



Space Applications: The Experiment Controller for C3D on UKube-1

Introduction

XCAM has developed increasingly complex electronics as part of its camera systems, with use of advanced components such as field programmable gate arrays (FPGAs), which undertake many of the data control and flow operations in the cameras. In 2011, XCAM was asked by the Open University to develop the controller PCB for a small imaging camera experiment to be flown on UKube-1, the UK's first national micro-satellite.

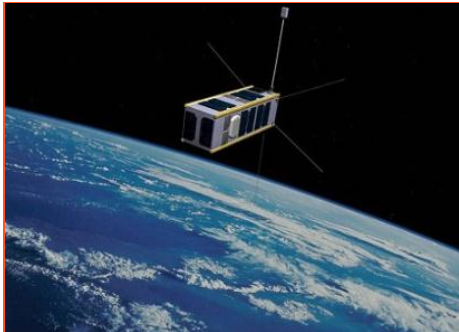


Figure 1 : Artist's impression of UKube-1 orbiting earth (Credit ClydeSpace)

CMOS Image Sensors

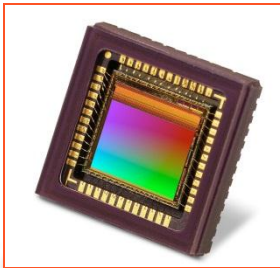


Figure 2 : Colour CMOS Image Sensor (CIS) from e2v

The UKube C3D experiment was to use a new type of image sensor based on CMOS technology. The instrument needed to operate 3 sensors of the e2v type EV76C570 which has 1.3 Mpixels of 5 μ m pixel pitch, and with colour imaging being provided by a Bayer filter set. The image sensor is a true "camera on a chip" and includes 10-bit ADCs with setup via a serial peripheral interface (SPI) bus.

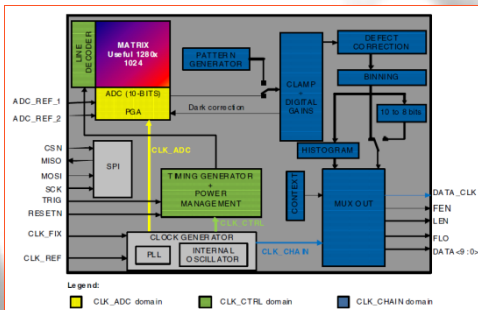


Figure 3 : EV76C560 "Sapphires" block diagram

C3D Experiment Controller

The C3D experiment controller was designed around XCAM's existing interface circuitry used in its CCD controller electronics; providing communications between the CCD controller and experiment PC. The conversion of an existing design helped ensure that the development risk was low, and resulted in a short project development cycle.

The system block diagram is shown in Figure 4 below, and bounded in blue are the primary functions within the FPGA, which is the heart of the controller. In the final design configuration, the experiment drove 3 independent CMOS image sensors; which each performed a different function.

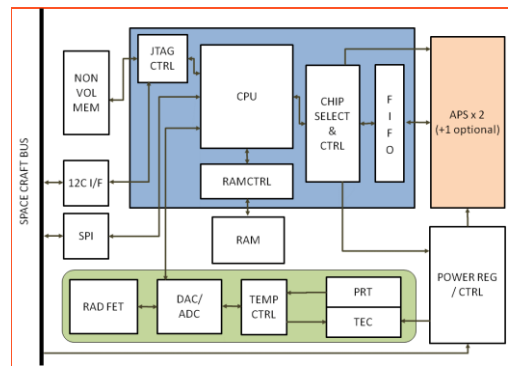


Figure 4 : Block diagram of the C3D experiment controller. The items bounded by green are part of the support electronics provided by the Open University with the remainder part of the controller.

Figure 5 below shows the initial build of the experiment controller, its complex shape was derived to fit around the other spacecraft components in the experiment. The central FPGA is visible, together with four miniature connectors, 3 for coupling to the CMOS image sensors, and the fourth to interface to the support board developed by the Open University.

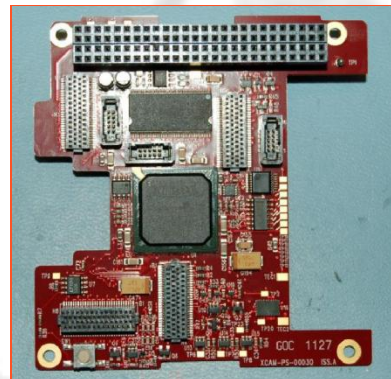


Figure 5 : Image of the UKube-1 C3D experiment control PCB

UKube-1 is due for launch in October 2013. Further information on C3D can be found at the Open University's Centre for Electronic Imaging pages : www.open.ac.uk/cei And for UKube-1 at the UKSA pages : <http://www.bis.gov.uk/ukspaceagency/missions/ukube-pilot-programme>