LCLS LLRF
PAC
Software Specifications
May 10, 2006

The PAC is used for control of the LLRF to the Solid State Sub-Booster (SSSB). The control board for he PAC will drive an IQ modulator. It also supplies the SSSB with a trigger and monitors analog and digital parameters. This document describes the software requirements for the PAC. The PAC calibration will involve setting Gain and Offset adjustments to balance the IQ modulator which it will be driving. Other station calibrations, involving operational waveform setup, will be described in another document.

This document references the PAC write up by Jeff Olsen dated 03/17/06.

LCLS RF requirements for the PAC:

LLRF Waveform
(Set during station setup)

Load waveform, I & Q, of a specified length.

Length of RF waveforms	Time Duration	#Pnts
RF Gun	3uS	300
RF Gun wave shaped	1.2uS	120
SLEDed Klystron	4uS	400
UnSLEDed Klystron	1uS	100
X-Band Station	100nS	10

Length of waveform will be selectable in powers of 2 from 128 to 2048 Bytes. The waveform will be generated in SciLab, MatLab or other utility and loaded into I and Q Memories during initial calibration.

Adjust Gain and offset of waveform
(Set and adjusted during initial calibration)

Each I and Q waveform will have a value to adjust the Gain and offset of the waveform. These values will be set during initial calibration. Checks will be made to ensure the waveform does not exceed the 16bit range, 0 to 2^16-1. The offsets and gain corrections will be made during calibration only. Offset range is +- 2048 and Gain Range should be 0 to 2^15-1. The offset and gain corrections are done as follows:

Memory = (Waveform x Gain / 2^15) + Offset

Adjust Amplitude and Phase
(Adjusted at 120Hz during normal operation)

An amplitude and phase correction will need to be made at 120Hz based on feedback information. This will require the I and Q vectors to be multiplied by and I adjust and Q adjust value to change the amplitude and rotate the phase. The initial values of I adjust and Q adjust will be 2^15. The I and Q vectors, waveforms, will be multiplied by this value and divided by 2^15 to normalize. I adjust and Q adjust values will be sent by the feedback IOC, the I & Q vectors updated and on the next trigger the waveforms sent out at 120Hz.

Memory = (Waveform x (Adjust/2^15) x (Gain / 2^15)) + Offset

Trigger Control
(Adjusted during station setup)

There is a single trigger input to the PAC. The FPGA generates two triggers from these triggers, one for the DAC waveform and one for the SSSB.

The DAC trigger has a programmable delay. Values from 0 to 4095 should be able to be written to this register. If the clock is at 102MHz the display can read in nS from 0 to 40147nS.

The SSSB trigger can have both the delay and pulse width adjusted. These adjustments can be made in the appropriate registers and should allow values from 0 to 4095.

During normal operation the Trigger mode should be set to Normal; External. During calibration mode the Trigger should be set to internal.

Calibration Mode
(PAC calibration - not station setup)

During calibration of the PAC, the system will have a 2048 word cosine waveform with I offset added and multiplied by I gain loaded into the I Memory. A 2048 word sine waveform with Q offset added and multiplied by Q gain will be loaded into Q Memory. The trigger will be set to internal and the Internal Trigger Rate set to 2048. During calibration the gain and offset values for I and Q will be changed while monitoring an external analyzer for distortion and feedthrough. Each change of offset or gain will cause recalculation of the vector and load Memory. Amplitude of cosine and sine waveforms should be scaleable from 2048 to 2^15-2049.

Voltages to be Monitored
(During Operation at slow rate, < Hz)

The voltages to be monitored are listed below:

	Source	Type	Range	
0	SSSB Amp	Temperature		
1	IQ Modulator	Temperature		

2	Control Board	Temperature		
3	SSSB Amp	Bulk Supply	+12V	
4	SSSB Amp	Bulk Supply	-12V	
5	RF Board	Bulk Supply	+15V	
6	Control Board	Bulk Supply	+5V	

These voltages will be monitored by slow loops and have thresholds set to notify operators when they go out of tolerance.

Other Signals to Monitor
(During Operation at slow rate, < Hz)

The 119MHz Missing, Ext.Trig. Missing, and SSSB Over Temp are binary indicators that should notify operators when conditions are not normal.
Version Number should be read on command?

Get input from Jeff on all of this.