Crab project memo #1

SNAP board design

Dec. 15, 2017

- SNAP board is used for signal sampling, channelization and cross correlation in the Crab system. The design diagram is shown in Fig 1.

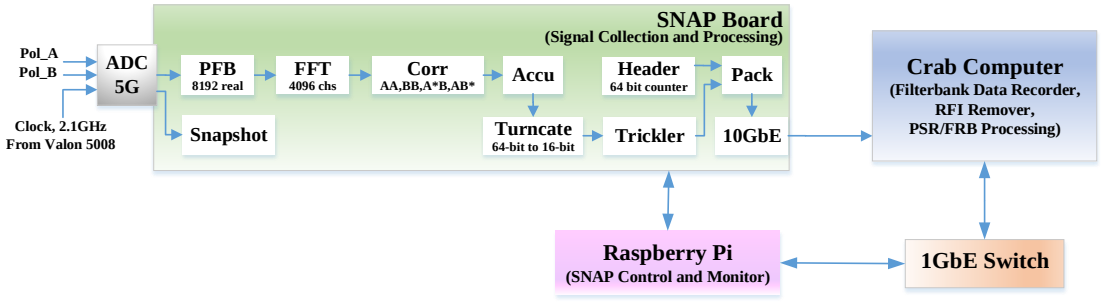

Fig. SNAP Design Diagram

Two polarization signals are fed to an ADC card which is clocked by an Valon 5008 and sample at 2.1GHz. After that, several modules are performed for Fourier transformation and cross correlation include PFB, FFT, Correlation and Accumulation. A snapshot can capture the raw ADC data for signal quick look and analysis. For data reduction, 64-bit accumulation result will be cut to 16-bit data by a Turncate module. A 64-bit counter will count the clock of FPGA as header information for packets checksum and time extraction. This header will be merged with data and form each single packet and send to Crab Computer through a 10 Gb Ethernet port. The Raspberry Pi can be used for download the FPGA executable file to SNAP and read and write the registers of this program. It connect to a 1Gb switch and can be accessed from Crab Computer or other machine.

- The output data format of SNAP is shown in Fig. 2.

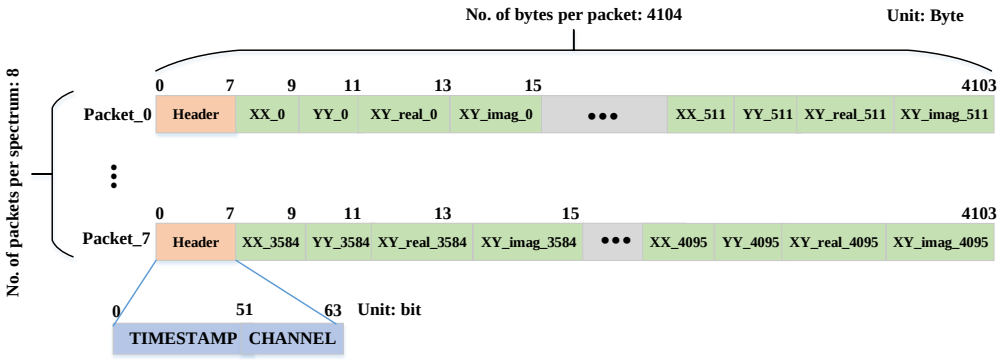

Fig. 2 output data format of SNAP

Each spectrum has 8 packets, and each packet has 4104 bytes of data, 8 bytes header and 4096 data, and each data point has two bytes, so each packet has 512 of XX,YY,XY_real,XY_imag.

- Some registers are defined as follows:

Name	Type	Function
rst	bool	reset correlator, packetizer and ten Gb Ethernet
pps_arm	Bool	pps armed trigger
sw_pps	Bool	Software synchronization
eth_dest_ip	Int	ten Gb Ethernet destination IP address
eth_dest_port	Int	ten Gb Ethernet destination port
eth_tge_en	Bool	ten Gb Ethernet enable
filterbank_fft_shift	Int	fft shift
vacc_acc_len	Int	length of accumulation
vacc_shift	Int	barrel shift, least 6-bits effective, 0~63
tvg_cmult_en	bool	test vector generator enable

- Control and monitor snap spectrometer

  cd /home/public/crab_obs on crab machine

  run ./crab_config_fpga.py to start and initialize snap board

  run ./adc_m_snap.py to monitor the adc snap shot plot

  run ./spectrum_monitor.py to monitor the spectrum data from 10Gb NIC, after spectrum checking, you have to close this program so that the acquisition program can use NIC.
- Some useful settings and calculations

1. Sampling clock: 2.1GHz
2. Time resolution:

   T_samp = vacc_acc_len x N_PFB_Chs / Samp_clock

   for example, if vacc_acc_len = 2^8, T_samp = 2^8x 8192 / 2.1GHz = 998.6438095 μs
3. vacc_shift example:

   y = x << vacc_shift

   if x = 0x75, vacc_shift = 2, y = 0x1D4 ; if vacc_shift = 10, y = 0xD400(not 0x1D400), because y is a 16-bit integer.

   vacc_shift can be set to 51 when vacc_acc_len = 8 in SNAP spectrometer has been tested which was a proper number on Crab system, and 46 when vacc_acc_len=11.