Request for Comments: Overall Arrangement of the protoDUNE-SP Timing and Synchronization System (PDTS)

Version 0.1

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The protoDUNE Timing System provides timing for the readout electronics that instruments the single-phase protoDUNE experiment at CERN (NP04). A small system using passive optical splitting to reach up to eight timing end-points is already in operation. This document describes the arrangement of timing end-points in the full system and the active fanout module needed to interface to the number of end-points required.

1 Introduction

The PDTS distributes timing signals using a mixture of active electrical and passive optical fan-out modules. The interface between the PDTS and the timing "end points" is either by 1000Base-BX bidirectional optical link or by an electrical link with four differential signals (clock and data in each direction). The interface and protocol used is described elsewhere [1]

There is one system master and the timing , trigger and other synchronization signals are distributed to the end-points by a mixture of active and passive fanouts.

2 System Overview

The system receives information from a GPS time source and about the SPS spills on singled-ended (coaxial) cables. These signals are received by an AIDA-2020 TLU [2] with custom firmware. The TLU generates the master signals. The signals are then fanned

[1] ProtoDUNE-SP Timing System: Interfaces and Protocol, DUNE DocDB 1651,`http://lbne2-docdb.fnal.gov/cgi-bin/RetrieveFile?docid=10720&filename=DUNE-data-rate-annex.pdf&version=3`

[2] AIDA-2020 Trigger/Timing Logic Unit (TLU) `https://www.ohwr.org/projects/fmc-mtlu`

out to all the end points. The arrangement of fanouts and end-points is illustrated in figure 1

2.1 Interface to Trigger

Information is passed between the PDTS to and from the trigger using the same protocol as is used to communicate with the other end-points. It differs from the other end-points in that the trigger passes trigger decisions to the PDTS for distribution to the other end-points and is connected directly to the PDTS master (TLU hardware).

2.2 End-points on Cryostat

A single PDTS fibre runs to each flange on the cryostat and a passive splitter is used to split the signal to the readout electronics for the LAr TPC and the photon detection system. There is also provision of one fibre on each flange for a possible calibration system

2.3 End-points in Readout "Barracks"

The master units and active fanouts for the PDTS are located in the readout barracks together with the RCE DAQ electronics. Each RCE ATCA crate receives timing signals via an SFP direct-attach cable.

2.4 Other End-points

There is a single PDTS fibre foreseen to each of the Cosmic Ray Tagger (CRT) and PID by ToF systems. Near each of the CRT and ToF systems there is a set of PDTS reference hardware (FPGA carrier board + FMC) which receives the PDTS data. A 50MHz clock and a separate synchronization signal are sent on copper cables to each of the CRT and ToF signals. More details of this interface can be found elsewhere[3].

3 Active Fanout

The active fanout boards can receive information from either a HDMI connector or an SFP. In this way a number of active fanout boards can be cascaded if necessary (the clock chip used has very little jitter-peaking and the PLL bandwidth can be configured). Figure 2 is a block diagram of the active fanout.

4 Passive Fanout

The passive-fanouts are single mode 1:8 fanouts with LC/APC connectors.

[3] upload interface doc and add reference....

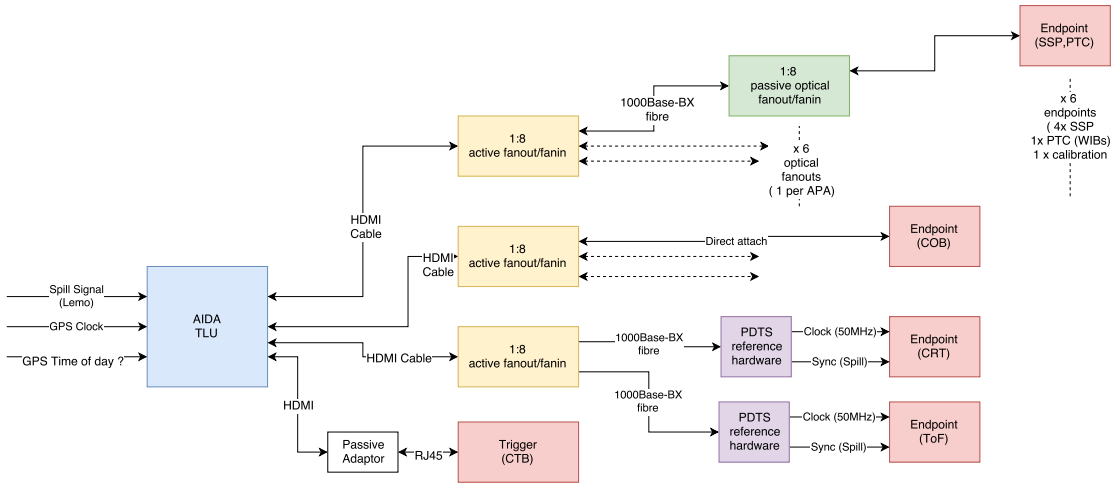

Figure 1: Block Diagram of protoDUNE-SP timing system

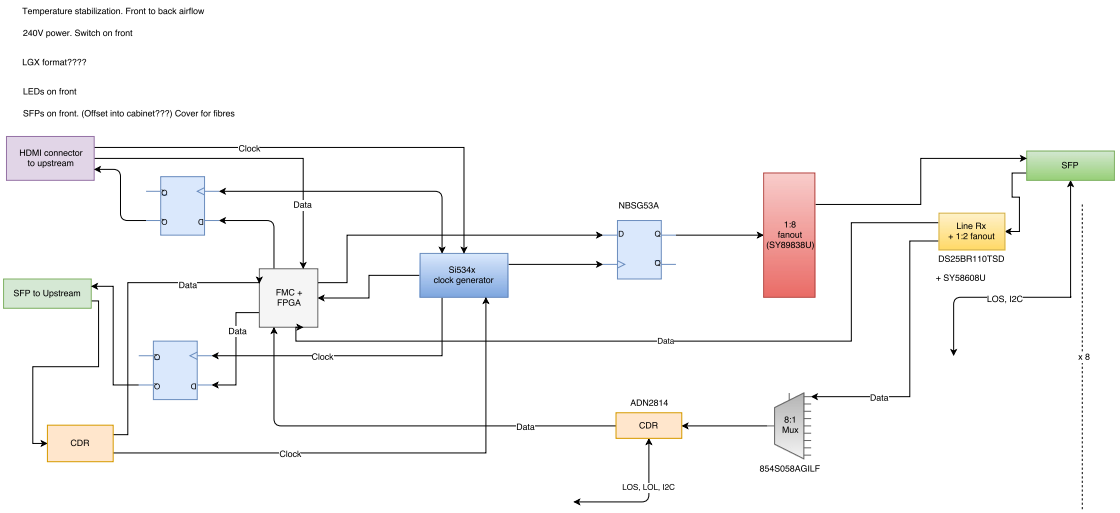

Figure 2: Block Diagram of PDTS Active Fanout

5 Optical Transmission pathSFP (miniGBIC) Transceivers

When the PTDS signal is passed on an optical (rather than copper) path 1000Base-BX SFPs are used with upstream (the master end) using wavelengths of 1550 (TX) / 1310 (RX) nm (usually identified with a yellow lever) and downstream (at the end-points) using the corresponding wavelengths of 1310 (TX) / 1550 (RX) ns (usually identified with a blue lever).

The fibres used are single mode with a 9/125um diameter core, terminated in LC connectors. UPC at the SFPs, APC at the splitters.