Using the Portable Fast Sampler

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1 Software overview

`pfs_radar` main data taking program
`pfs_hist` computes histogram of data
`pfs_stats` computes statistics of data, including DC offsets
`pfs_unpack` unpacks data to four-byte floating point numbers
`pfs_downsample` applies boxcar filter and downsamples data
`pfs_fft` performs spectral analysis

Usage information can be obtained by specifying the program name followed by `-help` at the command prompt.

All programs require the `-m` argument which specifies the data taking mode. The sampling modes available with the EDT PCI CD-20 are listed in table 1.

mode	channels	bits	sampling rate	data rate
0	2	1	(N/A)	
1	2	2	5 - 40 MHz	2.5 - 20 MB/s
2	2	4	5 - 20 MHz	5 - 20 MB/s
3	2	8	5 - 10 MHz	10 - 20 MB/s
4	4	1	(N/A)	
5	4	2	5 - 20 MHz	5 - 20 MB/s
6	4	4	5 - 10 MHz	10 - 20 MB/s
7	4	8	(N/A)	

Table 1: Description of sampling modes. Note that the maximum reliable sampling frequency varies depending on operating conditions. At Goldstone and GBT, the PFS systems appear to work well at 20 MHz or higher. In the AO control room, the PFS does not always operate reliably at 20 MHz.

Source code and Makefile are available from a CVS repository. They reside in /home/pfs/src/pfs, executables are in /home/pfs/bin. Recompile with `make; make install`.

2 Required signals

- One second tick (1 pps), TTL level.

- Sampling clock (sinewave 1-40 MHz), +13 dBm (∼3 Vpp into 50 Ohms).

- Data inputs (RCP I-Q, LCP I-Q), 1 Vpp into 50 Ohms.

The sampling clocks should be locked to the station reference (or appropriately drifted according to Doppler shift with a programmable oscillator locked to the station reference). The minimum value of the sampling clock is given by the specifications of the A/D converters. For the PFS assembled at Arecibo (no LEDs on front panel), it is 5 MHz. For the PFS assembled at JPL (LEDs on front panel), it is 1 MHz. When sampling only two of the possible four data inputs, always use the rightmost BNC connectors.

3 Setting levels

The full-scale voltage range of the A/D converters is +-0.5 V. Levels outside the +-2.5 V range may destroy the A/D boards permanently. Please be careful and use appropriate attenuation. If in doubt, check levels on the oscilloscope *before* connecting to the sampler. Note that levels tend to rise significantly when switching to the load or during transmit cycles. Figure out what the worst-case situation is and set the attenuators accordingly. It is good to have a batch of BNC attenuator pads for this purpose. Attenuators should be connected to the PFS front panel.

After selecting the PFS attenuator pads, select gain settings (as upstream as you can without saturating equipment downstream) that will yield RMS voltages near 0.25 V or 1 dBm at the input of the A/D converter. This can be set with an oscilloscope (select 50 Ohm termination) or it can be set by acquiring PFS data for several minutes and adjusting gain settings iteratively (with `pfs_radar` and `pfs_stats -e`, see below).

4 Sampling data

The command to start the samplers is `pfs_radar`. The simplest way to run it is to go to the directory where data will be stored. Then specify a sampling mode by its numeric value and the duration in seconds:

`pfs_radar -dir . -m mode -secs sec`

Data taking will start after a key is pressed by the user. The actual data-taking start takes place on the second tick following the keyboard event + 2 seconds, giving enough time to allocate memory, open files, etc. Data taking can be interrupted prematurely by hitting CTRL-C.

It can be convenient to specify the UTC start time with the `-start` option, in the format `-start` yyyy,mm,dd,hh,mm,ss.

Other useful options are `-step` and `-cycles`, which allow the user to specify a number of recording cycles separated by step seconds.

The data filename is simply the timestamp of the data-taking start of each cycle in UTC, ie "datayyyymmddhhmmss", with a monotonically increasing three-digit extension if the data-taking volume exceeds the nominal file size. By default, the individual file size is 2e9 bytes, but this can be changed with the `-code` and `-fft` options if it is desirable to split the data differently (i.e. make it an integral number of codes or hops). By default the program opens 40 files at startup, but this can be changed with the `-files` option. Make sure that the individual file size times the number files to open exceeds the expected data volume.

The log file (radar.log by default) keeps a record of the sampling parameters. Data-taking progress can be monitored remotely by examining this file.

The full list of options and their default values in parentheses are listed below.

```
Usage: pfs_radar -m mode -dir d [-secs sec] [-step sec] [-cycles c]
                                [-start yyyy,mm,dd,hh,mm,ss]

  -m mode
         0: 2c1b (N/A)
         1: 2c2b
         2: 2c4b
         3: 2c8b
         4: 4c1b (N/A)
         5: 4c2b
         6: 4c4b
         7: 4c8b (N/A)
```

```
-dir d      directory to use (.)
-secs sec   number of seconds of data to take (9000)
-step sec   timestep between A/D cycles (0)
-cycles c   number of repeat cycles (1)
-start yyyy,mm,dd,hh,mm,ss  UTC start time

-files f    total number of files to open (40)
-rings r    number of input buffers to use (8)
-bytes b    size of input ring buffer (1e6 bytes)
-code len   code length (7812500)
-fft len    fft length (128)
-log l      log file name
```

5   Analyzing data

It is a good idea to display a histogram and statistics of the data with `pfs_hist` and `pfs_stats`. With no arguments, these programs read the first MB of data of the given filename and compute statistics. With the -a argument, they compute statistics on the entire data file. With the -e argument, they compute statistics on the last MB of data. This last option is very useful when iteratively adjusting levels and DC offsets.

Both programs print results on the standard output by default, or alternatively in a file specified with the `-o` option. The input filename is specified by the last argument on the command line.

```
Usage: pfs_hist -m mode [-o outfile] [infile]
Usage: pfs_stats -m mode [-o outfile] [infile]
```

`pfs_unpack` and `pfs_fft` have an additional option `-c` (1 or 2) to specify which channel to process. The default is 1 (rightmost BNCs), the other channel can be processed with `-c 2`.

6   Other considerations

Data taking computer Rack-mount storage servers (Aberdeen Stirling X31, 8 TB storage) running CentOS 5.3 are available to run the PFS at GBT and Arecibo.

Remote operation Once cabled properly, the PFS can be operated remotely.

Login The user name is `pfs`, the current password is

Programmable attenuators The NAIC PFS at the GBT is equipped with adjustable attenuators which can be set with the program `pfs_levels`.

Network Time Protocol The control computer needs the ntp clients running to get its clock within a few milliseconds of the station clock. The actual data taking starts on the station 1 PPS signal.

Timezone Proper operation requires the data-taking computer to run on the UTC or GMT timezone.

```
$Id: pfs_usage.tex,v 1.8 2009/10/26 23:34:20 jlm Exp $
```