Address Level Calibration and Baseline Calibration in Pixel Online Software

Souvik Das
(Cornell University)

01/11/07

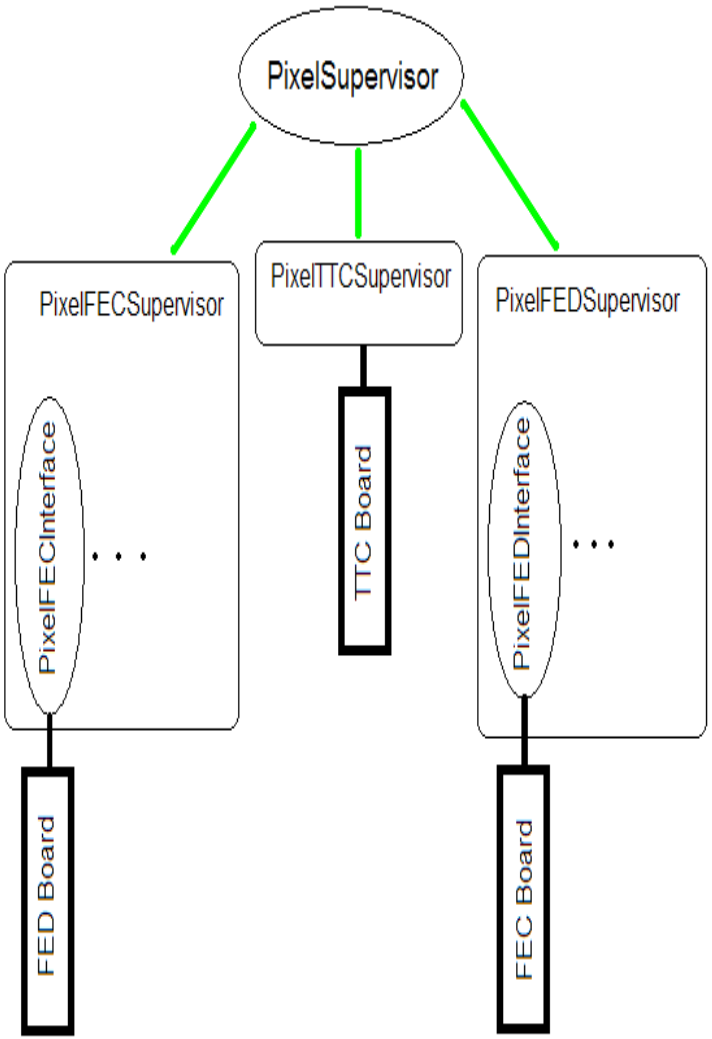
Address Level Calibration – Configuring State

PixelSupervisor, PixelFECSupervisor and PixelFEDSupervisors operate as state machines as specified in the Level One Function Managers document.

Configuring State

If PixelSupervisor receives the Global Key (3 for now) from PixelSupervisorGUI (RCMS Function Manager), it:

- Retrieves from Configuration Files which ROCs and TBMs it must calibrate and stores them in a Calibration Object
- Retrieves the Name Translation Table to use with Calibration Object and finds out which FEDs and FECs are concerned
- Instructs concerned FED and FEC Supervisors via SOAP messages to download into local objects their copies of the calibration information from Configuration Files and configure themselves
- SOAPs PixelTTCSupervisor to configure so as to able to send PreCal triggers when required.



Collecting Address Level Data

- **Running State**
  - PixelSupervisor SOAPs all concerned PixelFECSupervisors to ClrCal all their ROCs involved in this calibration routine.
  - From its Calibration Object, PixelSupervisor determines the number of triggers requested per pattern of pixels to be fired on each chip.
  - Two blanks are fired: PixelTTCSupervisor is instructed to issue two pre-Calibrate triggers. PixelFECSupervisor does not enable any pixels. PixelFEDSupervisor collects data (in transparent mode). This is to find the Ultra-Black levels on each channel and is required to tell ROCs apart later.
  - PixelSupervisor loops over all patterns of pixel hits specified in its Calibration Object, instructs the concerned PixelFECSupervisors to CalPix those hits on the specified ROCs, instructs the PixelTTCSupervisor to issue a CalSync trigger, and instructs PixelFEDSupervisor to collect transparent mode data. PixelFEDSupervisor stores the address levels of TBMs and different ROCs in independent arrays for analysis outside the loop.

Analysing the Data – Detecting Peaks

- Still in **Running State** within PixelFEDSupervisor
  - Consider a TBM or ROC histogram.
  - Create a boolean variable ***peak*** which if true designates a peak in the histogram. Set ***peak*** to **false**.
  - Scan through all the bins in the given histogram
    - If ***peak*** is *false* and the two consecutive bins are populated, consider it to be the beginning of a new peak and set ***peak*** to **true**. Collect the frequency in the bin.
    - If ***peak*** is **true** and bin is populated, continue to collect data for the peak by recording bin frequency.
    - If ***peak*** is **true** and two consecutive bins are not populated then consider it the end of that peak and set ***peak*** to **false**.
      - If the peak has less than a minimum number of points (100 for now), dismiss it.
      - Else save its statistics.
  - Set recommended address levels in between two peaks. If a recommended address level falls within 3 standard deviations of a peak or the number of peaks is unequal to 6, issue a warning and do not program address levels for that ROC.
  - Same goes for TBM address levels, except the number of peaks should be 4.

Sample Output

```
End of peak at bin 344
a peak mean=323.763 with a stddev=5.5604
N=1400 sum=453268 squares=1.46795e+08
End of peak at bin 450
a peak mean=433.133 with a stddev=4.68827
N=799 sum=346073 squares=1.49913e+08
End of peak at bin 561
a peak mean=540.037 with a stddev=5.64117
N=2098 sum=1.133e+06 squares=6.11927e+08
End of peak at bin 666
a peak mean=649.534 with a stddev=5.74127
N=1099 sum=713838 squares=4.63698e+08
End of peak at bin 731
a peak mean=729.5 with a stddev=0.5
N=2 sum=1459 squares=1.06434e+06
I'm sorry, peaks with less than 100 data points are not allowed in!
End of peak at bin 767
a peak mean=750.3 with a stddev=6.01523
N=1548 sum=1.16146e+06 squares=8.71504e+08
End of peak at bin 863
a peak mean=844.954 with a stddev=6.78984
N=548 sum=463035 squares=3.91269e+08
FED Crate 1, VME Base Address 0x2c000000 channel=1 FED ROC number=6 has 6 peaks.
Peak #1 = 323.763, std dev = 5.5604
Peak #2 = 433.133, std dev = 4.68827
Peak #3 = 540.037, std dev = 5.64117
Peak #4 = 649.534, std dev = 5.74127
Peak #5 = 750.3, std dev = 6.01523
Peak #6 = 844.954, std dev = 6.78984
Recommended L 0 = 378
Recommended L 1 = 486
Recommended L 2 = 594
Recommended L 3 = 699
Recommended L 4 = 797
```

Baseline Calibration – Configuring State

Configuring State

If PixelSupervisor receives the Global Key (1 for now) from PixelSupervisorGUI (RCMS Function Manager), it:

- Retrieves from Configuration Files which ROCs and TBMs it must calibrate and stores them in a Calibration Object
- Retrieves the Name Translation Table to use with Calibration Object and finds out which FEDs and FECs are concerned
- Instructs concerned FED and FEC Supervisors via SOAP messages to download into local objects their copies of the calibration information from Configuration Files and configure themselves. They move to their respective Configured states.
- SOAPs PixelTTCSupervisor to configure so as to able to send PreCal triggers when required.

Baseline Calibration – Running State

- **Running State** in PixelSupervisor
  - PixelSupervisor SOAPs all concerned PixelFECSupervisors to ClrCal all their ROCs involved in this calibration routine.
  - While PixelFEDSupervisor doesn't return a SOAP message that says “Baseline Calibration Done” AND MaxIterations (=15) are not complete, PixelSupervisor repeats the following:
    - SOAPs PixelTTCSupervisor to send a PreCal signal.
    - SOAPs PixelFEDSupervisor to use its “ChannelOffsetCalibrationWithPixels” method
- ChannelOffsetCalibrationWithPixels method in PixelFEDSupervisor (can only be activated in if its FSM is in Running state)
  - Set a replyString = “Baseline Calibration Done”
  - Loop over all FEDs and channels specified in the Calibration Object.
    - Collect all Black levels that occur before TBM header starts in each channel.
    - Keep track of which AOH are used for these FED channels.
    - For each AOH, find the maximum and minimum of (mean) Black levels among its channels and associate these two values with the AOH.

Baseline Calibration – Running State

- PixelFEDSupervisor::ChannelOffsetCalibrationWithPixels continued...
  - Loop over all FEDs in the Calibration Object.
    - Pluck out its PixelFEDCard object for later use
    - Loop over all the AOHs
      - If the AOH is being used:
        - Check if any of its FED channel's offset DACs are touching 0. If one is, then set shiftDown=true
        - If any of the channels are touching 255, set shiftUp=true
      - If shiftUp is true AND shiftDown is true, report that this situation can only be corrected by changing the AOH Biases.
      - If shiftUp is true, add 1 to the Optical Receiver Input Offset
      - If shiftDown is true, subract 1 from the Optical Receiver Input Offset
      - If both are false, change the Optical Receiver Input Offset such that the average of the maximum and minimum Black levels approaches 512. (Emperical observation that 1 step of Input Offset = 175 ADC counts is used.)
    - Loop over all the FED channels
      - Update all Channel Offset DACs so as to bring the Black level of every channel to 512 having considered any change in the AOH Input Offset effected in the previous loop and the observation that one unit increase in Channel Offset DAC lowers ADC count by 2.
      - If the baseline of the channel is further than 10 away from 512, set replyString=”Baseline Calibration Not Done”

Baseline Calibration – Running State

- Update the PixelFEDCard
  - SOAP back the replyString to PixelSupervisor.

Sample Output:

```
PixelTTCSupervisor #1 has been used.
Shifting down Input Offset!
FED number=1, optical receiver=0 B (mean of max, min)=529.391 old inputoffset=10 new inputoffset=9
FED number=1, channel=1 B=547.781 old channeloffset= 179 new channeloffset= 255
FED number=1, channel=2 B=528.969 old channeloffset= 96 new channeloffset= 210
FED number=1, channel=3 B=538.406 old channeloffset= 206 new channeloffset= 255
FED number=1, channel=4 B=524 old channeloffset= 170 new channeloffset= 255
FED number=1, channel=5 B=516.969 old channeloffset= 86 new channeloffset= 194
FED number=1, channel=6 B=515.438 old channeloffset= 0 new channeloffset= 107
FED number=1, channel=7 B=511 old channeloffset= 58 new channeloffset= 163
FED number=1, channel=8 B=517.219 old channeloffset= 140 new channeloffset= 248
 Setup from the parameter structure
 FIFO2/3 enable 0 0 0 0
 ADC GAIN Set 0 0 0 0
Load Control register from DB 0x19
Set Control register 19
Load Mode register 0
   PixelTTCSupervisor #1 has been used.
Shifting up Input Offset!
FED number=1, optical receiver=0 B (mean of max, min)=557.891 old inputoffset=9 new inputoffset=10
FED number=1, channel=1 B=594.25 old channeloffset= 255 new channeloffset= 227
FED number=1, channel=2 B=490.094 old channeloffset= 210 new channeloffset= 130
FED number=1, channel=3 B=639.125 old channeloffset= 255 new channeloffset= 250
FED number=1, channel=4 B=543.844 old channeloffset= 255 new channeloffset= 202
FED number=1, channel=5 B=495.094 old channeloffset= 194 new channeloffset= 117
FED number=1, channel=6 B=476.656 old channeloffset= 107 new channeloffset= 21
FED number=1, channel=7 B=483.406 old channeloffset= 163 new channeloffset= 80
FED number=1, channel=8 B=483.531 old channeloffset= 248 new channeloffset= 165
 Setup from the parameter structure
 FIFO2/3 enable 0 0 0 0
 ADC GAIN Set 0 0 0 0
Load Control register from DB 0x19
Set Control register 19
Load Mode register 0
   PixelTTCSupervisor #1 has been used.
FED number=1, optical receiver=0 B (mean of max, min)=454.172 old inputoffset=10 new inputoffset=10
FED number=1, channel=1 B=442.812 old channeloffset= 227 new channeloffset= 211
FED number=1, channel=2 B=454.938 old channeloffset= 130 new channeloffset= 120
FED number=1, channel=3 B=441.719 old channeloffset= 250 new channeloffset= 234
FED number=1, channel=4 B=452.844 old channeloffset= 202 new channeloffset= 191
FED number=1, channel=5 B=448.531 old channeloffset= 117 new channeloffset= 104
FED number=1, channel=6 B=466.625 old channeloffset= 21 new channeloffset= 17
FED number=1, channel=7 B=462.094 old channeloffset= 80 new channeloffset= 74
```

Baseline Calibration – Running State

FED number=1, channel=8 B=460.562 old channeloffset= 165 new channeloffset= 158
Setup from the parameter structure
FIFO2/3 enable 0 0 0 0
ADC GAIN Set 0 0 0 0
Load Control register from DB 0x19
Set Control register 19
Load Mode register 0
PixelTTCSupervisor #1 has been used.
FED number=1, optical receiver=0 B (mean of max, min)=477.891 old inputoffset=10 new inputoffset=10
FED number=1, channel=1 B=479.531 old channeloffset= 211 new channeloffset= 213
FED number=1, channel=2 B=479.469 old channeloffset= 120 new channeloffset= 121
FED number=1, channel=3 B=477.875 old channeloffset= 234 new channeloffset= 235
FED number=1, channel=4 B=479.188 old channeloffset= 191 new channeloffset= 192
FED number=1, channel=5 B=478.438 old channeloffset= 104 new channeloffset= 105
FED number=1, channel=6 B=477.406 old channeloffset= 17 new channeloffset= 17
FED number=1, channel=7 B=478.125 old channeloffset= 74 new channeloffset= 75
FED number=1, channel=8 B=476.25 old channeloffset= 158 new channeloffset= 158
Setup from the parameter structure
FIFO2/3 enable 0 0 0 0
ADC GAIN Set 0 0 0 0
Load Control register from DB 0x19
Set Control register 19
Load Mode register 0
FED Channel Baseline Calibration Done!