Characterisation setup for a novel CMOS TDI image sensor

Adriano Ferrucci

under the supervision of Konstantin D. Stefanov

Centre for Electronic Imaging, The Open University, Walton Hall, Milton Keynes, MK7 6AA, UK

Summary

A prototype CMOS image sensor (CIS) based on the Time Delay and Integration (TDI) technique has been designed and manufactured by Teledyne e2v. Within the collaboration between Teledyne e2v and the Centre for Electronic Imaging (CEI), it has been necessary to create a setup in order to characterise the sensor. The project concentrates on the design and test of a Printed Circuit Board (PCB) that will accomplish the task of driving the image sensor. During the project period, it has been possible to manufacture the PCB. This gave the opportunity to ascertain the proper design of the board by driving it with a custom made LabVIEW software. The same PCB and software will be used in the future to conduct a full characterisation on the image sensor in order to verify its suitability for space applications.

Time Delay and Integration (TDI)

TDI is a readout technique that allows image acquisition that is suitable for specific conditions such as imaging of fast moving objects or in very low light conditions.

- This technique is based on the concept of accumulating different exposures of the same object, which is moving relative to the camera. It is made by shifting the charge synchronously with the movement.
- It allows large Signal to Noise Ratio (SNR) compared to a "single shot" capture.
- It is the perfect technique for imaging of fast moving objects.
- This procedure can naturally be done in CCDs as the *modus operandi* is by moving charges from row to row.
- The sensor is basically a "CCD in a CMOS", but the manufacturing technique is that of a CMOS image sensor.
- TDI in CMOS has the advantage of better radiation hardness and lower power dissipation than CCDs.

Picture of Pluto and Charon obtained by TDI imaging (from New Horizons mission, NASA)

The Design

This PCB design has been inspired from a previous board that drives a CMOS sensor from Teledyne e2v (CIS 115).

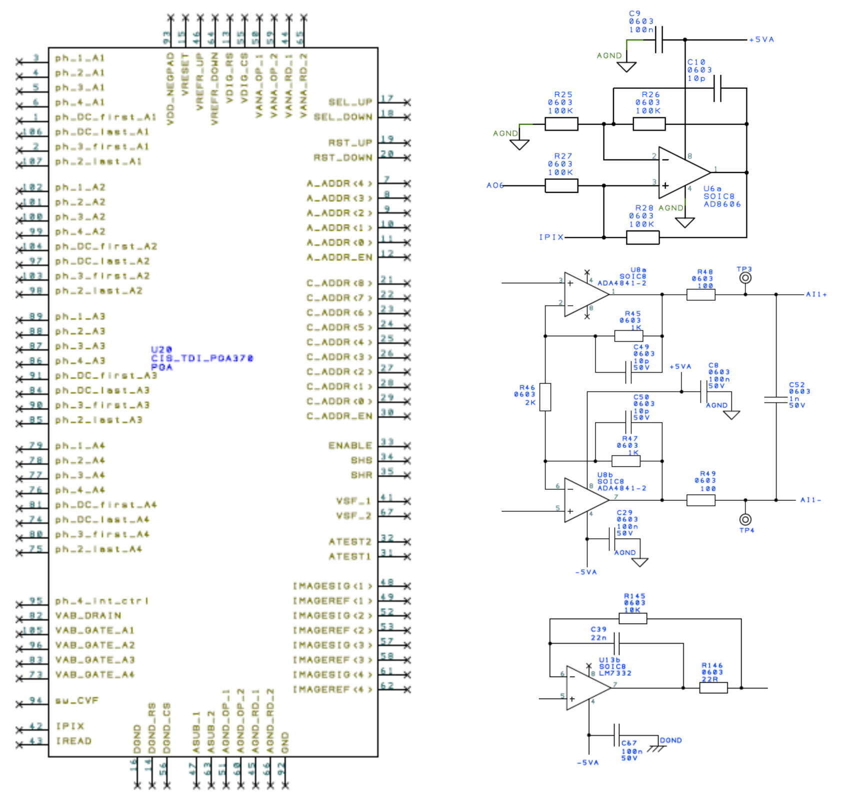
The circuits employed to carry the input signals and supply voltages are:

- Howland current pump, a simple current source generating bias current.
- Instrumentation amplifier, amplifying the differential analogue outputs and filtering high frequency noise.
- Operational amplifiers driving several bias lines with capacitive loads.

The whole Schematics design has been carried out with *DesignSpark PCB*.

The Schematics is the design part that requires to be as clear and as coherent as possible.

- New schematic components for were created, with all the corresponding pins and labels.
- The circuits delivering the analogue input signals had to be displayed on the same sheet as the main component.

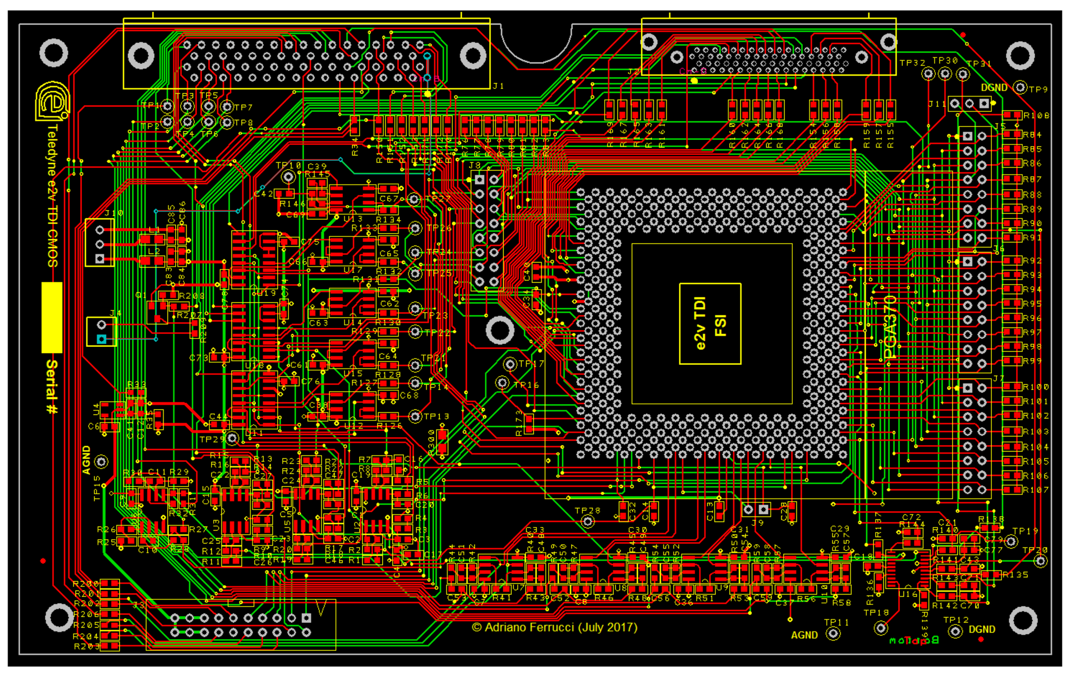


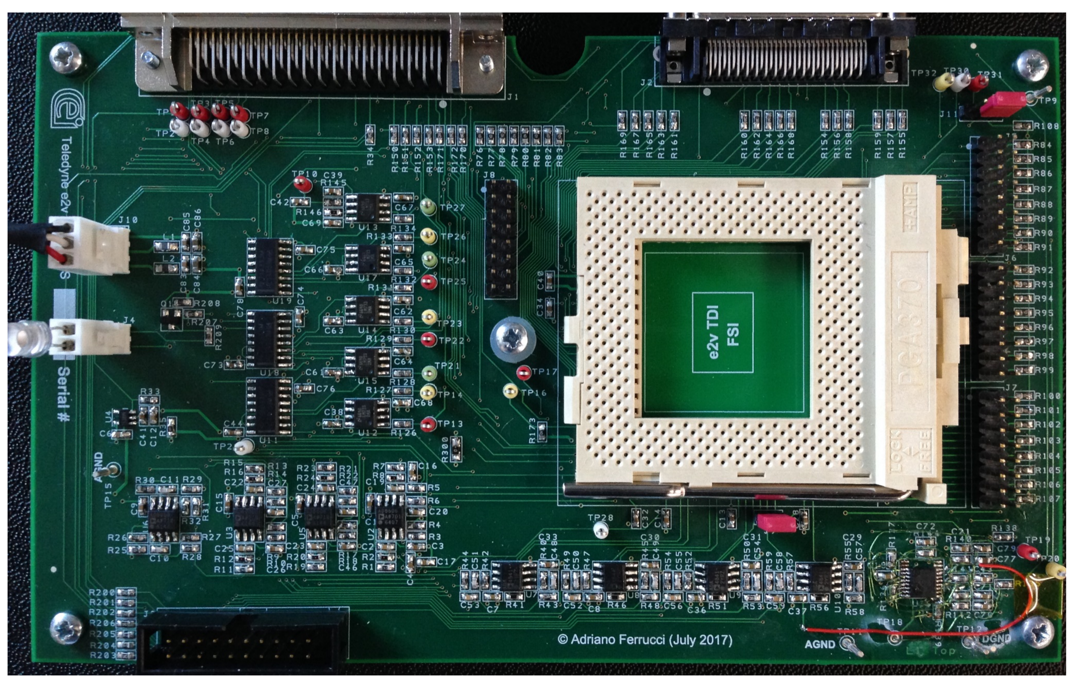
PCB layout design

This has been the task during which, still under *DesignSpark PCB*, the position and organisation of all the components were established.

It had to be done using the following rules:

- Placing the components in a way that makes assembly and test easier (for example placing the test points and labels on the edges of the board).
- Use as few as possible layers for the tracks, eventually using 4 layers.
- Group as much as possible the components drawn together on the schematics.
- Miniaturise as much as possible the size of the board.
- The board was assembled by hand in the CEI labs.



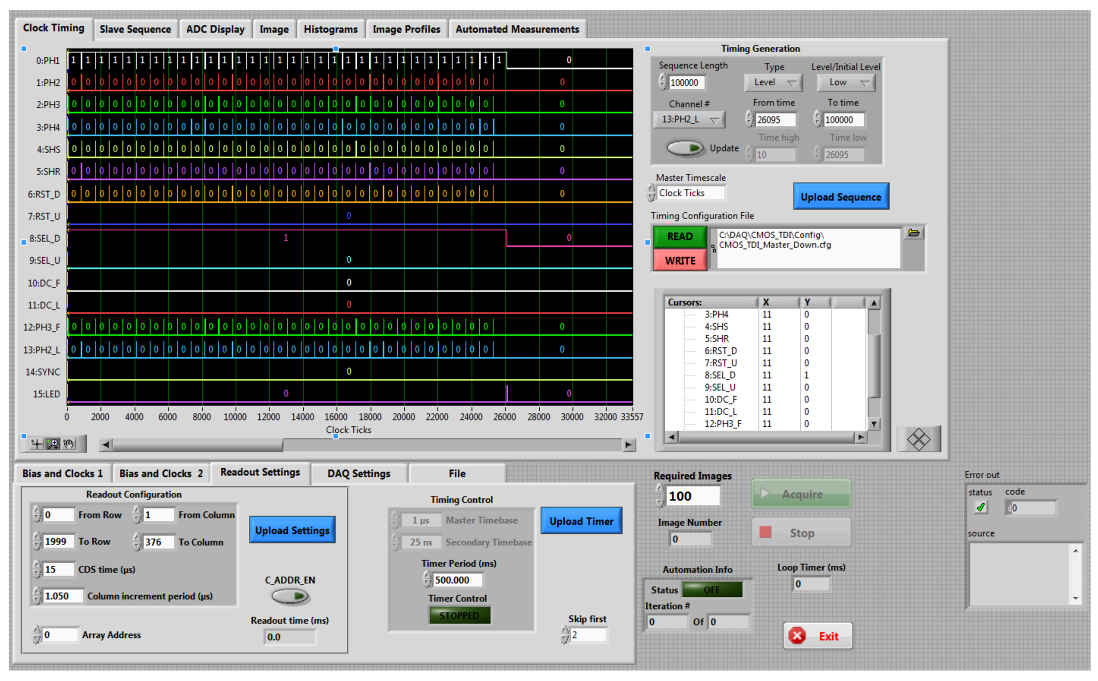


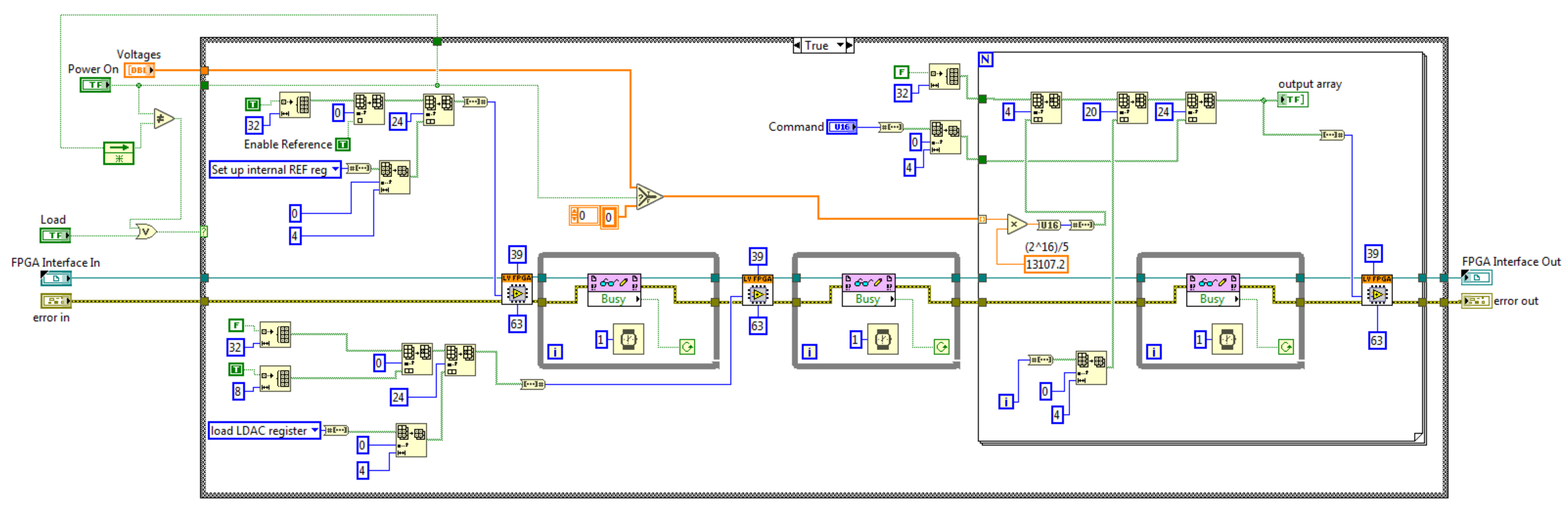
Testing with LabVIEW

In order to verify the correct operation of the PCB it has been necessary to test all voltages, clocks and biases.

To do so, an improvement of an existing testing software under LabVIEW has been developed.

All the biases, voltages and clocks have been tested.





These were the last tasks before handing the PCB and the software for a subsequent test of the image sensor.

SPIN Showcase
The Imperial College
London, United Kingdom
6 September 2017

Centre for Electronic Imaging
The Open University, Walton Hall, MK7 6AA
http://www.open.ac.uk/cei
Ferrucci.Adriano@gmail.com