TIMING DEVICES FOR HIGH-SPEED DIGITAL CAMERA SENSING

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ABSTRACT

This paper deals with issues of using digital high-speed camera Olympus i-SPEED. Basic description of the digital high-speed camera and issues associated with using of high-speed camera are described in the first part. Devices used to timing are described in the next part of this paper. Schematics and functional description is alleged.

1 INTRODUCTION

High-speed camera is a device used for exploration of fast processes. Using this device has many advantages and some disadvantages of course. A high-speed camera is now almost always of a digital type, where there is used a CMOS sensing unit. Frames picked up by the sensing unit are converted to digital data and saved to computer memory unit.

2 USE OF HIGH-SPEED DIGITAL CAMERA

Technology of frame saving by CMOS sensing unit allows fast collection of data from the sensing unit. This speed is unreachable for standard cameras using CCD sensors. The digital high-speed camera Olympus i-SPEED used for exploration of fast processes on Department of Power Electrical And Electronic Engineering saves the data from sensing unit with frequency up to 480 MHz. If the frequency is less then 1000 frames per second, possible resolution of frames is 800x600 pixels. This limitation is determined by maximum magnitude of data flow. For higher frame rate the resolution must be restricted. Thus, a compromise is required between resolution and the frame rate, during sensing of very fast processes.

Intensity of light in sensed area is critical for quality of pictures. Especially for sensing in very high frame rate a very high intensity of light is needed. This requirement results from the principle of high-speed camera. Exposure time of every single frame is inversely proportional to the frame rate. From table 1 it can be established, that maximal exposure time is in microseconds. Therefore high-power halogen studio lights are usually used. Advantages of this solution are easy regulation and acceptable price. Disadvantage is a very high undesirable thermal power generated by the halogen lights and power needed for sensing of

very fast processes (eg. shooting) is too high. For sensing of these very fast processes, high power flash lights are used. Flash light illuminates scanned place about 5–6 ms. The place is illuminated by equivalent power as 100 kW of halogen lights. So high power cannot be acquired by any other system of illumination. Exposure time can be reduced if so high illumination is used and higher fidelity of sensed picture can be accomplished. Fuzzing of very fast moving objects is reduced.

Using of flash light brings some special problems in timing of right flash moment. To reduce this problems a **time delay line** was designed, which makes possible precise timing of

Frame rate [fps]	1 000	1 500	2 000	3 000	4 000	5 000	6 000	8 000	10 000	15 000	20 000
Resolution X [pixels]	800	672	576	448	384	320	288	256	224	160	128
Resolution Y [pixels]	600	504	432	336	288	240	216	192	168	120	96
Pixels (thousands)	480	338	248	150	110	76,8	62,2	49,2	37,6	19,2	12,3
Zoom 1:	1,0	1,2	1,4	1,8	2,1	2,5	2,8	3,1	3,6	5,0	6,3
Max . exposure time [μs]	1000	667	500	333	250	200	166	125	100	66,7	50,0

Tab. 1: *Framerates and resolutions of digital high-speed camera Olympus*

the flash. Time delay line is created from three discreet devices. **Command device** is started by sound or light and gives impulse to start of sensing. **Signal convertor** makes it possible to start the high-speed camera by external starting signal, if this signal is not compatible with starting system in camera. The **Delay device** is the last device in time delay line. The Delay device makes it possible stating up to four flash lights in regulated intervals. Output of timing device is TTL signal. High-speed camera is started by falling edge of impulse from the timing device.

2.1 COMMAND DEVICE

The Command device is designed to acquire starting impulse in case, when the direct electrical signal is not available. In this case it is necessary to start the high-speed camera by acoustic or optical signal. Because of it, the Command device has two inputs. To sense the acoustic signal a standard electric microphone is used. This type of microphone has excellent sensitivity, good price and availability. Photodiode can by used to sense an optical signal, in this case it can be type 1PP75. Adjustment for another standard type of electrical component eg. phototransistor is easy. Function of this device can by described as: signal from detecting part (microphone or photodiode) in fist part amplified to level needed for following processing. Gain of input amplifier is infinitely adjustable, so input sensitivity of the whole system can be easily regulated. The signal is now routed from the input amplifier to a simple comparator with adjustable comparating level. If the signal from input amplifier has higher level then is the comparation level, the comparator will roll over and sent impulse on it´s output. This impulse is routed to shaper made by 555 circuit. This circuit generates impulse about 300 ms, if is started. Contemplate edge is designed as falling. Following circuits responding to this edge, and camera system is also compatible.

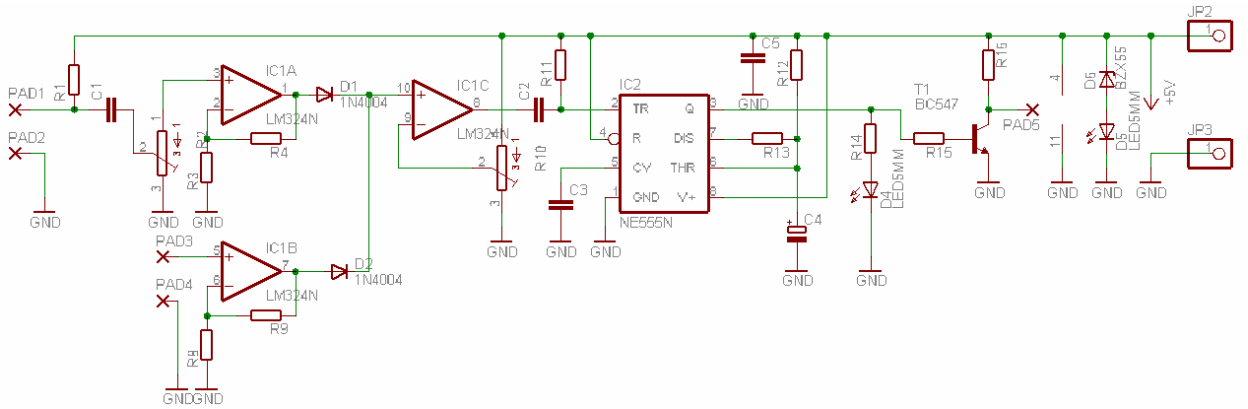

Fig. 1: *Detailed schematic of command device*

The Command device makes it possible to synchronize the flash light with the high-speed camera in cases, when there is no other then acoustic or optical signal accessible. It can by used in eg. cases of sensing gun shooting.

2.2 SIGNAL CONVERTOR

A signal convertor is used in practical case, when an electrical signal for starting and synchronizing high-speed camera and flash light is available, but this signal has wrong form. Signal convertor has been designed to adapt this synchronization signal to a compatible form with high-speed camera and flash light.

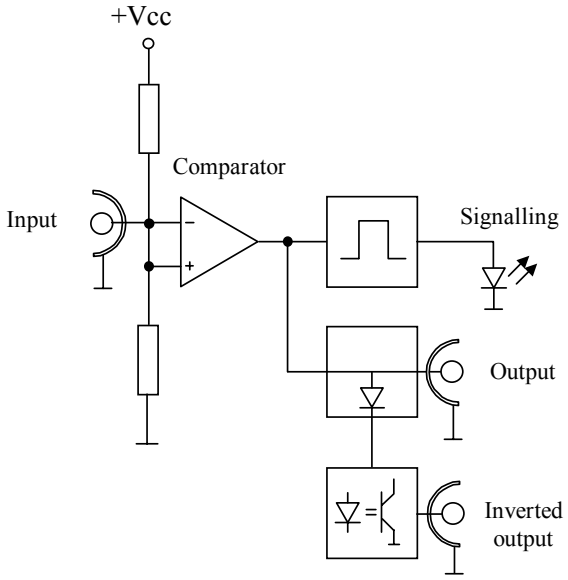

Fig. 2: *Block diagram of signal convertor*

The signal is routed from input to comparator. Function of the comparator is to start following circuits if the input signal is higher then the comparating level. The signal from comparator is routed to a signalisation block (so controlling person can adjust the convertor) and to output. The signal is also routed to an inverted output. This output provides impulse

with falling edge. This is necessary to synchronize and to start high-speed camera.

2.3 DELAY DEVICE

The purpose of the delay line is to allow flash timing. Independent timing of four flash lights can by achieved by this device but only one impulse is necessary to start. The function is simple, but needs exact adjustment.

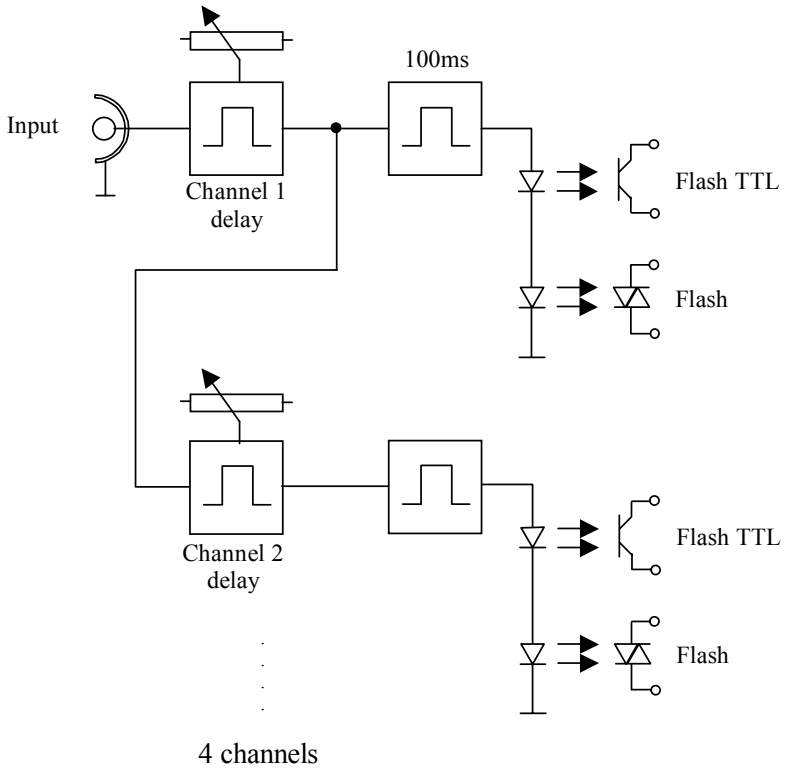

Fig. 3: *Block diagram of delay device*

The signal from the command device or an external signal (may be adjusted by signal convertor) is used as the starting signal. This signal is routed to input comparator. This comparator is used because of exact adjustment of the delay line. If comparator starts, a signal is routed to the first channel of delay line. After a default time, the output signal is routed to the first channel output and to other channels of delay line. Levels 2 – 4 are started in dependence on the first channel, but delay of these channels is independent. The fist channel must by used. This is the only restriction. the signal from the delay line is used to start the connected devices.

3 CONCLUSION

Assembly of devices as described makes possible a more effective usage of the high-speed camera. It makes the control more simple and precise. All devices has been designed according to practical experience from using of high-speed camera and with knowledge of

practical problems. Devices are designed as independent equipment. It makes using these devices more flexible.

Fig. 4: *Practical usage of signal convertor and timing device – gun shooting*

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