FSpace Laboratory

F-1 CubeSat project

F-1 Telemetry Decoder

Software User Manual

Hanoi, September 2012
# Table of Contents

1. **Introduction** .................................................................................................................. 3
   1.1 Purpose .......................................................................................................................... 3
   1.2 Definitions and Acronyms ........................................................................................... 3

2. **F-1 Cube Satellite** ........................................................................................................... 3

3. **F-1 communication schemes for radio operators** ............................................................ 4
   3.1 UHF channel (only operational in daylight): ................................................................. 4
      3.1.1 Pulse-Width-Modulation Morse code telemetry ................................................... 5
      3.1.2 F-1’s callsign ......................................................................................................... 5
   3.2 VHF channel (operational during night time but may be turned on in daylight later) ................................................................................................................................. 6

4. **Installation Guide** .......................................................................................................... 7
   4.1 Environment Requirement ............................................................................................ 7
   4.2 Installation Package ....................................................................................................... 7
   4.3 Installation Guide F-1 Telemetry Decoder .................................................................... 8

5. **User Manual** .................................................................................................................... 10
   5.1 Application Overview .................................................................................................... 10
      5.1.1 Available Features .................................................................................................. 10
   5.2 User Manual for Functions ............................................................................................ 11
      5.2.1 Complete personal information ............................................................................ 11
      5.2.2 Decode data (OBC 1) ........................................................................................... 12
      5.2.3 Decode Data OBC2 ............................................................................................... 13
      5.2.4 Submit data ............................................................................................................ 14
1 Introduction

1.1 Purpose

This document is prepared as the software user manual for F-1 Telemetry Decoder, in scope of F-1 cube satellite project

1.2 Definitions and Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>OBC 1</td>
<td>On board computer 1</td>
<td></td>
</tr>
<tr>
<td>OBC 2</td>
<td>On board computer 2</td>
<td></td>
</tr>
</tbody>
</table>

Table 1-1: Definitions and Acronyms

2 F-1 Cube Satellite

F-1 is a picosatellite (cubesat) developed at FSpace laboratory, FPT Technology Research Institute, FPT University in Hanoi, Vietnam. The project’s goal is for education and training for young engineers and students about aerospace engineering. It carries a low-resolution camera, a magnetometer and some temperature sensors for study of space environment.

Engineering model of F-1 CubeSat
F-1 satellite components

**Satellite specification:**

Size: 10x10x10cm (1U cubesat)

Mass: 1kg

Structure: aluminum alloy T-6061

Power supply: body-mounted solar cells 1.5W in average, Li-Polymer rechargeable battery for energy storage

Main and backup computers: PIC18 and PIC16 microcontrollers

Communication: 02 independent transceivers (Yaesu VX-3R) using amateur radio VHF & UHF bands, transmission speed from 1200bps; AFSK modulation, KISS protocol

Payload: low resolution C328 cameras (640x480 maximum resolution)

Sensors: temperature sensors and 3-axis magnetometer

Attitude Control System: passive ADCS system consists of permanent magnets and hysteresis rods

3 F-1 communication schemes for radio operators

3.1 UHF channel (only operational in daylight):

- Frequency: 437.485 MHz
- Modulation: Narrow FM
- Power: about 0.3W RF
- Antenna: half-wave dipole

There are 3 types of beacons:
3.1.1 Pulse -Width-Modulation Morse code telemetry

- Baud rate: 20 wpm (configurable)
- Beacon interval: every 60 seconds (configurable)
- Beacon length: 10 characters, about 25 seconds each transmission
- Note: F-1 broadcasts prefix “zz” and suffix “zz” in addition to the beacon string to avoid the loss of the first and the last characters during reception so please ignore these characters

Beacon format

<table>
<thead>
<tr>
<th>No</th>
<th>Data</th>
<th>Description</th>
<th>Size (bit)</th>
<th>Size (char)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>F-1’s callsign</td>
<td>“XV1VN”</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>OBC1 reset count</td>
<td>Number of OBC1’s reset since the beginning</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Temperature 1</td>
<td>oC (temperature inside F-1)</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Temperature 2</td>
<td>oC (temperature outside F-1)</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Parity bit</td>
<td>0 if sum of item No2 to No4 is even</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 if sum of item No2 to No4 is odd</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 parity bit</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Total</strong></td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

Note:
Temperature reading from sensors, will be added with 100 before transmission to ensure a positive number so please subtract 100 to get actual value
- 25 bits, divide to 5 chunks of 5bit, each chunk becomes one byte.

Example:

<table>
<thead>
<tr>
<th>Received Morse-coded string</th>
<th>zzXV1VN08CHHzz</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Callsign</th>
<th>XV1VN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data</td>
<td></td>
</tr>
<tr>
<td>Decimal value</td>
<td></td>
</tr>
<tr>
<td>Binary value</td>
<td></td>
</tr>
<tr>
<td>Bit stream</td>
<td></td>
</tr>
<tr>
<td>Group into bytes</td>
<td></td>
</tr>
<tr>
<td>Decimal value</td>
<td></td>
</tr>
<tr>
<td>Actual value</td>
<td></td>
</tr>
<tr>
<td>Data description</td>
<td></td>
</tr>
</tbody>
</table>

3.1.2 F-1’s callsign
Once every 7 minutes F-1 broadcasts its callsign “XV1VN” via PWM Morse code automatically
3.2 VHF channel (operational during night time but may be turned on in daylight later)

- Frequency: 145.980 MHz
- Modulation scheme: AFSK/FM
- Power: about 1W RF
- Antenna: half-wave dipole
- Baud rate: 1200bps
- Beacon type and interval: one AX.25 packet every 30 seconds (interval configurable)
- You can use the below table for decoding 14 bytes data

<table>
<thead>
<tr>
<th>FEND</th>
<th>Command</th>
<th>Data Type and offset</th>
<th>14 Bytes Data</th>
<th>FEND</th>
</tr>
</thead>
<tbody>
<tr>
<td>C0</td>
<td>00</td>
<td>02 00 00</td>
<td>08 80 00 81 7E 28 88 93 8E 8C 91 90 8F 8F C0</td>
<td></td>
</tr>
</tbody>
</table>

**F-1’s AX.25 packet format**

<table>
<thead>
<tr>
<th>No</th>
<th>Data</th>
<th>Description</th>
<th>Size (bit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Date time</td>
<td>Date: dd/mm/y: 5/4/3=12 bits Time: hh/mm/ss: 5/6/6=17 bits</td>
<td>29</td>
</tr>
<tr>
<td>2</td>
<td>Battery voltage</td>
<td>Battery voltage multiplied by 100, divide by 100 to get actual value</td>
<td>11</td>
</tr>
<tr>
<td>3</td>
<td>Solar cells voltage</td>
<td>Solar cells voltage multiplied by 10, divide by 10 to get actual value</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>Temperature 1 °C (side 1)</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>5</td>
<td>Temperature 2 °C (side 2)</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>Temperature 3 °C (side 3)</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>7</td>
<td>Temperature 4 °C (side 4)</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>8</td>
<td>Temperature 5 °C (side 5)</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>9</td>
<td>Temperature 6 °C (side 6)</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>10</td>
<td>Temperature 7 °C (inside solar cell)</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>11</td>
<td>Temperature 8 °C (onboard)</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td>112 bits = 14 bytes</td>
<td></td>
</tr>
</tbody>
</table>

Note:
- Temperature reading from sensors, will be added with 100 before transmission to ensure a positive number so please subtract 100 to get actual value.
- 112 bits, divide to 14 chunks of 8bits, each chunk becomes one byte.
- years beginning from 2012, current year = 2012 -> \( Y = 0 \)
4 Installation Guide

4.1 Environment Requirement

Due to all modules of the project are developed on .NET platform, production environment needs to fulfill these following requirements:

- Operating system: Windows XP, Windows Vista, Windows 7


4.2 Installation Package

User needs to download and install the following file: F-1 Telemetry Decoder (.msi file)
4.3 Installation Guide F-1 Telemetry Decoder


These following steps show installation guide for F-1 Telemetry Decoder.

**Step1:** Firstly, open the **F-1 Telemetry Decoder.msi** file.
When the license screen appears, read and click “Next” button if you want to setup the program.

**Step2:** On next screen, click “Browse” button to select destination folder, and finally click “Next” button to install.
**Step3:** Click “Next” to start installation

![Step3: Confirm Installation](image)

**Step4:** Installation success, click “Close” to finish

![Step4: Installation Complete](image)
5 User Manual

5.1 Application Overview

5.1.1 Available Features

The below list is available features for user

<table>
<thead>
<tr>
<th>No.</th>
<th>Functions</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Decode data (OBC 1)</td>
<td>This feature allows user to decode F-1 CW data (OBC1 on UHF)</td>
</tr>
<tr>
<td>2</td>
<td>Decode data (OBC 2)</td>
<td>This feature allows user to decode F-1 telemetry data (OBC2 on VHF)</td>
</tr>
<tr>
<td>3</td>
<td>Submit data</td>
<td>This feature allows user submit data that received</td>
</tr>
</tbody>
</table>

Table 5-1: Available features for users
5.2 User Manual for Functions
Our client software allows you to submit decoded data from F-1 to our server so at the first time running the software, you are recommended to input your personal information so that we can acknowledge your contribution.

5.2.1 Complete personal information
**Step 1:** Go to tab [Information]

**Step 2:** Insert your information then click [OK]

**Step 3:** Click [OK] to finish
5.2.2 Decode data (OBC 1)

The format of F-1 CW data (excluding possible prefix and suffix “z” characters):

<table>
<thead>
<tr>
<th>Callsign</th>
<th>Data (5 characters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>XV1VN</td>
<td>xxxxx</td>
</tr>
</tbody>
</table>

**Step 1**: Go to tab [OBC1]

**Step 2**: Input data string into [Textbox]
   - For example: you receive a string XV1VNABCDF
   - You should input “ABCDF”
   - Then click [Decode]

**Step 3a**: If your string is correct.

**Step 3b**: If your string is not correct (beacon checksum failed). A messages box will be shown
5.2.3 Decode Data OBC2

*You should connect this program with your transceiver first.

**Step1:** Go to tab [OBC2]

**Step2:** Click [New Session] button to connect program with your transceiver

**Step3:** Select configuration and click [OK]

**Step4:** The GUI of OBC 2 terminal

Don’t change!!!
Step 5: Click [Data Viewer] to view decoded data

Step 6: You can click [Save as...] to save data to CSV file.

5.2.4 Submit data
Go to tab [Information] and click [Submit data] button