Fox-Plus-A High Level System Design
DRAFT

1.0 Overview

This document is a very high-level system architecture description which is meant to define the Fox-Plus-A 1U CubeSat (CS) design in order to get ready for its Preliminary Design Review (PDR). This document will provide a brief high level description of all components and subsystems to be used on Fox-Plus-A.

Reference Figure 1, Fox-Plus-A Subsystems Block Diagram Rev C. Each solid box shown is a pcb in the CS. There are two major groups of cards, the Linear Transponder Module (LTM) and the Electrical Power System (EPS). These will be described in following sections. Payload will **not** be considered as part of this high level document. But the Fox-Plus Interconnect bus and Interfaces will be included.

The LTM and its subsystems have been used on previous Fox series CS. The difference for Fox-Plus is the use of Commercial Off-the-Shelf (COTS) components provided by ISISPACE. These components include the EPS (ISISpace ICEPS), the antenna deployment system (ISISpace AntS), and Solar Panels. This will require software changes for command and data handling as well as ground (testing) software. LTM interfaces to the ISISpace components will be dictated by ISISPACE specifications.

2.0 Linear Transponder Module (LTM)

The LTM is designed and built by AMSAT. It consists of three PCBs: the Legacy Internal Housekeeping Unit (LIHU), the Improved Command Receiver (ICR), and the RXTX. These boards have been used on previous Fox missions, and are still in use (for Golf-TEE). The LTM Interface Control Document (ICD) Revision v1.2 covers this module, its components, and interfaces.

2.1 LIHU

The LIHU is also referred to as the Command and Data Handling (CDH) unit. It is to be the On Board Computer (OBC) in command. (The EPS also has a computer but it is under the command of the LIHU). The latest version schematics for the LIHU is LIHU Check Schematic (25 Feb 2020).

UW HuskySat (HS-1) used the ISISpace AntS. The LIHU was modified with a 9 pin connector to interface and directly control the AntS via I2C and CAN. It was designated the Linear Transponder Interface (LTI). TBD As of this writing, I am unsure whether this will be necessary or whether the AntS will be controlled via commands to the ISISpace Power Integrated Unit (PIU) which is the controller for the ICEPS.

2.2 Improved Command Receiver (ICR)

As stated above, the ICR is still in use. The version to be used for Fox-Plus is schematic is v. __

2.3 RXTX

The RXTX has also still in use. This board contains the 2m receiver and 70cm transmitter used for the FM transponder. The version to be used for Fox-Plus is schematic is v.__.
The RXTX will interface to the ISIS antenna system (AntS) in a manner TBD. The interface will be determined by ISIS documentation (ISIS Antenna System User Manual ISIS.ANT.UM.001) and previous Fox documents.

3.0 Electrical Power System (EPS)

The EPS for Fox-Plus-A is an commercial off-the-shelf (COTS) module from ISISpace. They call it the ISIS Compact Electrical Power System 2 (ICEPS2). It is intended for 1U to 3U platforms and LEO missions. It consists of three parts: the Power Conditioning Unit (PCU), the Power Battery Unit (PBU), and the Power Distribution Unit (PDU). These three parts or components are implemented on the Power Integrated Unit (PIU) mainboard.

For Fox-Plus-A, the ICEPS consists of two physical components / boards: the PIU mainboard, and the PBP-4S1P battery pack. The PIU mainboard must be mounted to the LIHU via the PC104 connector. See section 5, Electrical Interfaces. The battery pack may be mounted anywhere in the stack.

The ICEPS2 Interface Control Document (ICD) covers the EPS in detail. Version 1.1 is the latest as of this writing. The PIU contains three functional elements: the Power Conditioning Unit (PCU), the Power Battery Unit (PBU), and the Power Distribution Unit (PDU). These are described below.

3.1 Power Conditioning Unit (PCU)

The PCU includes all electronics interfacing with the solar panels. The electronics are contained on the PIU mainboard.

3.2 Power Battery Unit (PBU)

The PBU includes all electronics interfacing with the battery pack and is located solely on the PIU board.

3.3 Power Distribution Unit (PDU)

The PDU includes all electronics interfacing with the LTM and microcontroller. It is part of the PIU.

4.0 Physical Structure

The 1U CubeSat structural components of Fox-Plus-A consist of the card stack (including battery pack), the solar panels, and the frame.

4.1 Card Stack

The LTM PCB are interconnected by the Fox-Plus bus via the QSH / QTH stacking connectors (refer to Section 5, Electrical Interfaces). The ICEPS2 connects to the LIHU via the PC104 connector (ISIS utilizes an abbreviated version of the PC104 called the CubeSat Kit Bus (CSKB) light.) As of this writing, no full card stack for Fox-Plus-A has been implemented. There will likely be changes to the LIHU PC104. The card stack will have stand-offs on the four corners of the cards as detailed in the AMSAT Linear Transponder ICD v1.2.

4.2 Solar Panels

The physical construction of Fox-Plus-A has yet to be built as of this writing. However, since the solar panels, frame, and antenna module will be COTS from ISIS, all should go together well. These are the main structural components of the Fox-Plus-A CubeSat.

4.3 Frame
As mentioned above, the CubeSat frame will be a COTS unit from ISIS. [Yes?]

5.0 Electrical Interfaces
Major Fox-Plus-A electrical interfaces consist of the QSH/QTH (together known as QxH) connectors for the card stack, solar panel connections, AntS connections, and the LIHU interconnects.

5.1 The AMSAT card stacking QxH pinouts are termed the Fox-Plus Bus. The latest version v1.0 can be found on the Fox-Plus GitHub website.

5.2 The ISIS solar panels connect to the ISIS PCU. These interconnects are documented in ISIS ICD _____.

5.3 The LIHU PC104 pinout is shown in the AMSAT Linear Transponder ICD v1.2, subsection 2.1.2.2. Other LIHU descriptions can be found in the same ICD under subsection 2.1.2.4 Signal Buses.

5.4 AntS connections are via MIL-STD-681 DB9 connector for I2C communications and 3.3 vdc power. RF connections are via (2) MMCX connectors. (The exact configuration needs to be verified).

6.0 Software
The Fox-Plus-A software is needed for two main functions: ground testing and flight software. The ground testing software should be nearly reusable from the last Fox-1 series, with changes for the new interfaces. The On-Orbit software will require greater modification from Fox-1 series as there are new modes. This has been documented in the Fox-Plus-A System Requirements.

7.0 Optional Experimental Payload
There are no plans for an experimental payload as of this writing. The payload possibilities for the future include a stand-alone Radiation Tolerant (RT)-IHU, camera or other instrumentation. If used, the experimental payload would interface to LIHU mainly via the PC104 connector so that power to the payload, provided by the ICEPS on the PC104, may be controlled by the OBC.