A PC104 Based BeagleBone Black Integrated Architecture and Tracking System for CubeSats

Andrew Santangelo, sci_Zone
CDW 2019
sci_Zone, Inc.

- Established in 2003
- Located in Holland, Michigan and Rio Rancho, New Mexico
- Core competencies: software development, satellite design, systems engineer, DO178B, Flight Systems, and Communications
- Customers include Space Dynamics Lab, AFRL, DARPA, NASA, DornerWorks, and Leidos
LinkStar
A Paradigm Shift in Satellite Communications
LinkStar-D, HD Duplex

Product Features

• No deployables
• up to 4.82 cm diameter circular patch for duplex
• Rapid acquisition
• Data rates
  • up to 70 kbps maximum
  • SMS Uplink Messaging
**LinkStar Product Features**

- Almost anytime, anywhere vehicle Telemetry, Tracking and Control
- Common FCC Satellite-to-Satellite License
- No Amateur bands
- No satellite to ground license required
- Globalstar will work with sci_Zone on obtaining FAA and FCC licenses
- Ground station over Internet Protocol (IP)
- **Access your vehicle from anywhere!**
- **Piggy-backs on established 2 billion dollar network**
- **Low Cost**
A Large Global Coverage Area for the LinkStar duplex
LinkStar-STX3

A Simplex Radio
The **LinkStar-STX3**

- Beacon payload data only
  - GPS Data
  - Battery Life
  - Flight Data
- No control capability
- Can work with *LinkStar-HD, S-Band, etc* or standalone
- Full coverage U.S. for UAV, High Altitude, Vessels, other vehicles
- Near global coverage in space
The LinkStar Architecture

- LinkStar-STX3
- LinkStar-HD
- LinkStar-STX-PC104

Other radios

LinkStar STX

QuickSat

- Industrial BeagleBone Black Flight Computer

OEM-615, OEM-719

ADA Fruit UltimateGPS GPS

MAI-400

Sensors

Actuators

Other Computers

sci_Zone, Inc.
www.sci-zone.com
The LinkStar-STX3-PC104

- Complete Support for CubeSat Bus
- Powered by the STX3
- Integrated Flight Computer
- I2C Control
- Integrated GPS
- Global tracking
- Global coverage
Interfaces
Integrated GPS

**OEM719 GPS with the **LinkStar-STX3-PC104** provides global tracking in space from ANYWHERE in Low Earth Orbit!**

Acquisition time within 15 seconds. Location within 4-6 minutes.

Screenshot from **QuickSAT/VMS** on the **LinkStar-STX3** in LEO. Yes, you see a speed of 7.11 km/s!
QuickSAT/VMS

Flight and Health Management with a Communications Framework
QuickSAT/VMS

- Broad Use: Aviation, Satellites, Cars
- A complete Flight and Health Management System
- Vehicle Health Management & Monitoring
- Vehicle Commanding Services
- Communications services
- Test/Monitoring interface
QuickSAT/VMS

• Can serve as a stand alone ground station or part of an expanded environment

• Customizable

• Utilizes open source software where possible

• Works on a range of flight hardware

• Web based - PCs, Tablets, etc.

• Certified DO178B for Aviation
Interface

Message and GPS information

Radio messaging control and radio information

GPS signal quality information

OEM 719 Accepts SNR > 29 db
Screen Shots: LinkStar-STX3

You can also view how many GPS satellites you are tracking, where they are located and the strength of the signal.

You can view all the messages transmitted and save them to CSV, Excel, and PDF format files!
Plotting and Data Tracking with *LinkStar*

QuickSAT/VMS on the *LinkStar* radio system allows you to track your data, monitor it, and even generate plots!

Plots can be saved in JPG, PNG, PDF and SVG formats. Data can be saved in CSV, Excel and PDF formats.

sci_Zone, Inc.
www.sci-zone.com
Up coming Missions Featuring *LinkStar* and the *Globalstar* network

<table>
<thead>
<tr>
<th>Mission Name</th>
<th>Mission</th>
<th>Expected Launch Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space Dynamics Lab/DoD</td>
<td>Not Public; Not Public; Measuring low energy neutron flux in LEO</td>
<td>December 2019</td>
</tr>
<tr>
<td>Carthage College</td>
<td>CaNop; Imaging rainforest canopy, plus studying impact of LED lights on night skies</td>
<td>October 2019</td>
</tr>
<tr>
<td>Hawaii Space Flight Laboratory</td>
<td>Neutron-1; Measuring low energy neutron flux in LEO</td>
<td>October 2019</td>
</tr>
<tr>
<td>New Mexico State University</td>
<td>INCA; Student Test Flight; Virgin Galactic Test Flight</td>
<td>2020</td>
</tr>
<tr>
<td>Auburn University</td>
<td>TRYAD; Detect and study Terrestrial Gamma Ray Flashes</td>
<td>2020</td>
</tr>
<tr>
<td>University of South Alabama</td>
<td>TBD; Magnetosphere Studies</td>
<td>2020</td>
</tr>
<tr>
<td>North Dakota State University</td>
<td>OpenOrbiter-1; Test flight open cubesat platform; 3D printing in space</td>
<td>2020</td>
</tr>
</tbody>
</table>

*Plus numerous more missions from Boeing, U.S. Naval Academy, DARPA and others!*
<table>
<thead>
<tr>
<th>Feature</th>
<th>LinkStar-HD</th>
<th>LinkStar-STX3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communications Type</td>
<td>Duplex</td>
<td>Simplex</td>
</tr>
<tr>
<td>Data Rate</td>
<td>up to 70 kbps</td>
<td>up to 144 Byte Packets</td>
</tr>
<tr>
<td>Input Power</td>
<td>~ 4 W</td>
<td>~ 200 mW</td>
</tr>
<tr>
<td>Pointing Required?</td>
<td>Yes, ±40º</td>
<td>No</td>
</tr>
<tr>
<td>Internet Access in Orbit</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Coverage</td>
<td>~ 40%</td>
<td>Near 95%</td>
</tr>
<tr>
<td>Messaging</td>
<td>Uplink only - 35 bytes</td>
<td>Downlink only - up to 144 bytes</td>
</tr>
<tr>
<td>QuickSAT/VMS</td>
<td>Yes!</td>
<td>Yes!</td>
</tr>
</tbody>
</table>
Globally connected through Globalstar
Next STEP - Join the Fun!

- email: andrew_santangelo@sci-zone.com
- web: www.sci-zone.com