NO. TH-1088 DATE: 11/16/01

No-delay Async shutter Option

Basic concept of No-delay Async shutter

What is No-delay Async shutter?

Defined for industrial video cameras, which have asynchronous reset and electronic shutter function, it takes the external async reset signal with pulse width control, discharges the CCD immediately, and the exposure control is done without any internal delay. In short, an external trigger with pulse width control dictates discharge of the CCD and transfer of the image without internal delay inside CCD cameras.

No-delay async shutter is becoming more important to today's multiple-camera application. Regardless of whether cameras are synchronized by genlock or not, external async trigger and shutter control can be completely random from the internal sync signal (horizontal and vertical reset signal, called HD and VD).

Pulse width controlled electronic shutter

This operation in PULNiX's camera is defined as "External pulse width control." When this mode is selected, the camera expects to receive a VINIT trigger pulse, which means the pulse width controls the opening of electronic shutter. In theory, the negative-going leading edge generates a CCD discharge pulse, called Vsub pulse and the rising edge of VINIT generates a CCD transfer gate pulse. This period is the exposure time of the shutter function. Then camera starts video output clocking.

In reality most cameras, including PULNiX standard digital cameras, are reset at internal horizontal timing after receiving the VINIT pulse.

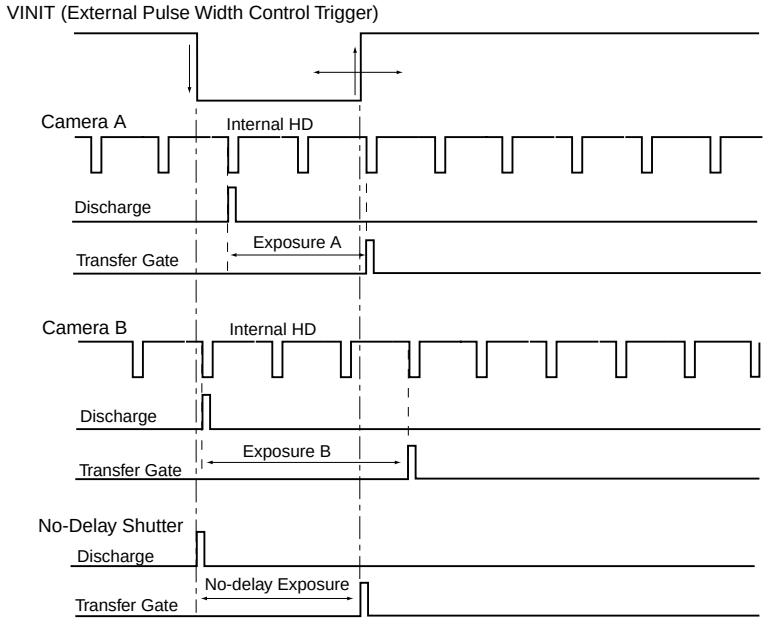

Fig. 1

For the majority of asynchronous applications, this is sufficient, especially when cameras are genlocked to each other with external sync, and the VINIT is controlled by using HD or H sync frequency. This operation is consistent for all cameras and reliable.

However, when the external trigger is completely asynchronous and the cameras are not genlocked, this type of reset does not generate a consistent result for each camera. The specific timing of Camera A and B in Fig.1 indicate different image capture timing and exposure time. Camera A has a shorter exposure than No-delay shutter. Camera B indicates longer exposure than No-delay shutter. The starting point of the exposure is also different. This is more realistically true for digital cameras as they tend to be used without genlock. Digital frame grabbers are more flexible, and are therefore better able to capture images by taking clock, LDV and FDV from the camera for any async timing than conventional analog frame grabbers. Though the variation of shutter speed and beginning of image capturing is always within 1H (64 µsec for fH =15 KHz) and affects only fast-moving objects at high-speed shutter settings, it is critical to some applications such as 2D, or 3D imaging of fast-moving objects.

No-Delay Shutter Option

The no-delay shutter option can be implemented in two methods, both mainly caused by internal HD reset (or LDV output).

CCD discharge timing

The discharge pulse for CCD is created at the external trigger timing at pixel clock delay, typically 2 to 5 pixels from VINIT edge. (One pixel clock runs at 50 nsec at 20 MHz for example, total delay is 100 nsec to 250 nsec.)

This is due to dull wave form of the input pulse. If the input VINIT pulse is sharp, the delay is minimal. However, any fast-settling drivers tend to generate ringing or overshoot on the pulse edges, and the length of cable, impedance, and termination may vary the characteristics.

Discharge control is relatively easy.

Transfer gate timing

Charge transfer timing in CCD cameras requires more complex timing adjustment as it relates to the vertical shift register clocking as well. There are two methods described below.

1. Reset internal HD and LDV at end of VINIT (Fig. 2 A)

Async reset in industrial cameras can reset vertical, horizontal and clock state. However, because of the interface with other video equipment such as frame grabbers, async V reset is the most common method.

In this case, it resets H sync and V sync together. If the frame grabber interface is done via PLL genlock, this does not work. If the frame grabber is only looking for camera output with enable signals (FDV, LDV and clock) for image capturing, then H sync reset is available for digital cameras. The digital video output has to come with FDV and interrupted LDV.

The shutter speed can be faster than 1H period (1/2H....1/32,000 sec for fH = 15 kHz).

2. Shutter control is completely asynchronous from the internal HD (Fig. 2 B).

In this method, the async reset is only done on V reset and the horizontal sync runs without any interrupt. The HD can be synced with external sync.

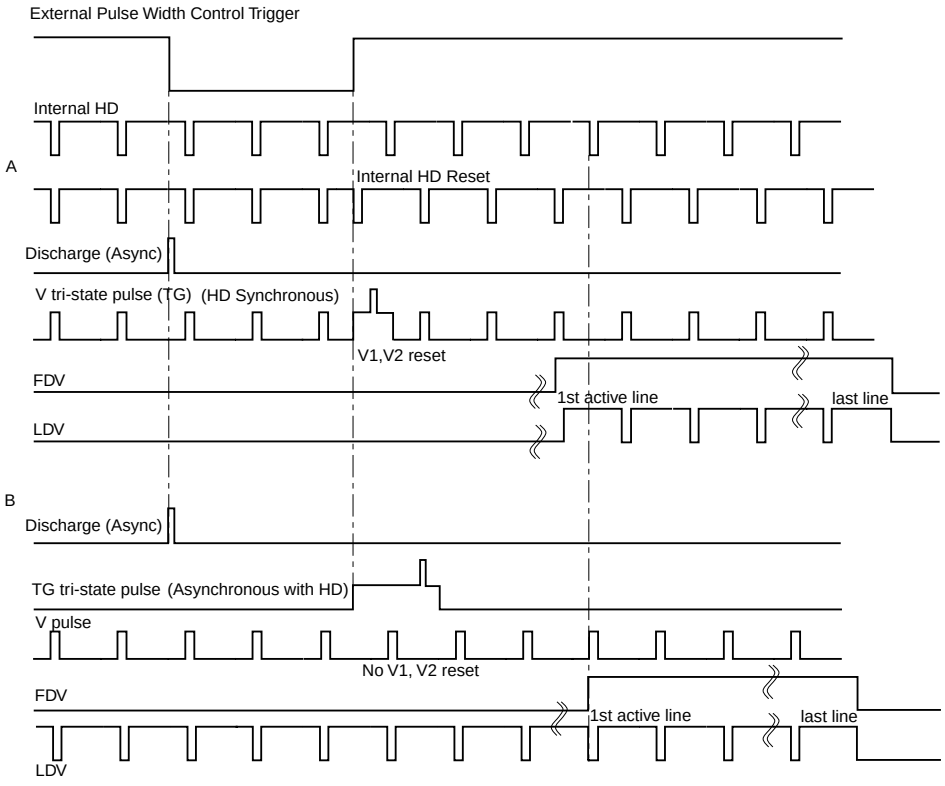

Fig. 2

The charge transfer occurs completely independently from the internal H sync, and the vertical shift register pulse must be generated with a combination of the internal pulse and asynchronous transfer gate. This requires at least 1H delay on the transfer gate from the rising edge of VINIT to provide stable operation. The amount of the delay is consistent and only affects maximum shutter speed.

The maximum shutter speed is limited to 1H to 2H (1 1/2H typical...1/10,000 fro fH = 15 KHz).

No-delay shutter option (OP. 29-6)

PULNiX provides the no-delay shutter in B format to the TM-1020 family. This allows cameras to work in external sync and PLL applications.