

## APPLICATION NOTE

# NIR-Enhanced Mode Operation of Kodak Interline CCDs

for use with Kodak KAI-1003, KAI-2000,  
KAI-2093, KAI-4000, KAI-4010 and KAI-  
4020 interline CCD image sensors

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Revision 1

## INTRODUCTION

Kodak interline CCDs can be operated in such a way that near infrared sensitivity is increased. This mode is called **NIR-Enhanced Mode**. A 30% increase in quantum efficiency at 800 nm is typical for a 7.4- $\mu\text{m}$  pixel when operating in NIR-Enhanced Mode.

## SET-UP and OPERATION

To operate a Kodak interline CCD in NIR-Enhanced Mode do the following, in this order, before taking an exposure:

- (1) Set all VCCD clocks to their low voltage level
- (2) Set all HCCD clocks and the Reset clock to their high voltage levels
- (3) Set FD to its low voltage level
- (4) Make no changes to the OG and ESD voltages
- (5) Wait at least 500 $\mu\text{s}$
- (6) Set RD and VDD to zero (output circuit must allow VOUT to go to zero also, some constant current circuits may not allow this)
- (7) Wait at least 10 $\mu\text{s}$
- (8) Set VSUB to 1V--**never allow VSUB to go below 0.7V for any length of time!**

When the exposure is done:

- (1) Restore VSUB
- (2) Wait at least 10 $\mu\text{s}$
- (3) Restore RD and VDD
- (4) Start clocking the HCCD (no need to wait 500 $\mu\text{s}$  before starting the clocking)
- (5) Flush out the VCCD
- (6) Read out the image

**If these steps are not taken in the proper order, or any one of the instructions is not followed, the device could be permanently damaged.**

When the VSUB voltage is reduced, dark current that is normally swept away by the vertical overflow drain is allowed to collect in the photodiode. If the level of this dark current is too high with VSUB = 1 V, raise the substrate voltage until the dark current reaches an acceptable level. The increase in NIR response will be reduced at the higher VSUB voltage.

Since it is required to stop the clocks during integration, this mode can be used for single frame captures but not for continuous video mode.

When operating in this mode the photodiode charge capacity will be larger than the VCCD charge capacity, so charge will bloom from the photodiode to the VCCD if the exposure is not properly set. Anti-blooming protection has been traded for increased NIR response.