Minutes from GlueX electronics conference call

28 April 2005

Paul Smith, scribe

Participants:

Alberta: Jim Pinfold, Lars Holm, John Schaapman

JLab: Chris Cuevas, Elliott Wolin, Fernando Barbosa

IU: Paul Smith

IUCF: Gerard Visser

There will be a meeting of those working on GlueX electronics at Jefferson Lab, Wednesday, May 11 at 3 pm.

John Schaapman summarized the results of a first search for a suitable tracking chamber front end chips:

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Electronics - frontend chip candidates, questions, requests
                U of A     John Schaapman  April 27, 2005

 existing preamp/shaper candidates:

1.     VTX  preamp/shaper - candidate for Central Drift chamber
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Description: The VTX preamp board was developed for CDF tracking chambers at Fermilab. Sixteen and twentyfour channel preamp boards were developed using three or four six channel custom ASICs each. [IEEE Transactions on Nuclear Science Vol 39, No 4, 1992]

Current Use: The VTX preamps became surplus to CDF after an upgrade and were found to be suitable for use on the TWIST spectrometer, which has about 4,000 channels, at TRIUMF. Most of the recoverable VTX boards are now mounted on sixteen or twentyfour channel preamp PCBs which provide HV bias, HV signal coupling, input protection, output signal coupling, dc power distribution and input/output connectors. Most of these preamp PCBs are currently mounted on the TWIST spectrometer or on spare chamber modules.

Availability: The TWIST experiment is projected to submit final publication in 2008 so there is little chance that these preamps would become available for use by another experiment before completion. Production of a new batch of VTX chips (Tektronix QuickChip 2S bipolar linear array semicustom IC) after about 15 years would be very difficult and would have to be done by Fermilab/CDF. A small quantity of these preamp boards, say ten sixteen channel type, could likely be made available to GlueX to aid in chamber development.

Specs/Suitability: risetime - 5 nsec
falltime - 15 nsec
input range: - 400 fC to + 20 fC - should handle typical 40 fC of CDC if polarity is right although S/N will suffer
input noise: 860 electrons + 47 e/pF
gain: 1 mv per fC - typical output would be 40 mv into a 50 ohm termination
crosstalk: < 0.5 % - this sets a limit on usefull dynamic range
power dissipation - 10 mw/channel
output - single ended

Conclusion: not a very good candidate due to availability, and crosstalk/dynamic range problems.

existing preamp/shaper/discriminator candidates

1. ASD8 preamp/shaper/discriminator - candidate for Forward Drift anodes

Description: The ASD8 is an eight channel amplifier/shaper/discriminator IC developed for the ATLAS MDT system by the Boston Muon Consortium. [ATLAS Muon Note: ATL-MUON-2002-003]

Specs/Suitability: peaking time - 15 nsec
gain: ~ 10 mV/fC linear to ~ 150 fC
shaping: bipolar, area balance < 500 nsec
input impedance: 120 ohm
noise: ENC < 6,000 e- with 380 ohm termination
crosstalk: < 1 % - this sets a limit on usefull dynamic range
power consumption: < 35 mW/channel @ 3.3 V supply
output logic level: LVDS
dead time: 300 - 800 nsec adjustable
S/N compared to max input of 150 pC: 42 db - 125
dynamic range at nominal threshold (6 fC): 25 max.
- would be ~ 6.7 relative to typical charge of 40 fC

discriminator time slew: 2 - 3 nsec for input charge range
of 20 - 80 fC before leading edge charge correction via
pulse width
charge measurement pules width variation: typically below
600 psec RMS corresponding to typical error below 1 % of
the measured charge when ASD is set for maximum output
width of 200 nsec

Conclusion: With better definition of the signals of interest from the Forward Drift anodes this may be a very good match.

Availability: GlueX would need 550 untested ICs to fullfill the requirements for the FDC anodes and spares. This is about one tenth of the miniumum batch that can be produced. Production of another batch of ASD8s would have to be done via the Boston Muon consortium. One lot of ICs should yield about 5,400 good ICs and would cost $ 55,000 mask charge, if needed, plus $ 54,000 for production and packaging, which could take 12 - 14 weeks. They would need to be tested before board installation. This testing would take about a week if the automatic chip tester developed by the Boston Muon Consortium was used. The Boston Muon Consortium achieved their required amount after 4 of the 5 lots were tested and have packaged and tested the remaining lot as additional spares. Obtaining 550 of these spares from ATLAS would be an ideal solution.

2. MAD4 preamp/shaper/discriminator - candidate for Forward Drift anodes

Description: The MAD is a four channel charge-preamp/shaper/latched-discriminator/one-shot/LVDS full custom ASIC developed for the barrel muon chambers of the CMS detector at CERN by INFN of Padova. It is also being used for the COMPASS experiment MWPCs at CERN. The COMPASS group did a comparison test of the ASD8 and MAD4 chips and found that the MAD4 chip had better stability and lower noise. However, they were not concerned about time resolution and in this regard the ASD8 is much better.

Specs/Suitability: gain: ~ 3.35 mV/fC +/- 10 % constant up to 500 fC
input impedance: 200 ohms
noise: 1600 e @ Cd = 0 : slope 80 e/pF
max input: 800 fC
input rate without loss of accuracy: > 2 MHz @ 800 fC
crosstalk: < 0.2 % [0.2 % on test board where half
is due to PCB traces. 0.3 - 0.5 % for readout

board which has F1 TDC on it]
time walk: < 3.5 nsec [3 fC - 1,000 fC with threshold set at 1.5 fC]
dynamic range at threshold of 1.5 fC : ~ 300
- would be ~ 27 re typical charge of 40 fC
output pulse width: 20 - 200 nsec adjustable
oneshot dead time: 9 nsec
power consumption: ~ 25 mW/channel @ +5 V & +2.5 V

Comments: It seems better than the ASD8 at the low end of the input signal range. The time walk looks bad but it is over a very wide range.

Availability: It is being used in current experiments. Beyond that, availability isn't known. It's claimed to be cheaper than the ASD8. GlueX would need about 1,100 of these for the Forward Drift anodes.

Questions

Questions re: CDC electronics

1. Is shaping desired and what rise and fall times should it be?
2. Specify crosstalk requirement.
3. Dynamic range of 1,000 needs to be spec'd in terms of max/min fC; i.e is the typical output of 40fC the middle or top of the range?
   Is this wide range meant to accomodate different chamber conditions such as gas mixture and HV?
5. What is input signal voltage range spec for FADC module?

Questions re: FDC electronics

1. What shaping rise and fall times are desired for the anodes and cathodes?
2. Specify crosstalk requirement - anodes and cathodes.
3. Dynamic range needs to be spec'd in terms of max/min fC; i.e is the typical output the middle or top of the range? Is this wide range meant to accomodate different chamber conditions such as gas mixture and HV? For the Forward Drift anodes the range above the minimum operating threshold is a more usefull way to look at things.

Questions re: Jlab High Resolution TDC module

1. If the ASD8 amplifier/shaper/discriminator is selected for readout of the Forward Drift anodes a TDC capable of recording pulse width is required as noted in the Hall D electronics review committee report. Obviously the AMT-3 TDC chip (the most recent version of the TMC series) developed to match the ASD8 would certainly work but the committee also commended the decision to standardize on a single TDC module. This has brought up the question of whether the Jlab F1 TDC module can be operated in this mode. It appears from information in the functional description manual for the F1-TDC chip provided by the manufacture, acam-messelectronic, that it has programmable edge sensitivity modes. So the only question is whether use of these modes are implemented in the module design and if not whether it would be difficult to add these modes or if there is some reason why they can't be implemented.

2. Is the F1-TDC board user manual available yet? The answer to the previous question would likely be in there.

Requests:

1. Since the Hall B 'CLAS DC' SIP preamps are used on the FDC prototype and they will be used as a benchmark we would like to have a couple of these preamp boards and their documentation to help us with comparisons.

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Alberta will try to get samples of some chips and boards to try out on the GlueX chamber prototypes. Note that further refinement of chamber signal characteristics is required to fully specify the preamps. The dynamic range needs to be in terms of minimum and maximum charge, the crosstalk requirement needs to be determined, etc. There will be at least 100's of watts of heat that will need to be removed from the inside of the solenoid.

The ASD8 and MAD4 chips are intended to drive TDCs. The Central Drift anodes and Forward cathodes need to drive flash ADCs; none of these candidates are suitable. We may want to use fADCs instead of TDCs on the Forward anodes; this would facilitate a dE/dX measurement, and could possibly reduce the system cost if shaping enabled the use of the same fADC as the Forward cathodes. In this case all preamps would be the same; ideally a linear differential amplifier with output amplitude around 100 mV.

Fernando showed the JLab ideas for a 250 Msps flash ADC intended for both the existing halls and eventually for hall D. A baseboard section implements the data pipeline and feature extraction as well as an interface to VME64X. For the GlueX calorimeter energy sum and other potential advanced features a mezzanine card would piggyback on the base card. There would be 16 channels of a MAXIM digitizer; there are a number of 8, 10 and 12 bit options in pin compatible series. There are drawings on the GlueX portal as docs 464 and 465. The first user of the module will be hall C in the fall of 2006.

Better detector simulations are needed, especially of the dE/dX measurements from the GlueX tracking system. Detailed algorithms will be needed to design the data processing section of the flash ADC boards. A decision needs to be made regarding the FDC anode readout method based on physics needs.

Chris Cuevas showed some slides summarizing the VXS standard backplane. These slides are available on the portal as GlueX-doc-466. Currently these backplanes are only available up to 12 slots, although 21 slot versions are proposed. The links are 8 pairs rated for up to 10 Gbps each. The fabric slots do not implement the VME parallel data bus; this is a problem for the GlueX calorimeter energy sum since we may want to program some parameter in the crate sum modules and we certainly want some way to read the intermediate sums as a way to test the operation of the sum. It would be possible to distribute the clock, reset, trigger, etc signals on the VXS backplane. This could also be done on a PICMG 2.17 backplane which should be less expensive and has the normal data paths to the fabric slots.