# NanEye Camera

AWAIBA

**Revision History**

| *Version* | *Date* | *Modifications* | *Author* |
|---|---|---|---|
| 0.0.01 | 23/02/2009 | Document Creation | Stephan Voltz |
| 0.0.02 | 03/24/09 | Modification for 80cm Flex | Stephan Voltz |
| 0.0.03 | 07/15/09 | Update Drawing | Stephan Voltz |
| 0.0.04 | 20/11/09 | General Review and formating | M. Wäny |
| 0.0.05 | 19/02/2010 | | |

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# 1 Overview

NanEye is a tiny camera module which consists of an CMOS image sensor with a size of 1mm x 1mm and optionally an adapted miniature optics. The device is mounted on a flex cable of 56cm length. The flex cable is connected to a small interface board ,which acts as an repeater and also has integrated the power supply for the module. The interface board can be connected with a standard USB cable up to 5m length to the AWAIBA basestation.

The basestation is the electronic between the camera and a PC and does the deserialisation of the data stream that comes from the camera and has an USB interface to a Standard PC. The Windows XP based Camera Viewer is a software tool that is able to grab the images of the camera via USB, and does image corrections like offset and gain correction and demosaic color reconstruction etc.

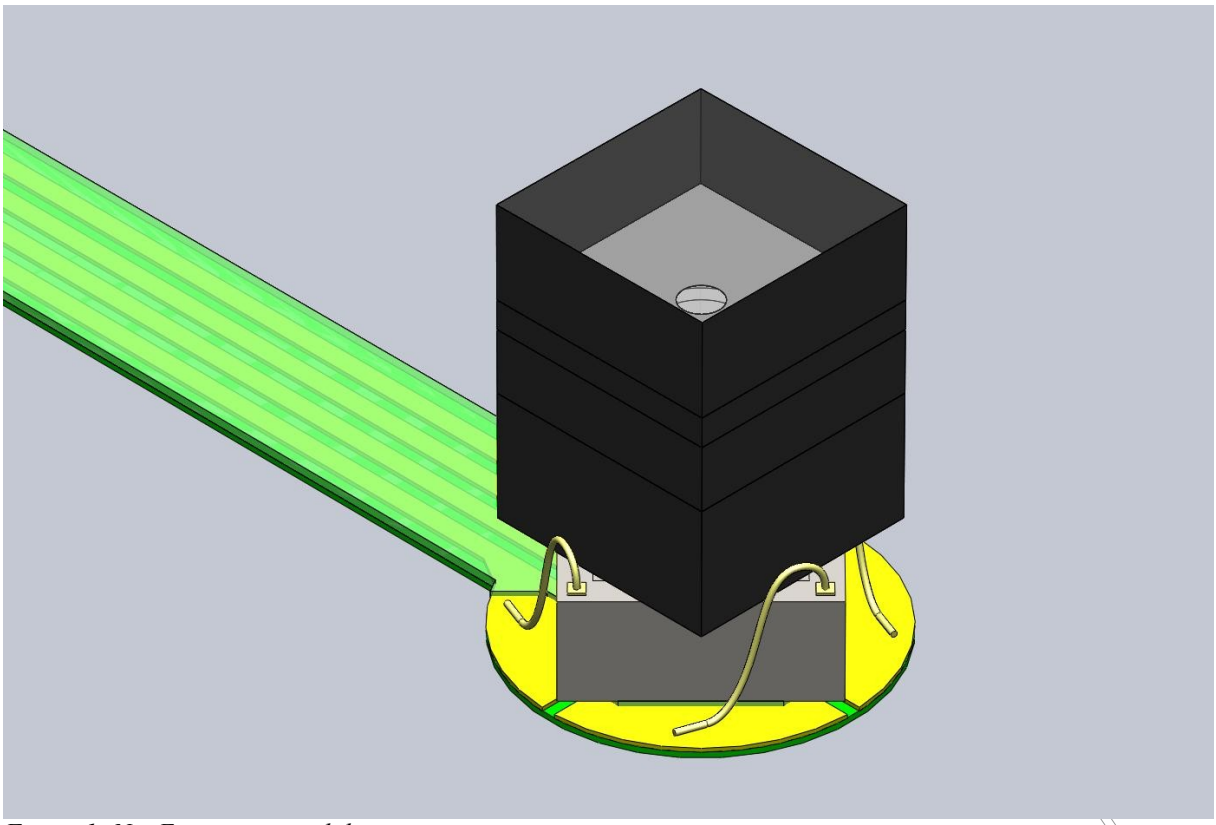


*Figure 1: NanEye cameramodule*

# 2 NanEye image sensor

The NanEye image sensor based on CMOS technology and is a system on chip, which means that no external component close to the sensor is needed to run the sensor, not even an external capacitor.

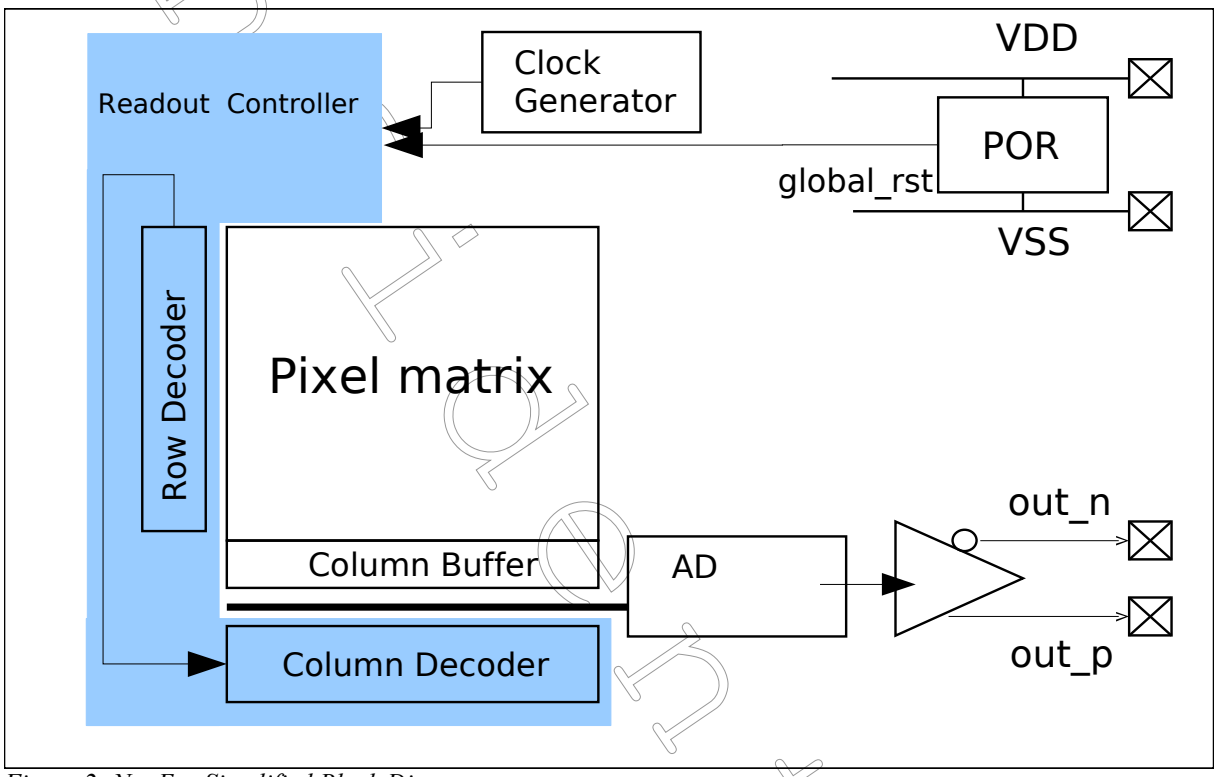



*Figure 2: NanEye Simplified Block Diagram*

## 2.1 Specification NanEye image sensor

| *Parameter* | *Value* | *Remark* |
|---|---|---|
| Number of Pixels | 62,5k, 250 x 250 | |
| Pixelsize | 3µm x 3µm | |
| Color | Bayer Pattern RGB | |
| Shutter | Rolling | |
| Dynamic range | 42dB | |
| Responsivity | 8DN/nJ/cm² | |
| Full well capacity | 10ke- | |
| Temporal Noise dark rms | 2DN | 1DN= 1 Digital Number of 10bit |
| FPN | <0.5% | Corrected by Software |
| PRNU | <1% | Corrected by Software |
| Data output | 10bit digital LVDS | |
| Supply | 1.8V | |
| Framerate | 44fps | |
| Size | 1000µm x 1000µm | 960µm + 40µm dicing |
| Number of pads | 4 | VDD, VSS<br>Data+, Data- |

Notes:

1. Typical operation mode 1.8V@37 degrees.
2. For operating conditions VDD min is 1.75V and 1.85V for the max value.

## 2.2 Pixel Matrix

The pixels are placed in a square matrix of 250x250 pixels. The first and the last 4 read out pixels of a frame, are clamped to the high and low level saturation signal alternatively (black and white pixels). The readout direction is set such that if the chip origin is placed in the lower left, the readout image is displayed on a screen beginning in the top left corner. See Figure 3 for the placement of these pixels and the readout direction.

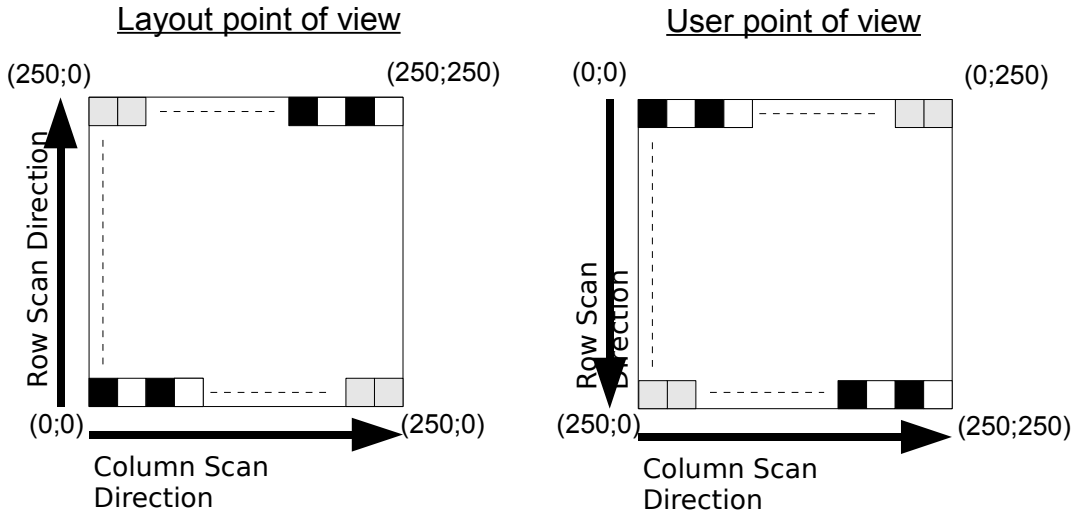



*Figure 3: Matrix Readout direction and pixel placement*

## 2.3 Pinout

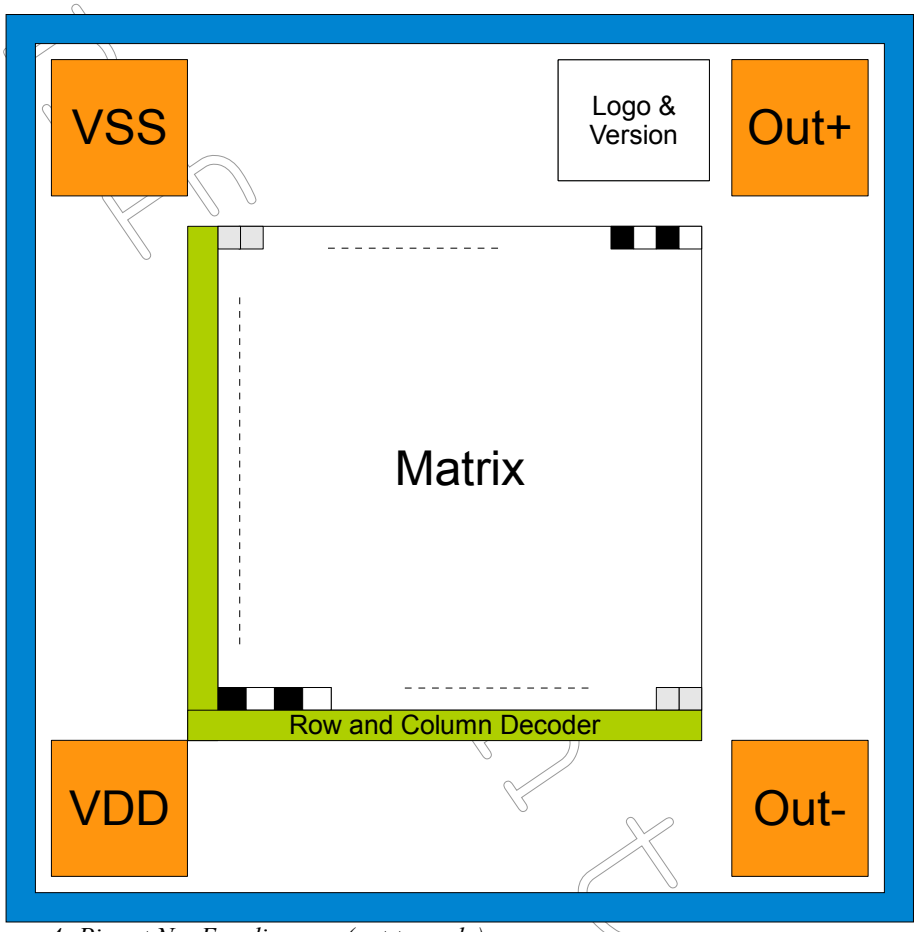



*Figure 4: Pinout NanEye diagram (not to scale)*

## 2.4 Pads Position and Connections (Pinout)

For wire bonding pads:

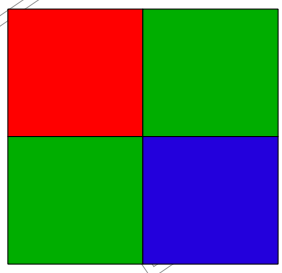
| *Number* | *Name* | *Middle of the PAD* | | *Notes* |
|---|---|---|---|---|
| | | x (um) | y (um) | |
| 1 | VDD | 49 | 49 | Power |
| 2 | VSS | 49 | 911 | Chip Ground |
| 3 | OUT+ | 911 | 911 | Positive Output of the LVDS driver |
| 4 | OUT- | 911 | 49 | Negative Output of the LVDS driver |

The size of the pads is 65umx65um for the passivation opening, the total size of the metal in the pad is 65umx65um.

## 2.5 Colour filters and Micro-lens

The CFA and u-Lens shift is optimized for a chief ray angle of the optics.

The color filters are implemented according the standard Bayer pattern.



# 3 Optic

The optionally available optics has one aspherical surface and one aperture. It will be directly glued on the image sensor and has its best focus position defined by design, so no mechanical set of focus is needed. The material is based on B33 (Borofloat glass) The design is made in that way, that the surface towards the object is flat, so the lens performance is not influenced by the medium between the object and lens, only the opening angle of the lens is reduced when the system operates in water.

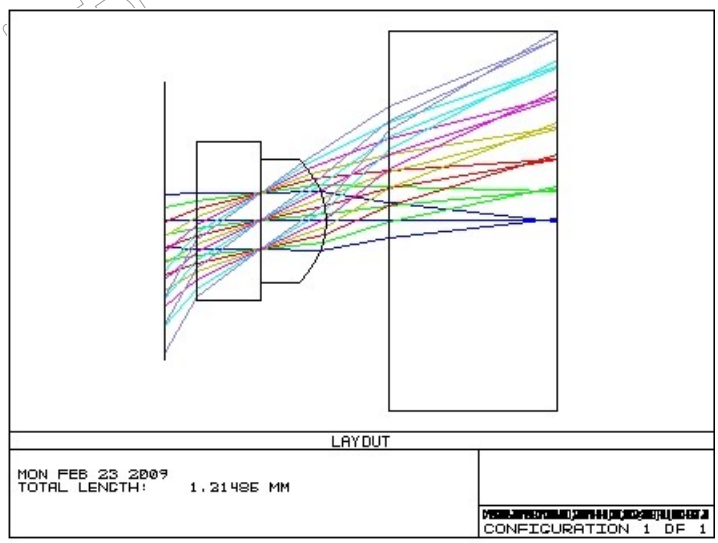



*Figure 5: Optic Layout*

## 3.1 Optical Specification and Performance

The specification and performance of the of the optic is found in the following table:

| *Parameter* | *Value* | *Remark* |
|---|---|---|
| EFL | 0.51mm | |
| F# | 3.8 | |
| Depth of focus | 1mm - 50mm | |
| Best focus position | 3.5mm | |
| MTF centre | 40% Sag/Tan | @150LP/mm |
| MTF max horizontal angle | 15% Sag/Tan | @150LP/mm |
| Field of view horizontal | 80° | In air |
| Field of view diagonal | 110° | In air |
| Material | Borofloat B33 | |
| Size | 1,21mm x 0.9mm x 0,9mm | |

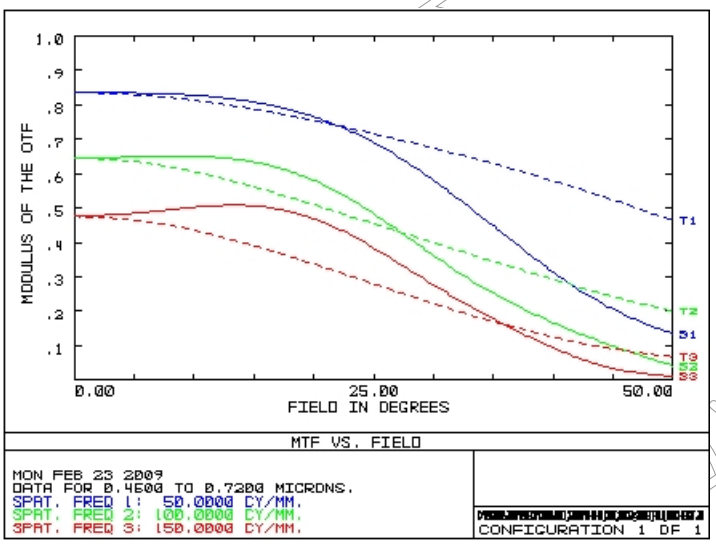



*Figure 6: MTF vs. Field at best focus position 3.5mm*

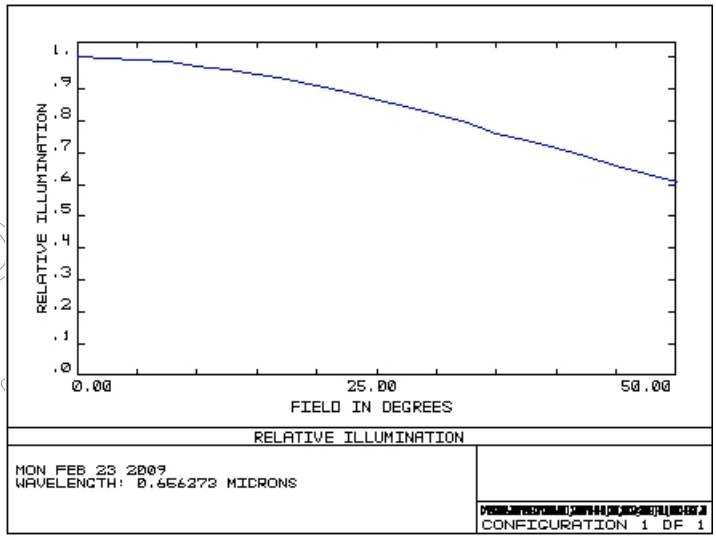



*Figure 7: Relative Illumination*

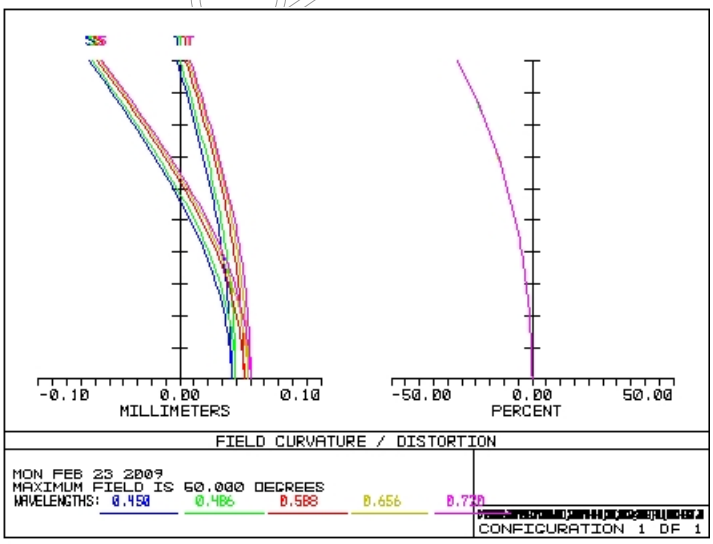



*Figure 8: Lens Distortion*

# 4 Packaging and Flex

The sensor is wire bonded on a flex substrate. The standard length is 56cm. However if necessary the length can be increased. The maximum length the camera can drive the signal is 2,5 meter. The flex cable has a  width of 700µm and a diameter of 1,5mm at the tip where the sensor is mounted. The thickness of Flex cable is 65µm. A very small bend radius can be achieved, down to ~100µm.

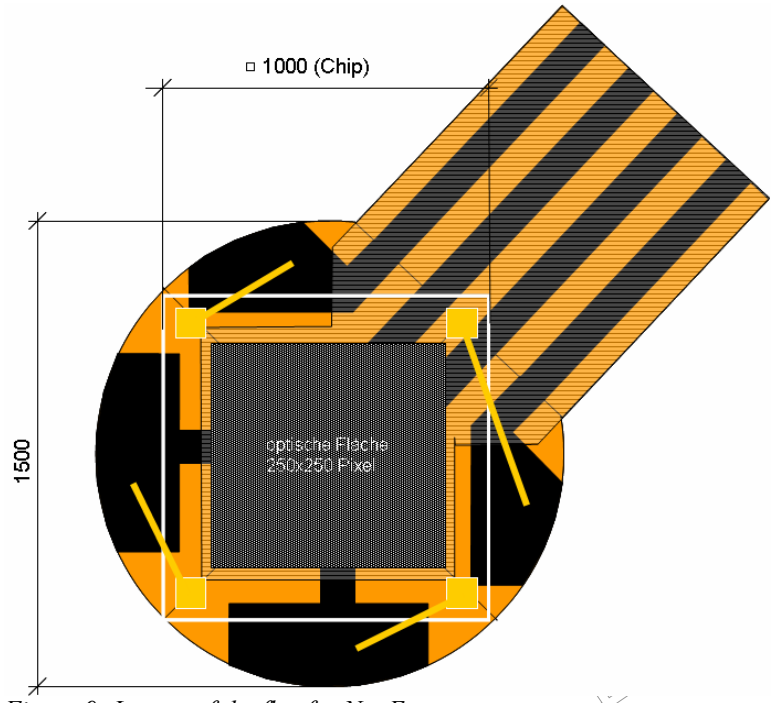



*Figure 9: Layout of the flex for NanEye*

The bond wires the and chip bond are mechanically protected by black globe top material. At the proximal end the flex cable is extended to 900um width providing 4 large soldering pads for electrical contact.

# 5 Base station and Software

With the camera AWAIBA provides optionally electronic and software to run the camera on a PC in real-time with all necessary image corrections. The complete system consists of the camera, an small repeater interface board, the USB basestation and the PC software.
The repeater board has a size of 15x13mm and acts as a repeater to amplify the LVDS signal that comes from the camera. The repeater board is able to drive up to 5m of cable. The repeater board includes also the power supply for the camera.

The basestation is an electronics box that is the interface between the camera and the PC. The input is an differential LVDS, and the output an USB 2.0. The basestation is supplied via 5V from a USB interface of a PC.

The NanEye software runs under WINDOWS XP and consists of the USB driver and the viewer software. The viewer software is able to display the image on the PC in real-time and perform the following functions:

- offset correction (Fix Pattern Noise correction)
- gain correction (PRNU correction)
- demosaic color reconstruction
- white balance
- distortion correction
- image zoom, rotate, shift etc
- brightness adjustment
- image normalization
- dynamic noise reduction
- image enhancement by hyper resolution
- grab bitmaps
- store raw video files of any length
- replay raw video files
- store avi videos
- enable external image processing

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