

uEye – Temperature dependent CCD image quality. The challenge of CCD camera calibration.

This application note is related to all uEye CCD models (series UI-2xxx, UI-6xxx)

Symptoms:

Temperature dependency of image quality.

Calibration of Measurement equipment:

A camera can be treated as optical measurement equipment. Electrical measurement experts know that professional measurement equipment must be calibrated at its operating temperature to gain a maximum of accuracy.

Explanation:

CCD sensors are complex and sensitive devices regarding the quality of the external signals driving the CCD. The accuracy of the vertical and horizontal transfer clocks combined with the exact sampling points of the analogue output signal is the crucial factor for getting a high quality image with less distortion.

To accomplish this every uEye CCD camera is subjected to an extensive calibration process determining a set of 240 parameters. The calibration process runs an optimization strategy in real time by analyzing the captured images and calculating the optimum timing values.

At each pixel clock the edge position of the transfer and sampling clocks can be adjusted in steps of 1/48th of the pixel clock period. Assuming a pixel clock of 21MHz this leads to a timing adjustment resolution of about 1ns. At 30MHz the resolution is about 0.7ns. Temperature sensitivity is a commonly known effect for electronic circuits. On one hand there is the maximum allowed storage, soldering and operating temperatures or increased noise at high temperature and on the other hand also timing shifts of clocked signals.

Furthermore the parasitic distortions generated by the high speed digital circuits are overlaid to the analogue CCD signal by a small amount. A timing variation of signal edges of some nanoseconds is not exceptional and therefore will lead to a timing shift of these distortions. This shift in turn may move towards the calculated timing positions resulting in sampling a distorted portion of the CCD signal.

Taking all these facts into consideration it consequently leads to the statement that the CCD calibration process is temperature dependent. All uEye CCD models are calibrated at a typical ambient and operating temperature¹. Running the camera at the lower or upper end of the allowed temperature range may slightly affect image quality. This effect is increasingly visible at high pixel clocks.

¹ „typical“ means: ambient temperature 22°C, no special cooling or heat sink, camera not large-area mounted.