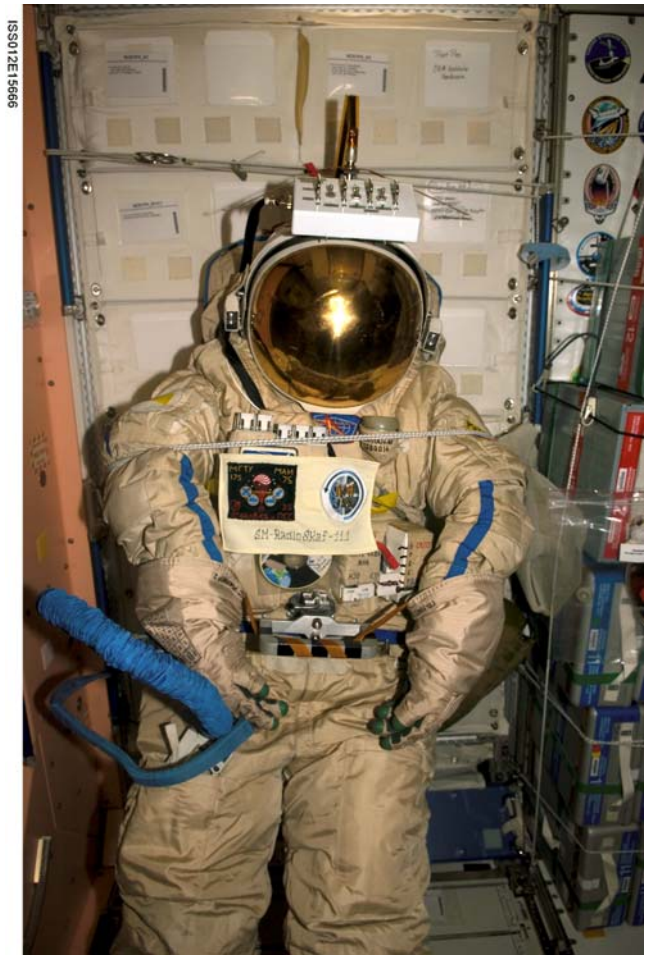
SuitSat-2

Lou McFadin
W5DID
June 2009

Suitsat 1 ready for Deployment



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SuitSat-1 Mission and Capabilities

Primary mission

Voice message Commemorating the 175thAnniversary of Bauman state University Moscow.

This included audio greetings from

Energia, Bauman State University, ARISS Europe, ARISS Canada, ARISS U.S.A. ARISS Japan

A CD ROM with photos contributed from schools around the world.

Secondary mission

SSTV images of Earth and Station

Amateur operations

Packet ops

Beacon

Earth sensor test data

Gather real space operating data and experience on several candidate sensors for Eagle.

SuitSat-2 Mission and Capabilities

Primary mission

Voice messages Commemorating (TBD)

This includes audio greetings from

Energia, ARISS Europe, ARISS Canada, ARISS U.S.A. ARISS Japan

A CD ROM with photos contributed from schools around the world.

Secondary Mission

Testbed for systems planned for future Amateur radio satellites

Amateur operations

CW ID

Packet ops

SSB Transponder

FM Cross band repeater

SSTV images of Earth and Station

Experiments (TBD-TSFR)

SuitSat-2 Top Level

- SuitSat-2 will transmit voice messages commemorating historic events as a primary objective.
- A second objective will be to use the suit as a test bed for Amateur Radio satellite operations including packet operations, SSB transponder, FM cross band repeater, and SSTV.
- Suitsat 2 will use a specially designed encoding protocol for the telemetry. This is designed to overcome the problems due to rotation and Doppler shift.
- Suitsat 2 also provides the opportunity to fly additional experiments designed by university students.
- A solar power system will also be used.

The Proposed Plan

- Build upon Suitsat-1 design
- Re-use safety interlock circuit with update for Solar panels
- Transmitter and Receiver module
- IHU Module
- Control Panel same as Suitsat-1
- New Power module for solar panels
- Solar Panels
- Up to Four Experiments
- Four Temperature Sensors
- Up to Four cameras for SSTV

Future Concept Testbed

- Use as a test bed for new concepts for future Amateur radio Satellites.
  - Satellite power system
    - Max power point converters for solar panel
    - Distributed Converters
    - Distributed Storage system
  - Software Defined Radio (SDR) Prototype
  - Additional experiments

SSTV

- SSTV
  - Four video ports
  - No power until switched on just before data take.
  - Four U.S. Supplied Cameras
  - No blank video
    - Processor examines video and skips if no image present

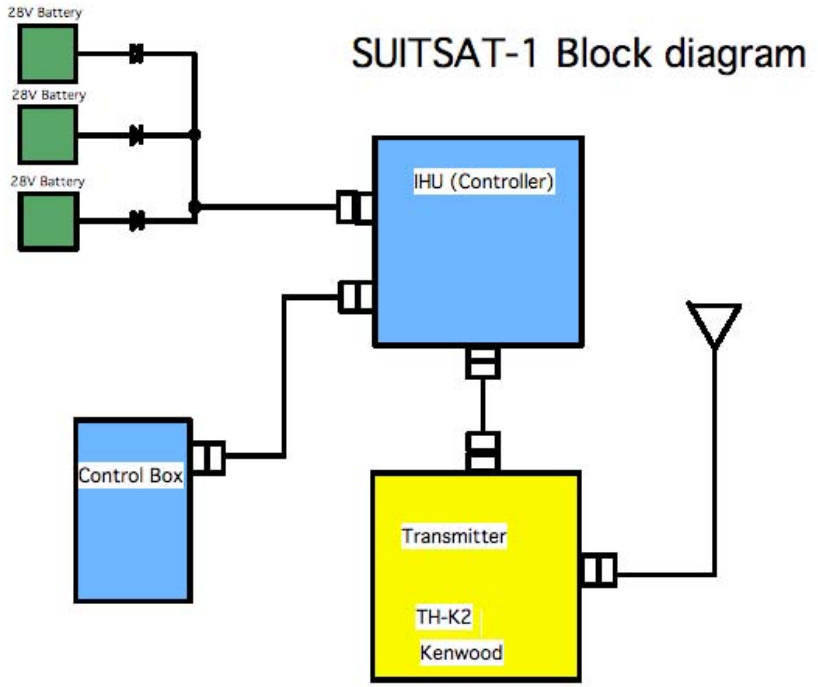
Experiments

- Experiment ports
  - Four ports
    - One reserved for MicroChip (Supplier of electronics) non commercial.
      - This experiment may be replaced by the Kettering University Experiment
    - One Russian
    - Data packets to be 2k Bytes transferred on request from the IHU.

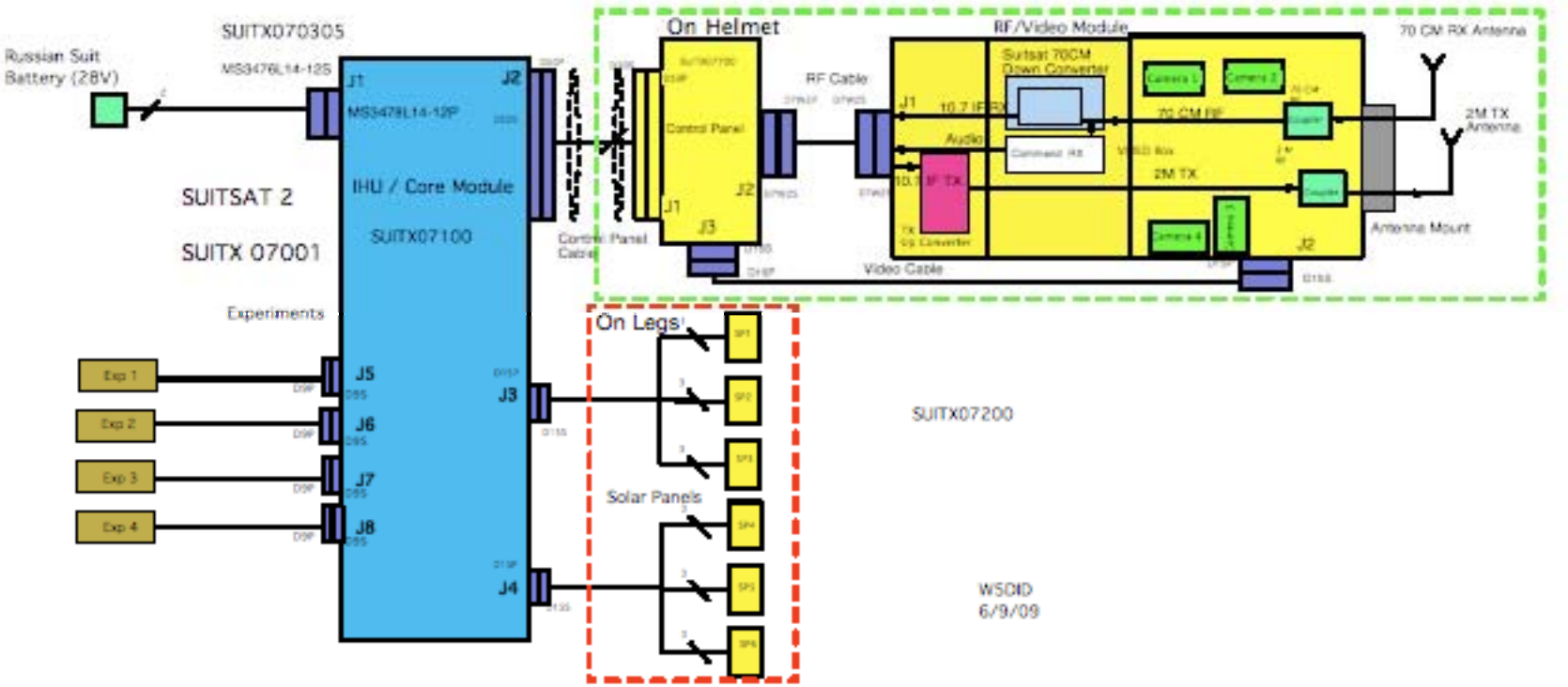
Radio Module

- Radio
  - SDX(Software Defined Transponder) Eagle prototype capabilities
    - Multimode
    - SSB Crossband (U/V) Transponder repeater with Telemetry beacon
    - FM-FM Cross band (U/V) packet
    - CW
    - Multiple signals simultaneously

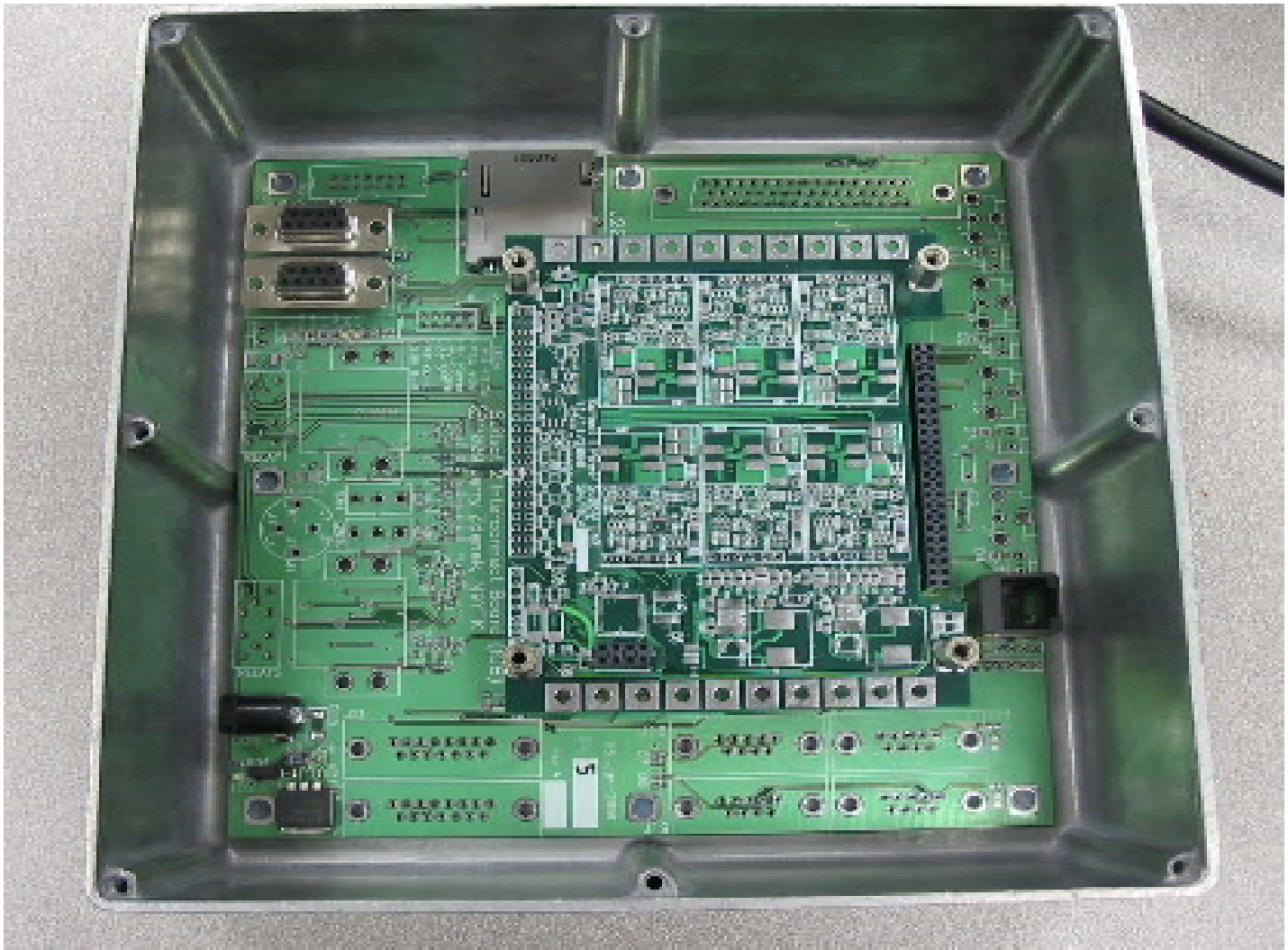
Suitsat-1 Block Diagram



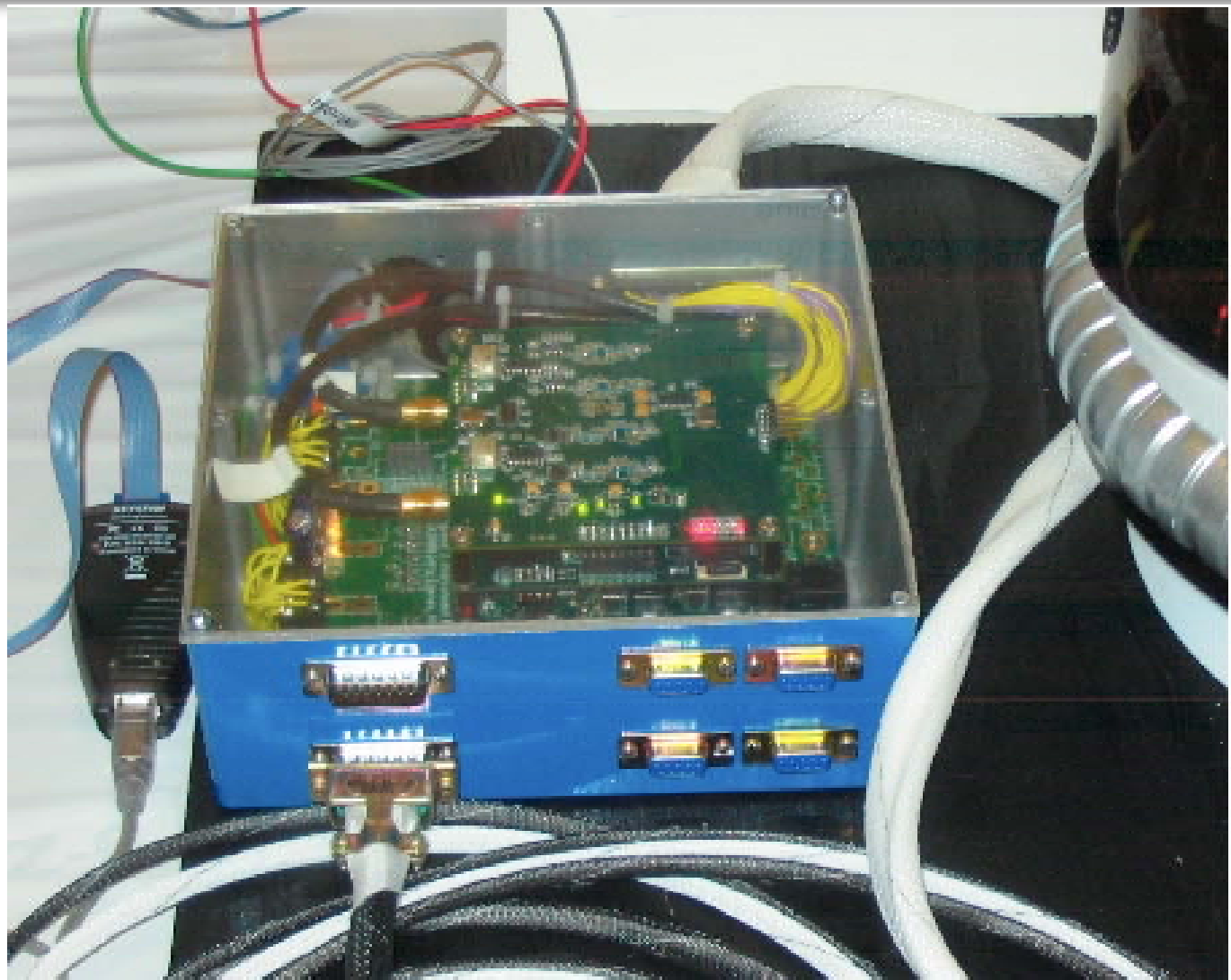
Suitsat 2 Interconnection diagram



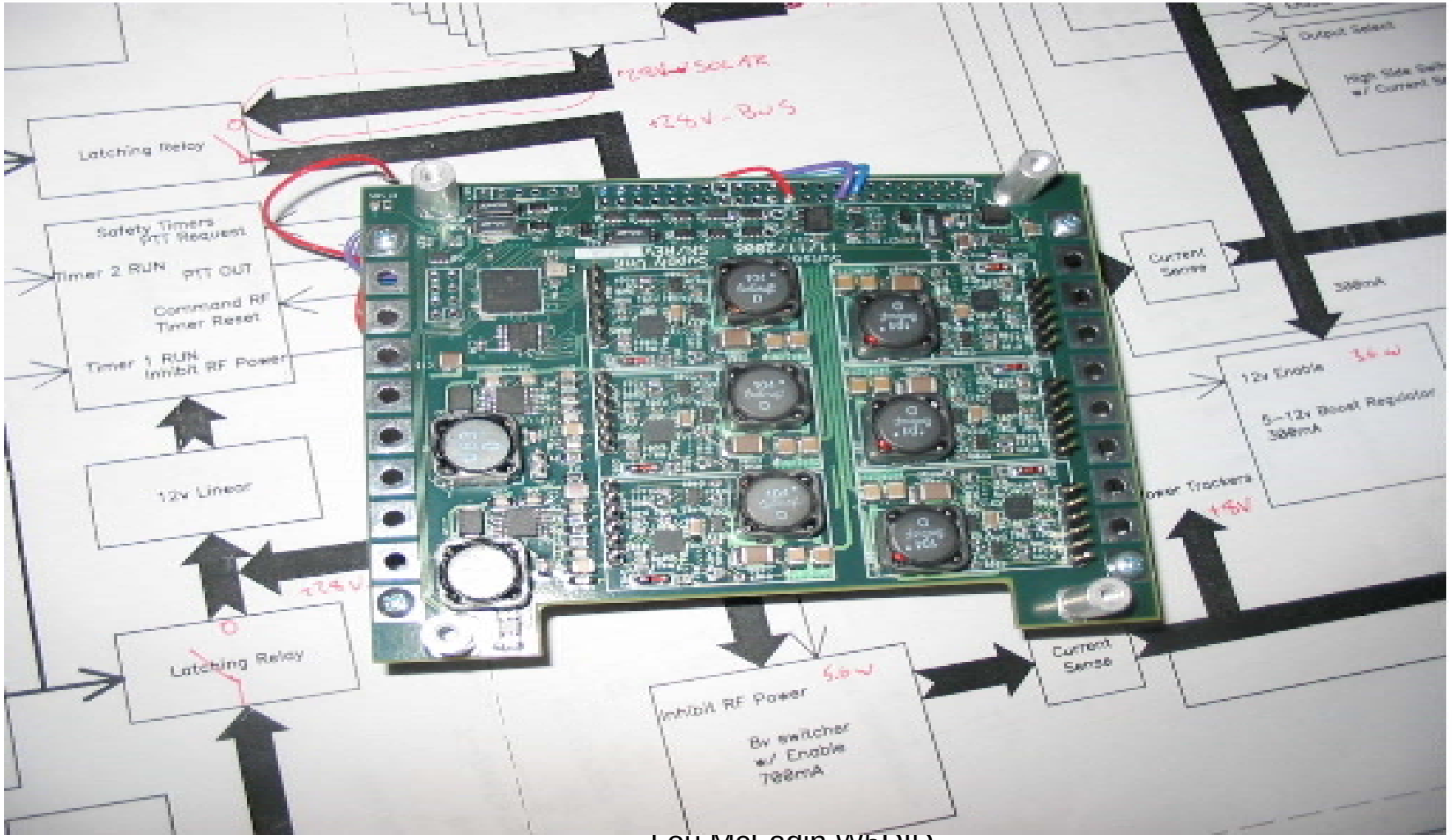
Inter Connecting Board in Housing



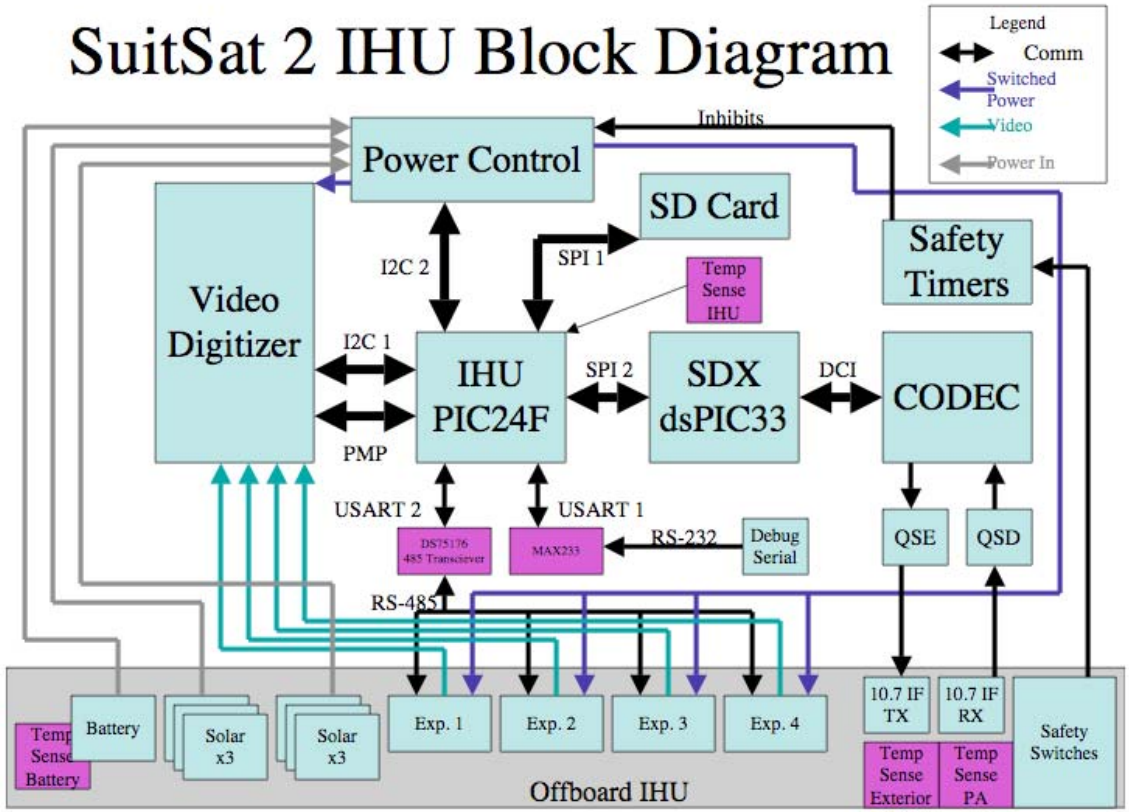
Suitsat IHU in Operation at Dayton



Suitsat Power Unit including Solar Power Converters



Suitsat 2 System Diagram



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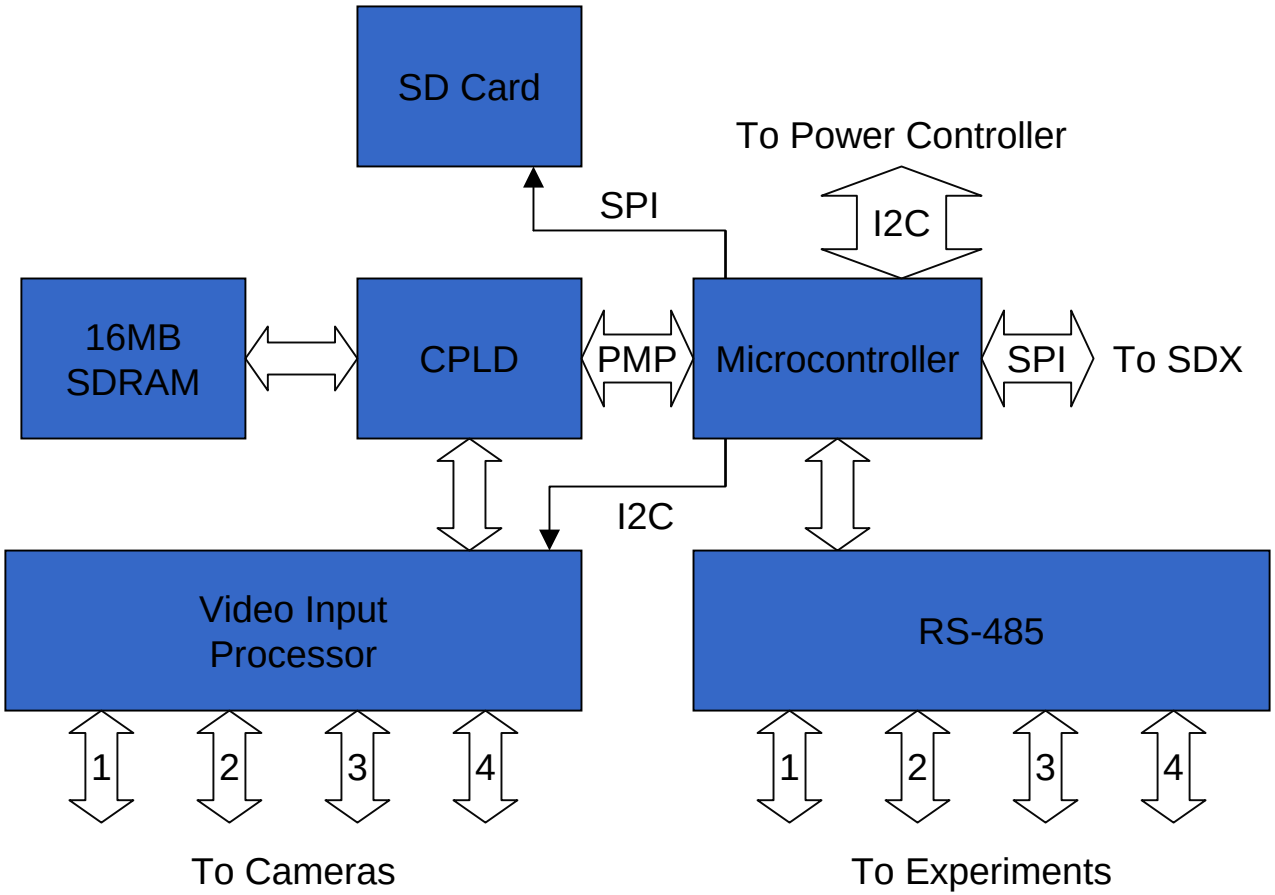
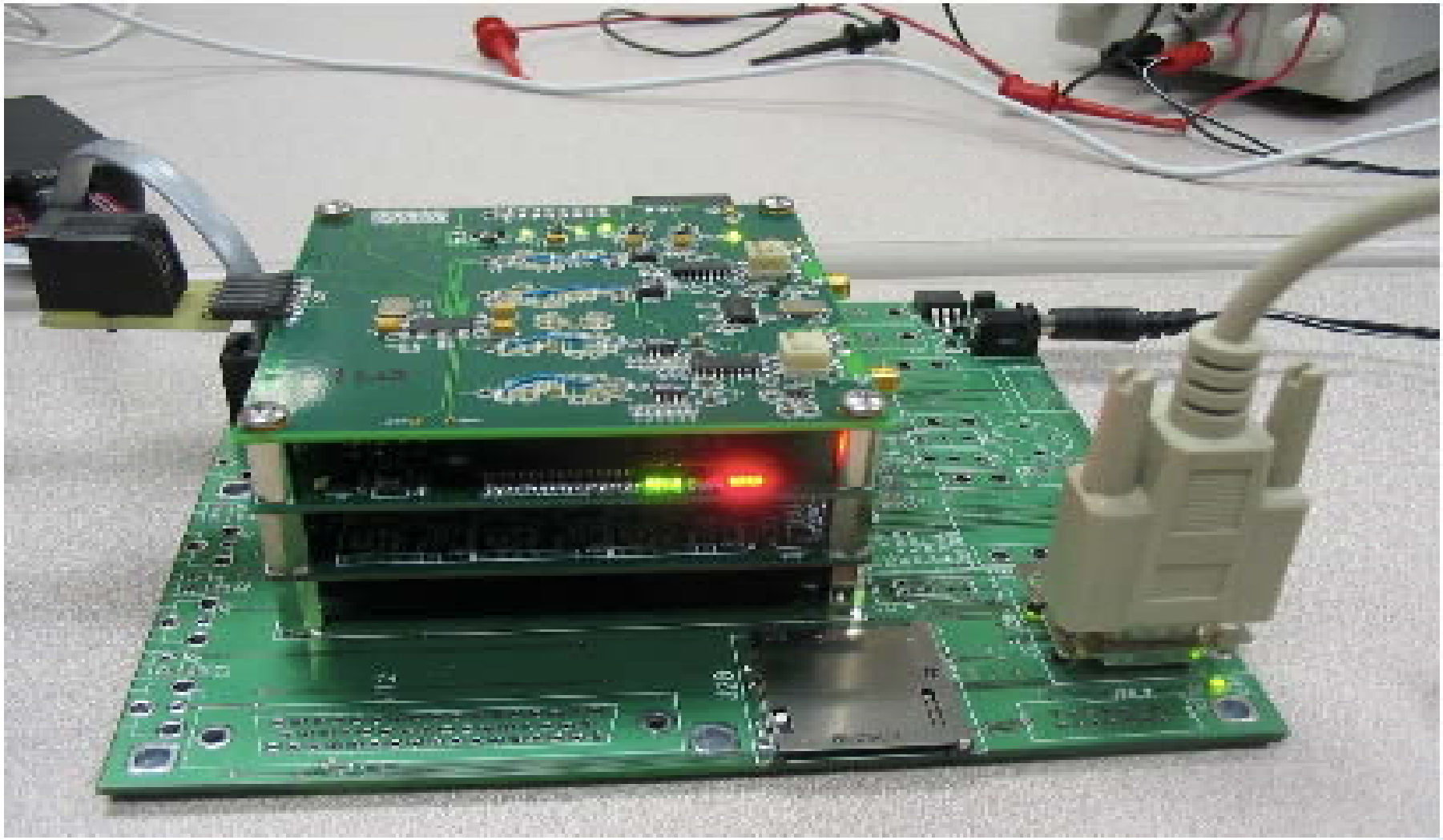
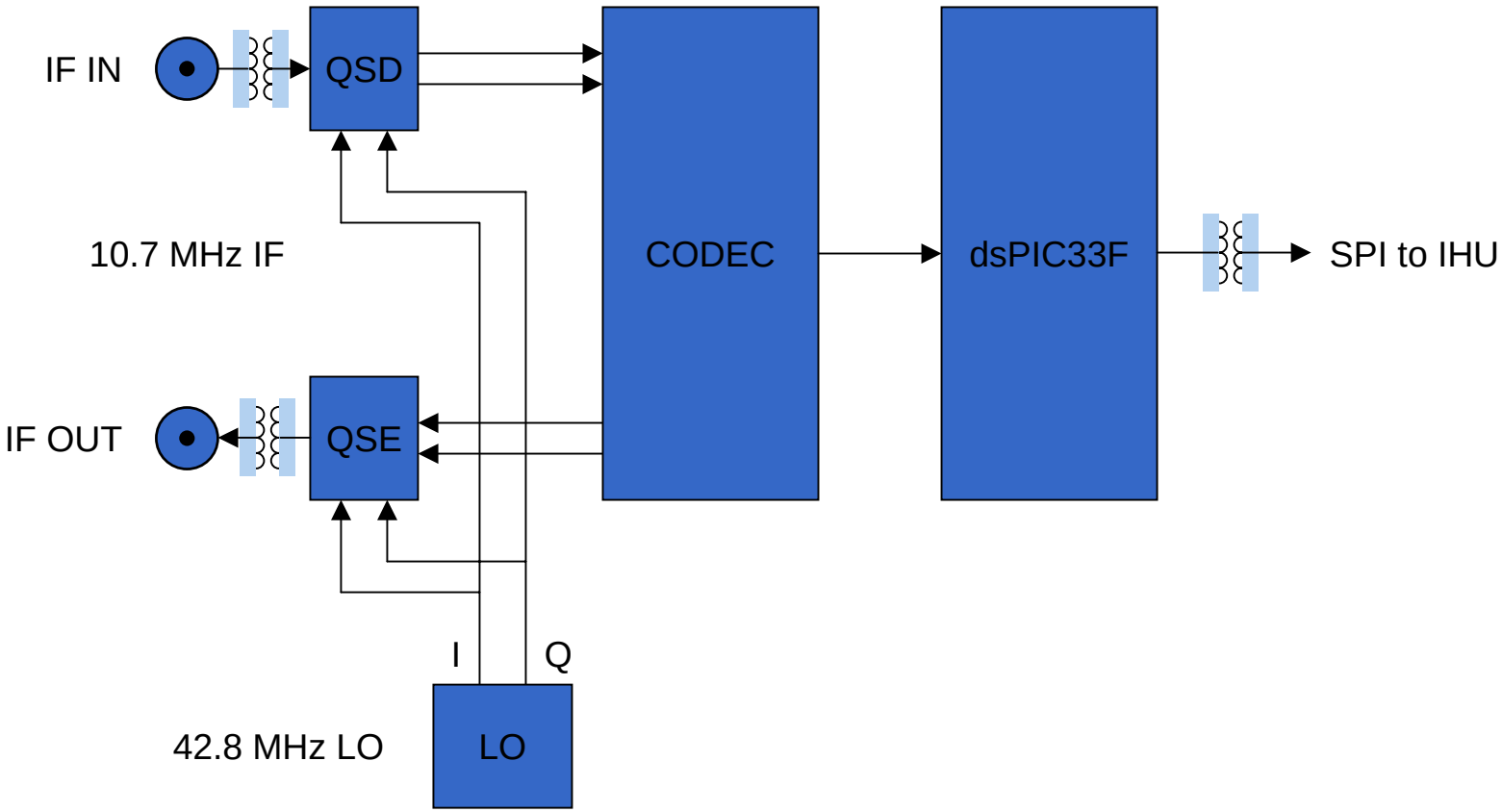
SuitSat-2 Internal Housekeeping Unit (IHU) Block Diagram



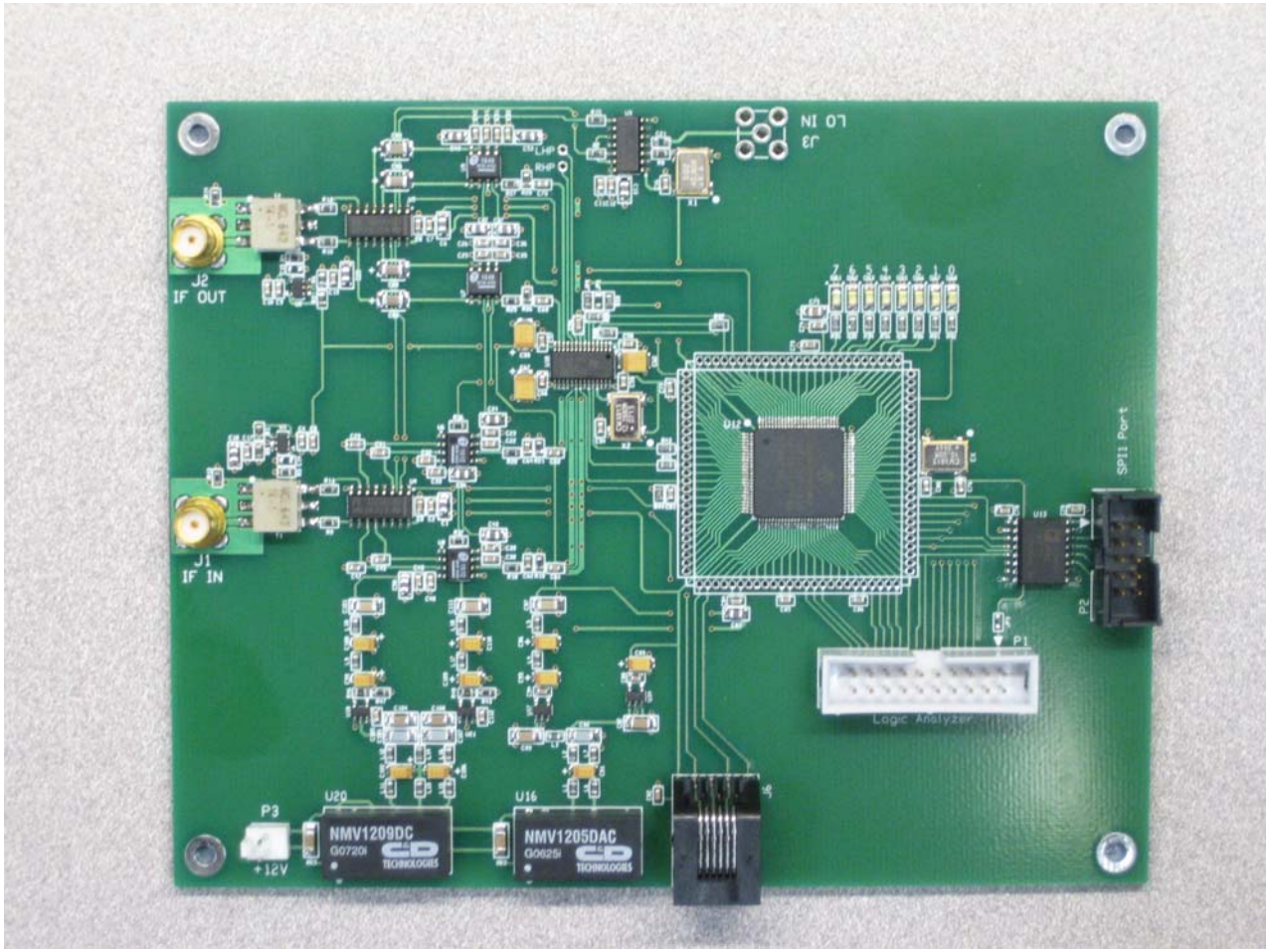
Suitsat 2 IHU stack in operation



SuitSat-2 Software Defined Transponder (SDX) Block Diagram



Suitsat 2 SDX first prototype



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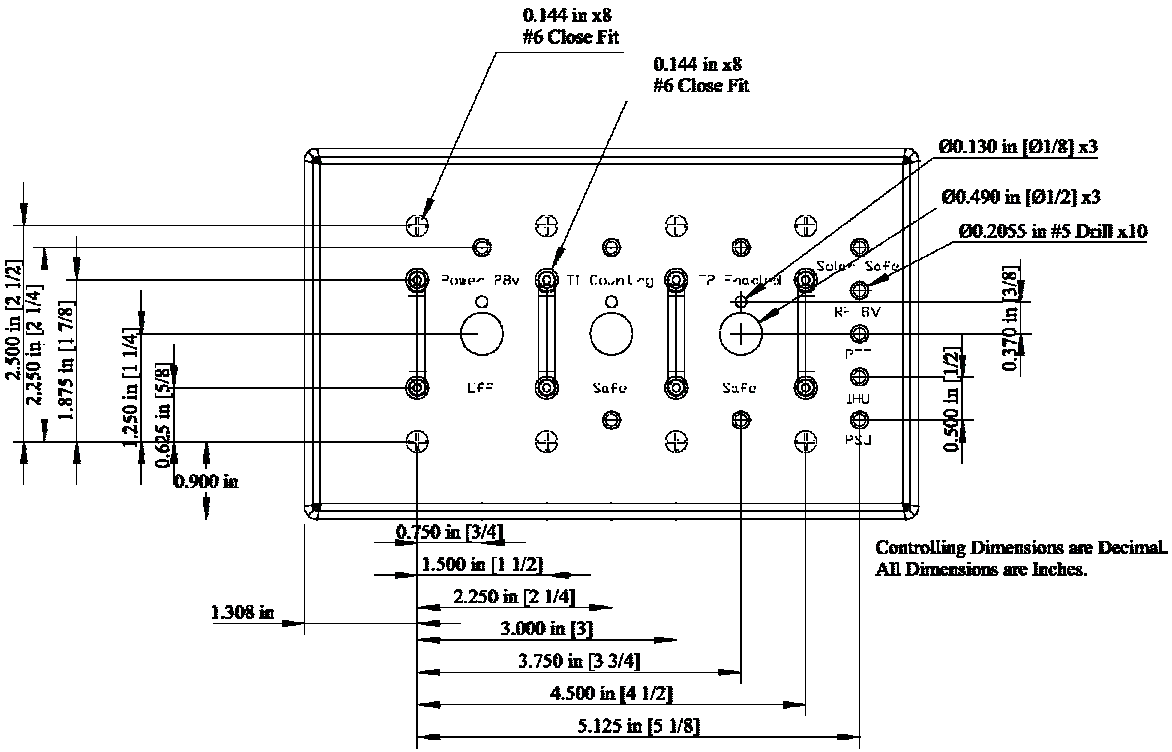
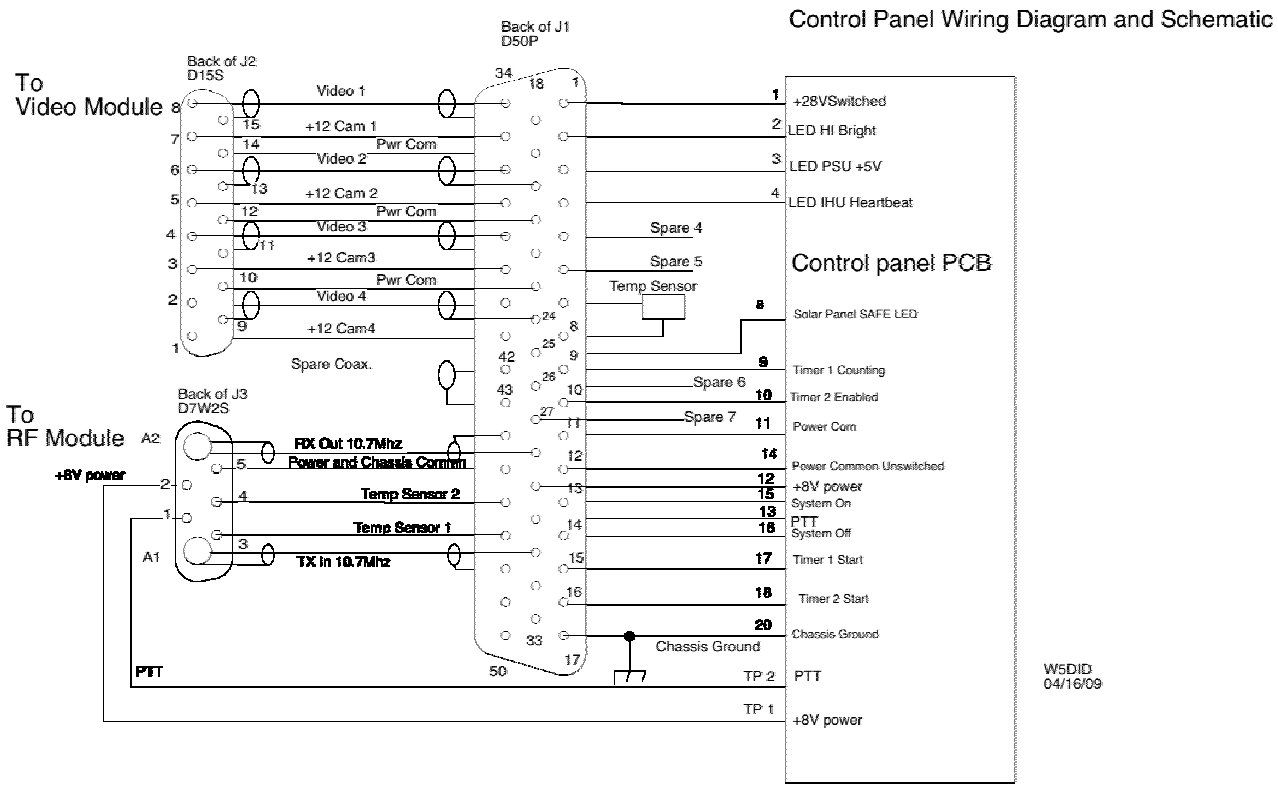
Panel Controls



Suitsat 2 Control Panel



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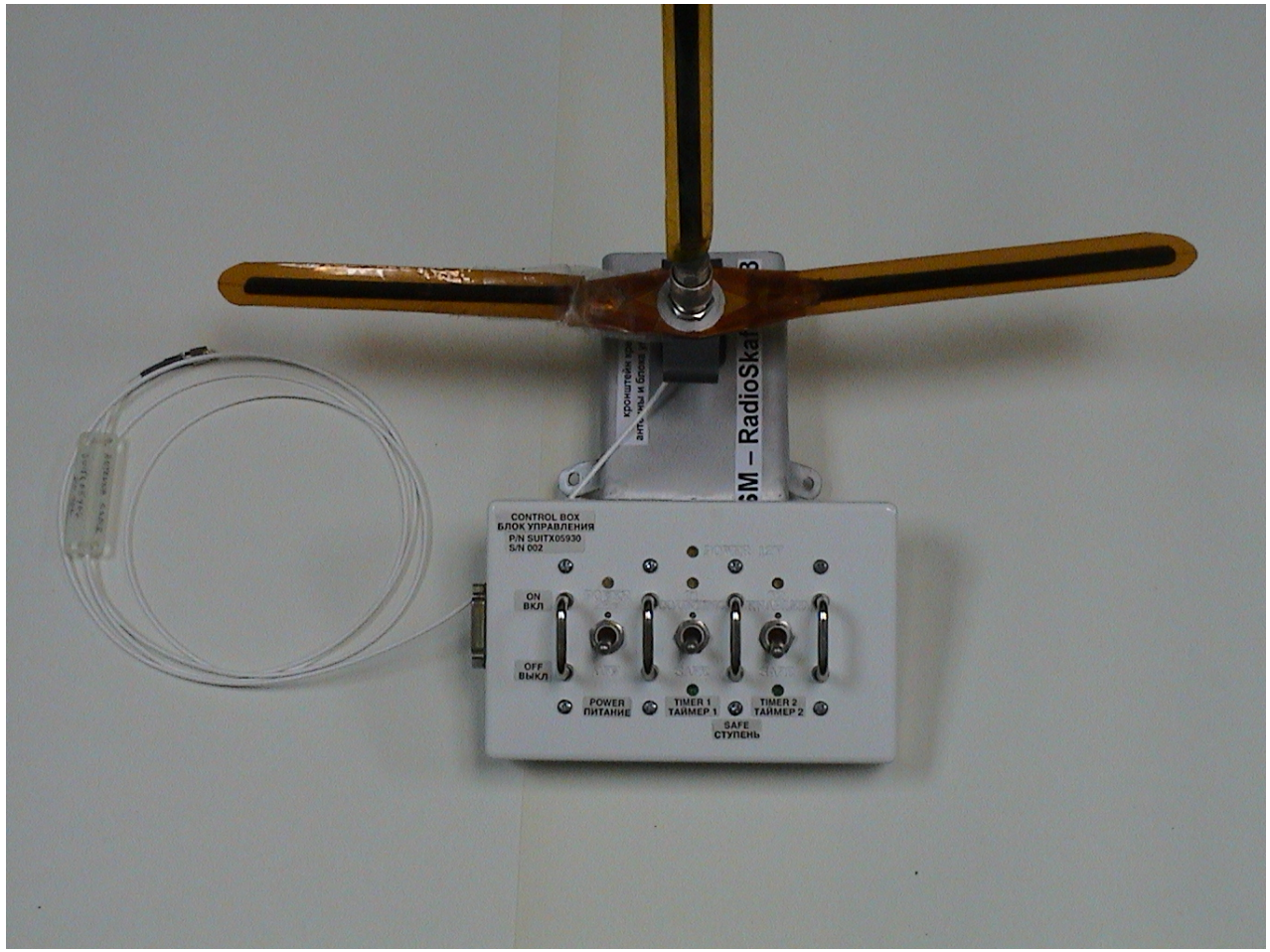
Suitsat 1 Antenna



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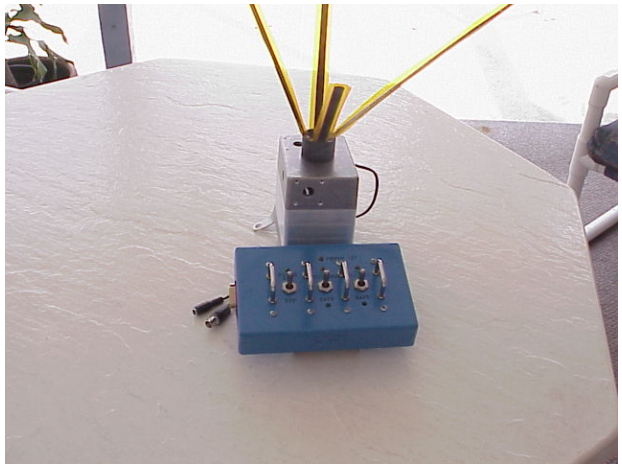
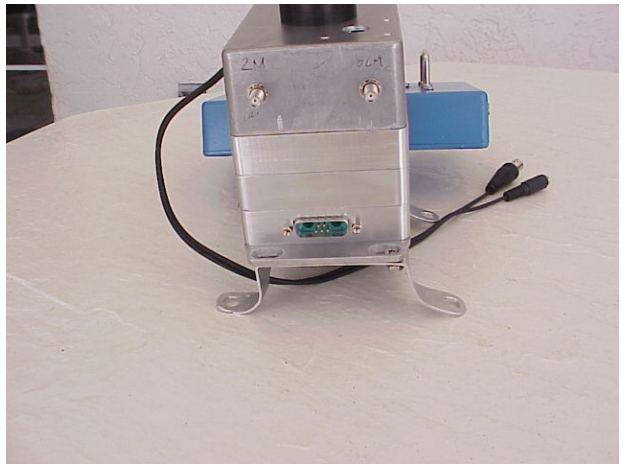
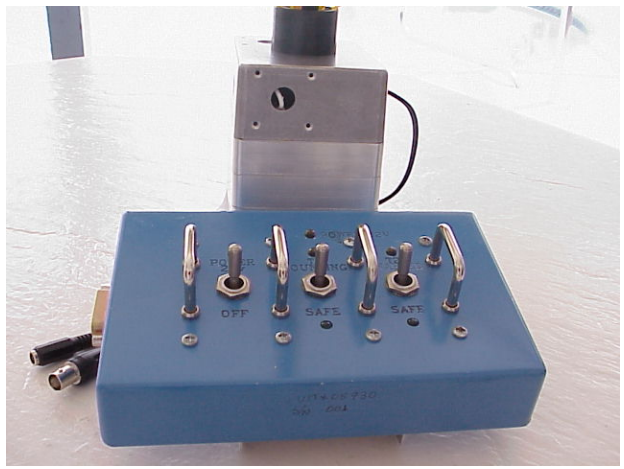
Suitsat 2 Antenna & RF assembly

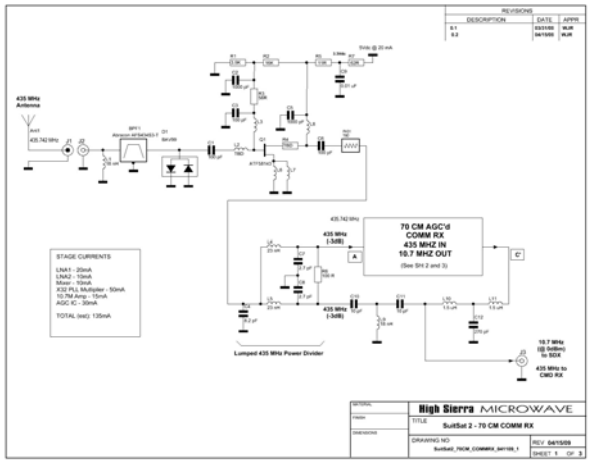


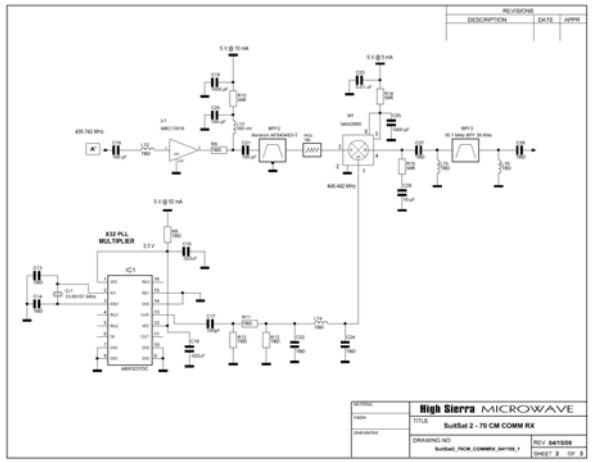


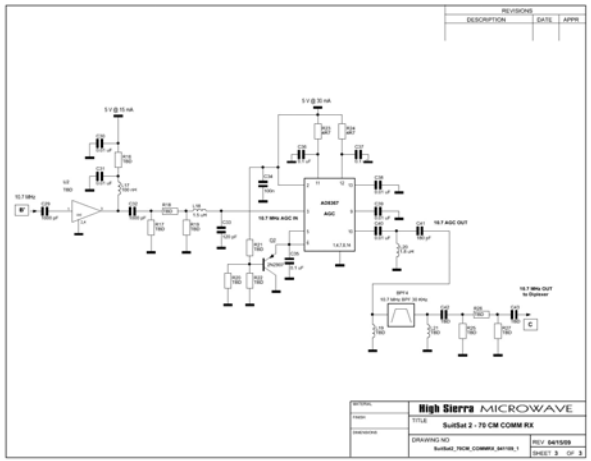


- Suitsat 2 Antenna and RF system is a fully modular system. It will be delivered as a tested operational module needing only one cable connection and mounting on the helmet.

Suitsat 2 Receiver

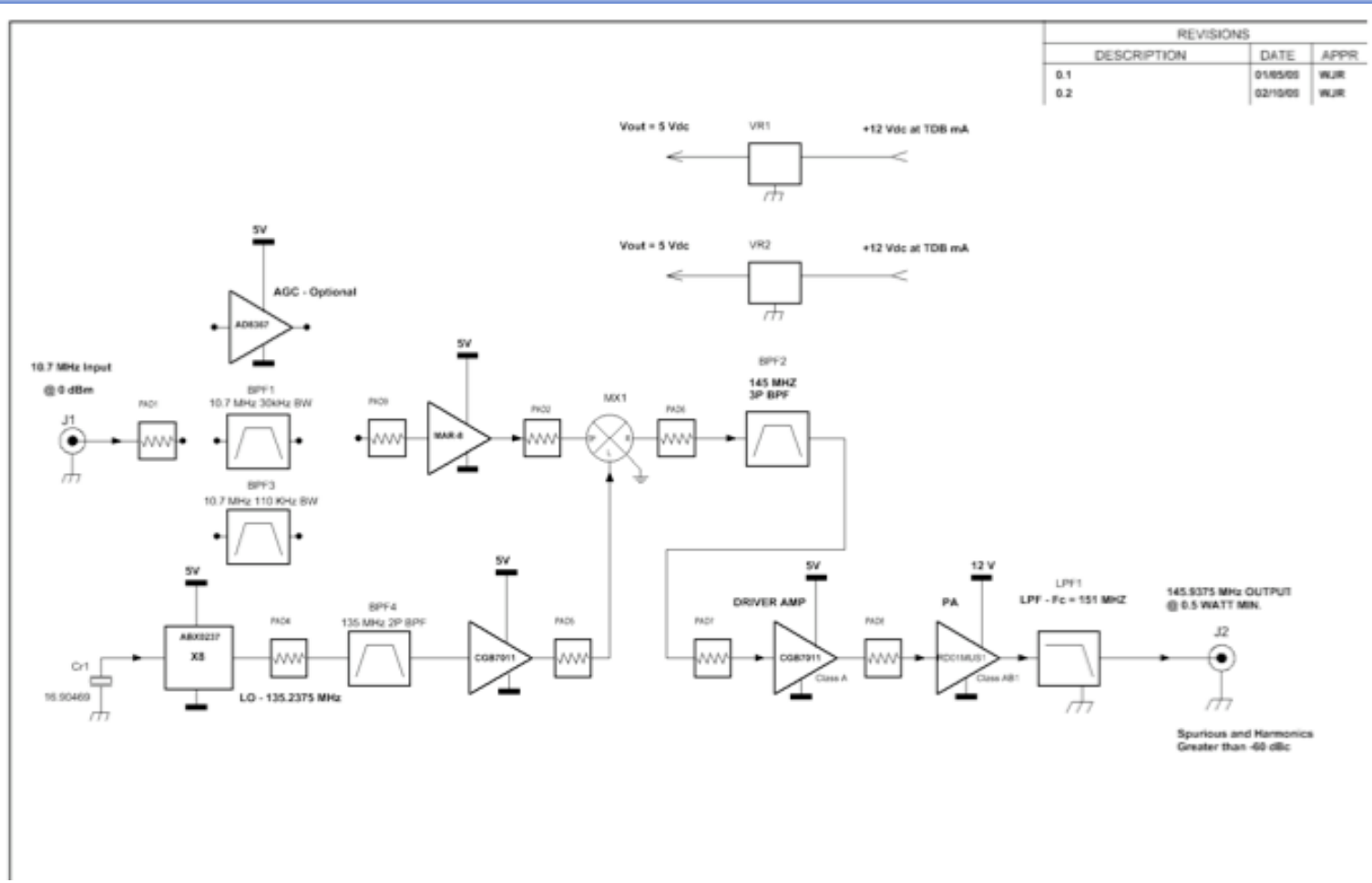


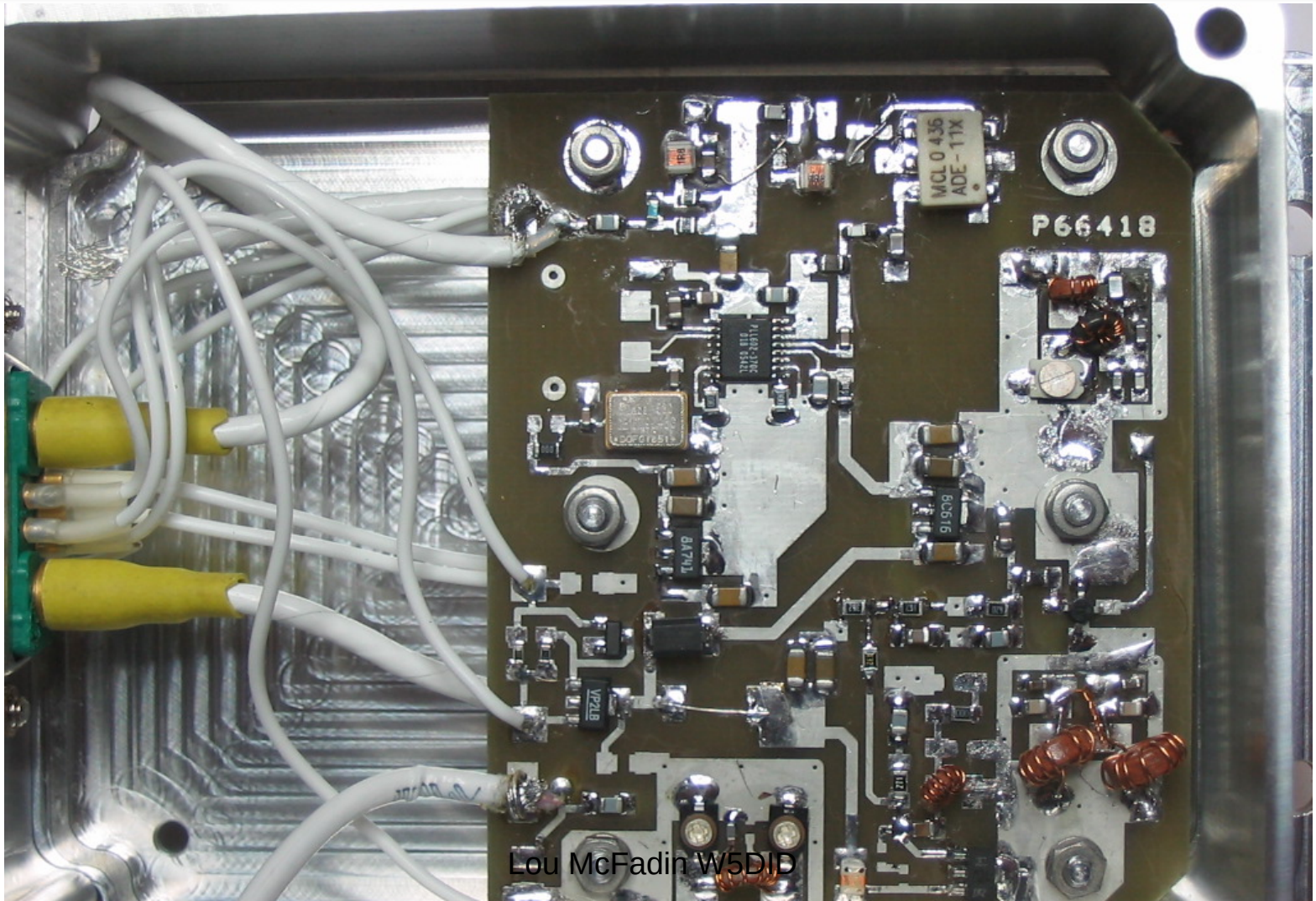




The Suitsat 2 receiver module includes two receivers. One is the communications receiver and the second is an independent Command receiver.

Suitsat 2 Transmitter





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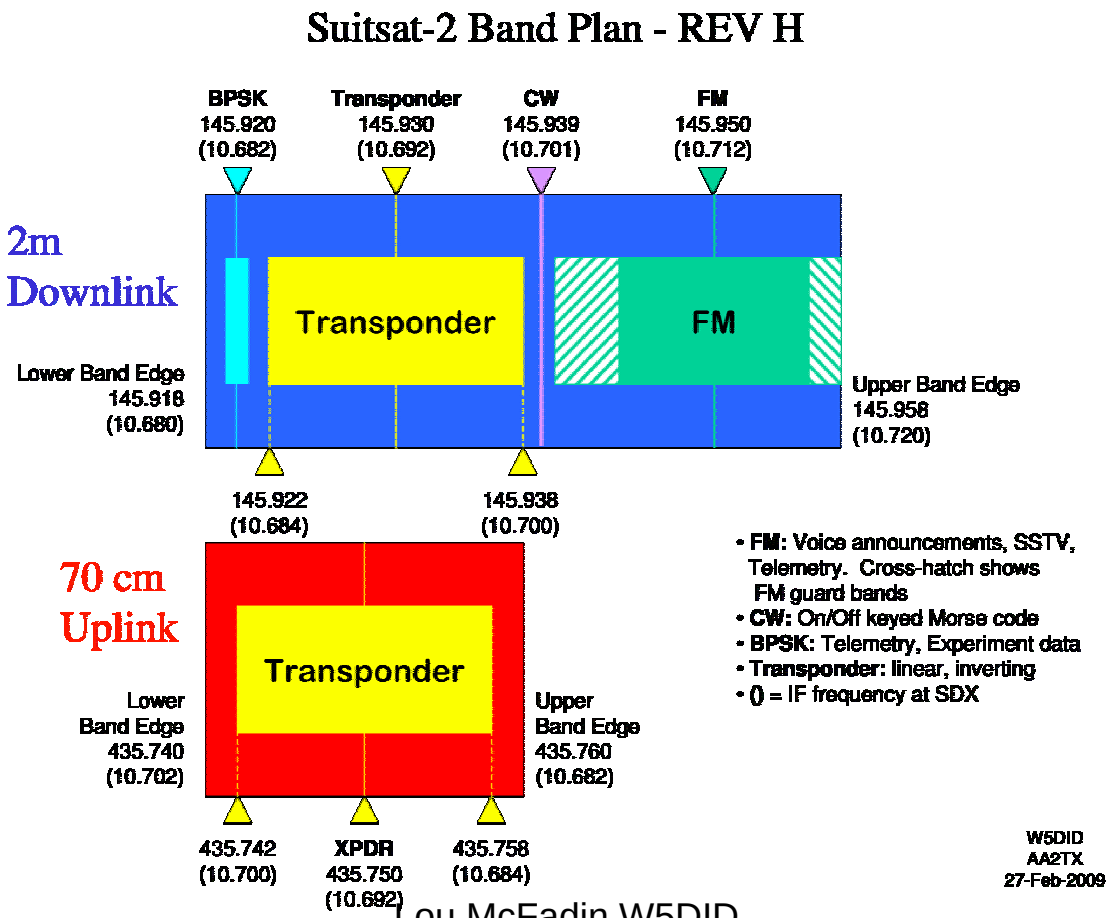
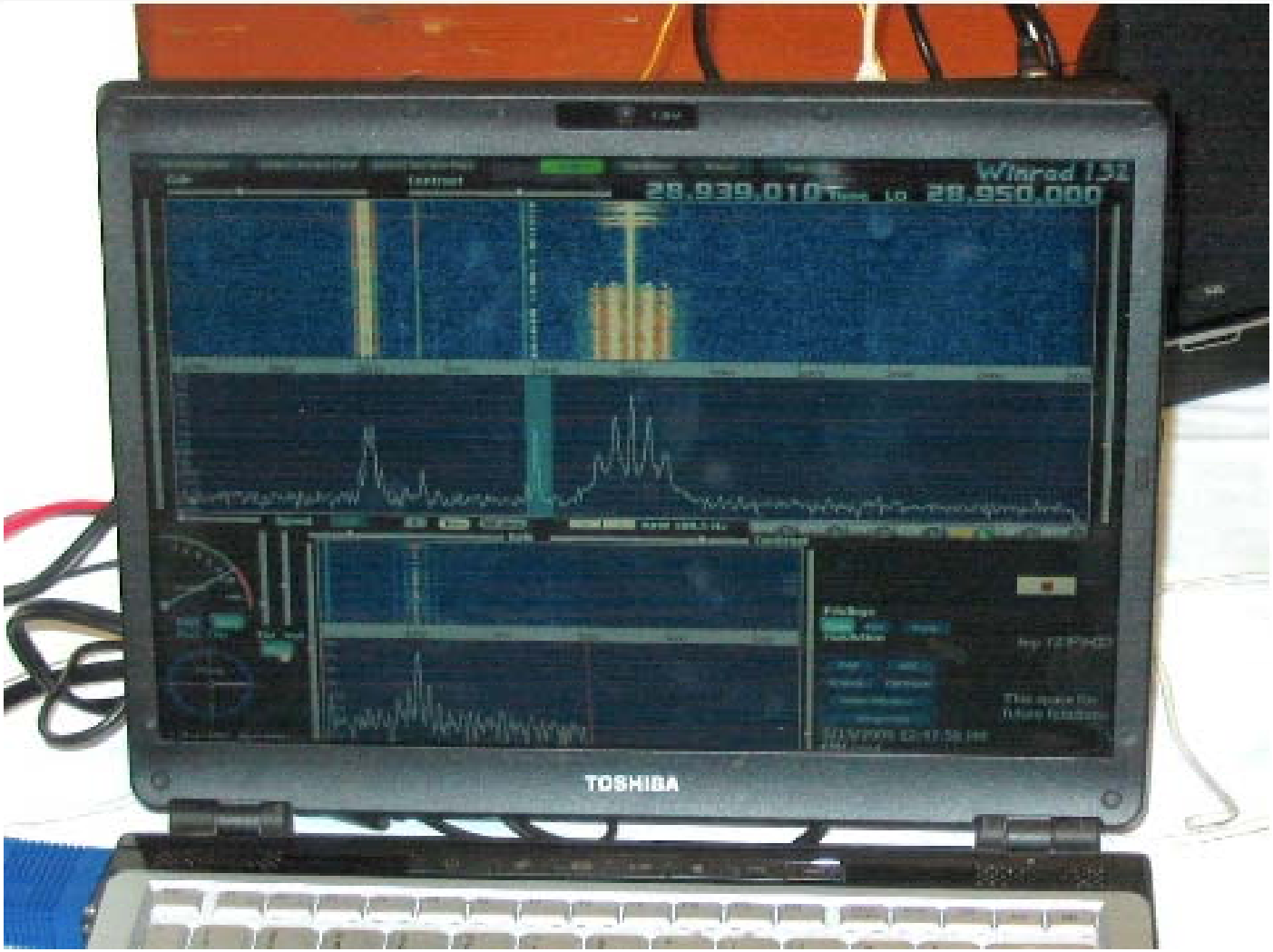
Proposed Suitsat 2 Band plan



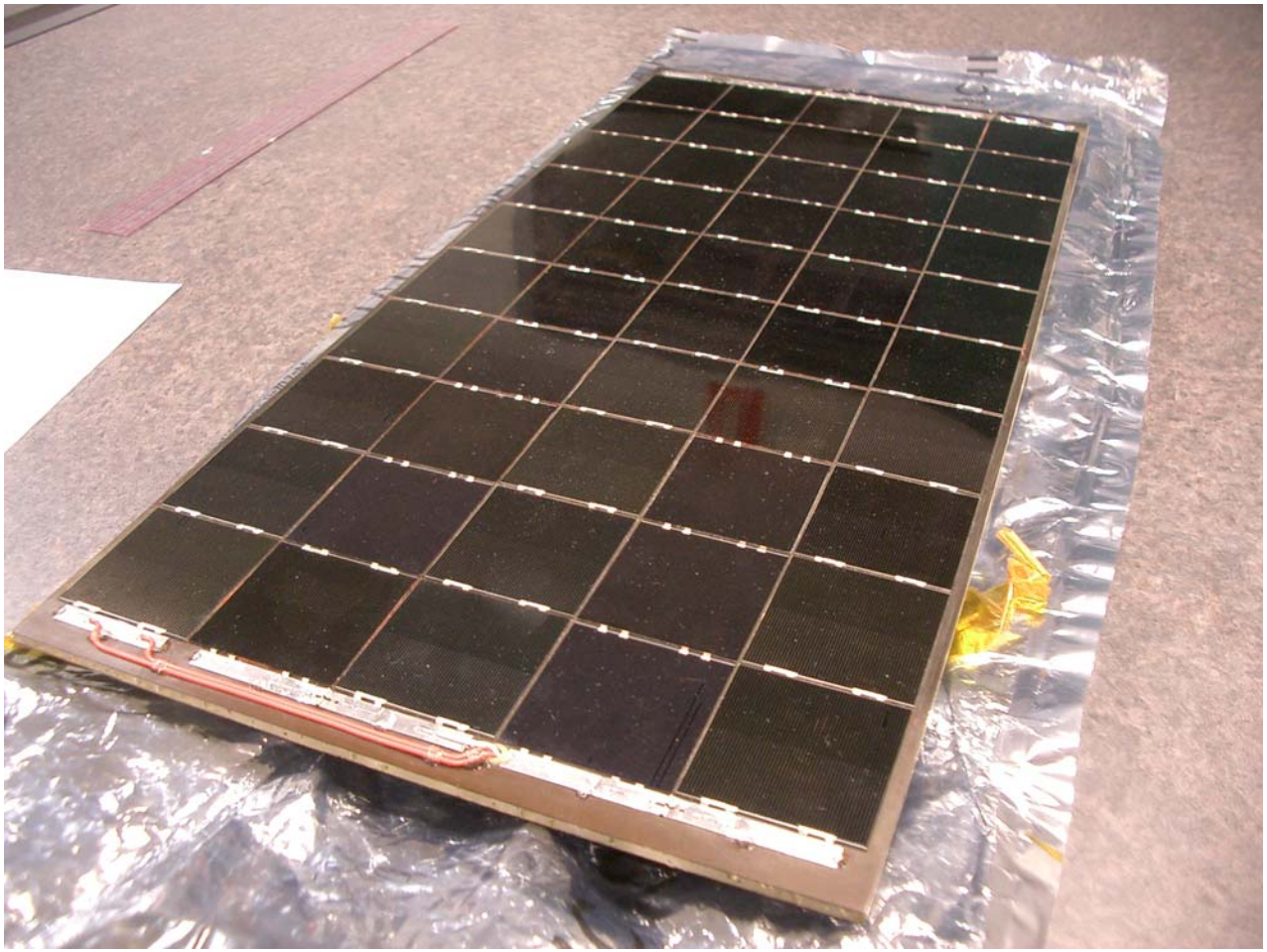
Suitsat Signals



Solar Power System Plan

- NASA supplied.
- Surplus from previous NASA SMEX (SMall EXplorer) satellite program.
- Power converter based on planned Eagle design.
- Designed to charge the surplus ISS Russian Space Suit batteries.

SMEX Solar Panel



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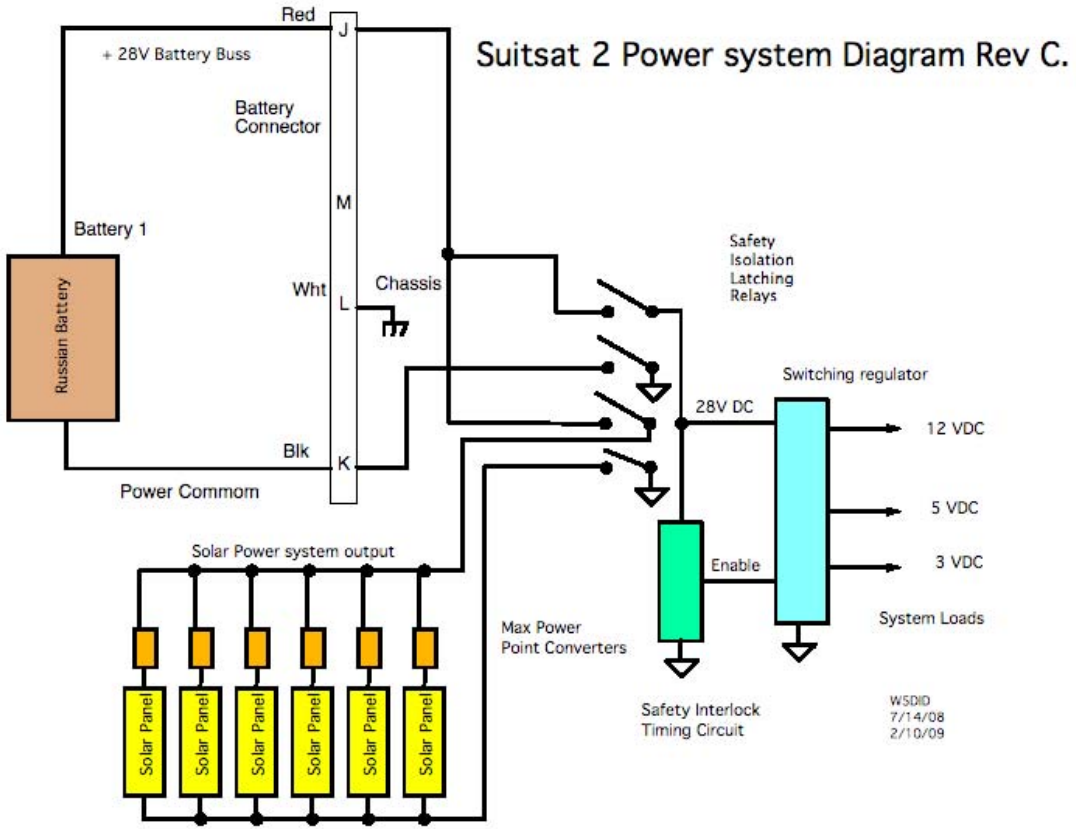
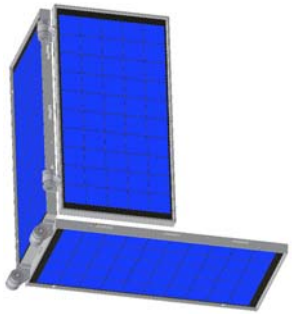
Power system will utilize a Russian Suit Battery

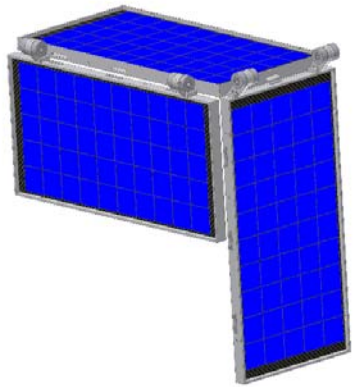


Suitsat 2 Solar Panel Assembly

- SMEX Panel is mounted in hinged frame that is closed until deployed outside cabin.
- Panel secured closed by three two sided Velcro straps and attached to suit inside cabin.

Solar Panel Deployment proposals





- Solar panels to be attached to the leg / boot.

Scientific Experiments

- The ARISS team will work together to determine how to select the schools that will fly experiments on SuitSat-2.

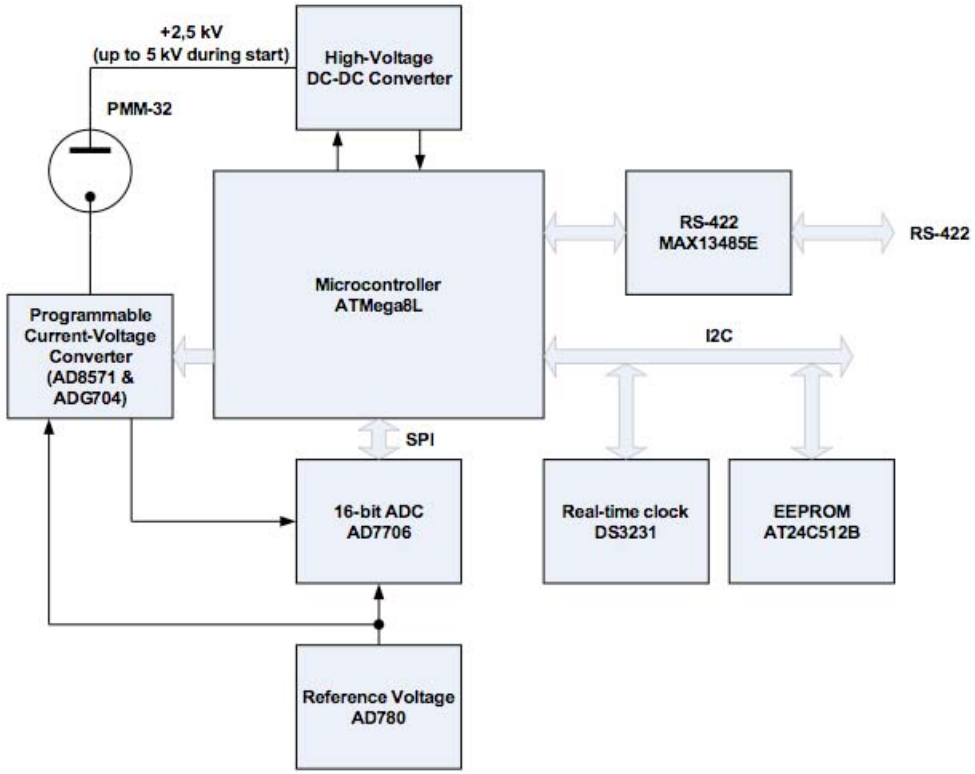
- Four CCD cameras will take pictures and whichever one has the image will be encoded and transmitted to the ground. The formats available will be Martin, Scottie- 1 and Robot-36. Cameras have been identified, but have not yet been purchased and will need to be certified.

The Kursk University Experiment

- The experiment is designed to measure the unevenness of the vacuum atmosphere in the vacinity of the Suitsat 2

- It must be mounted so that it is exposed to the atmosphere outside the suit.
- It must send it's data to the ground via the Suitsat 2 telemetry system

University of Kursk Experiment Block Diagram



Kursk Experiment Sensor

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Kursk team examining mounting possibilities

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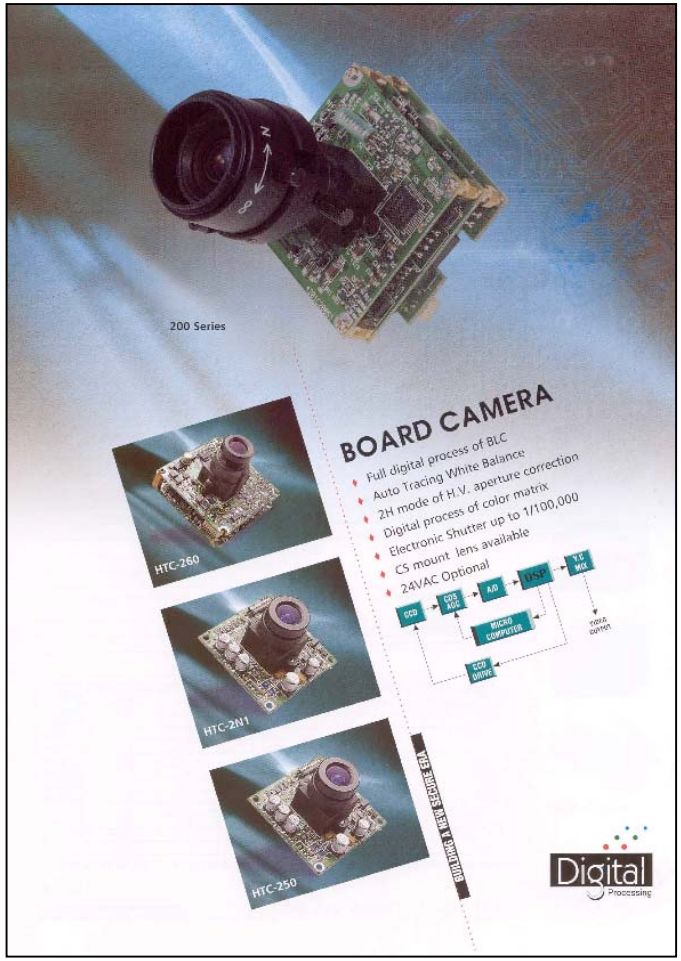
Suitsat 2 Camera



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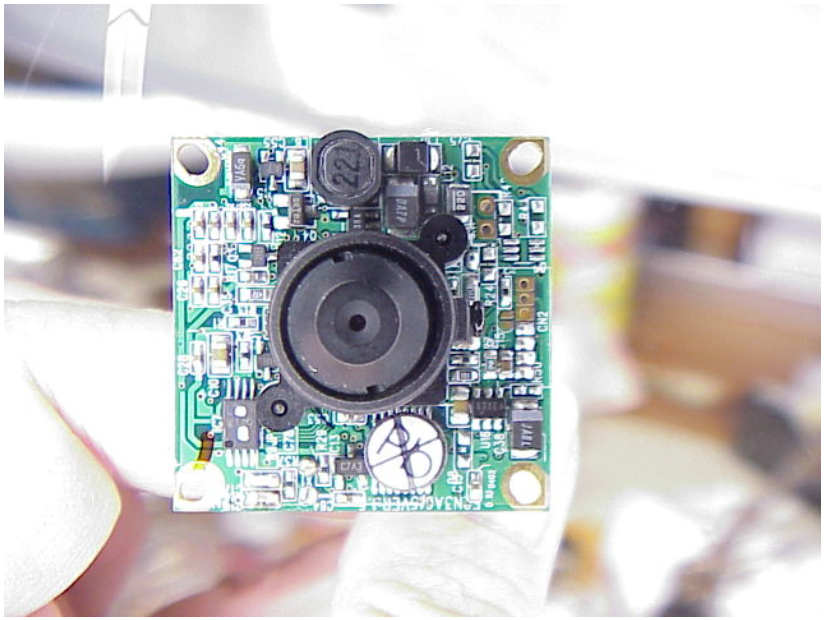
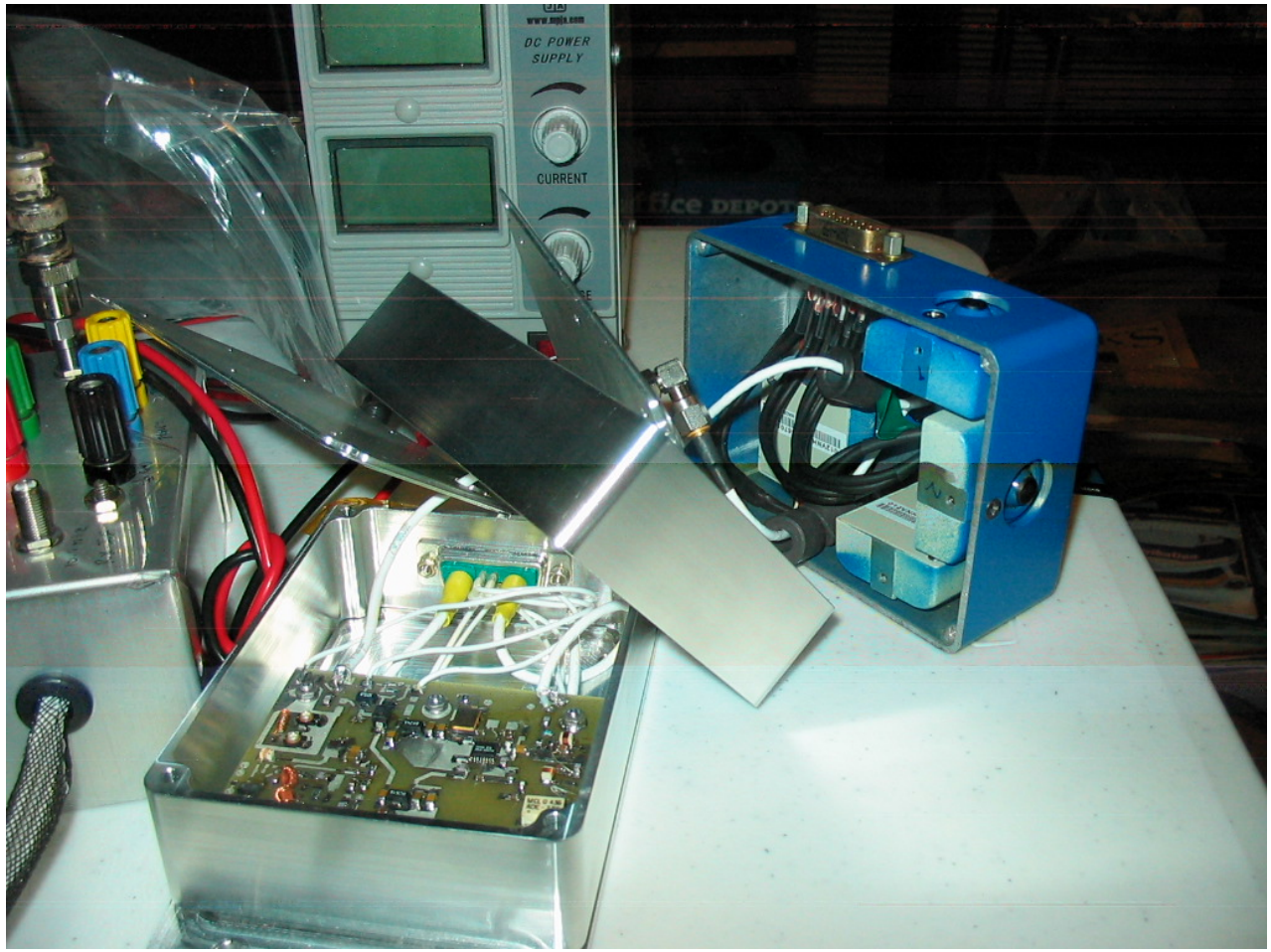
Hunt 2N323s Camera



Camera mount on helmet



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Suitsat Current Status

- Hardware
  - Prototypes of most systems have been built.
    - IHU prototype built and next generation in fab
      - Prototype housings built. Awaiting final approval to fab flight housings.
    - Power system prototype built and in test
    - Transmitter prototype built. Flight unit design in process
    - Receiver design complete PCB is being designed
    - RF module housings built. Currently in process of passivating the outer surface.
    - Helmet mounting bracket design complete. Ready for final approval and fabrication of flight brackets.
    - Antenna prototypes built in test
    - Video Module built and in test
    - Solar panel mount prototype built. Ongoing discussions on ways to attach to Orlan Suit.
    - Cable fabrication in process

Suitsat 2 Current status Cont.

- Software
  - First build of DSP software complete and in test.
  - IHU software build in process
  - Video and SSTV software first build demonstrated working at Dayton.
  - Telemetry software in process

What does the Amateur community get from Suitsat 2 ?

- Lot's of opportunity for good publicity
- Development of a new concept in the design of amateur satellites.
  - Software defined transponder
  - Maximum power point Solar power converter
  - Modular Receiver and Transmitter concept
  - An entirely new and robust telemetry encoding system capable of withstanding deep fades and Doppler effect.
- A system that can be used in the future to build small satellites on a quick turnaround basis.