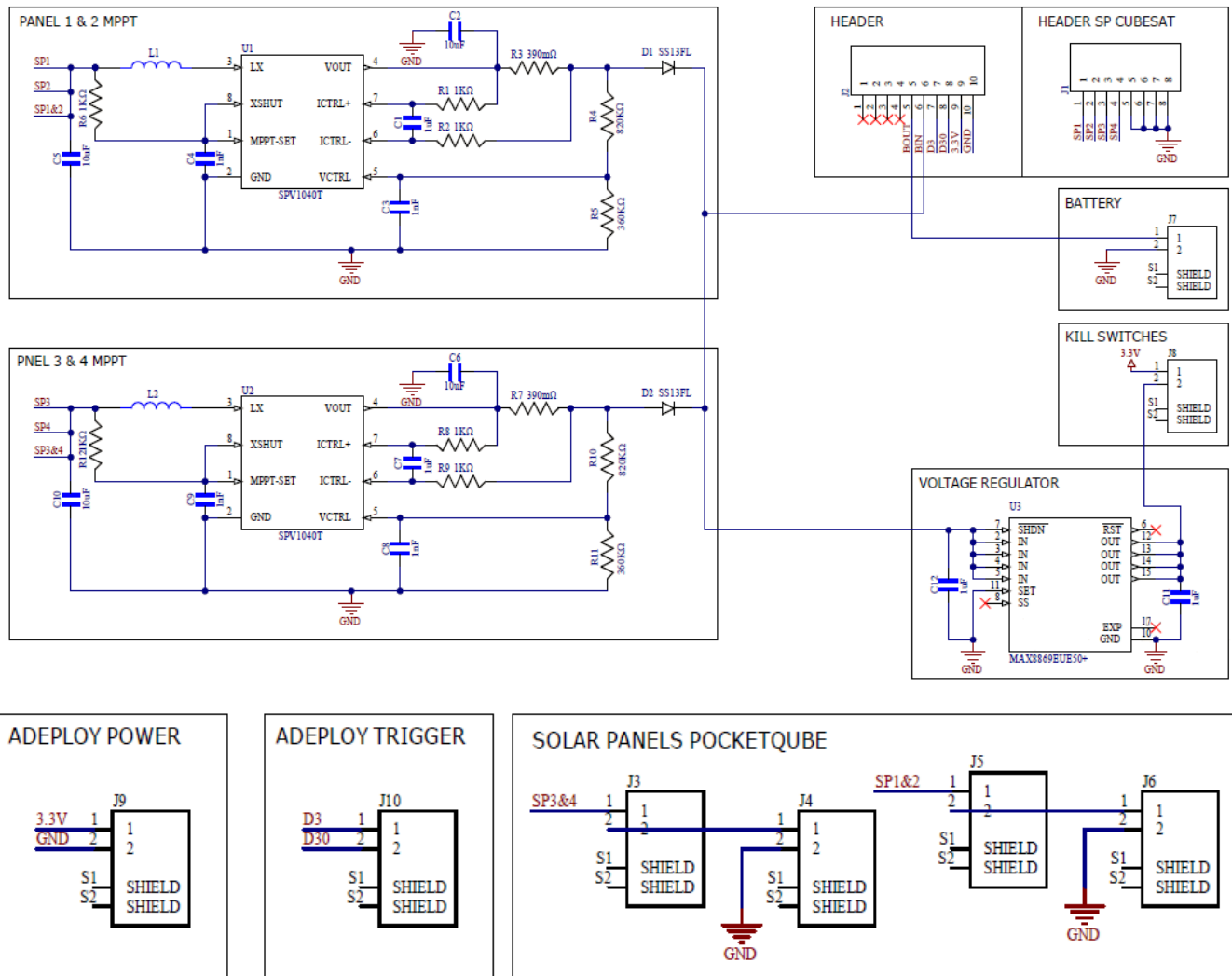
4.0 – Payload

This unit includes a gyroscope, magnetometer and accelerometer and a weather sensor (temperature, humidity, pollution and altitude), as well as an Ublox GPS module. The board is connected to the OBC unit by a PQ-10 standard header, featuring I2C and UART communication, and two I/O digital pins.

Main features:

- Bosch **BME680** temperature, humidity, altitude and pollution sensor.

- **PQ-10** Standard header.

- **TDK MPU9250** 9-axis accelerometer, gyroscope, magnetometer.

- **GPS**

4.1 – Payload Pinout

Pin number	Name	Pin functions
1	SCL	I2C communication SCL pin.
2	SDA	I2C communication SDA pin.
3	TX	UART communication TX pin.
4	RX	UART communication RX pin.
5		NC
6		NC
7		NC
8		NC
9	3V3	+3.3v VDD
10	GND	VSS

4.2 – Payload block diagram
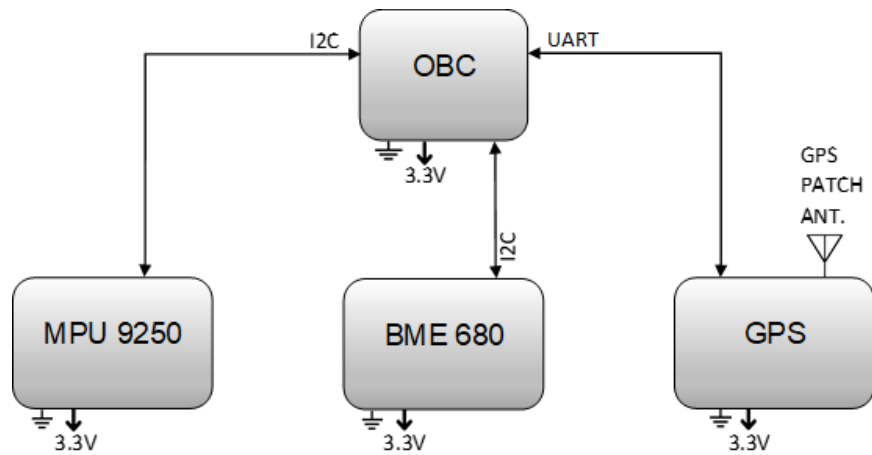
4.3 – Payload schematic design
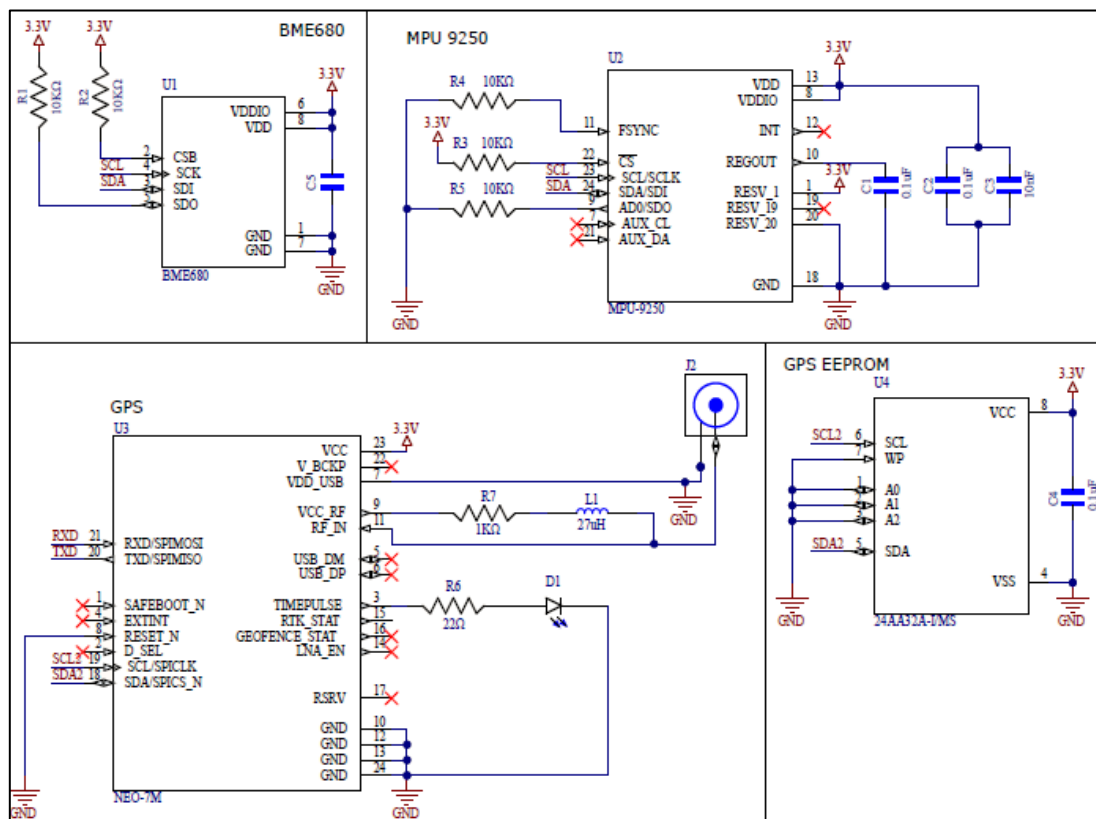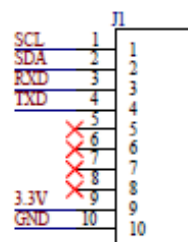
5.0 – Motherboard

As an optional feature for EduQube, the motherboard (flatsat) brings the possibility to perform specific tests and to add a custom payload module. The board is CubeSat-standard-sized, and its purpose is to integrate all the EduQube modules.

Main features:

- **18650** battery holder (battery not included).
- 3.5mm stereo jack **RBF switch housing** (male not included).
- **External power source** input (with built-in 3.3V regulator).
- **Solar panels inputs.**
- **Additional payload** slot.

5.1 – Motherboard Pinout
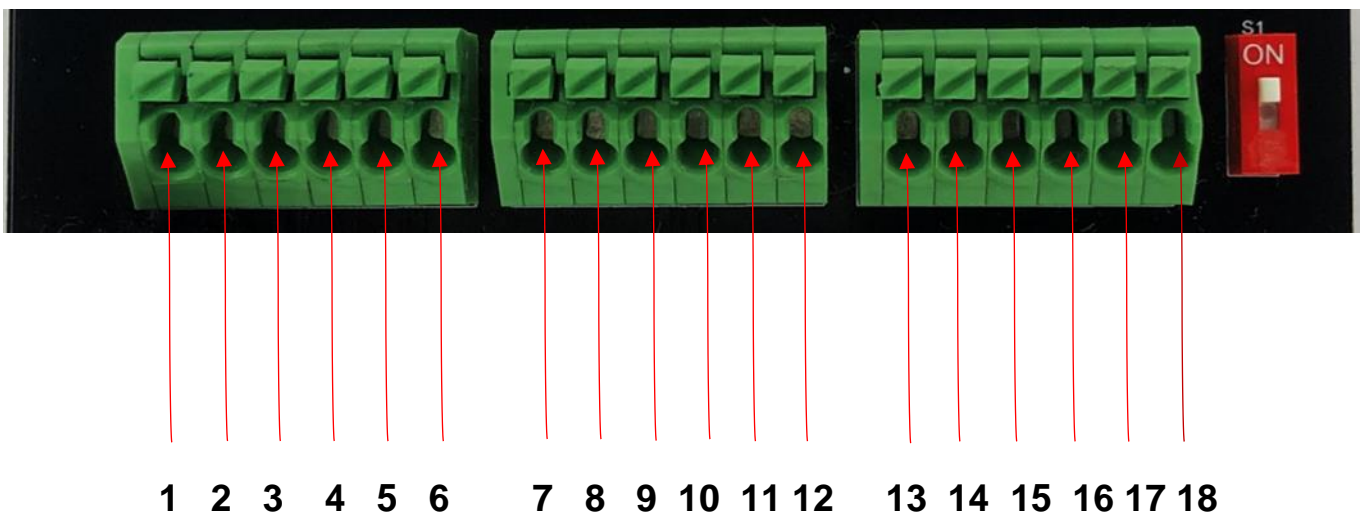
Pin number	Name	Pin functions
1	SCL	I2C communication SCL pin.
2	SDA	I2C communication SDA pin.
3	TX	UART communication TX pin.
4	RX	UART communication RX pin.
5	D1	Digital I/O pin.
6	D2	Digital I/O pin.
7	SP1	Solar panel input.
8	SP2	Solar panel input.
9	SP3	Solar panel input.
10	SP4	Solar panel input.
11	GND1	VSS
12	GND2	VSS
13	GND3	VSS
14	GND4	VSS
15	GND5	VSS
16	ES	External power source +VCC pin.
17		NC
18		NC

5.2 – Motherboard schematic design
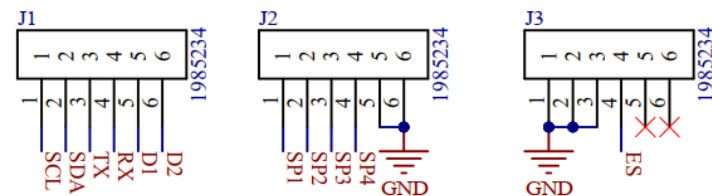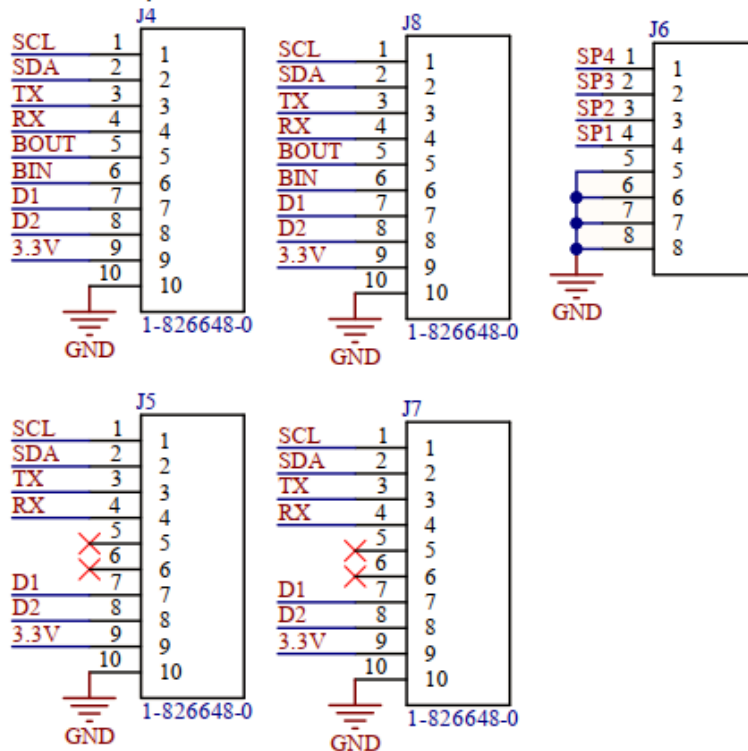
VOLTAGE REGULATOR

3.5mm SWITCH (RBF) / BATTERY

6.0 – PCBs dimensions

All dimensions are expressed in mm.

OBC/COMMS, EPS and Payload
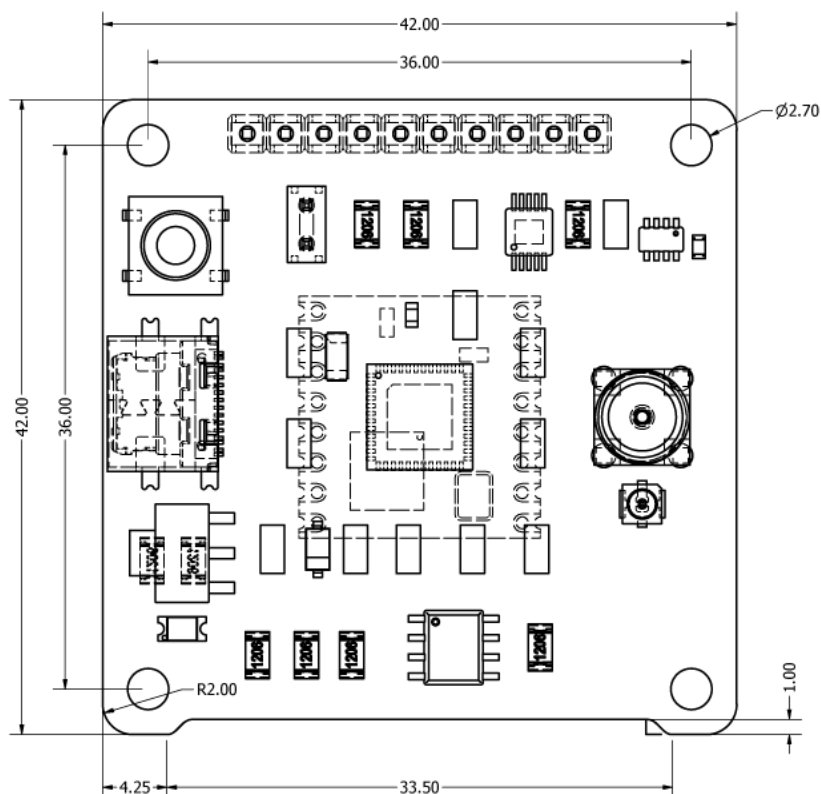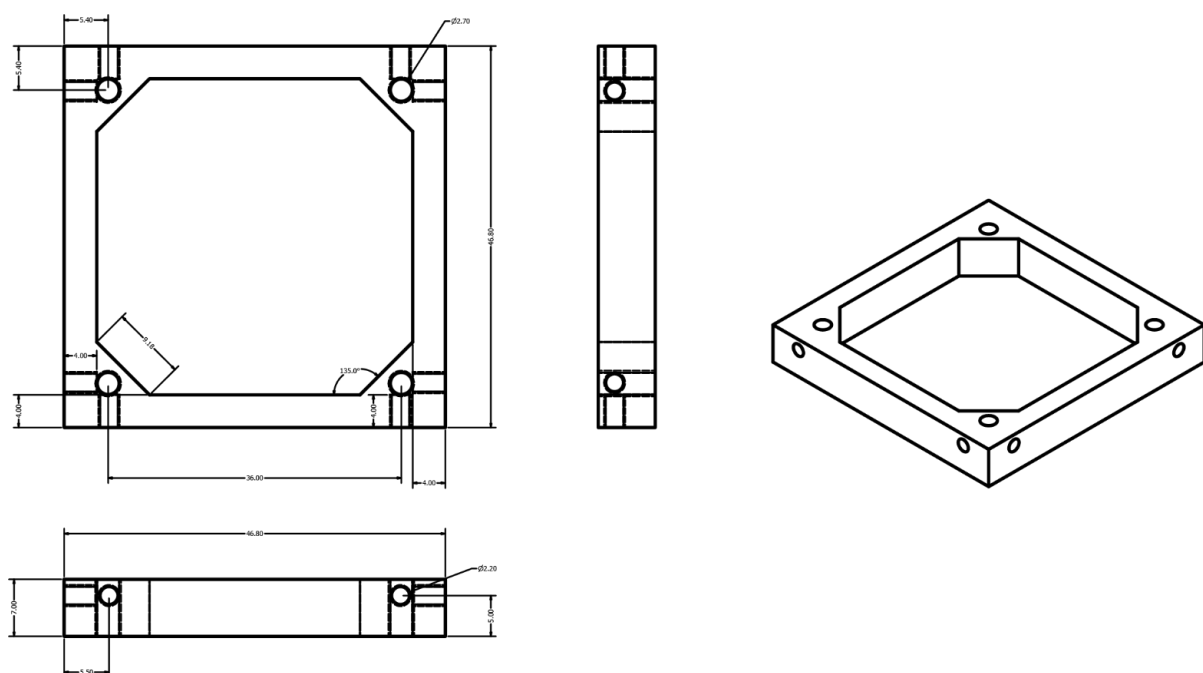
Motherboard
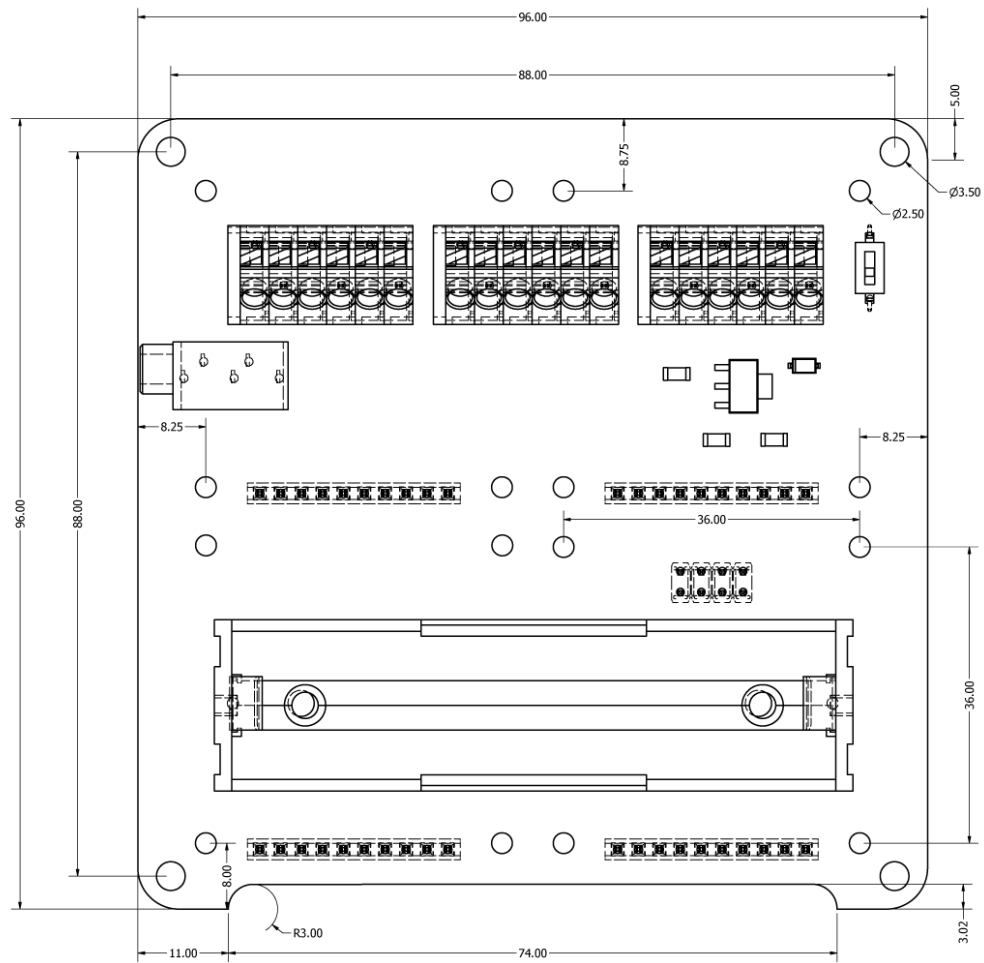
7.0 – Structures

1P PocketQube structure

Medium and advanced versions of the EduQube kit include a 1P PocketQube structure, which is composed of two individual frames, assembled by four threaded rods (M2.5mm).
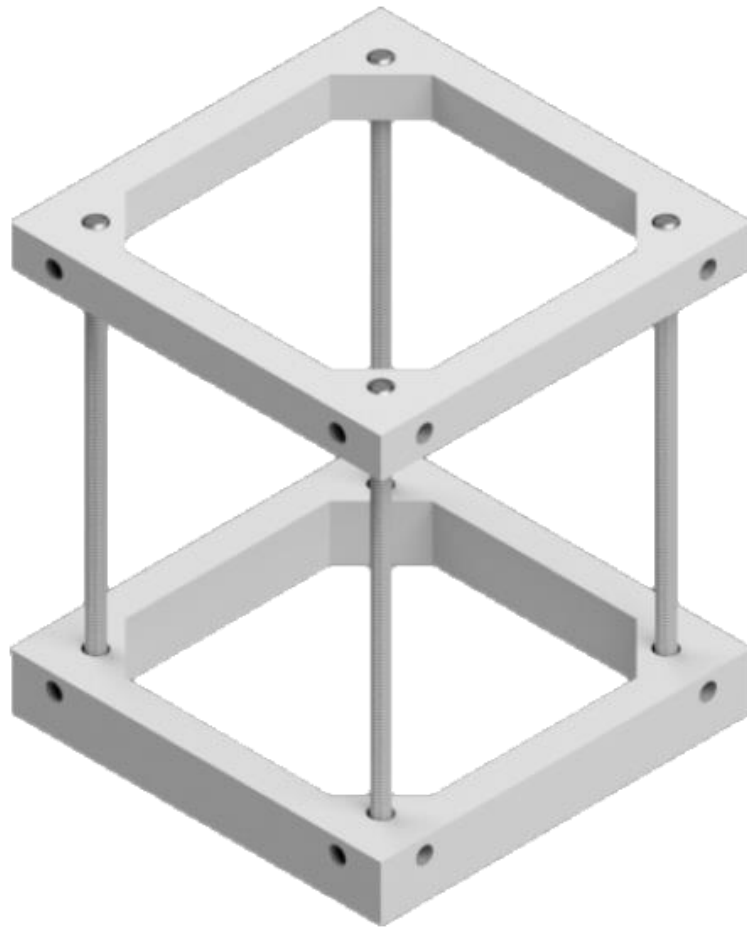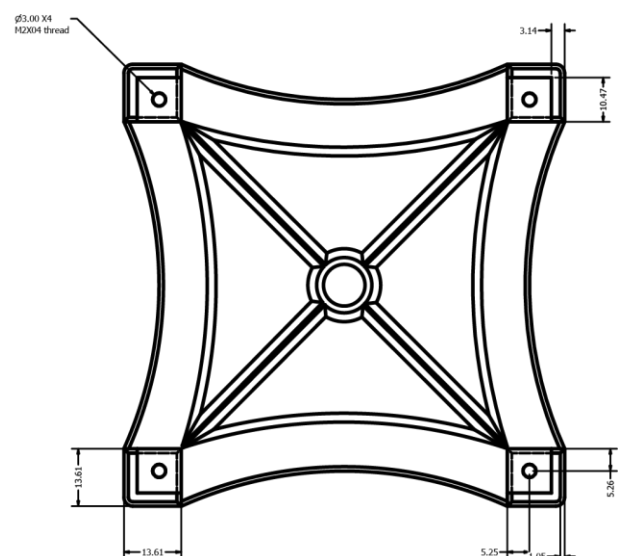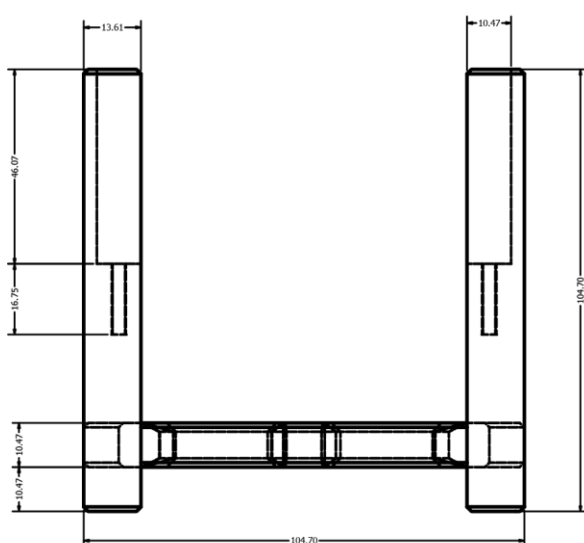
Dimensions

Top frame
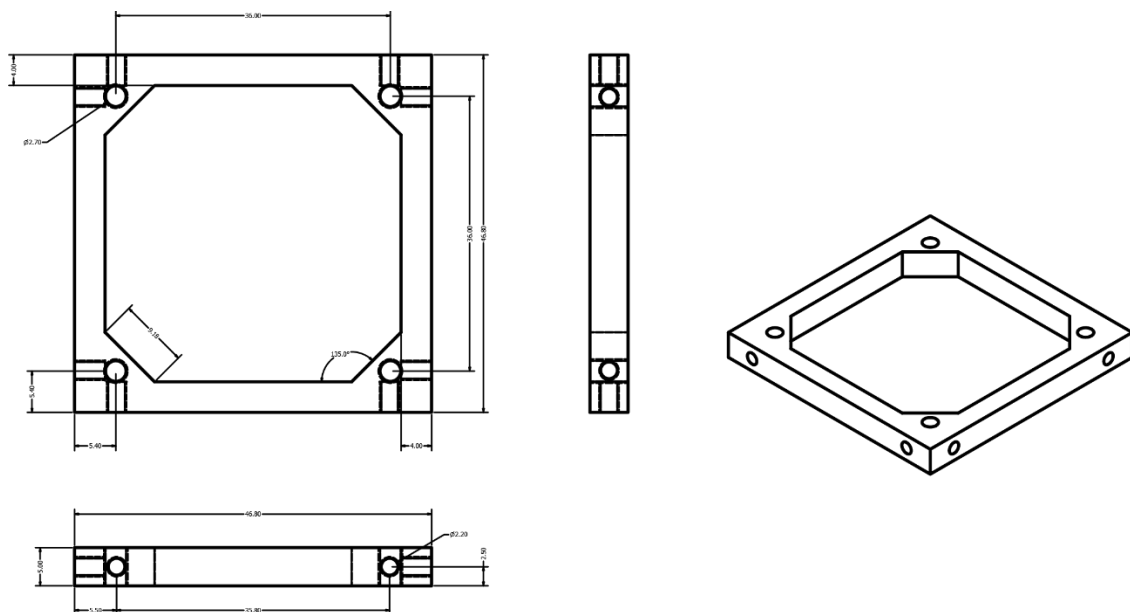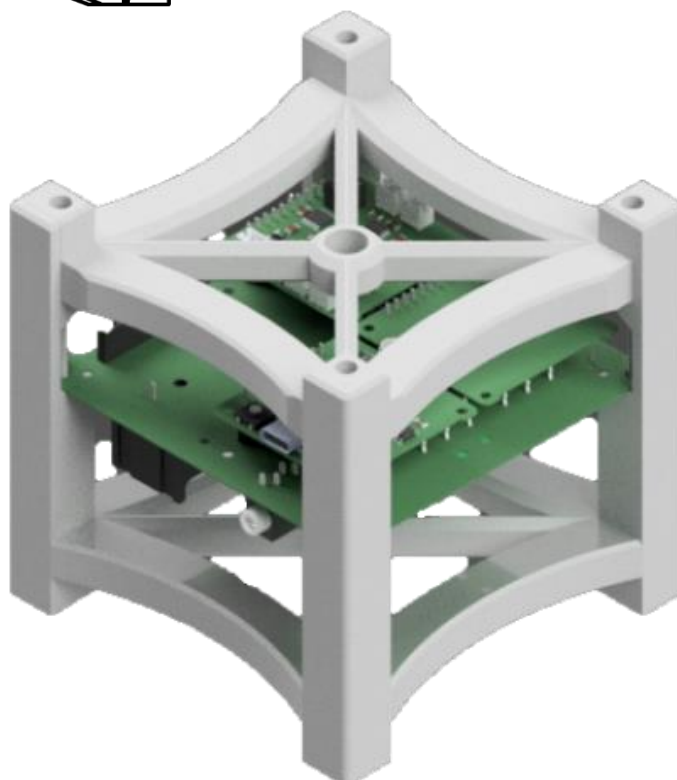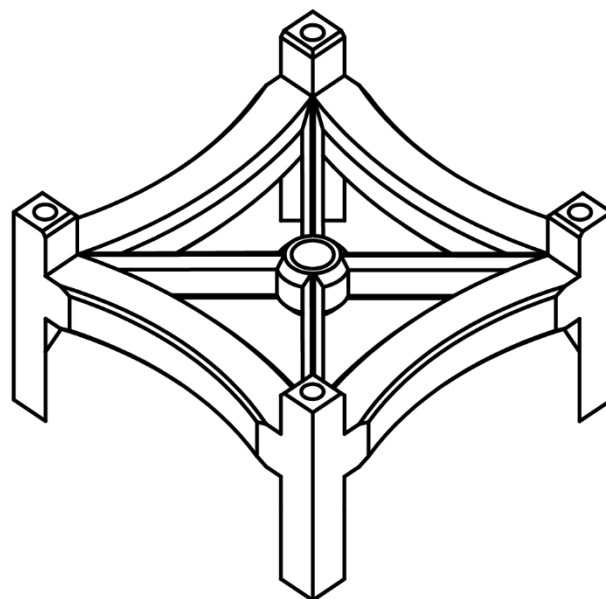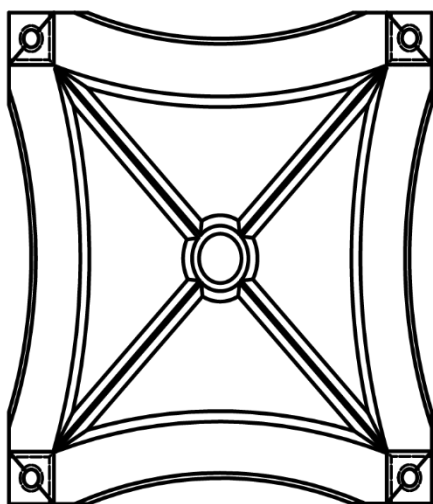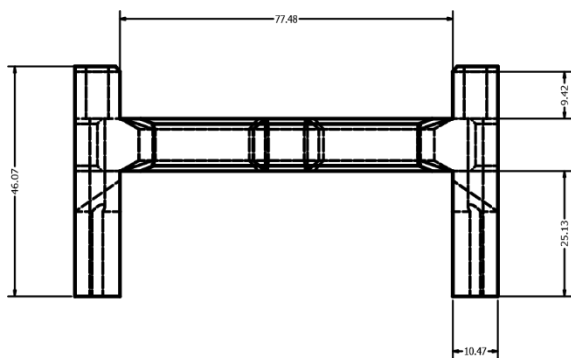
Base frame

CubeSat structure

 Advanced version of the EduQube kit feature a CubeSat-standard-sized structure. Its purpose is to host the Motherboard *(flatsat)* unit.
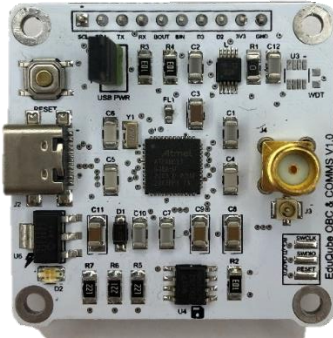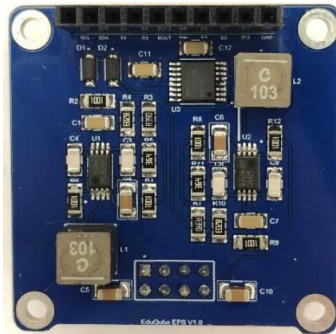
Dimensions

Chassis

Top piece

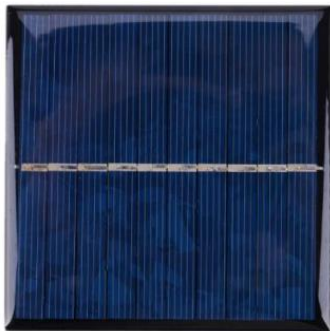# 8.0 – Kit

Basic version includes:

OBC/COMMS board	EPS board	Payload board

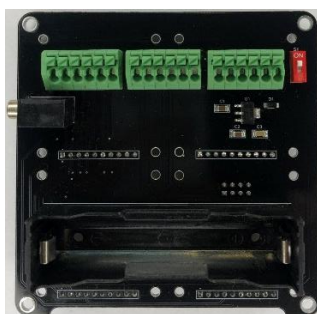| Solar panels 5x5 cm.(X4)	RF antenna (433 MHz)	GPS patch antenna

- Software
- Structures CAD files (3D-printable)

Medium version adds (over de Basic version):

Motherboard	Ground station (ESP32 OLED)	Solar panels 5x5 cm.(X5) Solar panels 10x10 cm.(X5)

Advanced version adds (over de Medium version):

- Structures *(see section 7.0 – Structures).*
- Exterior PCBs