Fermi National Accelerator Laboratory

8 Channel Fiber Optically Linked Data Acquisition System for Booster Modulators

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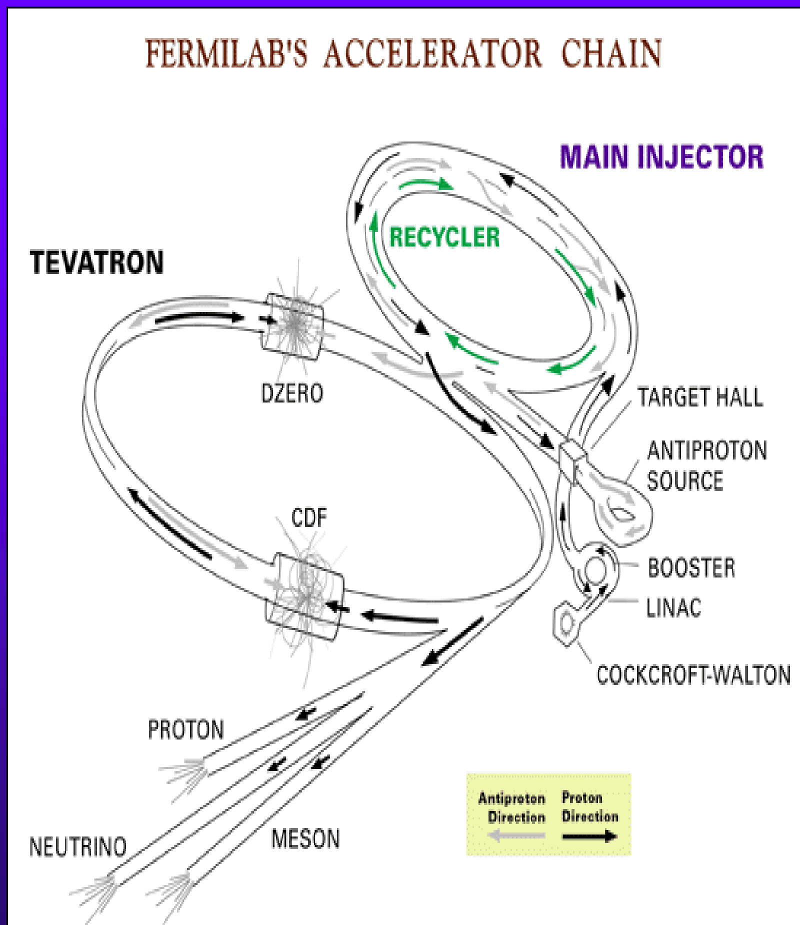
Scope

- Introduction
- Theory of Operation
- Experimental Details
- Results and Discussion
- Conclusions
- Acknowledgements
- References

The accelerator chain



- To create world most powerful particles.

  <u>Booster accelerator</u>

  * location-20 ft below ground

  * Protons travels 20,000 times

  *Leave booster with energy of 8 GeV

Introduction

- Booster beam is accelerated by application of Radio Frequency (RF) energy.
- The RF energy delivered to the beam as it passes through the cavities of the booster accelerator.
- Power supply to these cavities comes from a 30kV Anode Modulator.
- Also, manipulations of the beam, for various experiments at Fermilab require decreasing or increasing the beam’s RF levels. A function carried out only by the modulator
- Present modulator has been used for over 30 years and becoming very difficult to maintain.

Introduction cont'd

- It is therefore desirable to replace the current modulator with one easier to maintain.
- The design for the 30kV anode modulator used in the Main Injector was chosen as the replacement.
- However, this modulator needs a data acquisition system since by design its high voltage deck is located at the back of the modulator.
- Hence the need to design a data acquisition system to transmit noise free signals and provide isolation from the high voltage deck.

Objectives

- This presentation will describe two goals:

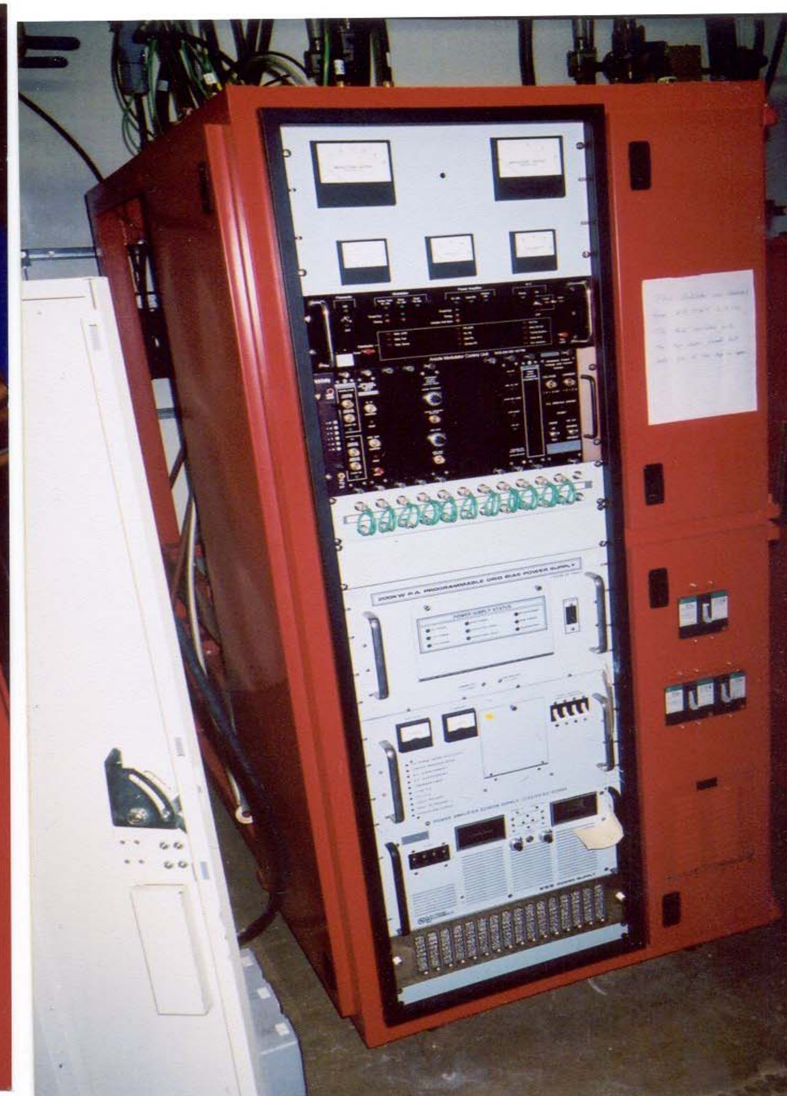
  1. Design of Data Acquisition System.

  2. If successful, the design will be used for all booster modulators.

30kV Anode modulator currently being used.
The high voltage meter panel is located at the front.

The new 30kV Anode modulator.

The high voltage meter panel is located at the back.



Theory of Operation

- The 8-channel data acquisition system will consist of a transmitter and a receiver connected by fiber optic cable.
- The analog signal will be converted to digital using ADC.
- Digital signal then encoded for transmission.
- Output from the transmitter is a 16-bit Manchester encoded serial output.

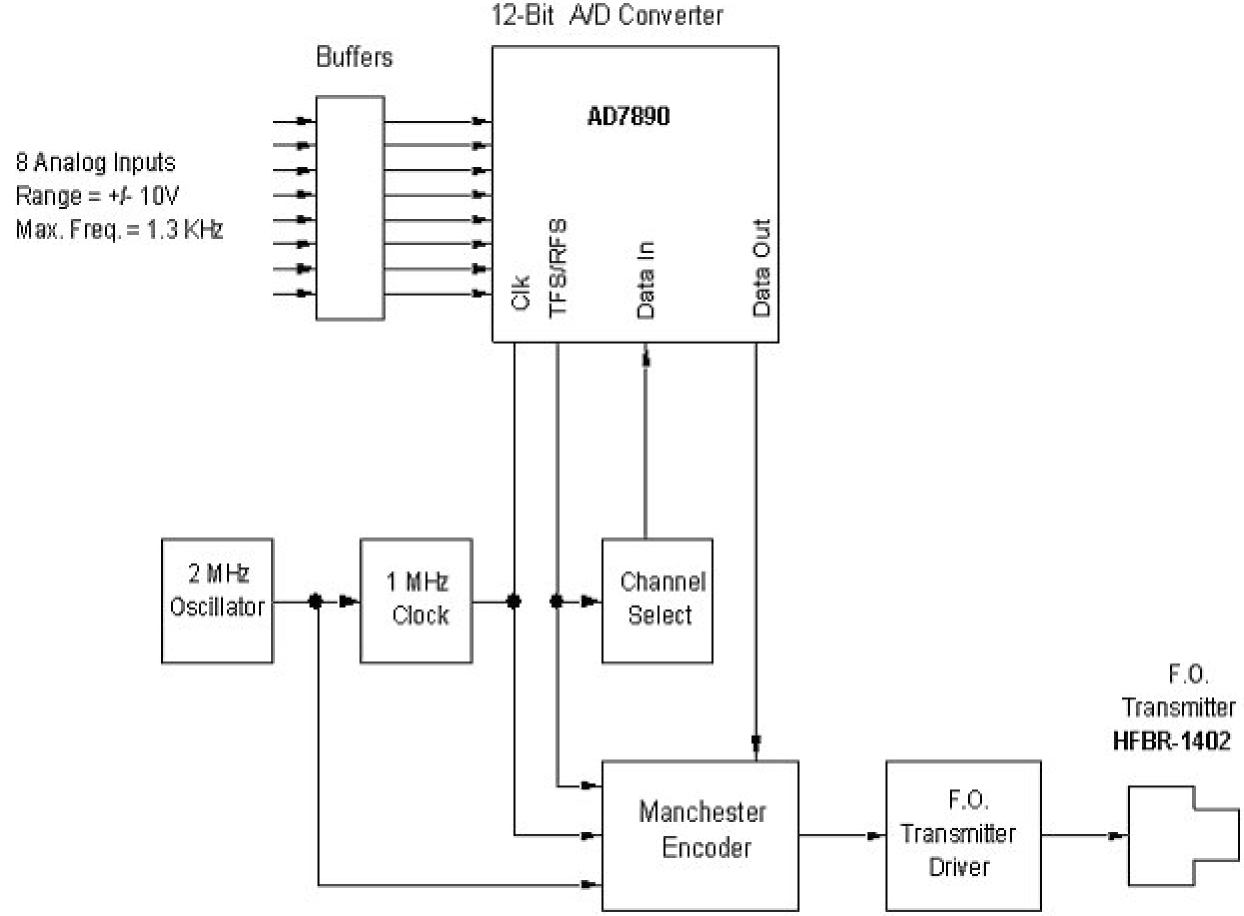


Figure 1. 8 Channel Fiber Optically Linked Data Acquisition System - Transmitter

Theory of Operation cont'd

- Transmitter has eight basic sections:
  1. Oscillator
  2. Clock
  3. Buffer
  4. 8-channel, 12-bit data acquisition system
  5. Channel Selector
  6. Manchester Encoder
  7. Fiber Optic Transmitter Driver
  8. Fiber Optic Transmitter

Theory of Operation cont'd

- Receiver has six basic sections:
    1. Fiber optic receiver
    2. Manchester decoder
    3. Digital-to-analog converter (DAC)
    4. Channel Selector
    5. Buffer
    6. Burndy Connector

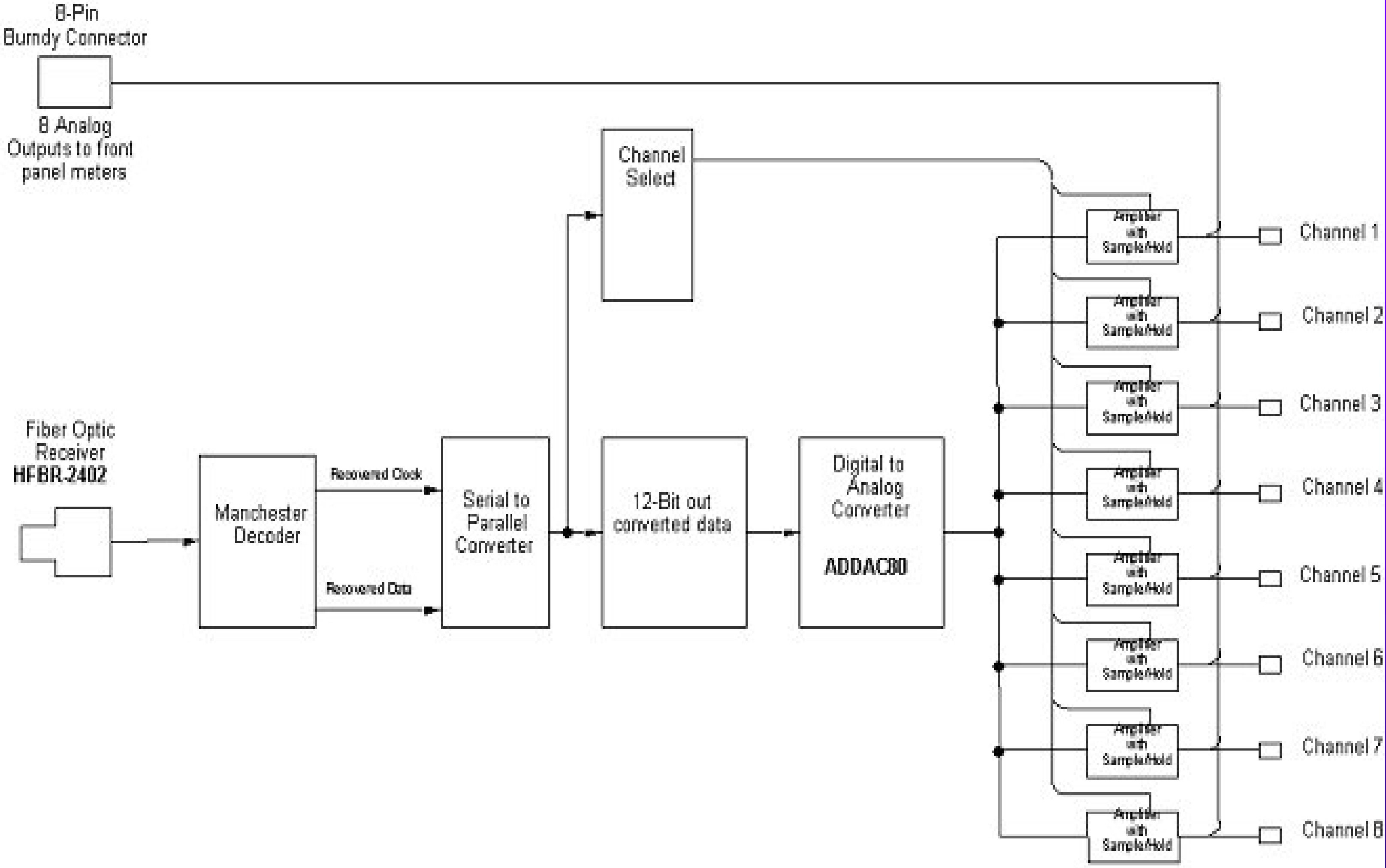


Figure 2. 8 Channel Fiber Optically Linked Data Acquisition System - Receiver

Experimental Details

- The high voltage signal is first scaled to +/- 10V. This is done by a voltage divider.
- The analog signal first goes to the ADC, where its TFS unit provides a pulse which triggers a binary counter.
- The binary counter provides 3-bit address channels to be read into a shift register. The result from here is an 8-bit parallel data.
- An edge-triggered logic input (software) converts the analog data to digital.

Experimental Details cont'd

- Output from the transmitter is a 16-bit data.
- This data is encoded, then transmitted via fiber optic cable to the receiver.
- In the receiver, the data is decoded and sent to the DAC.
- The result is an 8-channel analog signal.
- This is then transmitted to the respective front meter panels.

Results and Discussions

- Table A below shows high voltage readings for the back and front meter panel:

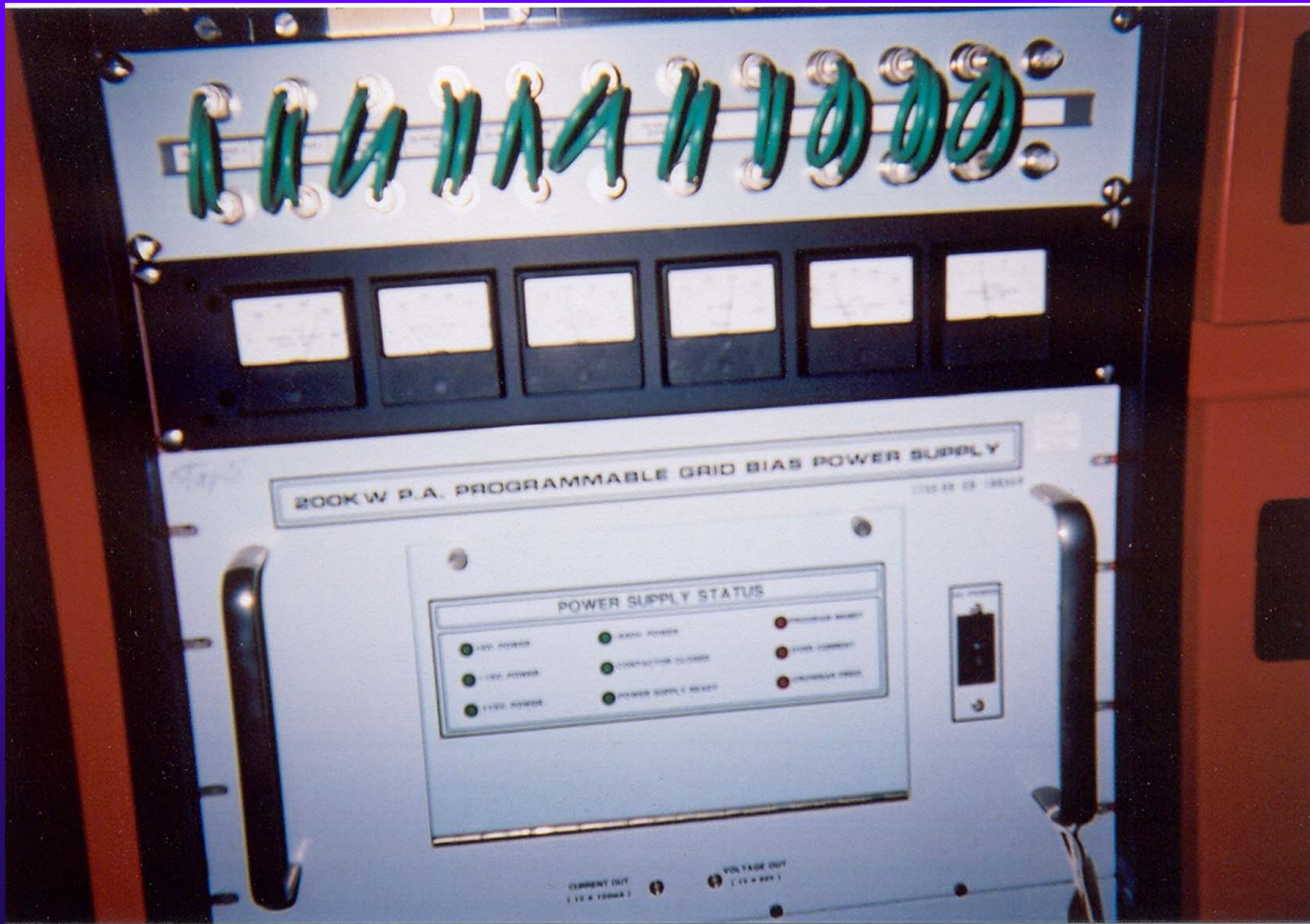
H.V.D	Back	Front
Screen V.	+800V	+750V
Screen I.	80Amps	80Amps
Grid V.	-400V	-380V
Cathode I	-5.8Amps	-5.9Amps
Filament I	180Amps	180Amps
Power S	600V	X

Results and discussions cont'd

- Successes recorded in two readings i.e. screen and filament currents.
- Screen voltage came 50V short on the front meter panel.
- Grid voltage recorded –20V more.
- Cathode current recorded –1.9v more.
- Differences due to wrong resistive values used in the voltage divider.
- Overall the results were good.


200KW P.A. PROGRAMMABLE GRID BIAS POWER SUPPLY
POWER SUPPLY STATUS

A clearer view of the modulator



Conclusions

- Design of the data acquisition system matches well with the theoretical predictions.
- This suggests design is reliable.
- The differences in values are minimized by use of correct resistor values for the voltage divider.

Acknowledgements

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  1. Rene Padilla --- supervisor
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  4. SIST committee
  5. All the people in the RF group.

References

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