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In-Line Leak Detection

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Ecolab
In-Line Leak Detection

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Faculty Mentor: Dr. Agajanian

Acknowledgements

Ecolab	Sponsor Organization
Joshua Martin	Sponsor Contact
Dr. Agajanian	Faculty Mentor
Prof. Schroeder	Senior Design Professor
Marty & Dominique	Keyence Senior Sales Engineers

Outline

- Background
- Problem Statement
- Design Alternatives
- Description of the Final Design
- Design Validation
- Challenges and Lessons Learned
- Conclusion
- Q&A

About Ecolab

- Global manufacturer
- Water treatment, healthcare and hygiene products, food processing and safety products, energy services
- Located in Joliet, Illinois
- Mixing and packaging chemicals for various applications
- Sponsor Contact: Josh Martin

Problem Background

- Leaking Bottles
  - Manufacturing defects
  - Caused by specific line section
- Causes downtime on the line
- Harsh chemicals are a safety hazard

Design Objectives

- Minimal costs
- Little interference or change to existing process
- Easy to maintain
- Durable
- Simple to implement and use
- Adaptable to other lines

Functional Requirements

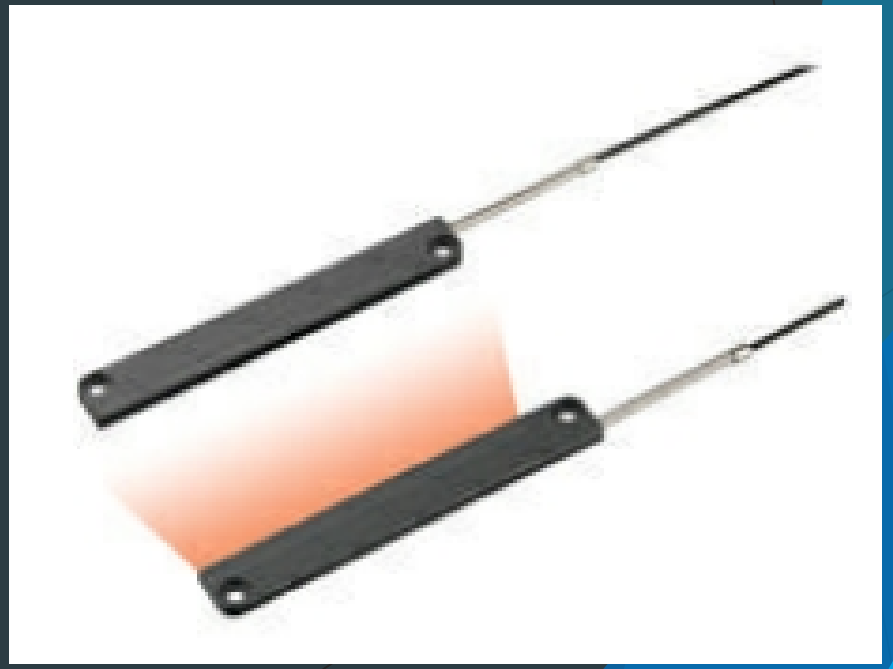
- Device should
  - Detect major leaks
  - Stop the line when a leak is caught
  - Specify the line was stopped for a leak

Design Constraints

- Device cannot exceed line boundaries
- Must not slow down the line
- Must not increase health risk to those near line
- Sensor must be able to sense leaks across the full width of the line

Design Alternatives

- ALPS Inspection: SX Linear (pressure testing)
- Keyence: Vision Sensor with AI
- Keyence: IB-30
- Keyence: FU-A100



Metrics and Evaluation of Alternatives

Options/Metrics:		Cost	Accuracy	Speed	Size	Modularity/ Adaptability	Durability/ Longevity	Health Risk	Complexity	Weighted Total
ALPS Inspection SX Linear (pressure tester)		6	9	5	7	7	8	8	6	42
Keyence Vision Sensor with AI		9	6	7	9	9	7	9	8	47.3
Keyence IB-30		10	7	8	9	9	6	9	9	50
Keyence FU-A100		10	7	9	9	9	7	9	9	**51.7**
Weight		High	High	High	Medium	Medium	Medium	Medium	Low	

Our Final Design

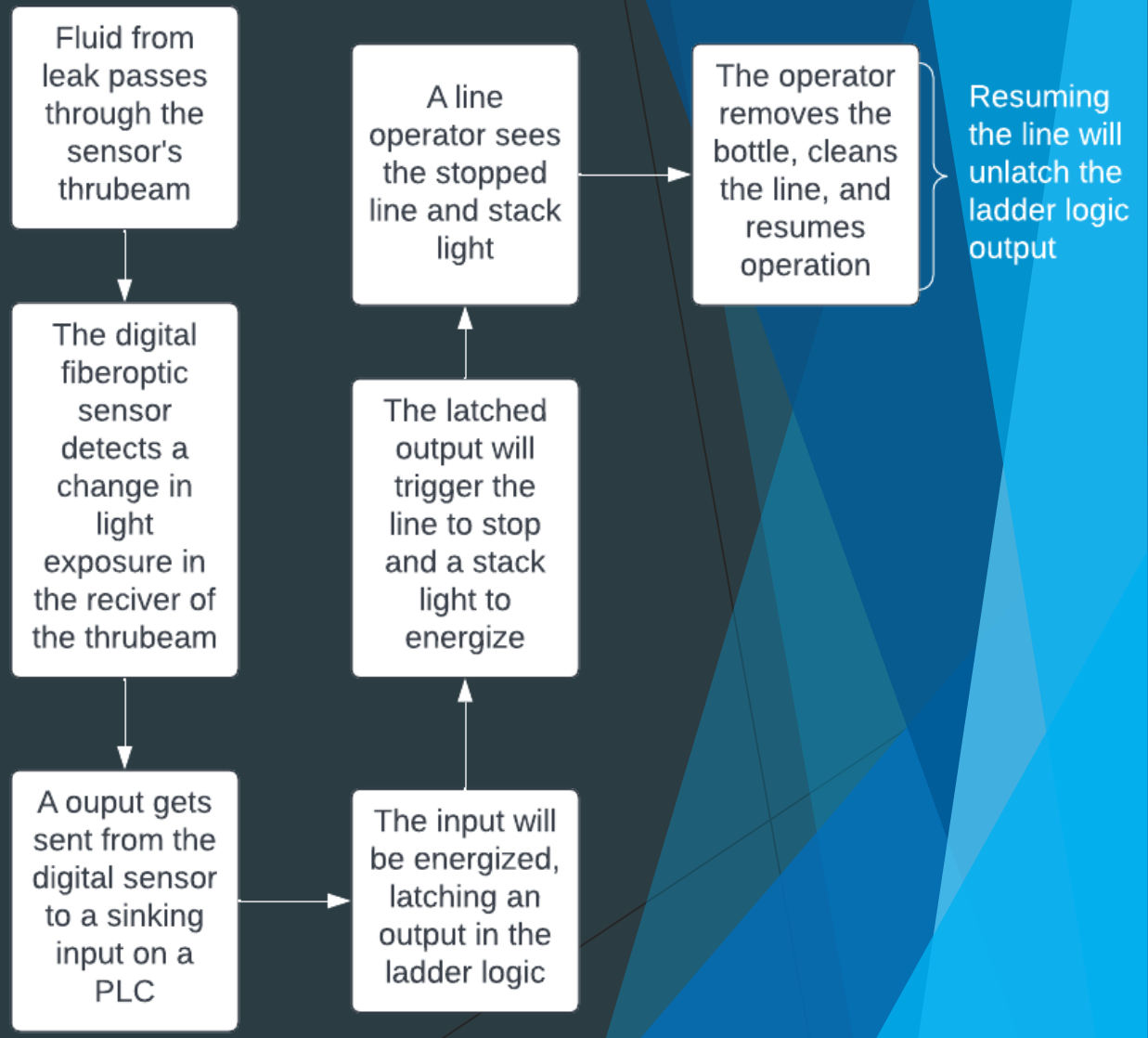
- FU-A100; Thru-beam fiber sensor
  - Detect drops of fluids from leaks
- FS-N41C; Digital Fiberoptic Sensor
  - Supply power to the sensor
  - Communicates with PLC

Supporting Materials

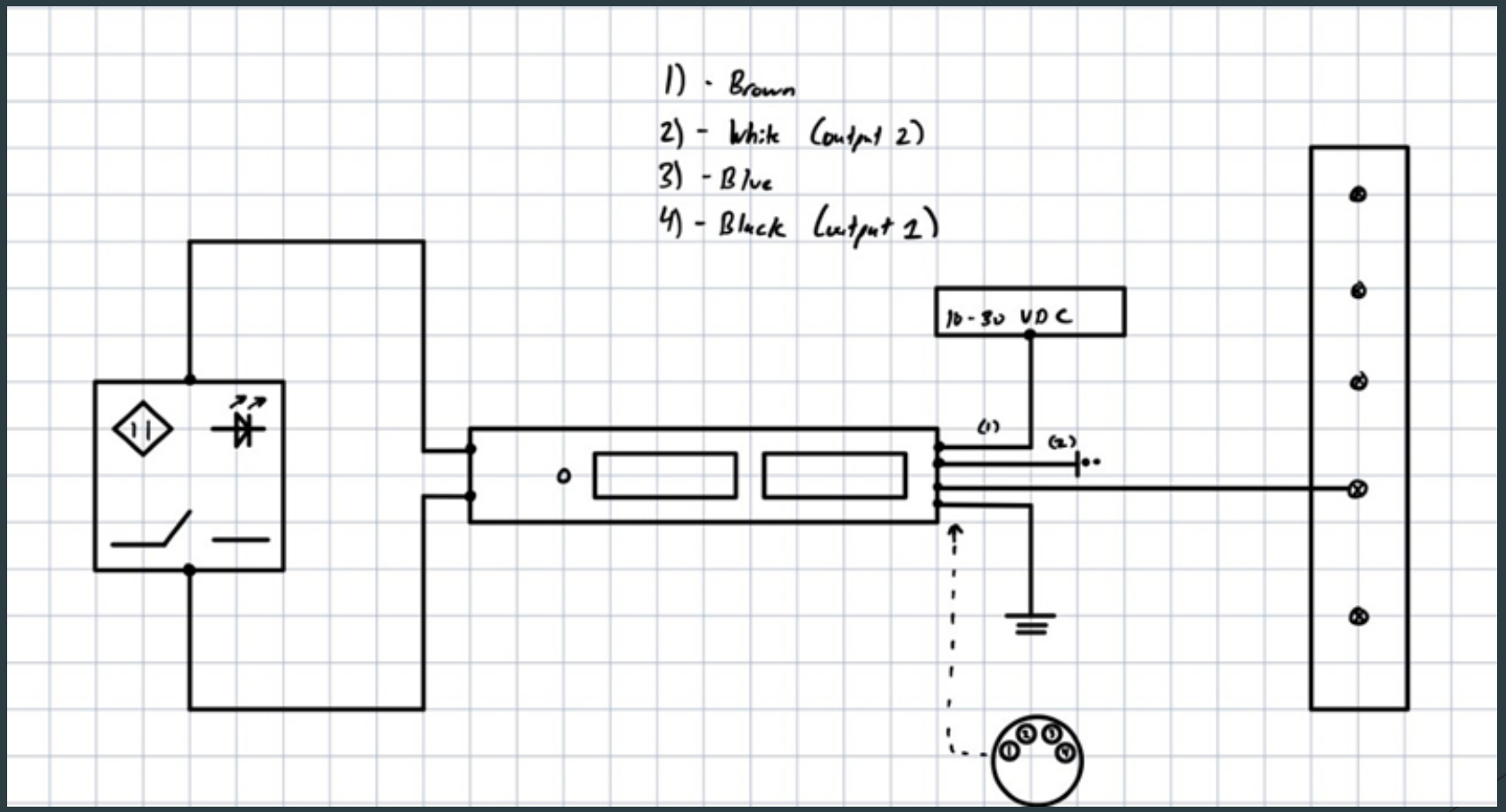
- OP-73864/OP-73865
  - M8 type connectors
  - Connect FS-N41C to the PLC, power, and ground
- OP-87098
  - Fiber cutters
- Mounting Screws (M4 x L8)

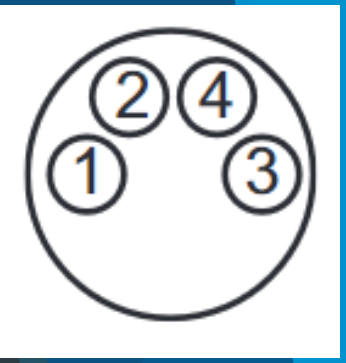
How our solution works

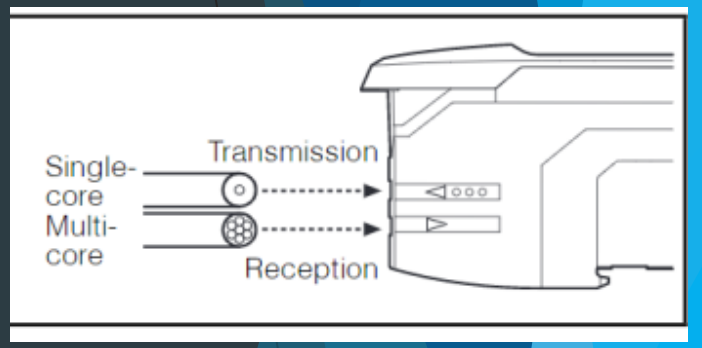
- Thru-beam fiber sensor
- Digital fiberoptic sensor
- Sinking PLC input
- Ladder logic
- Line stopped and stack light on
- Bottle removed and line cleaned
- Line operation resumed

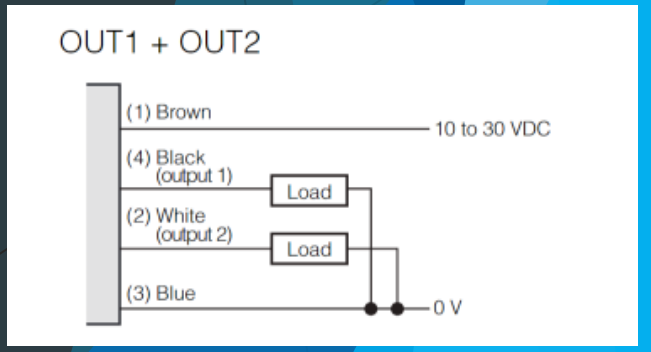


Wiring Diagram



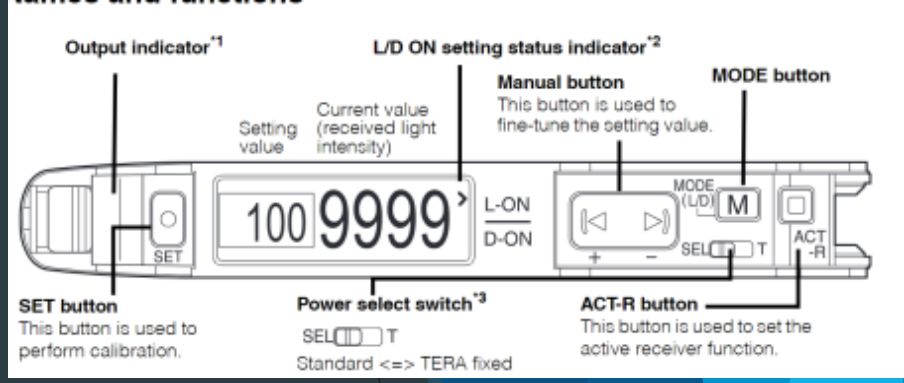


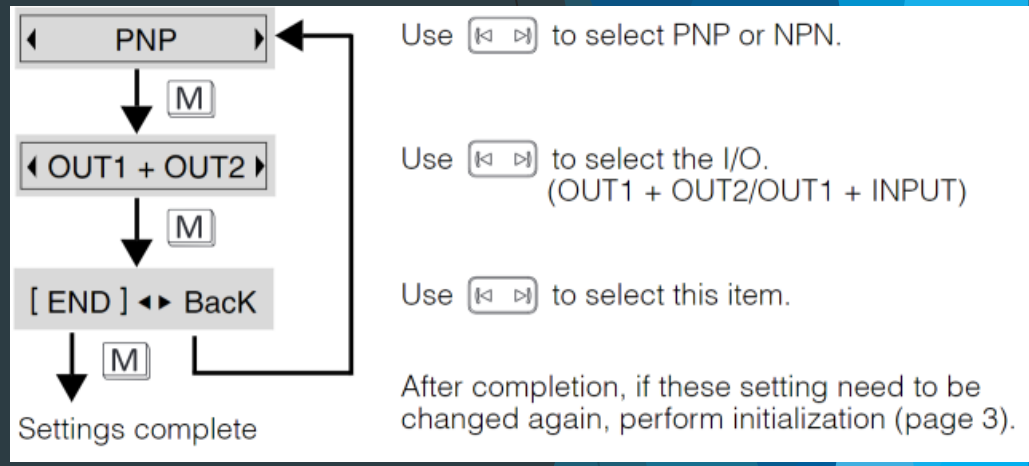




Initial programming the Digital Fiberoptic Sensor

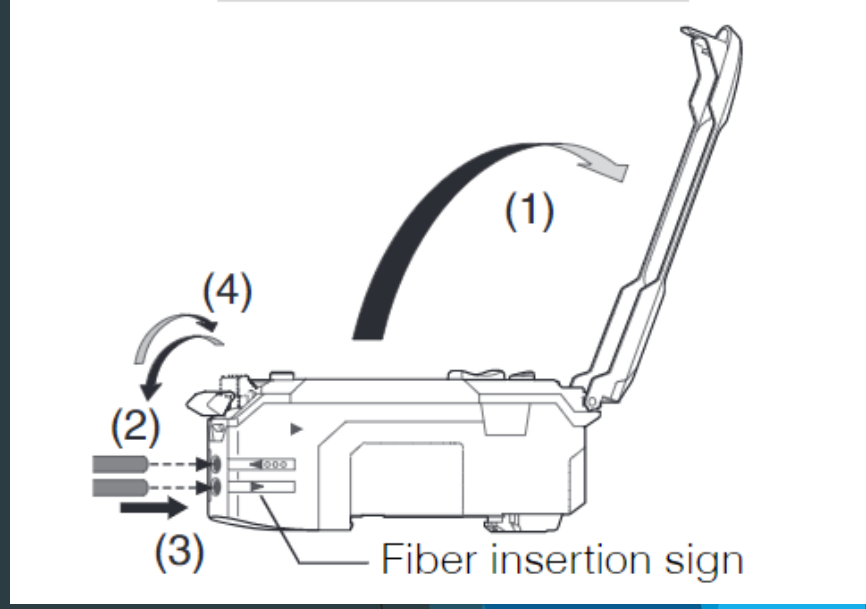
- Setting the function
  - PNP vs NPN
  - 2 outputs vs 1 output and 1 input
    - Can be changed by re-initializing
- Calibration
  - Maximum sensitivity calibration

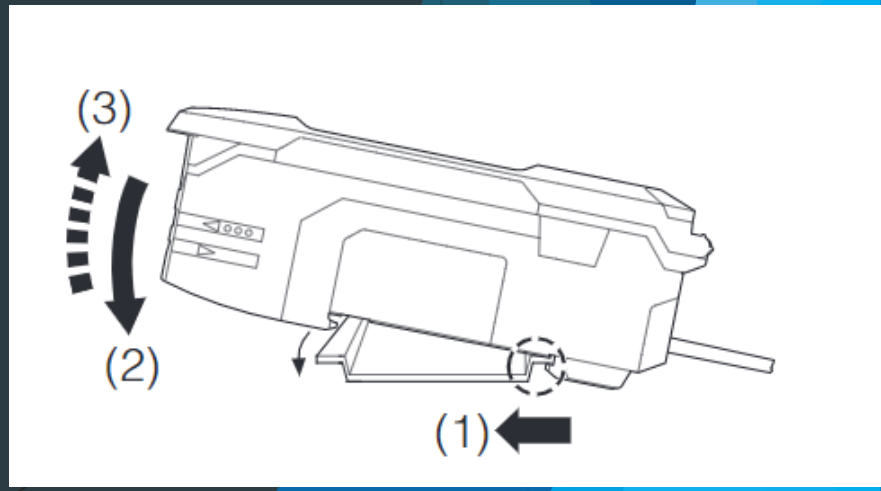




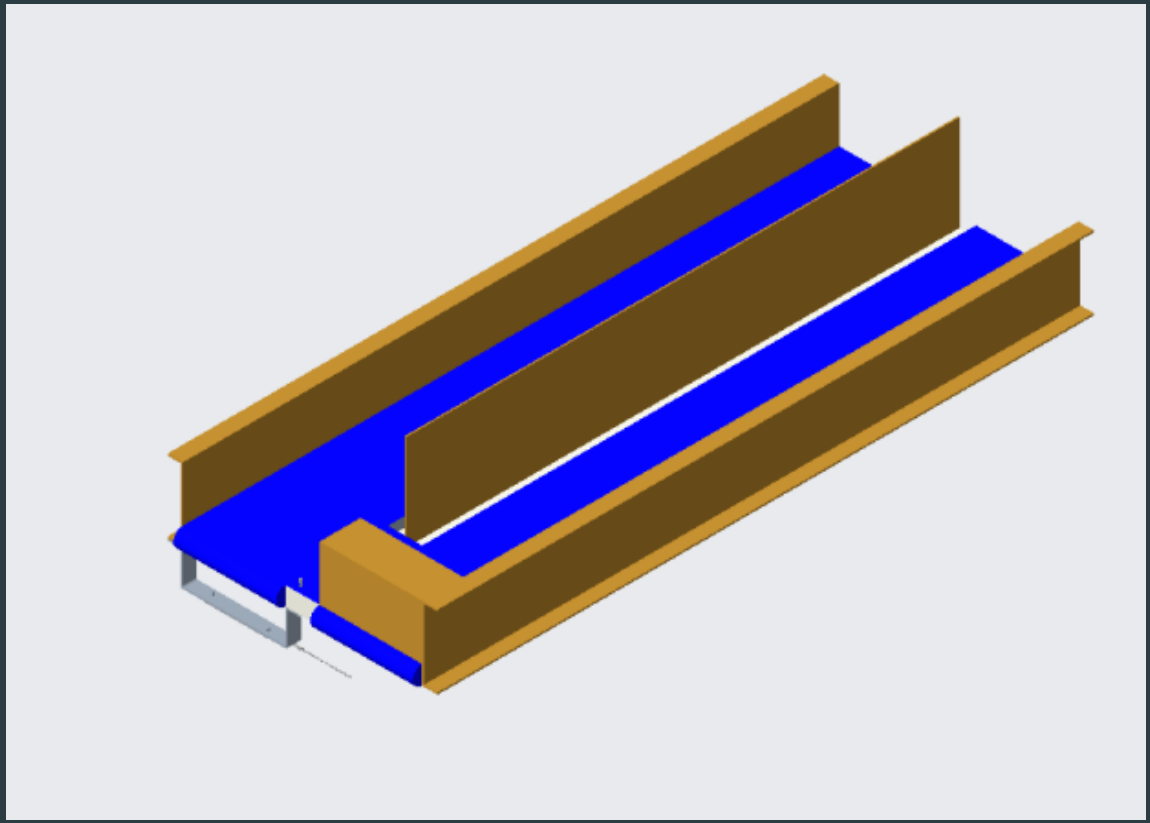
Physical Installation

- Thru-beam fiber sensor
  - Mounted underneath conveyor
  - Fiber optic cables cut with a cutter
  - Cables installed in the FS-N41C
- Digital fiberoptic sensor
  - Mounted on DIN rail in control panel
  - M8 plug connected and wired



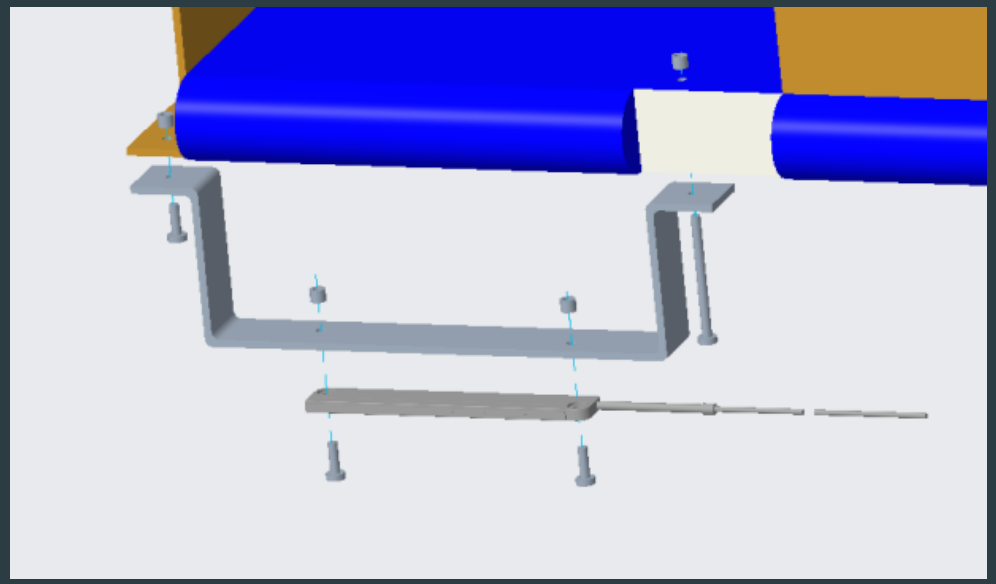


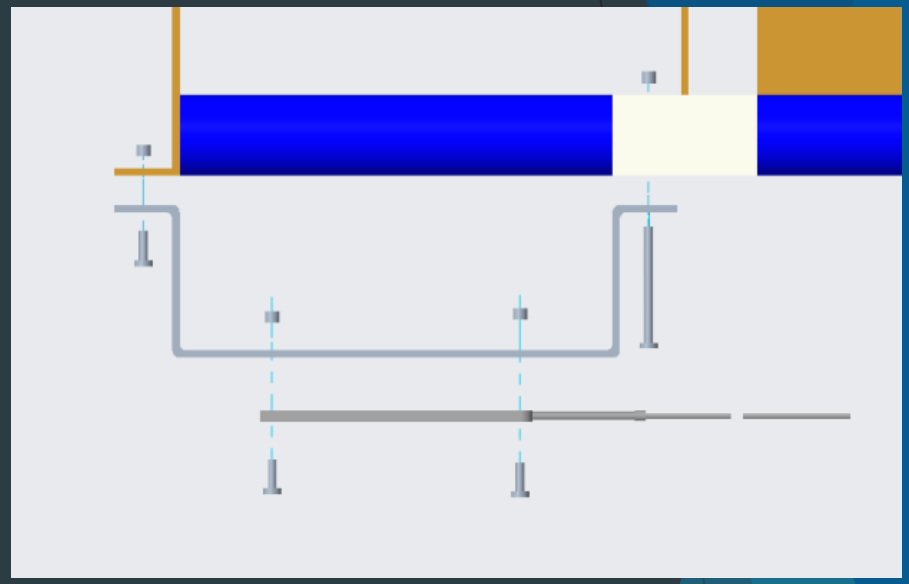
Creo Modeling and Mounting of FUA-100

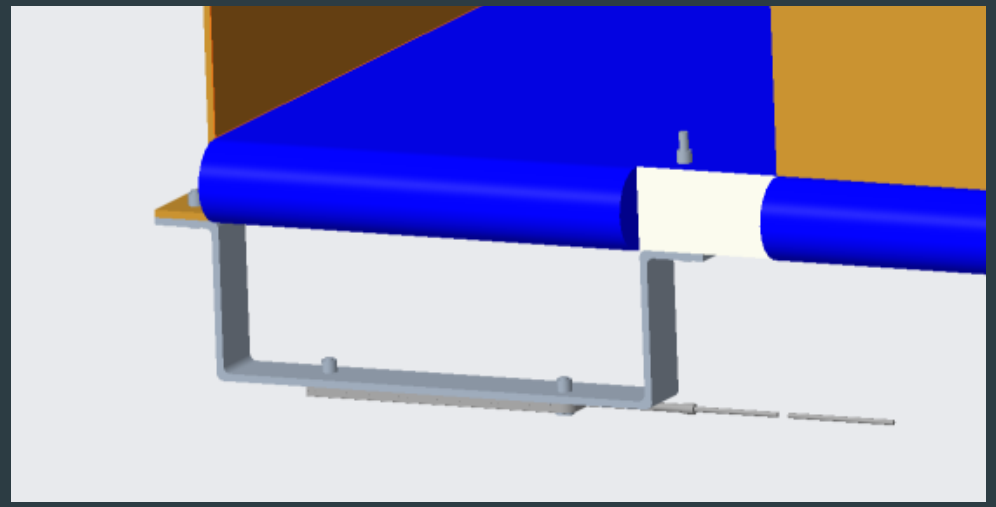


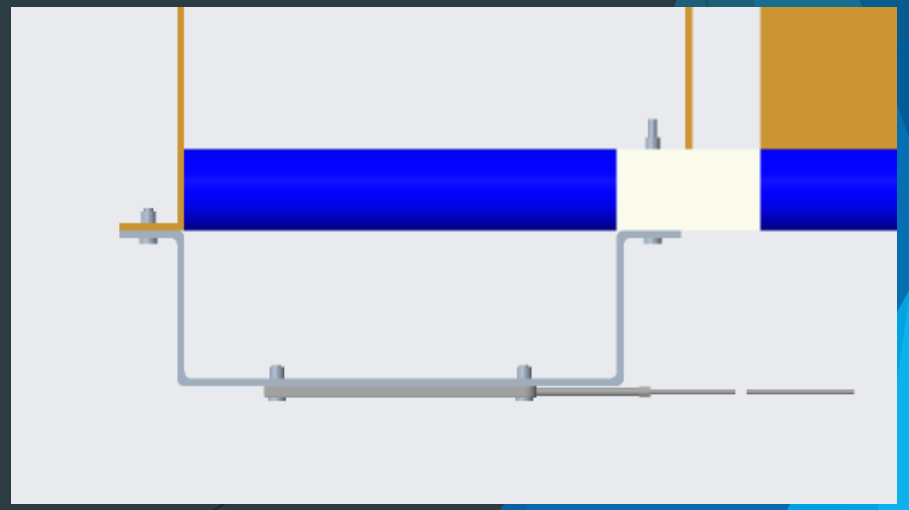
- Basic structure of line modeled for installation purposes
- Utilize gap in line sections
- Mounting Bracket/Splash Guard – stainless steel, machine screws, and nuts
- Orientation – horizontally under the line
- Cable management

Creo Modeling and Mounting of FUA-100









Design Verification Plan

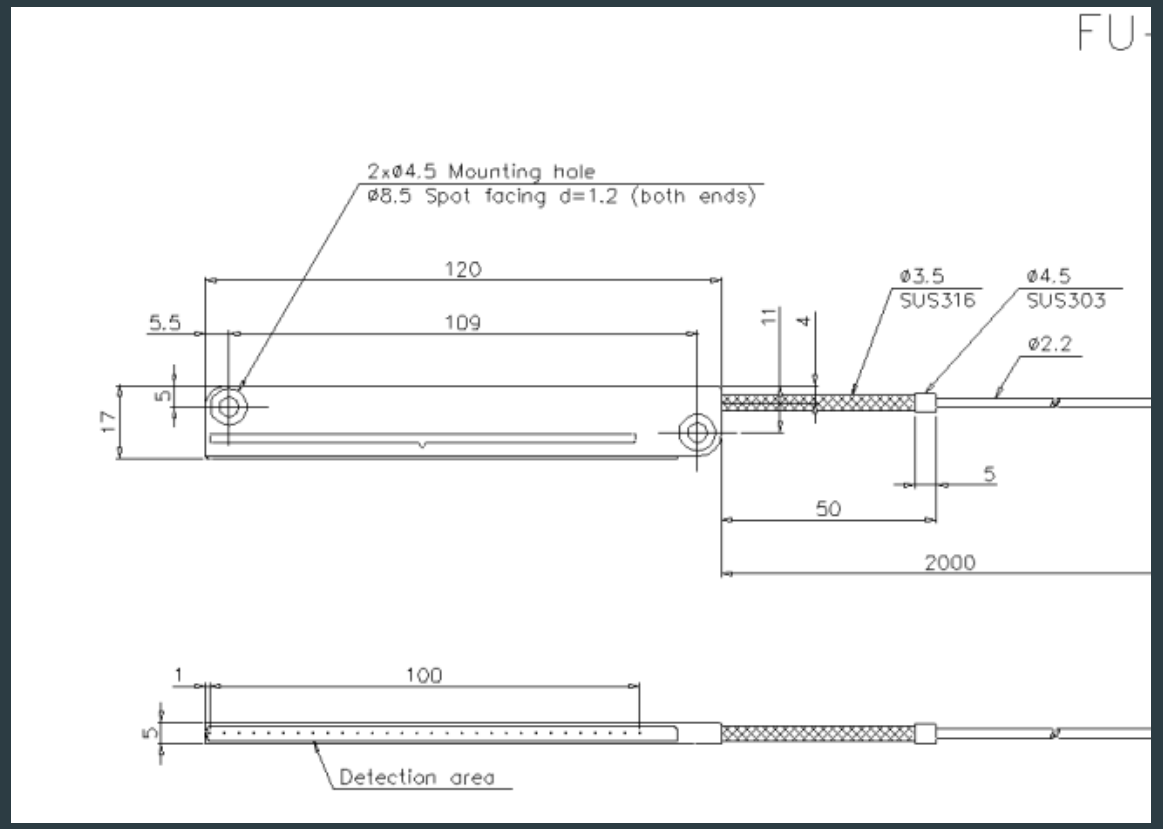
Pre-Testing Before Installation

- Assemble makeshift mount between sensors with a cup below the sensors
- Connect FUA-100 to computer or voltmeter to check for potential difference
- Use an eyedropper to drop varying levels of dyed water in the FUA-100 sensor's field of detection

Installation Testing

- Install FUA-100 to the portion of the line
- Measure outputs as the line regularly runs with voltmeter

Design Validation



- Cost: $1,100 - $1,300
- Interference with Existing Process: ***Satisfactory*** (About 4.75" x 0.75" x 0.2" and about 110g)
- Maintains Current Speed: ***Satisfactory*** (Compatible with standard HMIs)
- Durability: ***Satisfactory*** (IP67 rating, Die-cast Zinc)
- Detects Leaks: ***Satisfactory*** (About 0.25" diameter)

Challenges and Lessons Learned

- Consistent communication is key
- Divide work to suit our personal strengths
- Start somewhere and continue to improve
- Patience and adaptability with a big project is important

Conclusion

- Benefits to client & users
- Recommendations & future steps
- Chemical resistiveness
- Vibrational effects
- Sample test product quality

Q&A

Questions?

Comments?

Thank You!