Development of a 4-channel TTL scaler for detector signal counting

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Introduction

At NISER-IOP Experimental High Energy Physics (EHEP) laboratory various gas detectors such as Gas Electron Multiplier (GEM), Resistive Plate Chamber (RPC), Single Wire Proportional Chamber (SWPC) and scintillator detectors have been developed [1–5]. During the characterisation of these detectors signals are counted in general with source and without source. A rising edge triggered 4-channel TTL (Transistor Transistor Logic) scaler has been developed to record the number of pulses in a given interval of time. The four channels are independent and each channel is capable of capturing maximum 4,294,967,295 (2^{32}-1) number of pulses i.e. each channel can count maximum 4,294,967,295 (2^{32}-1) number of signals. The details of the design, fabrication and calibration of the scaler is presented.

Design principle

The 4-channel edge triggered TTL scaler is designed here to count the pulses from the detector. The front and back side view of the scaler are shown in FIG. 1 and FIG. 2 respectively. The scaler has been designed to avoid multiple counting with larger pulse width. So, the edge trigger with fast response has been designed i.e. whenever the digital signal changes its state from 0 to 1 then only the scaler counts. A rate of maximum 100 kHz can be counted without any delay independently in four channels. The scaler can accept user command by external knob (potentiometer) for setting up of sampling time. After setting up of sampling time one pulse switch (KEY) is pressed to start the count. The elapsed time and the sampling set time in seconds are displayed on the LCD. One such display is shown in FIG. 3. The time calculated in millisecond accuracy. The entire scaler is designed using independent Atmega328 microcontrollers. There are five numbers of microcontrollers out of them one is MASTER and other four are SLAVES and the MASTER-SLAVE communicates with (Inter-Integrated Circuit) I^2C protocol. The block diagram of the scaler is shown in FIG. 4.

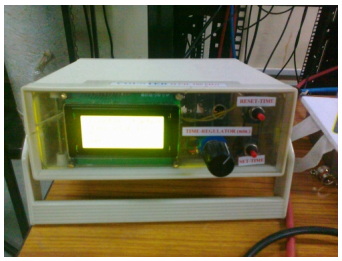

FIG. 1: Front side view.

FIG. 2: Back side view.

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FIG. 3: Display unit.

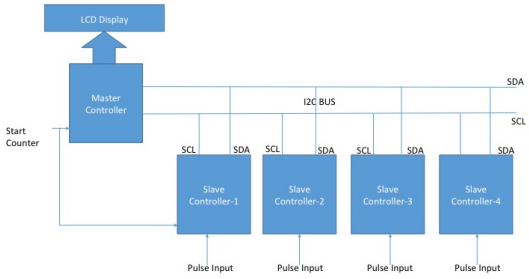

FIG. 4: The block diagram of the scaler.

Calibration of the TTL scaler

The TTL scaler is calibrated using a commercially available NIM-scaler. NIM signal is divided using a T-connector. One signal is fed to the NIM scaler and other is put to the TTL scaler through a NIM-TTL adapter. The calibration curve for the count rate is shown in FIG. 5.

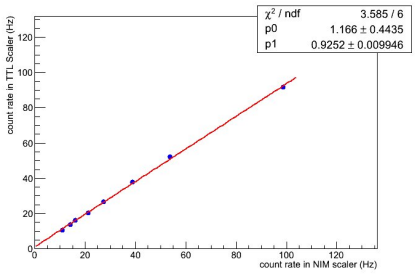

FIG. 5: The calibration curve.

Summary

One 4-channel TTL scaler has been fabricated. The scaler has the following characteristics. (a) The scaler has 4 channel, (b) each channel has 10 digit display, (c) the scaler can accept TTL input, (d) it can accept the maximum count rate of 100 kHz, (e) the maximum preset time can be 120 minutes and (f) count is displayed once the counting is stopped. The count rate of the TTL scaler is calibrated with a commercially available NIM scaler. The calibration curve is found to be a straight line with a calibration factor of 0.93.

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