PYRO OPTIC

LED FLASH LIGHT PULSER

Type FLP1000

LED flash for imaging of fast moving particles

Content

1 Introduction

The LED Flash Light Pulser FLP1000's short (23 ns – 75 ns) and intense flash lights allow imaging of very rapid processes. It provides uniform background illumination and it is a perfect light source to obtain high quality images of fast moving objects with a digital camera. The LP1000 LED flash light pulser is developed for accurate measurement of size and velocity of fast moving individual particles by a backlighting technique using a high power LED as light emitter. It can emit dual flash light pulses very closely spaced in time. The first light pulse is fired with a delay of only 50 ns at the rising edge and the second pulse at falling edge of the trigger signal with a similar delay of 50ns.The jitter is only a few ns. The time separation between the two pulses can be freely controlled in a wide range from 200 ns and up-wards. A time delay of 1.0 - 5 µs between pulses is typical needed for velocity measurements of fast moving particles (20 – 500 m/s). Triggering is flexible and simple and can be matched to nearly any application The emitted LED light is incoherent and has no speckle noise as opposed to an ordinary laser flash.

LED emitter is mounted via a connector directly at the driver electronics to generate shortest possible pulses. The LED, electronics and optics to shape the light beam are all built into a compact unit. The LED-head is connected to the power supply with a 3 m long cable. The LED is pulsed via a separate 3 m long trigger cable with BNC connector from the LED-head.

Customized versions can be offered at attractive conditions if standard options do not fulfil requirements. The LED Flash Light Pulser deliver uniform light from a high power LED with efficient optics. Optics is at delivery optimised at a given application (area, distance, camera and lens type).

A short test report is delivered with each system with information about serial numbers, width of light pulse, uniformity of the illumination, test pair of images, etc.

1.1 Features

The LED Flash Light Pulser FLP1000 has logic circuit to pulse the first light pulse at the rising edge of a square trigger signal and pulse a second light pulse at the falling edge, i.e. a single trigger channel is used to control dual pulsing. This simplifies the cabling. The time delay from a trigger edge to the start of the light pulse is only 50 ns (figure 1). The LED Flash Light Pulser is easy to synchronise with other measurements due to the ultra-short and stable time delay between trigger and light pulses. It is recommended to use a delay or pulse generator to control the time delay of the two pulses accurately and synchronise the LED Pulser with a digital camera or use I/O output directly of the camera.

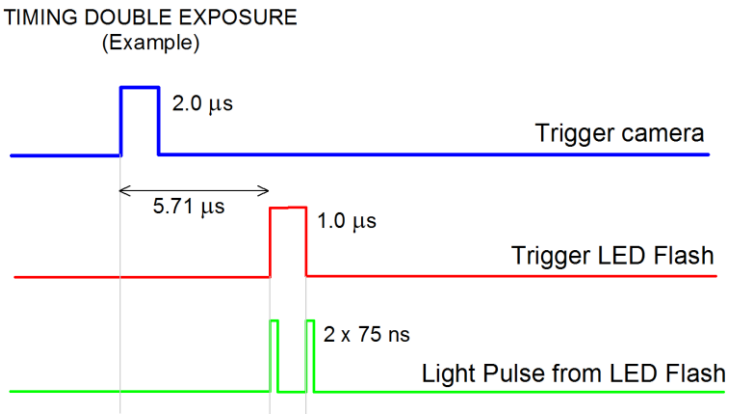

Figure 1 Example. A delay generator is used to control triggering of a PIV double exposure camera by a 2.0 µs pulse (blue curve: trigger input for camera). The delay generator is used to correct for a 5.71 µs internal delay in the camera and a trigger signal (red curve: trigger input LED Flash Pulser) control timing of the LED light flashes. The first 75 ns LED light pulse is emitted 50 ns after the raising edge of the trigger signal is received and similar the second light pulse is emitted 50 ns after the falling edge.

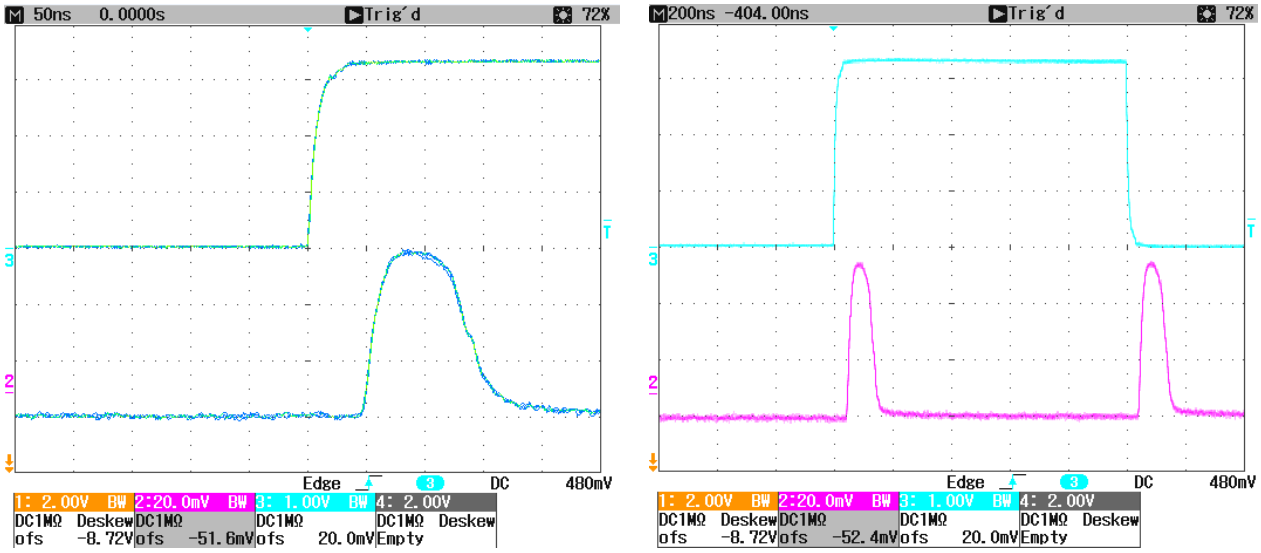

Figure 2 Left (50ns/division): ch2 light pulse emitted 50 ns after trigger rising edge signal ch3. Repeated pulses are shown and output is highly stable in time and intensity. Right: Ch3 (cyan) square trigger pulse with duration of 1.0 µs generate two light pulses separated by 1.0 µs.

2 Warnings, Limitations and Safety

LED light sources are today used everywhere for lighting of homes, cars, decoration of buildings, flashlights, etc. Lasers and LEDs light can cause thermal heating effect in proportion to the power density of the radiation, which can result in tissue damage in particular to the retina. Shorter wavelength radiation causes a photochemical effect in the retina, changing the chemistry of the cells, and there are dual limits (thermal and photochemical) in EN/DS 60825-1 between 400 and 600 nm. To date, the testing shows (ref. Cree) that blue and royal blue LED components (450-485 nm dominant wavelengths) pose a higher potential eye safety hazard than its white LED components. Other colours of LED components, such as green and red LED components, do not pose as high an eye safety risk. Regardless of LED colour, Pyrooptic advises users to not look directly at any operating LED component.

The LED Flash Light Pulser uses high power LEDs emitting at 460 nm (blue, standard), 523 nm (green, option) and 623 nm (red, option). However, the LED Flash light is on for only 65-80 ns and the energy of a light pulse is rather low despite of the higher peak intensity. So the average light energy is only a fraction of the energy in a typical continuous operation of the LED. Therefore, the light from the LED Flash Light Pulser would appear faint if you looked at it at a typical pulse rate of 20-50 Hz. Therefore, and for safety reasons, the LED light can be set to continuous operation. This is very useful when doing alignment of the setup. The power level is safe for the eye, but never look directly into the light beam. The alignment lighting mode is turned on and off with a switch on the power supply unit.

Although the energy of a light pulse is very low, never look directly into the LED light beam. Reflected light from a distant diffuse surface do not cause any safety risks, i.e. a simple light-blocking or diffuse screens can minimize risks.

Use a piece of paper to locate and align the LED light beam or use a video camera.

Stop LED Flash Light Pulser when measurements are not performed.

Do not use the equipment if there are any damages, e.g. damages on cable between LED-head and the power supply. Do not open or try to repair instrument, but send it for service if any problems.

3 Applications

The LED Flash Light Pulser can be used for low and high applications where information about individual particle size and velocity is needed. The LED Flash Light Pulser can be used with a wide range of low and high resolution digital cameras.

Velocity and particle sizing in air and liquid

Imaging of fast moving flows, e.g. sprays, powders

Microscopy of moving objects

Instrumentation for industry

On-line measurements

High-speed inspection

Research of flows, droplets, particles, moving objects

Measurements synchronised with other measurements, e.g. temperature, cycle information, etc.

Contact Pyrooptic to discuss your application and needs and we will be happy to deliver special systems.

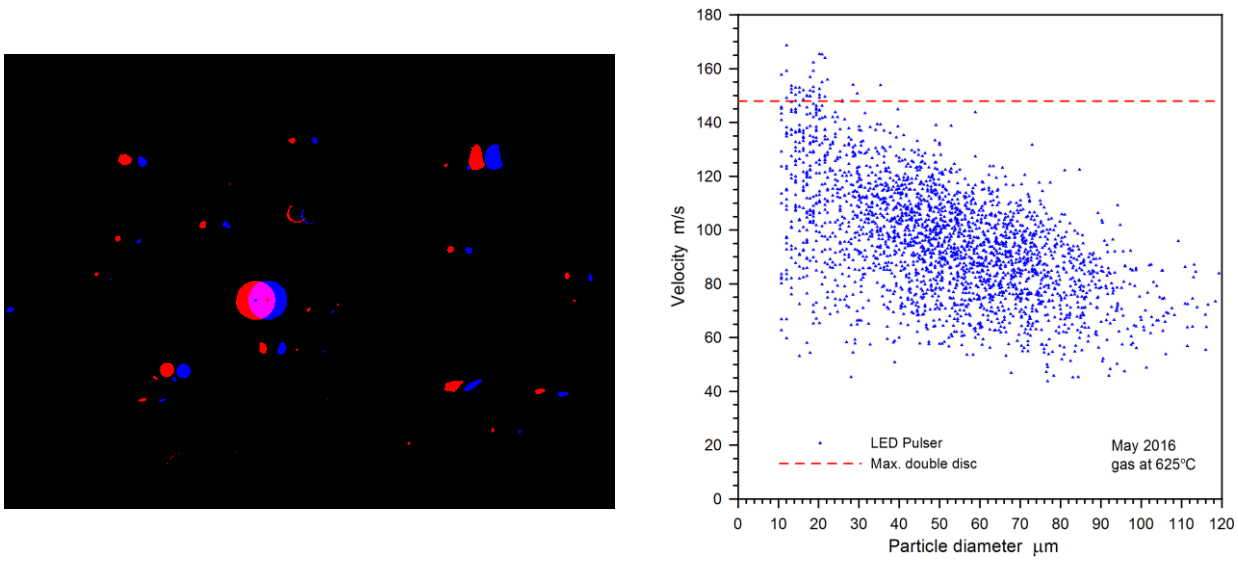

Figure 3 Left: Overlay of a pair of images (red and blue is first and second image, respectively) of glass particles from sandblasting gun. The velocity for each particle is calculated from displacement of the centre of mass. It is observed that the shadow area of an irregular particle is not necessary constant as it rotates and spin even with a short time separation of 1.0 µs between the two images. Right: Results of particle size and velocity measurements for erosion jet compared with double spinning disk (ASTM method) and good agreement is seen for the fastest particles whereas the velocity of larger particles is significant less, result from the Metrosion EU-project.

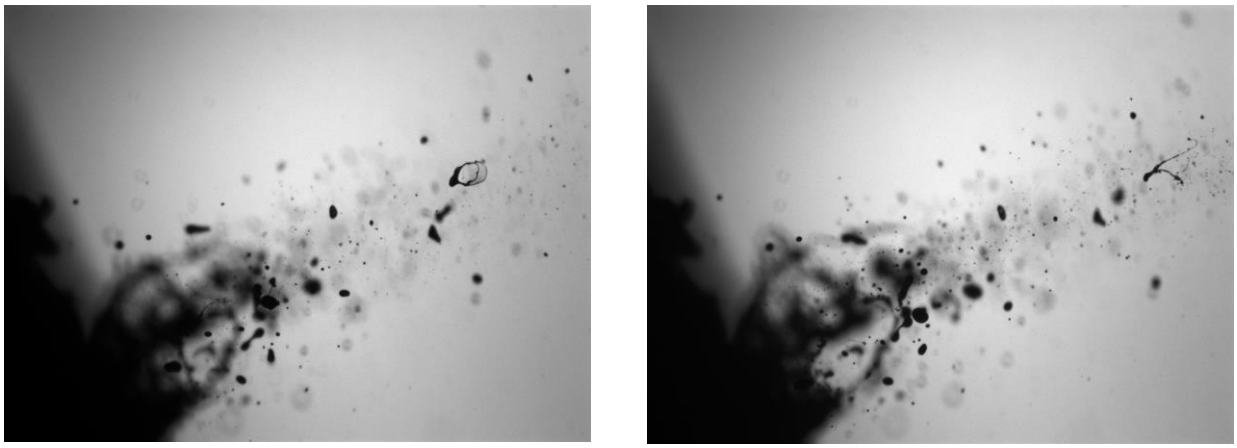

Figure 4 Bio-oil spray. Particle size and velocity can be found from a pair of pictures recorded shortly after each other. Details like droplet break-up can be studied. Pictures recorded by Ping Feng at DTU Chemical Engineering, Denmark.

4 Detailed use

4.1 Operation

Mount LED head in setup and consider safety issues. Connect LED head to the power supply unit with the 5-pin Lemo plug and connect trigger input, BNC connector on cable to LED head, to the trigger signal (camera, delay generator, etc.). Connect LED power supply unit to power and the system is ready for use. Power push switch is illuminated if the power is turned on. No light is emitted before a trigger signal is received or the alignment light is turned on by the toggle switch (down position). It is not recommended to operate with both LED flashing and alignment switch on at the same time, e.g. it will disturb recording of the second image in a pair with the Imperx B1310M camera as the exposure time is longer for the last recorded images. Read “LED Particle Size and Velocity Measurement” for more details of using the LED system.

Figure 5 LED power supply and LED Flash Light Pulser. The BNC connector on power supply for measurement of pulse current and width is an option.

5 Maintenance, Errors and Service

5.1 Lifetime of the LED's

The lifetime of the LED's in the LED Flash Pulser is reduced compared to manufactures specifications as a significantly higher current is used than the recommended max. current in pulse mode. Lifetime of the LED is shortest at high pulse energy that is defined by the operation voltage of the LED and the total capacity of the condensator. Life time of the LED can be month/years at moderate energy of light pulses and few days' continuous operation for some configurations of the system at 30 Hz. It is recommended to stop pulsing the LED if it is not used to increase the practical life time to months/years. The LED light source is easy to replace and spare LED sources is delivered with the system. Do not pulse with a higher rate than max. 1 kHz as the life time of the LED is reduced significantly due to overheating. A special model is offered at pulse rates up to 2 x 10 kHz.

5.2 Replacement of LED emitter

The LED light source might fail after long time use due to very high currents used. The LED source can be easily replaced.

Disconnect LED-head and read instruction before replacing the LED source

Turn off the power supply, disconnect main power cable and wait for 1 minute or wait 10 seconds while triggering LED light pulses. This is required in order to discharge the capacitors in the LED driver. Disconnect LED-head from the power supply. Remove M3 unbraco locking screw at rear end of LED-head and the outer stainless steel protection tube can be removed. Some force might be needed to slide the tube off as the unit is sealed by o-rings to prevent particles to enter into the unit. Screw off the lens/filter tube to get access to the LED emitter. For some versions must a o-ring and collimating lens placed in front of the LED be removed. Notice, avoid touching surfaces of optical components, but hold them at the border/edge or with a lens cleaning paper. Do not demount the electronic board.

The LED emitter can now be replaced via 2x6-pin Molex connector with care (do not bend connector pins). Be aware that "SIDE UP" mark on the connector is pointing up-wards for the right polarity. Reversed operation will destroy the LED's. Mount the optical part and the stainless steel protection tube again (do not use force) and fix the tube with the M3 locking screw. The alignment light is useful to perform a quick test of the LED emitter, i.e. a spot of light can be seen on a piece of paper.

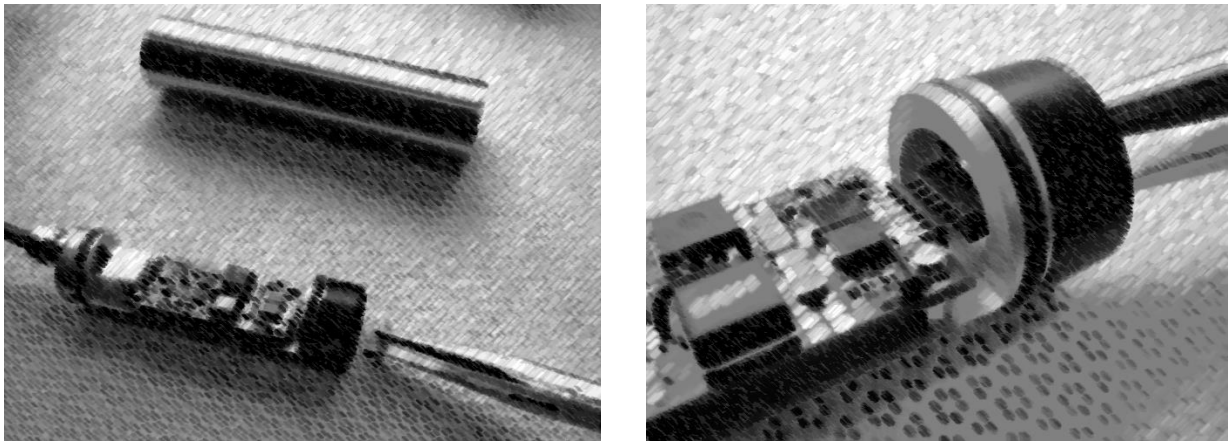

Figure 6 Replacement of LED (photo). Outer stainless steel tube is remove and the unit can be disassembled. Use a long nose plier to hold and mount LED via Molex connector. “SIDE UP” mark on connector (minus) must face upwards.

5.3 Service

Contact Pyrooptic if any question arises about use of the LED Pulser. Do not modify or try to repair the LED Flash Pulser. It contains high voltage parts.

Do not modify or try to repair the LED Flash Pulser

It is recommended to use a sapphire protection window for both the camera lens and the LED head if erodent particles are used as particles can harm the anti-reflection coating. Sapphire protection windows can be cleaned by a cloth or cotton swab without risk of harming surface. Note, the sapphire window is anti-reflection coated on the rear side, i.e. do not demount window from holder unless orientation is the same.

Do not bend the trigger BNC cable sharply as it can harm the cable.

6 Technical specification FLP1000

Light source	High power LED
Light colours	Blue (standard), green, amber, red, UV, etc.
Illuminated area	8 mm dia. (standard) at 110 mm from the lens
Light pulse width	23, 35 and 75 ns (HW) standard
Trigger input	50 ohm, TTL, BNC female connector
Trigger delay	50 ns to light pulse
Dual Light pulse separation	>100ns
Jitter	<5 ns
Repetition rate	1 kHz (10 kHz option) (pulse pairs per second)
Ambient temperature	0 °C – 70 °C (non condensing humidity)
Power consumption	less than 10 W
Power supply	230 VAC or 24 VDC
Cable LED-head	3.0 m (standard)
Housing (metal)	33.7 mm dia. x 150 mm LED Head
	175x155x80 mm (LxWxH) Power Supply
Weight	1350 g LED Power supply
	500 g LED Flash Head
Certification	CE

6.2 Options

OP1: Sapphire protection window

OP2: Purge flow optics and air cooling LED Flash Pulser head

OP3: Water-cooling of LED Flash Pulser head

OP4: Custom illumination area

OP5: 10 kHz repetition rate of double pulses

OP6: BNC output of current signal though LED source

OP7: Heat or light blocking optical filter

OP8: Wet or humid conditions

OP9: Water-cooled probe for measurements in flames, sprays and hot gas flows

OP10: LED light source separated from driver electronics

OP11: 3D imaging of particles

7 Declaration of Conformity

Manufacturer: Pyrooptic Aps

Address: Dyvelslystvej 5

DK-4060 Kirke Saaby

Denmark

We declare on our own responsibility, that the product:

Product: LED Flash Light Pulser

Model no.: FLP1000

Is in conformity with following directives

DIRECTIVE 2014/35/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
of 26 February 2014 on the harmonization of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits

DIRECTIVE 2014/30/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
of 26 February 2014 on the harmonization of the laws of the Member States relating to electromagnetic compatibility

DIRECTIVE 2011/65/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment

and was manufactured in conformity to the following standards

EN 61010-1:2010
Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirement

EN 61326-1:2013
Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements

Manager Sønnik Clausen	24th June 2016
……	…….
Position and name	Date and signature

8 Contact Information

www.pyrooptic.com

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