A Cockcroft-Walton HV-Generator / PMT-Base for NPS

Joshua Frechem
Charles Hyde
Old Dominion University
Why C-W Base?

• No HV cables – cuts cost
• Less (?) power dissipation.
• Better (?) stability vs pile-up fluctuations.
• Design Example:
  – ZEUS HCal → JLab/IU RadΦ → RHIC AnDY
Cockcroft-Walton Concept

• Generate HV with a DC Transformer
  – High frequency pulse generator drives a capacitor/diode ladder
    • Rectifiers stacked on rectifiers
  – Our version, 0→+5V pulse at 10–40 KHz drives a transformer to ~ 100V
  – Transformer drives ~20 stage ladder
Benefits of Using Arduino

• Easily programmable through the IDE vs ISP
  – This can be done remotely while installed via USB

• Scripts can be written to sequentially program
  – Eliminates manually having to upload code to each board

• Programs can be used/written to monitor & save
  – Save and monitor HV level for stability

• Easily turn HV on/off via logic gate
Readback is linear

\[ y = 1.1153x + 0.4396 \]

\[ R^2 = 0.99998 \]
Affect of Resonance on Feedback

Cathode and ADC Response to DAC input

DAC Value

Cathode Voltage

ADU

ADC Voltage
Effect of Resonance on Feedback

• Frequency range can be set to exclude resonance
  – Change resistance between Vcc & Set on oscillator
  – Easier control for when Vset < Vresonance

• Creates a non-linearity that is compensated for in code

• Create code so that resonance frequency is not reached
Sample HV Signal: It Works!

Cockroft-Walton PMT Base Startup

Cathode Voltage (V)

RMS=2.95V ~ 3ADU

Samples (~ms)
Planned Additions

• Mount Arduino on to PCB
• 12bit ADC separate from MCU
  – Allows finer control to match 12bit DAC
• Additional ADP3300 voltage regulator
  – Lower noise supply powering Arduino & transformer
• Smaller transformer
  – Isolation transformer to separate HV chain from digital components?
<table>
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<tr>
<th>Mfr. #</th>
<th>Manufacturer</th>
<th>Desc.</th>
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| Total (1000) | $27,226.00 |
| Total (single) | $27.23 |
Questions We Have

- How will PMT load chance readings?
- What is the Voltage ripple spec (≤ 1V rms ?)
- What is the dynamic range/stability criterion for anode current?
  - 1% at (10 MHz)(10⁵ gain)(10 p.e.) = 2 microAmp ??
- When is the deadline for a design choice
  - Yesterday?
Conclusions

• We have proof-of-principle prototype
  – We think we can improve it to meet spec
• We do not yet have a working PMT base.
  – We think we can get there by April (sooner?)
• Provides a digitally controlled, compact, and efficient alternative to resistive base
Starting Design

Pulse in →

Dynode HV
(12 for AnDY)
10 for NPS

Read back

Cathode

StarTng

Design

Pulse in →

Dynode HV
(12 for AnDY)
10 for NPS

Read back

Cathode
Feedback & Set-Point/Readback Communications

Power / I-O

Arduino

HV Readback to 10-bit ADC

Readback – Setpoint to DAC

Pulse-out to CW

RCO