Procedure for disabling DAS gain and threshold loops for pulsar observing

Version 19-Sep-2014: John Reynolds

Updated and expanded notes including a correction for the "DOS" version of the DAS interface, which neglected some steps for "band*2" filters (e.g. VSOP-type profiles).

These procedures apply to observations of pulsars recorded with an LBA DAS system where the recorded data from an individual station is to be analysed separately, as "single-dish" data. Where the data are to be used only for cross-correlation with other stations (VLBI data) these procedures may not be necessary, at least on smaller antennas, though it may be prudent in some cases to follow them anyway, just in case. The PI may change their mind and decide they need the single-dish data, or subtle effects may appear in the correlated data between the large antennas.

There are two internal loops in the DAS that try their best to cancel any pulsar signal;

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       -the GAIN loop : a voltage-controlled amplifier ahead of the
        sampler, servo'd to maintain constant 8-bit sampled amplitude.

       -the THRESHOLD loop operating on the digitally filtered data
        to keep the statistics of the 2-bit output data fixed (usually
        at 34.6%). This loop operates in a stepwise fashion, resetting
        the thresholds on a fixed cycle which depends on filter
        bandwidth. For 16MHz filters the cycle is 2^19 samples = 33ms.
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(At Narrabri there is no GAIN loop in the DAS. In the Pre-CABB era the equivalent loop was located with the samplers in each antenna but could be disabled from CAOBS. With CABB there's no active loop at all).

The GAIN loop evidently runs on a faster timescale than the threshold loop and was initially considered to be the more damaging effect. For the Vela pulsar with a period of 89ms (f=11Hz) the dilution and distortion of the pulse profile is severe. For longer periods the effect gets worse.

The threshold loop is slower but introduces sharp level-steps on boundaries of 2^19 samples, which can be very nasty for single-dish purposes (e.g. Tid and Parkes data in RadioAstron expt re70a in 2012).

So if you're going to turn one of these loops off you should probably disable both of them. This is a bit of a pain if you're relying on keeping the sampling statistics fixed, which will almost certainly be the case (usually at 34.6%). With both loops disabled the stats will drift proportionally with input level, requiring analogue level adjustment ahead of the DAS (e.g. step attenuators), or resetting the digital gain, as described below, when the stats drift out of an acceptable band.

There are two procedures, depending on whether you run the original DOS engineering version of the DAS control s/w (LBA_DAS.EXE, written by Martin Osterreich and Dick Ferris), or the GUI version (adapted from the DOS version by Simone Magri and Mark Leach).

Procedure for GUI Version of control software:

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1. Wait till you're on source (or levels are stable), then adjust the pre-DAS attenuation to centre the "LEVEL" bargraph/slider on each IFP.

2. Select "Detail" under "Monitor view".

   For IFP #1, observe and note the average value of the three arrowed "Level" and "Counter" numbers as shown below.

   ```
   Level  : lvl Auto    <== lvl
   X-Th BS: xth Auto                Y-Th BS: yth Auto
   Counter: cnt          <== cntX   Counter: cnt        <== cntY
   X-Th FT: ... Auto                Y-Th FT: ...
   Counter: ...                     Counter: ...
   ```

   Round the average (fluctuating) value of "cntX" by eye to the nearest EVEN integer CNTX (e.g. 70, 72 etc). If the value is less than 64, round it to the nearest multiple of FOUR.

   If using a band*2 filter (e.g. VSOP-style profile), also note the "Counter:" value cntY, which is displayed to the immediate right of cntX. Eyeball-average and round this value cntY to CNTY, as above.

   If using a band*1 filter the cntX and cntY numbers should be identical so use CNTY = CNTX.

   For "lvl", just estimate the nearest integer value LVL.

   Make a note of CNTX, CNTY and LVL.

3. Do the same for the 2nd IFP.

4. Under "Config_Sftw", select "Filter BSB"

      Set gain control to MANUAL for both IFPs

      Set the GAIN value to 4*(255-LVL)

      To lock the threshold loops set threshold control to MANUAL, and;

      set the X counter value to CNTX
      set the Y counter value to CNTY

5. Repeat for the 2nd IFP.

6. Hit "Config_Hdw" to upload the revised configuration to the DAS.

7. On the "Detail Monitor view" display you should now see for each
   IFP:

   Level : 128 Manual
   X-Th BS: 72 Manual   Y-Th BS: 72 Manual
   Counter: cntX   Counter: cntY
   X-Th FT: ... Auto
   Counter: ...

   where the values 128 and 72 might be varying by +/- a few.

8. Check that the stats on your VLBI recorder look normal (34.6% of
   samples in the two outer bins combined).

   Throughout the observation, monitor the "level" numbers for each IFP
   on the detailed monitor display. Adjust the step attenuators to keep
   the top bargraphs centred, or the levels as close as possible to
   128 (on the alternate display), if you want to keep the stats as
   close as possible to 34.6%. These numbers are in ~0.1dB
   steps, so if the lvl drops to say 123, remove 0.5dB to centre it.

Procedure for DOS version of control software

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1. Wait till you're on source (or levels are stable), then adjust the
   pre-DAS levels/attenuators to centre the "LEVL" bargraph on each IFP.

2. Hit the space bar to view the alternate monitor display.
   For IFP #1, observe and note the average value of the three numbers
   "lvl" and "cntX" and "cntY" as shown below;

   LEVL: lvl C   <== lvl   OFFS: 0 C

   X-TH: xth C   Y-TH: yth C
   CNTR: cntX   <== cntX   CNTR: cntY   <== cntY
   X-TH: ... C
   CNTR: ...

   Round the average (fluctuating) value of "cntX" to the nearest
   EVEN integer CNTX (e.g. 70, 72 etc). If CNTX is less then 64 round
   it to the nearest multiple of FOUR.

   For band*1 filters the values of cntX and cntY should be identical,
   in which case use CNTY = CNTX.

   For band*2 filters the number will in general be different so
   take the mean value of cntY and round, as above, to get CNTY.

   For "lvl", just estimate the average integer value LVL.

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       Make a note of CNTX, CNTY and LVL.

 3. Type "1" to get into the first page of the IFP1 config.

       Set parameter 23 to 1
                     24 to CNTX
                     25 to CNTY
                     26 to 1
                     27 to 4*(255-LVL)      <= enter number
                                               given by this expression.



 4. Repeat steps 2 and 3 for IFP2 (type "4" instead of "1" in step 3.).

 5. Type "S" to "Setup" the DAS (i.e. to upload changed config to DAS)

 6. On the monitor display you should now see for each IFP:

       LEVL: 128 M

       X-TH:  72 M           Y-TH:   72 M
       CNTR: CNTX             CNTR: CNTY
       X-TH: ... C
       CNTR: ...

       where the actual values 128 and 72 might be varying by +/- a few.

 7. Hitting the space bar to return to the default display you should now
    see "Monitoring Only" for "IF" on both IFPs
    The associated bargraphs should all be centred.

 8. Check, monitor and adjust sampling stats, as for GUI version above.
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