Contribution ID: **174** Type: **Oral**

Constant Fraction Discriminator for NA62 experiment at CERN

Thursday 5 October 2023 12:00 (20 minutes)

The newly build Constant Fraction Discriminator (CFD) with an additional
Time over Threshold (ToT) measurement capabilities designed by Peter Lichard, CERN, will be presented. It operates in a wide dynamic range 1:150, with an excellent time resolution better than 70 ps over one order of magnitude. It is highly customizable for a different signal shapes and thresholds, thanks to a remotely programmable parameters through the DCS commands. Two outputs, each in NIM and LVDS standard, provide ToT information with programmable thresholds. The technical specification and performance measured with cosmic rays and in the high-intensity experiment will be shown.

Summary (500 words)

A demand from new VetoCounter detector at NA62 experiment, CERN,
for a processing of an analog signals from the fast photomultiplier (rise times around 1 ns) in a wide dynamic range of 1:30 with a time resolution better than 200 ps
led to the development of the new perfomant Constant Fraction Discriminator (CFD).

The leading edge discriminator timing performance suffers from time walk caused by varying
signal amplitude while threshold is fixed.
The original CFD was proposed to eliminate this time walk by introducing variable threshold following the signal amplitude. The constant fraction of
input signal is subtracted from full amplitude delayed input signal.
The final signal has a zero crossing point (walk) which is fixed for signals with different amplitudes.
The schematic sketch of the CFD functionality is shown in Figure 1.

The two important parameters are signal delay 'Td'and signal fraction 'k'.
They depend on the rise time of the signal and the its shape, respectively.
To preserve the signal amplitude and signal to noise ratio, in active CFD, the input signal is not
attenuated but delayed signal is amplified by inverse attenuation ratio.
The presented active CFD allows to vary 'Td' by choosing internal PCB traces of different lengths on the prepared pads on the board.
Also, the signal fraction can be changed, either remotely through the DCS commands, or by a potentiometer mounted directly on the board.
In the same way one can vary other parameters, such as walk level, window, low and high thresholds.
The window threshold triggers the CFD, which output enters two SFDR shapers followed by comparators representing low and high thresholds.
They preserve the leading edge triggered from CFD, ensuring the precise timing, and set the trailing edge depending on the time over threshold measurement.
If the signal from CFD does not pass some of these thresholds, it outputs a fixed length signal.
The presented CFD provides a double output of LVDS and NIM signals for each, low and high thresholds.

The CFD was tested and its functionality verified with the cosmic rays, using Hamamatsu R9880U photomultiplier with the BC408 scintillator tile.
The tests were performed also with the pulse generator, varying the input signals in the range from 30 mV up to 4.5 V.
The measured performance with signal amplitudes in the range of 100 mV to 1 V shows an excellent time

resolution of 70 ps.
It was successfully installed and commissioned in the NA62 experiment, to process signals from the Veto-Counter scintillator detector, which has a large dynamic range of pulses.

The presented CFD demonstrated its functionality and performance in the NA62 experiment and can be used in other installations, where the precise timing over a wide range of the input amplitudes is required.

Authors: ZAMKOVSKY, Michal (CERN); LICHARD, Peter (CERN)

Presenter: ZAMKOVSKY, Michal (CERN)

Session Classification: Module, PCB and Component Design

Track Classification: Module, PCB and Component Design