

TELECOMMUNICATION

Introduction:

- This subsystem helps you in setting of connection between Ground station and Satellite.
- It consists of two important links: Uplink and Downlink.
- The communication links are also used for tracking the spacecraft by measuring the angular position of the downlink signal by Doppler measurements and by ranging or two-way Doppler.

Design Challenges:

The telecommunication challenges for Low Earth Orbit (LEO) missions vs. deep space missions are very different.

- In LEO, ground-antenna gain can compensate for limited onboard antenna gain and radio power and CubeSats can manage limitations of power generation and thermal dissipation by duty-cycling high-power components.]
- Most LEO CubeSats rely on UHF and/or S-band radios to receive commands or transmit telemetry back to Earth's ground station. There are only few radios available at X-band or Ka-band.
- Antenna Design for CubeSats is major challenge.
- X/ Ka band Communication Board design is another challenge to work on.
- Noise and Interference accommodation while designing is major challenge.

Components of Communication Subsystem:

1. Link Budget Design:

- Link Budget is accounting of all the gains and losses from the transmitter, through the medium (free space, cable, waveguide, Fiber, etc.) to the receiver in a telecommunication system.
- It accounts for the attenuation of the transmitted signal due to propagation, as well as the antenna gains, feedline, and miscellaneous losses.
- A simple link budget equation looks like this:
$$\text{Received Power (dB)} = \text{Transmitted Power (dB)} + \text{Gains (dB)} - \text{Losses (dB)}$$

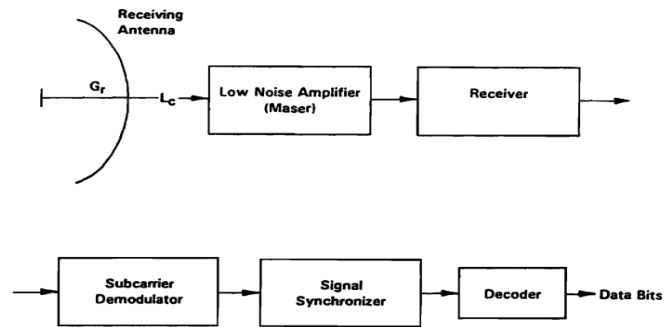
References:

- ✓ Element of Spacecraft design: Charles D. Brown
- ✓ CubeSat Antenna Design by Nacer Chahat

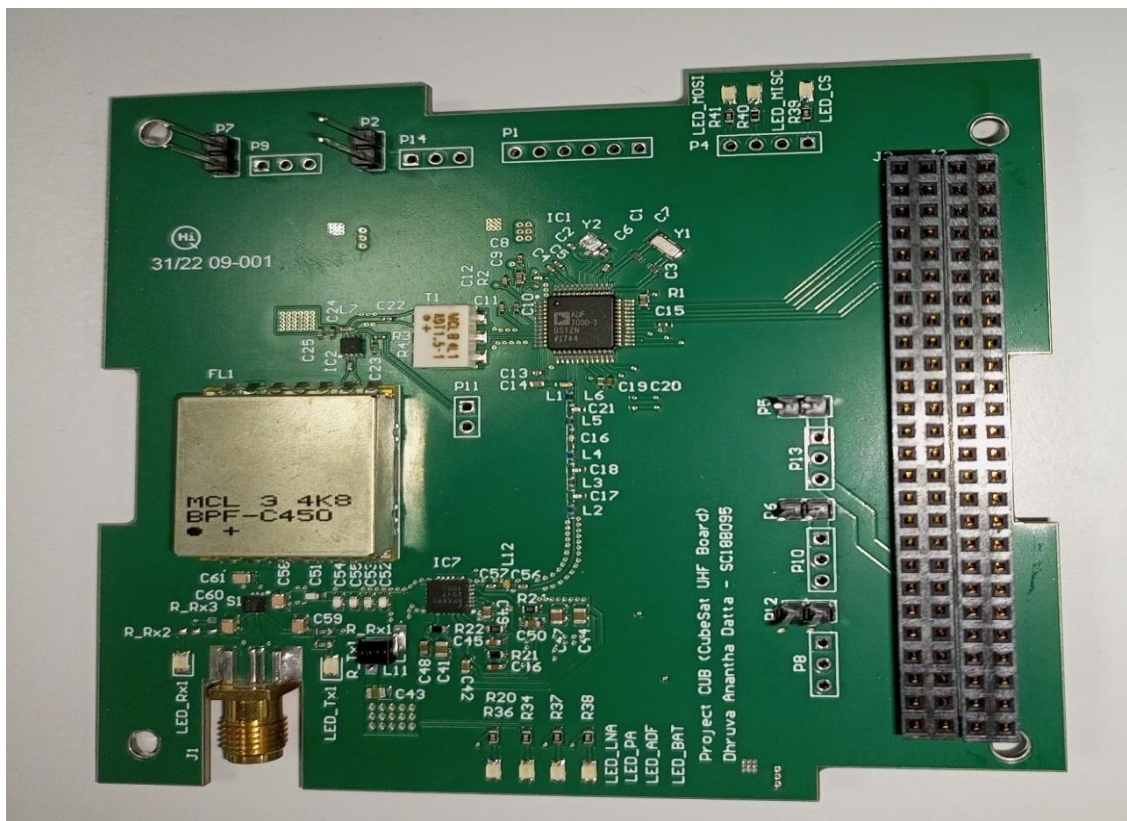
2. Communication Board Design:

- It consists of selection of different components for Transmitter and Receiver design.
- Shown below typical ground Receiver schematic.

- Selection of Power Amplifier, IC, Band in which we are going to transmit, etc while designing this board is important step to keep in mind.



- Shown Below UHF board Designed at SSPACE:



3. Antenna Design:

- Existing antenna technologies for CubeSats, we will classify them in the following categories: LGAs (<8dBi)-Low Gain Antennas, MGAs (<25dBi)-Medium Gain Antennas and high-gain antennas (>25 dBi).
- Usually CubeSats mission uses dipole, Microstrip Patch Antennas.
- New concept of Antennas are Foldable antennas based on ORIGAMI concept.

References:

1. CubeSats Antenna Design: Nacer Chahat
2. Magellan Communication System Example: From Element of Spacecraft chapter 9

NOTE:

1. Watch Lectures from Nanosat material: Lecture No. 10, 11, 12, 13 for basic of this subsystem.
2. Link Budget: Lecture-24 and Chapter 9 from Element of Spacecraft last part.