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Up, up, and away with CompactPCI from Kontron

CP303 Computers on the ISS

The University of Amsterdam's commercial spin-off, IDEAS! UvA B. V., has developed under the auspices of EADS Space Transportation the temperature control system and two experiment containers for the DECLIC materials research project, which will be conducted onboard the International Space Station (ISS) from 2008. IDEAS! uses a CompactPCI board from Kontron for the temperature control system. The combination of robust design, small size, and Kontron's first-rate customer service tipped the scales in favour of the CP303 board.

As the longest, most complex, and most cooperative space project ever, the International Space Station (ISS) is fascinating. A look behind the scenes reveals the tightly managed everyday life of a research operation that makes full use of the leading edge capacities of this space lab.

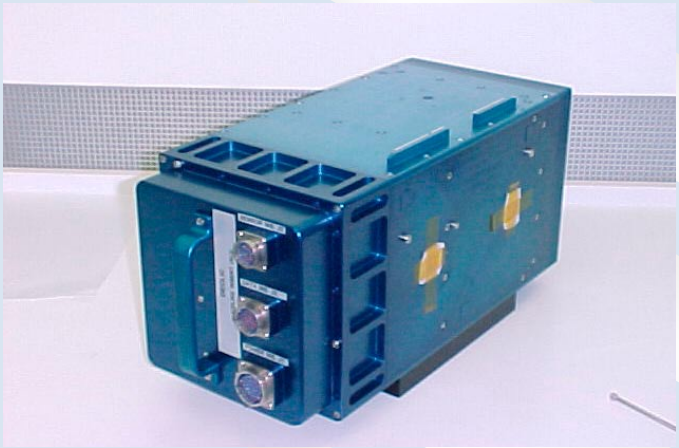
The interior design of Destiny, the US research module of the ISS, is designed for efficiency: all the control, supply, and research devices are installed as modules in 23 standard racks, which are simple for the crew to operate. Six "EXPRESS racks" are available for research. Truly, EXPRESS stands for quick, meaning "EXpedite the PRocessing of Experiments to the Space Station". These racks hold the experiments in microgravity conditions, in disciplines like physical sciences, life sciences, ecology, geology, space research, and technology which on Earth are prepared in standard bays or laboratory set-ups.

DECLIC – materials research under microgravity

From early 2008, one of these CompactPCI boards part of DECLIC will be in Destiny. DECLIC is dedicated to fluid and material research under microgravity and is a partnership between NASA and the French space agency CNES (Centre National d'Etudes Spatiales). EADS Space Transportation constructed the facility and the first three experiment containers for the various experiments under contract to the two project partners. As "telescience" experiments, the DECLIC processes will be managed by the CNES / CADMOS operation center in Toulouse limiting the ISS crew involvement to

hardware set-up and tear down.

Two of the DECLIC experiment containers and the subsystem for temperature control were developed and produced by the Amsterdam-based IDEAS! UvA b. v. as subcontractor to EADS Space Transportation. IDEAS! UvA is a spin-off of the University of Amsterdam and is dedicated to the transfer of technology from research to practice. With ALI, the "Alice Like Insert", scientists will study the behavior of near ambient temperature critical fluids (critical meaning here that they demonstrate the properties of liquids and gases at the same time). In the high temperature insert HTI, the chemical behavior of critical water will be studied at a temperature close to 400°C.



Electronics in space: compact, reliable, powerful

The development and production of DECLIC hardware is challenging in at least two ways, an usual situation for space equipment: as many functions as possible must be packed into the smallest possible volume and at the same time, it must operate extremely safely and reliably. It is designed to be used for two years and should work without maintenance by the ISS crew. If a critical component were to fail, the research program could face significant shortcomings, and in the worst case, DECLIC could go unused until the next space shuttle or logistics vehicle brings a replacement – putting at risk experiments that scientists have been preparing and working on for many years.

Therefore, IDEAS! was extremely careful in selecting components, including the "brains" behind the temperature subsystem, which IDEAS! entrusted to the CP303 CompactPCI board from Kontron: it combines the necessary performance characteristics with the expected "space qualities" of compact and robust design. The CP303 – which runs using a socketless low voltage 933 MHz Mobile Pentium III-M processor – manages three tasks:

CP303 controls, calculates, and collects

Firstly, it controls the temperature for each of the various experiment containers. Depending on which experiment container is currently installed and operated, a control library and a hardware description, relevant to that experiment, are loaded.

Secondly, it operates as the command interface for the scientific scripts which run on the data management computer, also based on a Kontron CompactPCI board. When the data management computer sends a command, it receives an answer and the associated data. Third, it collects the data from the five to eight microcontroller boards on which the specific intelligence for the individual experiment is implemented.

The software for these tasks is stored as a boot image on the hard drive of the data management computer and is booted via DHCP. After the initial boot, the application – which is completely housed on a RAM disc – automatically recognizes the current experiment and configures the hardware with automated XML/XSLT scripts.

CP303: robust, fast, and compact

The ability to host the Linux application was the CP303's most obvious advantage. The fast 2.6 Linux kernel has to execute an application that must precisely control the temperature to a few microKelvins in real-time. Furthermore, it was important to IDEAS! that the entire application be executable from a RAM disc and that the system can be booted via Ethernet.

CompactPCI, the directly soldered processor and 256 MB RAM make Kontron's CP303 robust enough to handle launch and work in orbit environment without failures. It is also possible to do without failure-prone, moving parts such as fans, because the Pentium III-M creates almost no waste heat despite its high performance level.
Beside the combination of performance and robust design, the compact shape of the board – just 100 mm x 160 mm – and the two Ethernet interfaces on the front and rear were important to IDEAS! Not only the boot processes, but also the communications between the data management computer and the EXPRESS rack will run via Ethernet. A certain degree of flexibility in equipment was also desired, since some of the board's components - such as the Flashdisk and battery - must be removed in order to best meet NASA's safety requirements.

Kontron, more than a product provider

As a solutions provider for its standard products, Kontron was able to score additional points in IDEAS!' decision-making process; the technology transfer company needed an adapted CMOS set-up. LAN booting was not planned in the original set-up, so that after launch to orbit – during which the board must cope without battery power – and installation in the EXPRESS rack in the space station, the board would have looked for a hard drive. Since neither monitor nor keyboard are available in orbit, the request "Press any key to continue" to continue the boot process would have been useless. Kontron programmed the CMOS so that the CP303 reliably shifts to operating status after installation.

Praise before launch

DECLIC is not yet in space, but the experiences that IDEAS! has so far had with both the board and Kontron's customer service are consistently positive. Currently, the CP303 is working in the engineering model – a form-fit-and function copy of the flight model, which is missing only the Nusil coating for the electronics – and in two laboratory/ground models. The front interfaces for the monitor, keyboard, and Ethernet have already proven to be very useful in developing the application and the Linux kernel.

"Because of the trouble-free operation of the project, we will certainly use Kontron products in further space activities, when conditions allow it," says Frank Kayzel, project manager with IDEAS!

Key Features of the CP303

- Low-voltage mobile Pentium III-M / microBGA 400MHz up to 933MHz
- Up to 512 MB SDRAM, 256MB soldered + one SODIMM socket
- 815 chipset internal or external AGPx4-VGA
- Two Fast Ethernet channels
- Two serial channels
- 4U, 8U I/O
- 64 bit CompactPCI interface
- Optional I/O support on the rear side

Compact PCI boards in the CP300 series come in 3U form factor with a wide range of processors. The top-of-the-line model CP307 operates with an Intel Core Duo processor up to 2 GHz.

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