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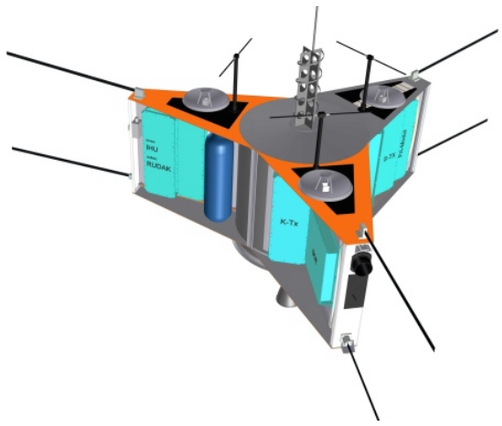
P3-Express – An Intermediate Report

This article first appeared in the AMSAT-DL Journal of December/February 2003/2004



The work on P3E has taken several steps forward; the form and function of the new satellite has been crystallized after many examinations and discussions.

An important subject for the last three months has been the establishment of the propulsion system with our friends and partners at Astrium. Since the well-known 400-N propulsion system is no longer available, essential elements of the previous propulsion system had to be modified. A 220-N propulsion system will be installed that will have to be ignited more frequently and for longer periods. After a few corrections the tank has passed its tests as a first element.

The work on two key energy components, the batteries and the solar arrays has also progressed. About 100 different NiMH cells were conditioned and measured. A flight package of ten will be selected from the measured values on hand. For the solar arrays we are being advised for the approach externally. Several proposals were received, that are now in hand. The individual panels consist of three layers, a carrier substrate that AMSAT-DL will provide, the solar cells and a glass cover which is about 0.5 mm thick. From our experience the solar generator will be the most expensive single item on the satellite.

The transponder configuration in the microwave region was uncertain for a long time. The solution was found after a meeting with Michael Kuhne (DB6NT) and Freddy Guchteneire (ON6UG), as well as a way to integrate a transmitter for 24 GHz and also one for 47 GHz. Both will have a passband of about 50 kHz and a beacon outside of the passband. The 24 GHz transmitter will be in its own module and provide an output power of several Watts. The 47 GHz transmitter will share a module with the 5.6 GHz receiver and will deliver an output power of 1 W.

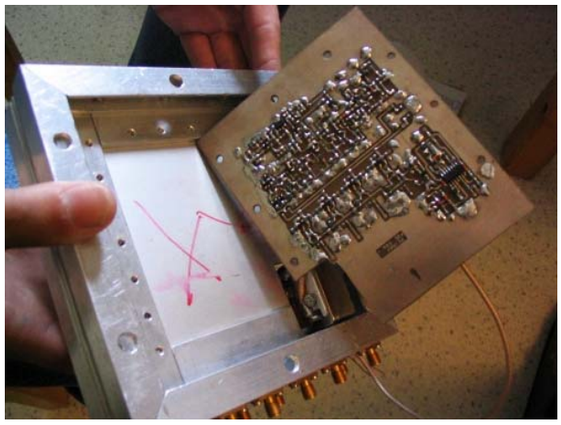
The antenna configuration has been modified by these changes. For the lower bands of 145 and 435 MHz the established systems (dipole, radiator/director combination) will be used again. Freddy Guchteneire would like to try a combination solution for the S-Band and L-Band using a central helix. Additionally, each satellite arm carries a 15-cm parabolic reflector.

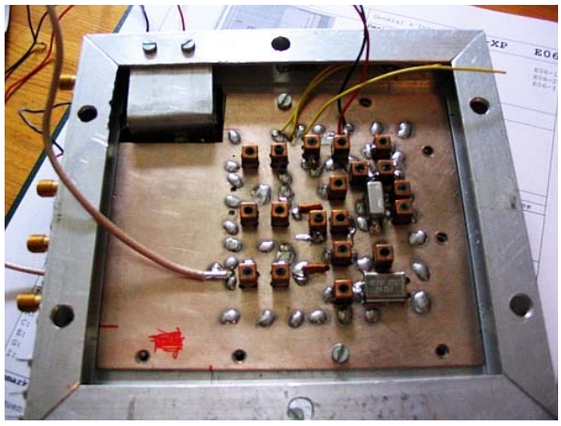
Each arm has one for the X-Band high power downlink, one for 24 GHz, one for 47 GHz and 5.6 GHz. In addition, there will be an omni-antenna for 145 and 435 MHz as well as various low gain antennas for the P5 transponder. Details of the U/V transponder were cleared up in a further meeting with William Leijenaar (PE1RAH). The flight hardware is already being built, since William would like to travel the world after he completes his studies and work on P3E.

A receiver for 29 MHz is completely new in the discussions. A short-wave receiver could be more attractive with the opening of the HF bands for previously limited license holders since after the lifting of the Morse code license requirement they can now use the HF frequencies; this has already begun in several countries. A higher uplink transmitter link budget can be easily achieved on these frequencies, which provides a good link budget at the perigee. The problem, however, is the satellite's receiving antenna for which there is currently no solution.

The necessary coordination process of the satellite frequencies has begun with the progress of the design and construction of the transponder modules. The table shows the frequencies that were proposed to the IARU frequency panel. We currently assume that there will be only minor changes. It is worth mentioning the frequencies above 5.6 GHz. For some time there has been an agreement between terrestrial narrow band and satellite segments that partially overlap.

This opens up the possibility to provide frequencies in which a transverter can work in both regions – satellite and terrestrial. The user group could thereby be enlarged in this frequency region.





The circuit design for the IHU3 has been completed. The new IHU3, which has been already assigned to the Mars mission, follows a new command concept. Previously signal recognition and decoding was performed by analog and digital hardware; this will be performed by the more powerful CPU. The on-board IHU3 computer will receive an LF signal from the command receiver. This modified concept was a result of the requirements for the P5A-Mission. In “emergency” operation, if, for example, the high gain antennas are not pointing to the earth, have low gain and a large squint angle, they will have to work at a 5 character/second rate. A long integration time has to be invoked at these low rates. In the previously established technique just the signal recognition, the scanning of the command passband, would take up to 3,000 seconds or 50 minutes.

This new technology, which is invoked in the IHU3, can examine the passband in parallel by using a DSP. This shifting of the on-board computer means, however, that there can never be a computer crash, since the signal recognition for the command operation would drop out, and a classical RESET would no longer be possible. A smart, multi level Watch-Dog system was developed as a result. For this the CPU has to compute the bit sequences on different processing levels, whose accuracy releases the triggering of the Watch-Dog. If the Watch-Dog fails to function correctly and doesn’t result in correct bit sequences or in no bit sequences, then the Watch-Dog logic can undertake various measures, among them is to switch over to different stored copies of the operations software.

Finally, it can be reported that the P3E metal structure has already been lacquered at press time. The black, space qualified lacquer serves to balance the thermal conditions.