24th IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Generic Technologies for Small/Micro Platforms (6A)

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INTEGRATING A LARGE NANOSATELLITE FROM CUBESAT COMPONENTS – CHALLENGES AND SOLUTIONS

Abstract

Fraunhofer EMI currently designs and builds a 12U nanosatellite with an advanced MWIR imaging payload. The mission is called ERNST (Experimental Spacecraft based on Nanosatellite Technology) and its main goal is to evaluate the utility of a nanosatellite mission for scientific and military purposes.

The satellite's payload comprises a high-resolution mid-wavelength-infrared camera that is actively cooled by a Stirling cryocooler. Most requirements of this payload (dimensions, mass, power budget) exceed a 1-3U CubeSat's capabilities. Instead of realizing the mission with a commercially available microsatellite bus, we pursue the concept of building a 12U nanosatellite from components designed for smaller CubeSats.

Since the first release of the CubeSat standard in 1999 a diverse market for CubeSat components has developed. Most of these components are comparatively cheap and many possess flight heritage. In recent years, there is also a trend to larger CubeSats. Consequently, all components necessary for a small microsatellite bus are now available on the commercial CubeSat market. This includes also more advanced subsystems like ADCS with three-axis stabilization and high data rate transmitters.

In order to fulfil the requirements we had to combine components from different manufacturers. While all subsystems share the PC/104 format, which means they all have the same dimensions and the 104-pin stack connector, only some signals on this connector are specified and many systems cannot be customized to incorporate the system's requirements. This leads to significant compatibility issues.

In small CubeSats it is sufficient to provide only two regulated voltages and the battery voltage on the stack connector. Larger systems like ERNST require several regulated and switchable power supply channels and additionally may operate at an unusually high battery voltage. Many CubeSat components do not consider these circumstances.

The solution we found is to split up the single stack of subsystems into multiple stacks connected through a common backplane. Each stack combines the systems with compatible pinouts. The backplane then translates between the different pinouts of the stacks to ensure compatibility. In addition, the backplane may contain auxiliary circuits and EGSE connectors.

After solving these issues, we were able to show that it is possible to build a 12U nanosatellite with three-axis stabilization and an advanced imaging payload from CubeSat components available today. Nevertheless, the CubeSat industry could help by incorporating the needs of larger satellites into their products. Adequate configuration options for header pinouts and power supply are the most obvious issues to address.