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LINEAR CCD ARRAY TH-7834B PERFORMANCES NEAR 10 MHZ

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The spatial resolution improvement of Earth obser ation satellites implies higher CCD readout frequencies (at the moment for an instrument such as SPOT 5, typical CCD readout frequency reaches 5MHz for an Earth resolution of 3.5 m and a 60 km swath). Soon, as we try to increase the spatial resolution without degradation of the swath, reading frequency of 10 MHz will be required. Furthermore, this output data rate needs to be achieved with Correlated Double Sampling (C.D.S) which remains the only way to deliver good performances in term of signal-to-noise ratio.

This poster shows results of measurements at 9.25 MHz readout frequency on a linear CCD array ATMEL TH-7834B, already used in spatial instrument SPOT 5 at lower frequencies.

The most important parameters to measure were :
- the shape of the CCD output signal, to determine the length of the area available to sample the signal,
- linearity and transfer efficiency, with respect to the irradiance of the CCD,
- the stability of the performances in case of phase shift of the CCD and acquisition clocks.

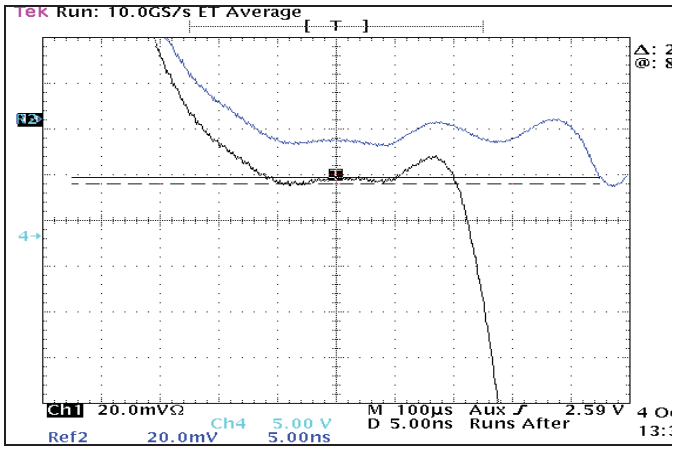
Me surement bench

First of all, precise measurements require a bench to catch CCD signal et measure the linearity error.
A specific electronic was designed, to allow a maximum bandwidth, and a fine tuning of the CCD clocks was performed, to optimize the shape of the output signal.
Our ideo chain was measured for a differential non linearity of +/- 0.3 LSB, and a global non linearity of 2 LSB (with a 12 bit resolution) at 10 MHz frequency.

CCD sign sh pe

The following figures show the reference and video levels at 9.25 MHz, both for a dark pixel, and an illuminated pixel. They exhibit a useful length of more than 10ns for the sampling.

Some improvements of the CCD internal output amplifier are possible to more improve the speed and reduce the ripple of the output signal.



Reference le el

The problem is ob iously : How precise ha e to be the clock phases, in order to maintain a long enough length for the ideo and reference le el ? In other words : what kind of drift is authorized for the slope of the clocks (of the CCD and of the acquisition chain) ? The following paragraphs gi e some answers to this question.

Line rity

We tested the degradation of the linearity between pixels at 5 MHz and pixels at 9.25 MHz
Linearity error is given by

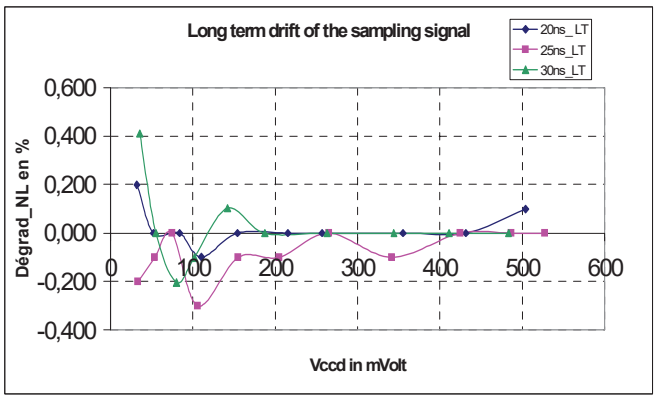
$$NL(\%) = \left(\frac{Vccd - Vobsc}{Vccdref - Vobsc}\,\frac{Eclref}{Ecl} - 1\right).100 \quad ,$$

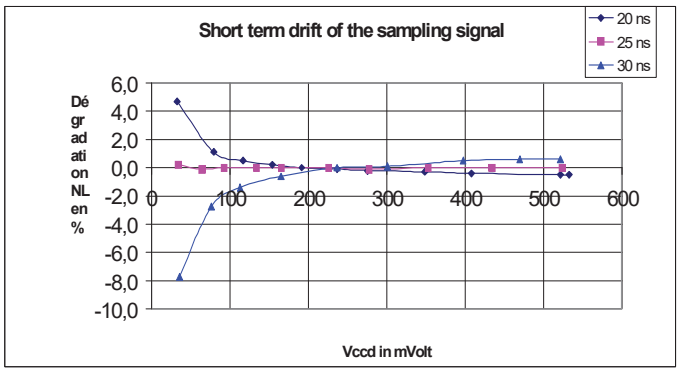
where
- Vccd (resp Vobsc) is the result of a CDS (Correlated double sampling) of the CCD signal for illuminated pixels (resp dark pixels),
- Ecl is the irradiance on the illuminated pixels (in W/m2),
- the "ref" alues are referenced to the middle of the dynamic (here 500 mV for Vccd).

The issue was of course to know what kind of margin existed for the clock signals, in order to maintain the linearity error at low le el.
So we simulated 2 kinds of time shift of the sampling clock signal :
- a long term shift, simulated with a similar shift applied to illuminated pixel and dark pixels : this case simulate a long term shift in orbit, due to thermal phenomenon, or radiation effects,
- a short term shift, simulated with a shift applied only to illuminated pixels, when dark pixels was sampled with the optimized clock phase : this case simulate the short term jitter , which is generally very small and well characterized by ground measurements.

The results are the following for the sampling signal of the CCD ideo level. The curves are given :

- with respect to th t t CCD l v l (Vccd-V b c),
- f r 3 diff r nt d lay f th am ling signal : th middl n i th b t





Th r lt ar : a l ng t rm hift f 10 n ak t ak f r the sampling signal induces a very small degradati n f the linearity, even at low signal level : so the auth riz d hift f r the sampling ignal can b
A h rt t rm hift induces a fast degradation of th linearity at low level. Hopefully, in the currently d acq i ition chains, this short term jitt r i v ry l w, and i n t d t increase dramatically in rbit

Similar investigations has been carried out for the oth r cl ck (am ling signal f r f r nc l v l, CCD cl ck), l ading to similar r lt :
- l ng t rm drift f ab t 10 n ar ibl with t ignificant d gradation of the linearity,
- h rt t rm jitt r ha t b limit d nd r n

Transfer inefficiency

N d gradation f thi aram t r ha b n b rv d f r cl ck fr q nci b tw n 5 MHz and 9.25 MHz