Multi Channel Vacuum Controller Using National Instruments Compact Rio and LabVIEW RT

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About Flexline LLC

- Focus
  - Test, measurement and control systems to the semi and biomedical industries.
  - LabVIEW and LabWindows CVI Programming
  - Provides integrated hardware and software solutions
  - In house electromechanical assembly and fabrication capabilities
  - Contract Manufacturing

- Key Competency
  - Fluid and gas system test and control
  - Motion/Pneumatic control using Dnet Sercos and Synqnet
- Located In San Jose Ca
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Multi Channel Vacuum Controller using Compact RIO

Task

- To design and integrate hardware and software into a multi channel vacuum controller
- Fabricate and multiple units for customer evaluation

Challenge

- Create a self contained 4 channel vacuum controller to replace and existing controller in a semiconductor tool with improved performance.
  - 3 channels 0-10” H20 with independent control.
  - 1 channel 0-500Torr
  - Legacy Serial interface

Requirements

- +/- 1% stability on each channel
- 2 Second response rate to setpoint changes
- Legacy Serial Interface with existing system controller

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Vacuum Controller using Compact RIO

Under the Hood Hardware Configuration

- Compact Rio Components

cRio-9474 8 Ch 24V 1uS HS DO	National Instruments	779003-01
cRio-9201 8 Ch +/-10VDC 500kS 12 Bit AI Module	National Instruments	779013-1
cRio-9472 8 Ch 24V 100uS DO	National Instruments	779004-01
cRIO 4-slot 1Mgate chassis	National Instruments	779052-01
cRIO -9002 Real time embedded Controller	National Instruments	779000-01

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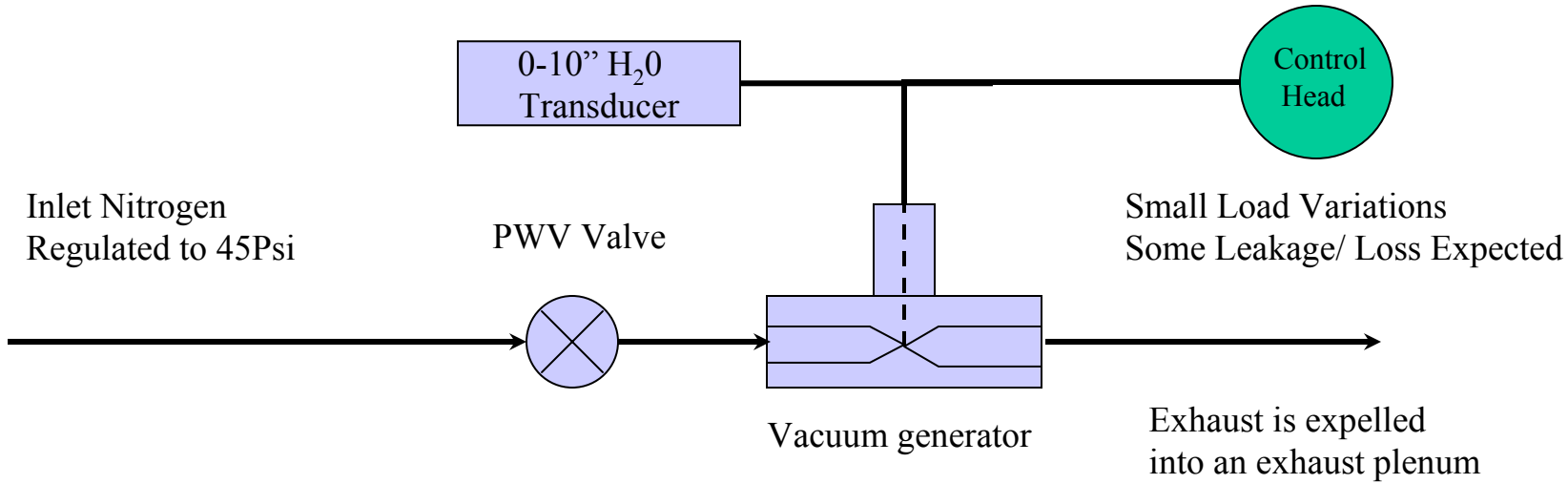
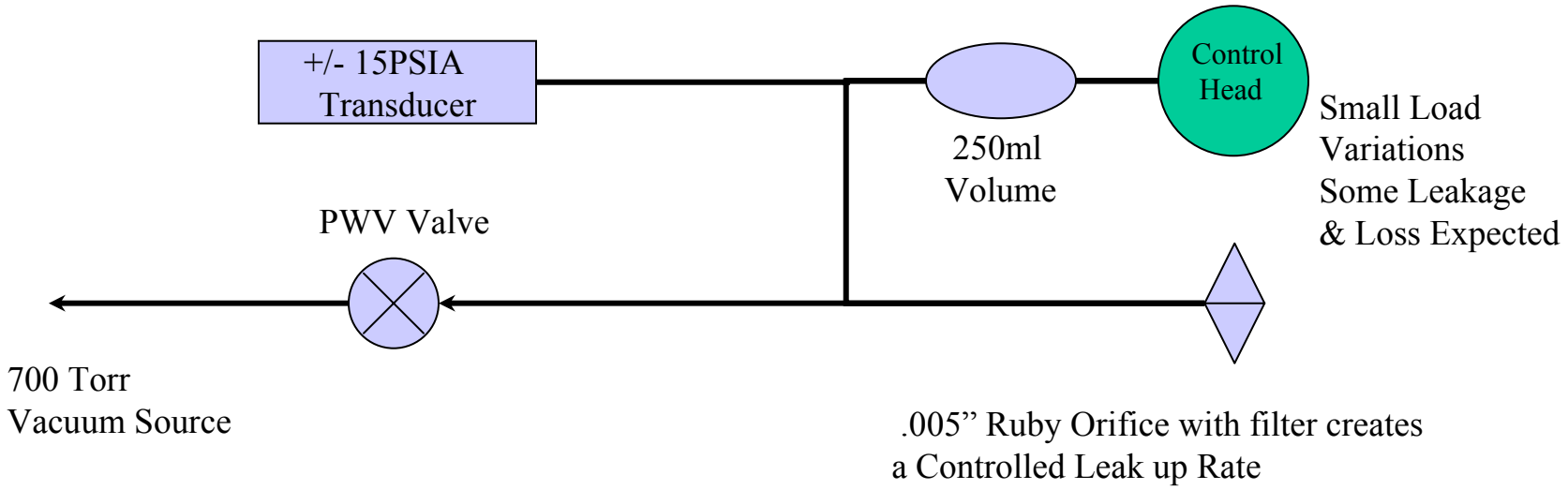
Vacuum Controller using Compact RIO

- Three channels of Independent Vacuum Control 0-10” H_20
- Vacuum is generated by flow through the Venturi
- Pulse Width Valve controls N2 flow into the Venturi
- Varying the flow through the PWV allows for control of pressure in the Vacuum line



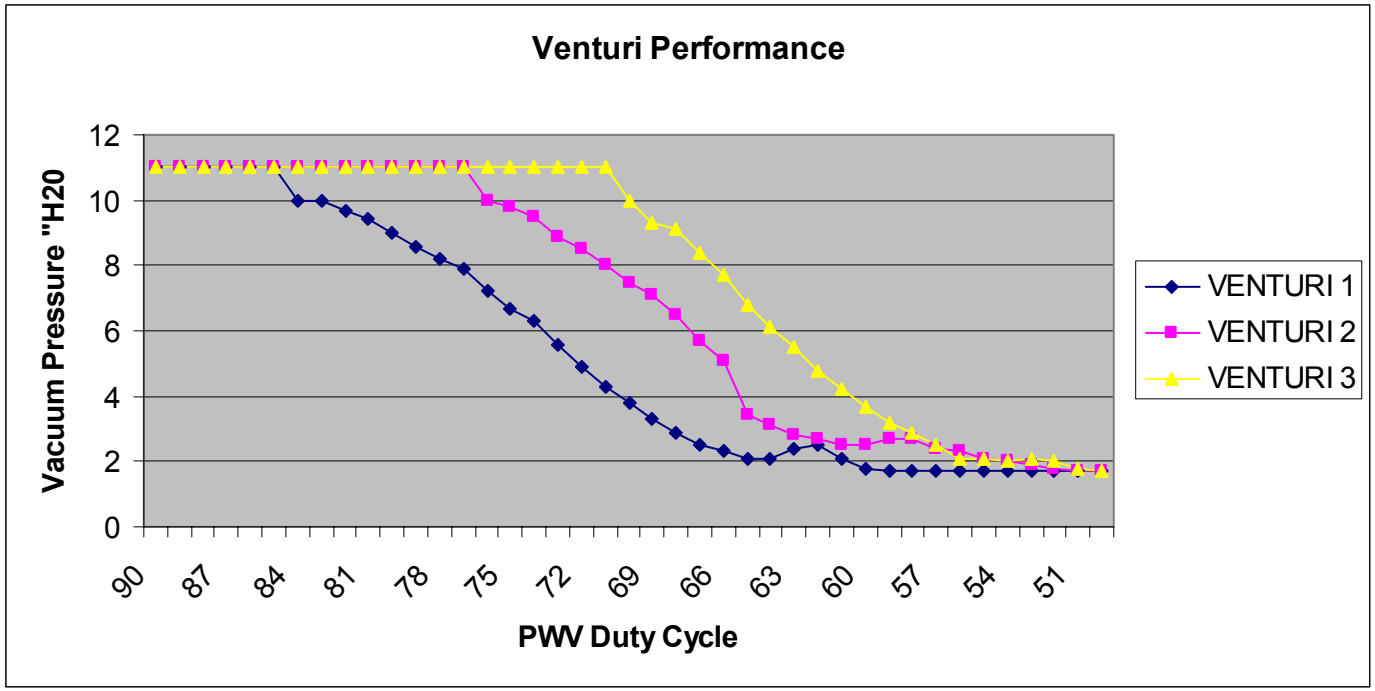
Vacuum Controller using Compact RIO

- One Channel 0-500 Torr vacuum control
- External Vacuum Source capable of 700Torr Ultimate vacuum
- PVW Valve to control vacuum level
- Fixed Orifice to control leak up rate (allows the system to balance at the setpoint)



Vacuum Controller using Compact RIO

Control Solution: Not all Venturies Are Created Equal



- Variations from Channel to channel are significant
- Lookup tables could not be used
- Active control area is between 50 to 85% Duty Cycles

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Vacuum Controller using Compact RIO

Result of Development and testing:

- •Each control channel has slightly different characteristics
- •All loads are slightly variable (Leakage / activities that occur in the head)
- •Needed about 150-250ms to allow for transducers to react to PWV adjustments
- •Some variation in the N2 Supply Pressure
- •Some variation in the Exhaust pressure (other elements in the exhaust system)

Conclusion: an adaptive control system is required

A Simple Dead-band control method was used with positive results

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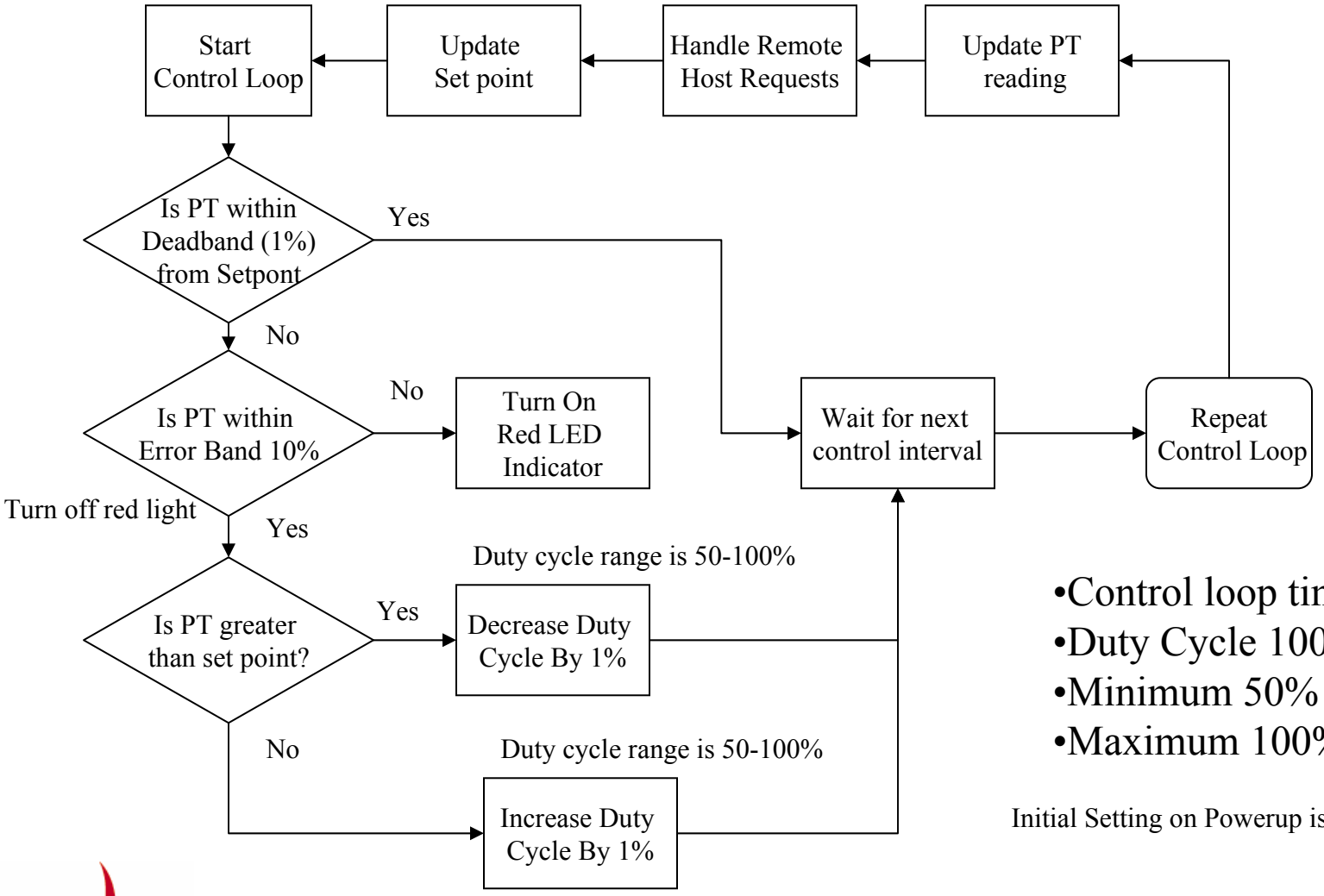
Vacuum Controller using Compact RIO



- Control loop time
- Duty Cycle 100uS
- Minimum 50%
- Maximum 100%

Initial Setting on Powerup is 50%

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Vacuum Controller using Compact RIO

How did it work?

- Transducer required over sampling to stabilize reading
- PWV Output Rate of Change had to be Controlled and Slowed Down (1% per iteration)
- Overall Loop time of 200ms had best performance
- Best performance of dead band was under 0.25 %
- PWV frequency 10Khz reacted faster but was less stable at setpoint

Changes Based on Experimentation

- PWV frequency Decreased to 1Khz gave better resolution
- PWV Rate of change has course and fine tuning

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Experiences Using the Compact Rio Hardware

- Short Development time (8 work Days)
  - Initial Coding of control system and experimentation 2 days
  - Coding of application 4 Days
  - Customer testing 3 Days
  - Design iteration 2 Days

- Recommend Training Course
- Follow Standard Models
- Product support was very good.

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A Copy of this presentation is available for download at

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