LIGHT EMITTING DIODE SOURCES OF CALIBRATED SHORT LIGHT FLASHES.

Brief description.

CONTENTS

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http://hvsys.ru/

1. Purpose and design.

Application:

Light emitting diode sources are intended for calibration in light of charged particles' energy detectors that use the scintillation principle.

They are applied in the following fields:

Precision calorimetry of nuclear physics particles;

Calibration systems in calorimeters of nuclear physics particles;

Multi-channel scintillation detectors of nuclear physics facilities.

The scintillation method in calorimetry is based on the fact that some optically transparent substances (zinc sulphide, sodium iodide, calcium tungstate, etc.) become luminous at the action of ionizing radiation. The emergence of the luminescence is the consequence of atoms' excitation under the action of radiation; when returned into normal conditions, atoms emit photons of the visible light of various brightness (scintillation). Light photons (λ= 300 ÷ 500 nm) are captured by the photo receiver that can register each flash. The energy of the ionizing particle is defined through the energy of the scintillation flash. For accurate calorimetry, it is necessary to control the photo converter coefficient with sufficient precision. For these purposes expensive laser calibration systems are often used in nuclear physics. The attractive light source in this task is a cheap light diode. However, light diodes have rather big temperature dependence on the intensity of the emitted light.

We offer a calibration device on a light diode; its key idea is in the intensity control of its radiation using a standby radiation monitor on a cheap silicon photo diode. Such photo diodes are relatively inexpensive (< $8/unit) and have very low temperature dependence of photo sensitivity in the range of light wave length λ=300 ÷ 500 nm.

Fig.1 shows the block diagram of the device. A moderate part of the energy of the light flash emitted by the light diode is controlled by the photo diode. The energy of the photo diode output current pulse is transformed into a digital code by the charge-sensitive converter QDC. The main part of the light flash energy is led onto the controlled calorimeter through the optical connector.

The operation of the light diode is controlled by a short pulse generator and a LED driver. The device operates with a fixed duration of the light flash. It may be produced with duration in the limits (5 ÷ 20) ns for various modifications of the device. The pulse repetition frequency is set by the internal generator in the limits (0.1 ÷ 1000) Hz, or the external generator on the synchronization input with NIM levels. The light pulse amplitudes are regulated with the microcontroller through DAC.

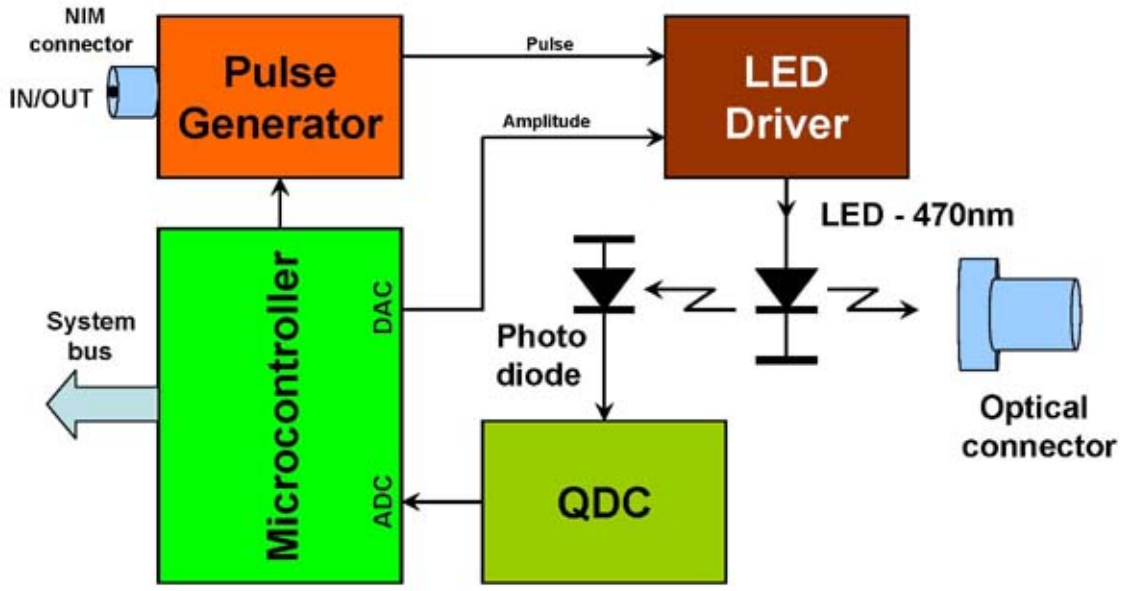


Fig.1 Block diagram of the LED calibrator.

A microcontroller built in into the device through line RS485 is connected with the supervisory computer and it controls the operation of all parts of the device. The device system bus includes:

- a power bus – 9 ÷ 15 Volt;
- a double line of serial line communication.

Each device has its own unique address and is connected with the supervisory computer through the system controller. The following devices produced by our company can operate as such a controller:

- a system module of the high-voltage power supply system SM32 (described in « 1_LHVPS_engl.pdf »);
- a system module of the translation system SiPM (described in «2_SiPM_eng.pdf »);
- a system module of the PMT_array system (described in « 3_PMT_array_eng.pdf »);
- a USB adapter of the system bus (described in «USB_br_eng.pdf»)

For the scintillation calorimetry metrology two scenarios are possible:

- at relatively high frequency of light flashes repetitions, the microcontroller adjusts the amplitude of controlling pulses of the light diode in the tracking mode with high accuracy for the flash energy level given by the operator;
- at low frequency of flashes, the digitized data on the energy of each flash is read out into the host computer and is used later in calorimetry data processing for their correction.

Light-diode sources of calibrated light pulses can operate on one system bus with high-voltage power supply channels of the calorimeter photo receiver.

2. Key Features

1. The duration of the light pulse, half-height, fixed, ns	5 ÷ 20
2. Pulse repetition frequency, Hz	1 ÷ 1000 (0.1 ÷ 100)
3. The wavelength of the emitted light, nm	468 (405, 428)
4. Resolution of amplitude control channel, bit	12
5. Width of the amplitude spectrum, max, %	1.5
6. Error of flash energy control, %	0.3
7. Error of flash energy stabilization, %	0.5
8. Temperature coefficient of the dependence of energy flashes in the auto substring mode, %/°K	0.08
9. Input/output of synchronization, standard	NIM
10. System bus connector	IDC-10
11. Output optical connector, optical diameter, mm	7
12. In-system interface	RS-485
13. Voltage of system powering	9 ÷15
14. Dimensions of the multichannel cell, mm	65x45x20
15. Operating temperature range of the cell, °C	0 ÷ +40
16. Operating humidity of air, %	0 ÷ 85

In parentheses are the options available on request.
The layout of the device is shown in Fig. 2.

Duration and shape of the light flash depend to some extent on the amplitude of the control pulses. Fig. 4 shows the waveforms of light pulses obtained with an oscilloscope Tektronix TDS3054C (500 MHz; 5 Gs/s) and a photomultiplier Hamamatsu R7400U-20 (D = 8mm; τ = 0.8 ns). The light during the measurement was repeatedly weakened.

Fig. 5 shows the amplitude spectrum of the energy of the light flashes obtained by the same PMT and spectrometric QDC «43ЦП397».

Fig. 3 shows a graphical window of control program of the light generator which is supplied with the device.

3. Control program.

1. Operational system — Windows; Linux.

4. The set of the purchase.

1. Power supply according to the ordered configuration — 1 ps.
2. CD contains: — 1 ps.
   - hardware drivers;
   - control program;
   - detailed description of the device and system control commands.

Fig.2 Photo of the light calibrator.

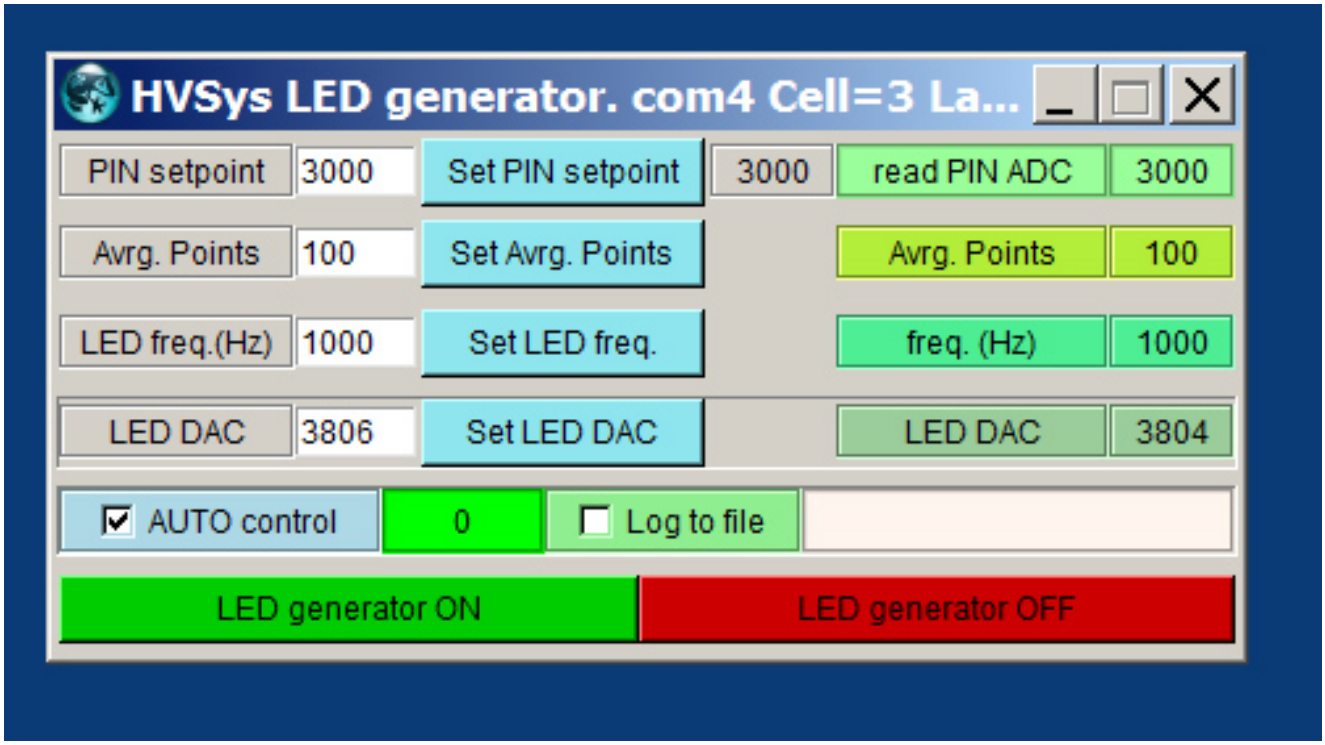
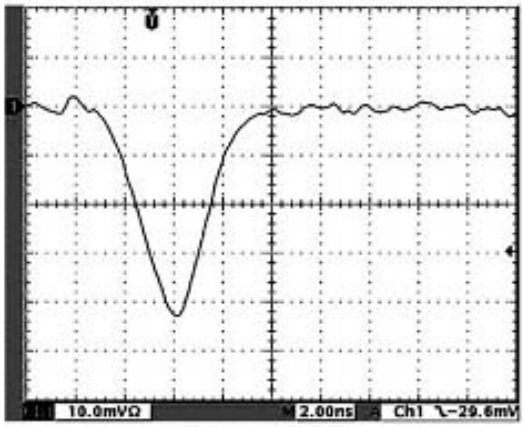
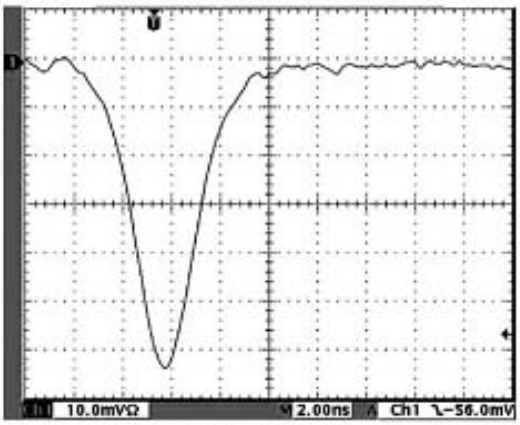


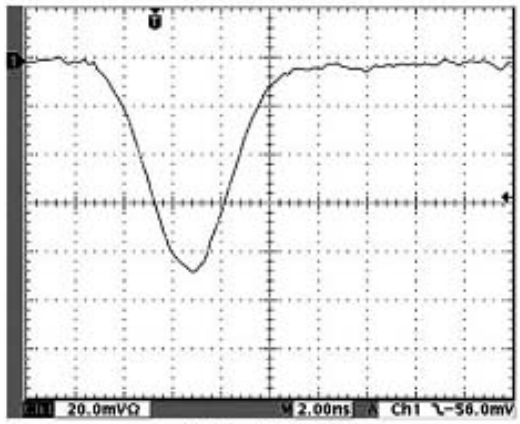
Fig.3 Window of control program for the light generator.



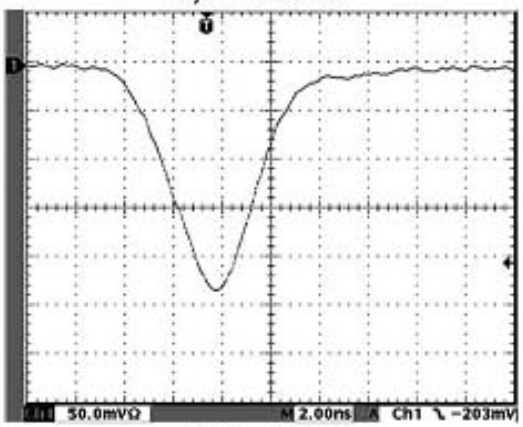
a) D = 100 bit



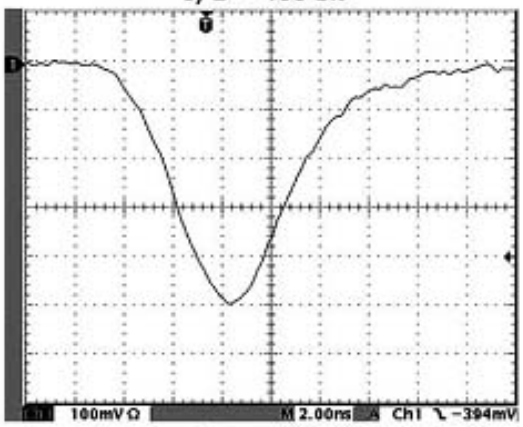
b) D = 200 bit



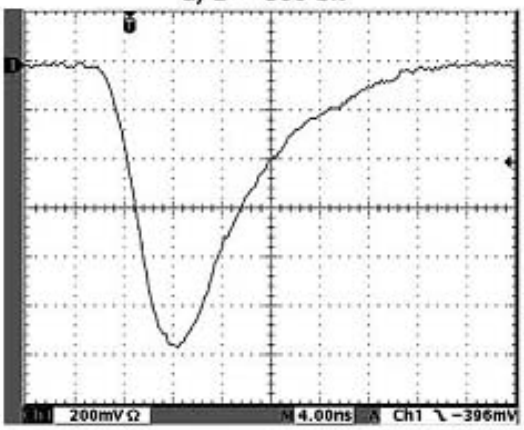
c) D = 400 bit



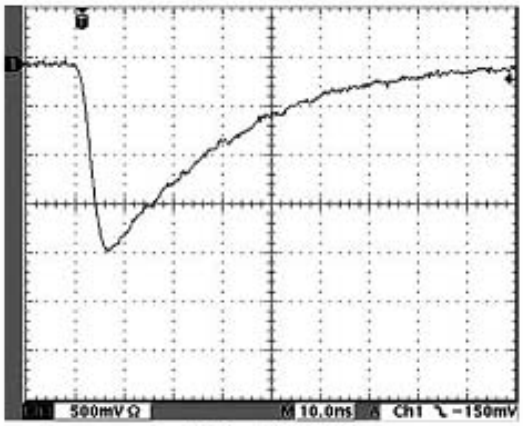
d) D = 800 bit



e) D = 1400 bit



f) D = 2500 bit



g) D = 4000 bit

D - LED control data (12 bit)

Fig.4 Oscillograms of the light pulses.

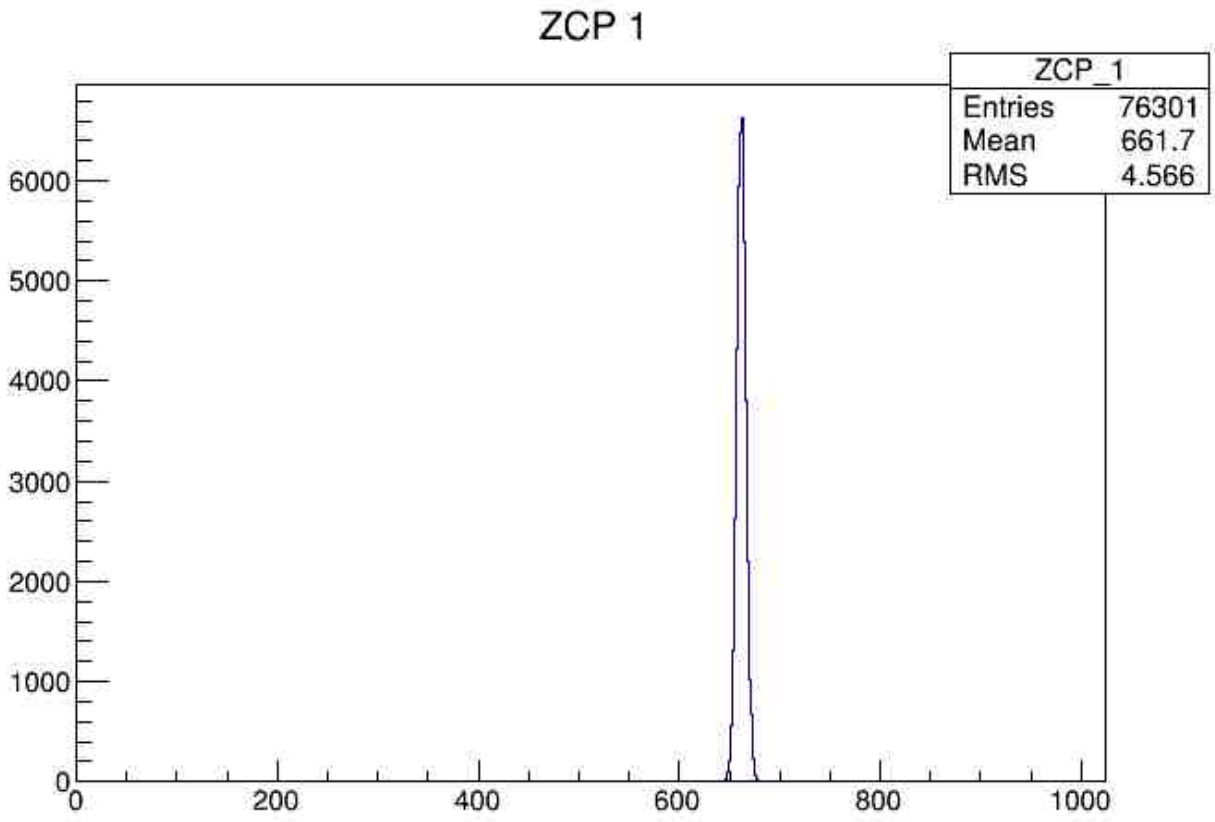


Fig.5 Amplitude energy spectrum of the light flashes.