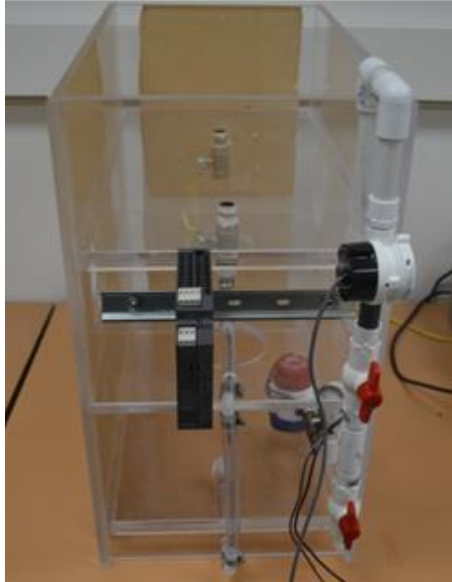


Chapter 25 Tank Over Tank

Tank over Tank Level Control Lab



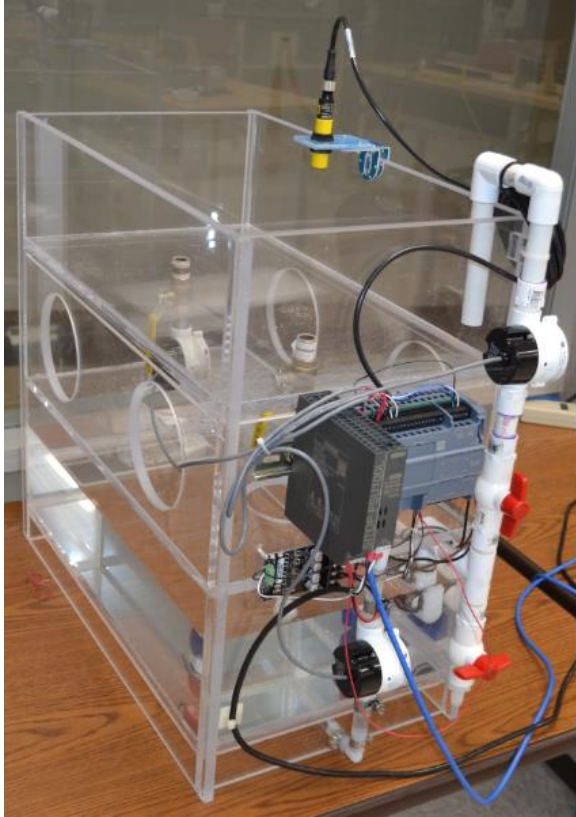
Level Control of Upper Tank with Multiple Drains and Feedback from Level Sensor

Purpose of the Lab – From experiences in industry, one individual stated that an auto controls course need only teach students to tune outer loops slow and inner loops fast to be successful with instrumentation applications. This stuck with this author and there has always been desire for students to have such an experience with a visual loop within a loop.^[6]

Materials – The tank with level control, flow controls, a bilge pump and PLC.

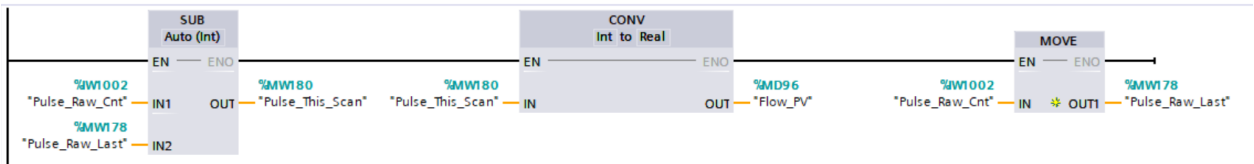
Cost – The cost of these systems is approximately \$1500/each. The lab pictured below is nearing completion for implementation in multiple labs. While relatively expensive, large and clumsy, it promises to replace units commercially available in the \$30K range/each. The major cost is the plastic of the system – roughly \$1000. It provides loop-within-loop control of level control in the upper tank.

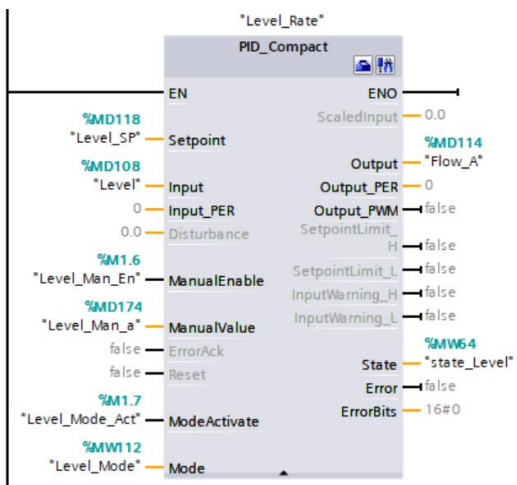
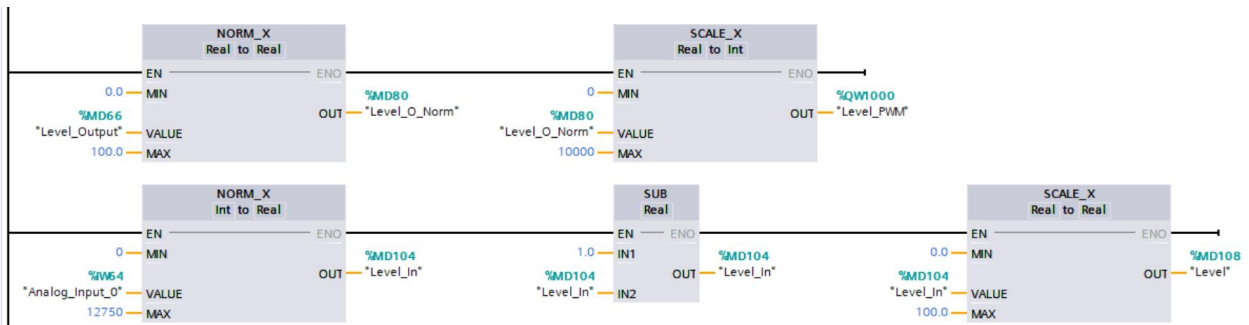
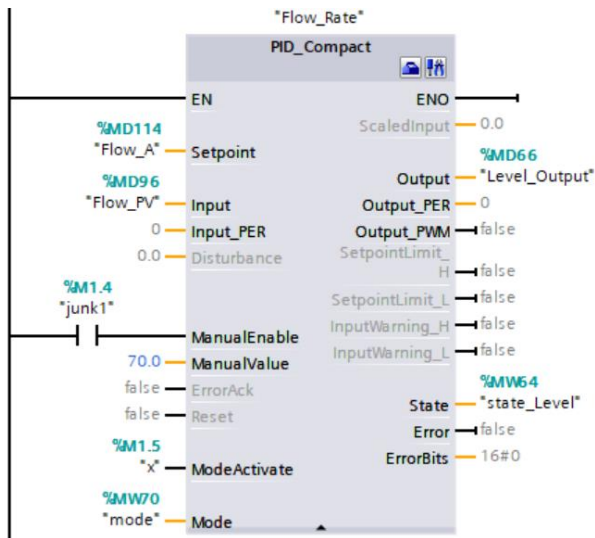
Benefit – This lab has been implemented on one system and that system used as a basis for building of eight new systems. Today the controller, flow control elements and level control elements are waiting final mounting on these eight vessels. The design was updated with new flow meters. In the course of the design, two level controllers were tried and failed. The third finally worked. The benefit of trial and error led to a good design that works. The experience of building and programming this lab was of great benefit to the experience base of the staff.

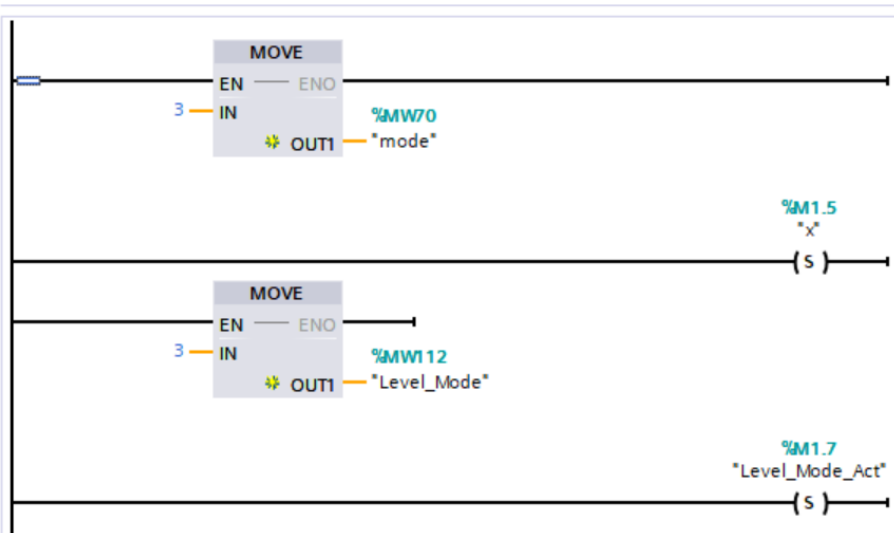
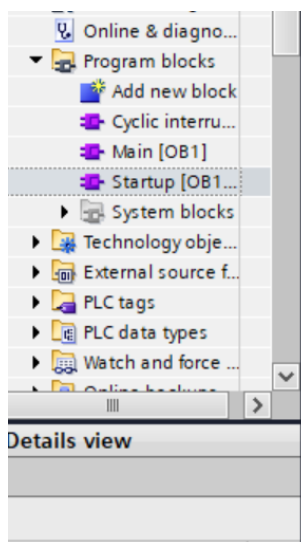
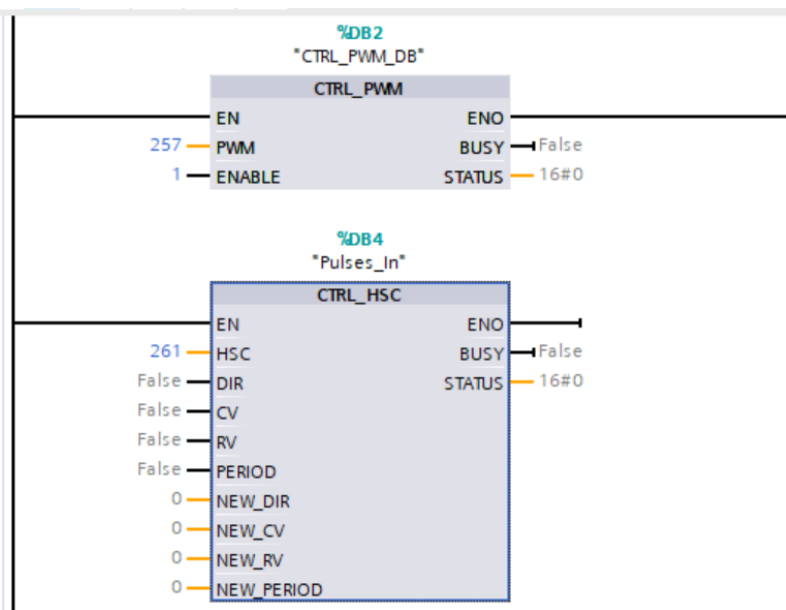
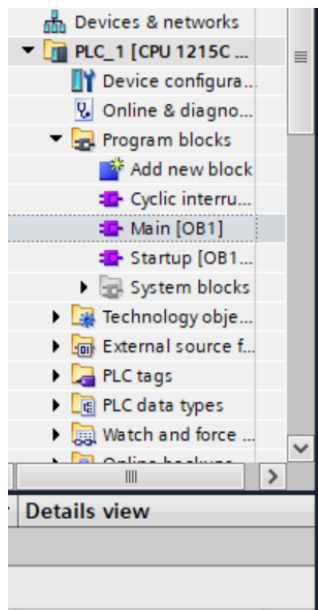
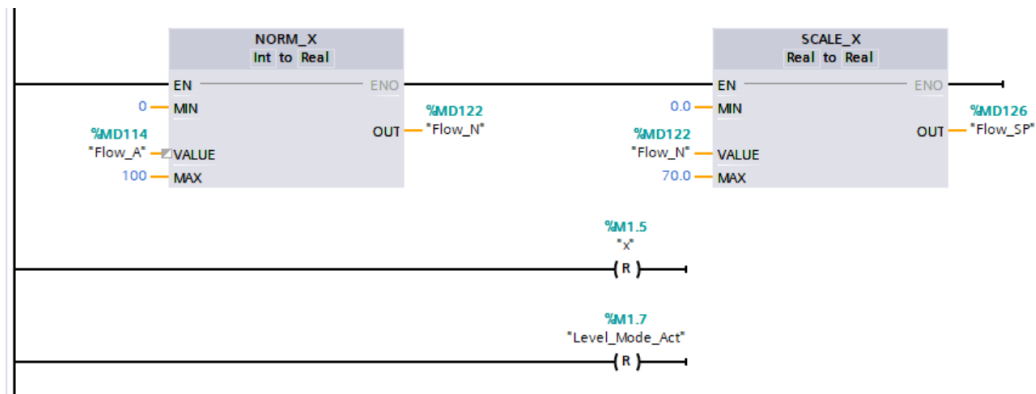


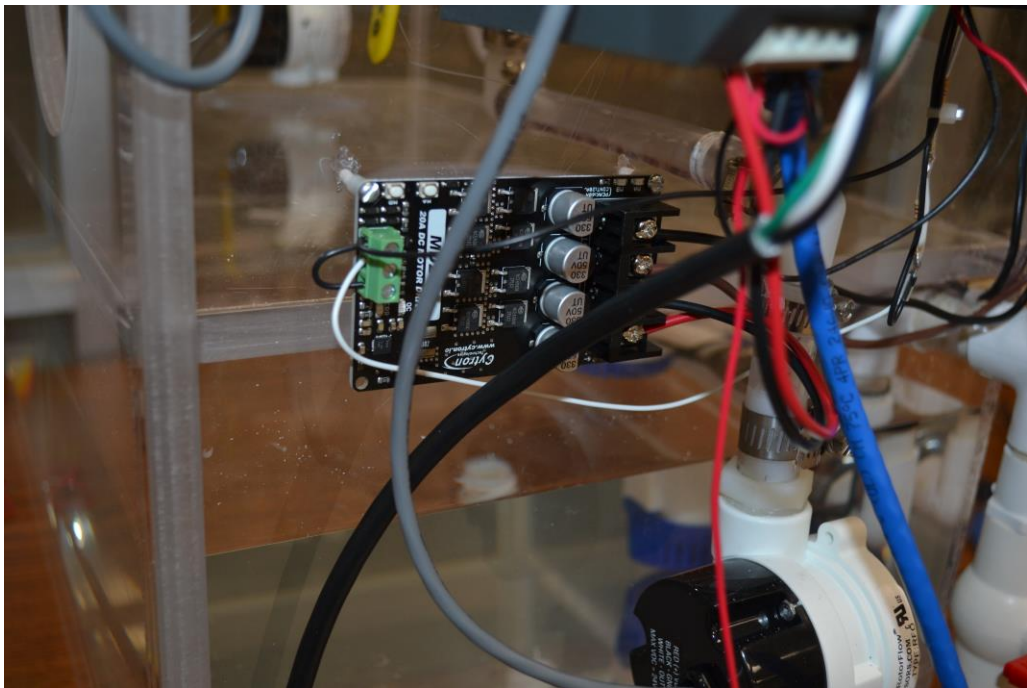
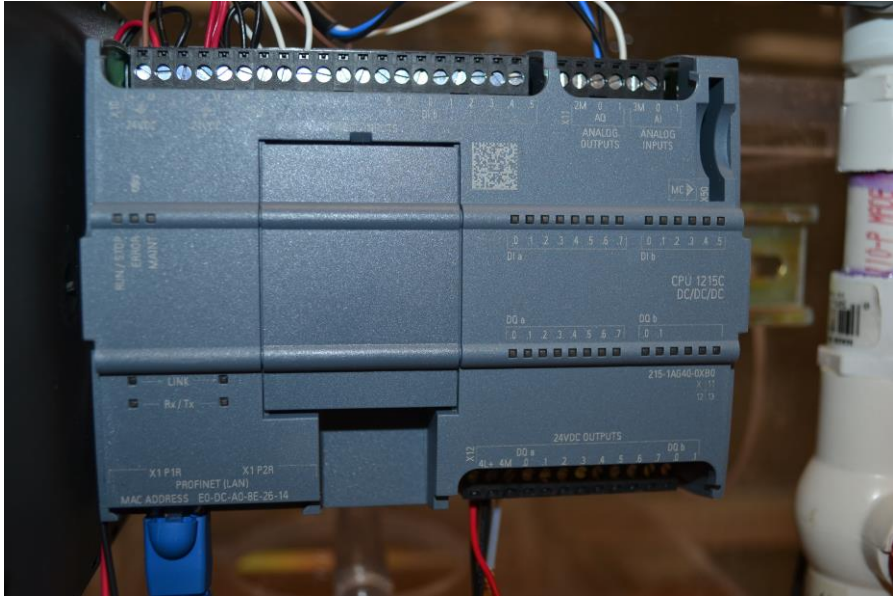
Program blocks

- Add new block
- Cyclic interrupt [OB30]
- Main [OB1]
- Startup [OB100]









Cytron 20Amp Bi-Directional 6V-30V DC Motor Driver Speed Controller 60A Peak

★★★★★ 12

\$19⁸⁰

FREE Shipping

Only 14 left in stock - order soon.



001	1.00	0.00	1.00 EA	155481	EA	148.0000	148.00
			1.0	RFO SERIESFLOW RATE MONITORING	1.0		
				1-2 WEEKS			



Gems Sensors 155481 RFO Series Flow Rate Monitoring Sensor

Brand: Gems Sensors

★★★★☆ 1 rating

Price: \$110.00 ✓prime & FREE Returns

- Body Material: Polypropylene
- Port Size: 1/2" NPT Female
- Flow Range (GPM): 1.5-20.0
- Low Flow Accuracy: +/- 7%
- Standard Flow Accuracy: +/- 15%

\$110.00

✓prime & FREE Returns

FREE delivery: Tuesday, April 13

Order within 3 hrs and 22 mins

Details

Only 13 left in stock
(more on the way).

Qty: 1

These Turbine Flow Sensors below are in process of replacing the Gems sensors above:

<https://www.gemssensors.com/search-products/product-details/ft-110-series-turbine-flow-sensor-173934-c#tab-2>

<https://www.grainger.com/product/GEMS-SENSORS-Turbine-Flow-Rate-Sensor-1ALZ4>

Unlike the previous paddle-wheel sensor these use micro-turbines and can measure flows between .26 to 4GPM with flow accuracies of $\pm 3\%$ across its entire flow range. (The existing sensors have an accuracy of $\pm 15\%$, which is less than ideal.) Gems also makes a .26-6.6GPM variant that may give a little more headroom, but with a significantly lower pulses per gallon number.

We may also be using the following down the road:

Badger Meter Vision series BV2000TRN075B

<https://www.omega.com/en-us/flow-instruments/flow-meters/turbine-flow-meters/bv1000-2000-3000-series/p/BV2000TRN075B>

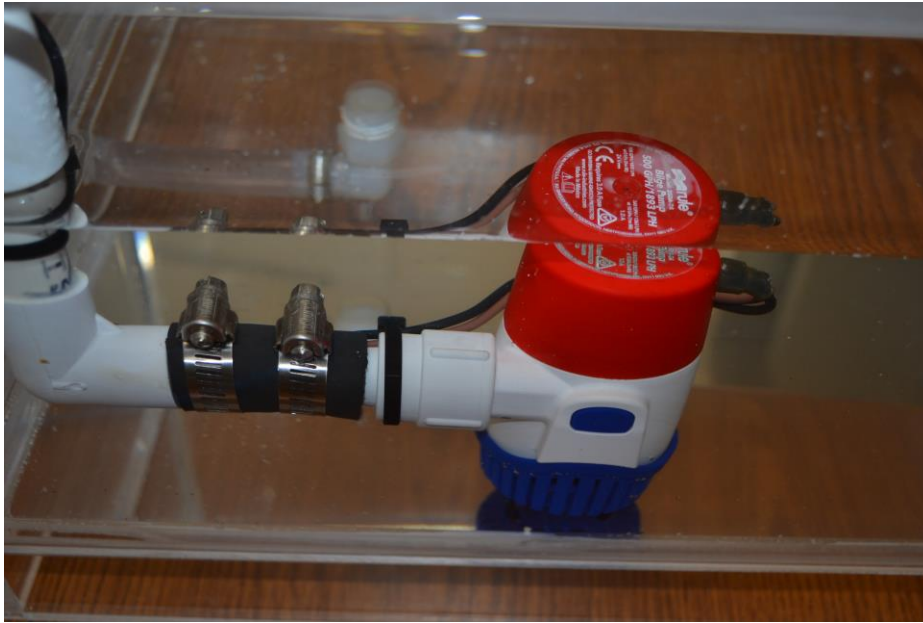
Catalog:

https://assets.omega.com/spec/dynasonics_product_summary_brochure_ttm-br-01388-en_2.pdf

Their TRN075B is a comparable sensor in terms of flow rang, accuracy and fittings with a 1m attached cable pigtail, but comes in at \$83.20/ea.

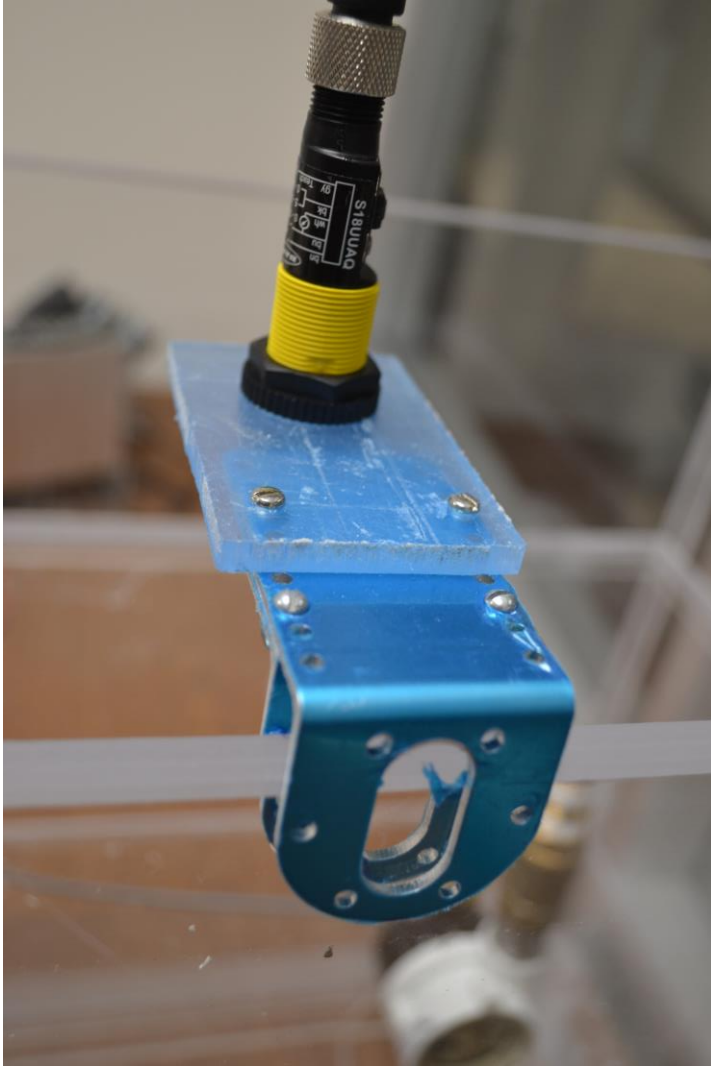
The screenshot shows the Zoro website interface. At the top, there is a navigation bar with the Zoro logo, a menu icon, a search bar with the placeholder text "Search by keyword or model #", and icons for Help, Sign In, and Cart. Below the navigation bar is a breadcrumb trail: Home / Pumps / Pump Controls / Flow Rate Sensors. On the left side, there is a "Filter" section with two expandable panels. The "Categories" panel is expanded to show "Flow Rate Sensors". The "Item Type" panel is also expanded and contains a search box "Search within Item Type" and two checkboxes: "Noncontact Ultrasonic Level Sensor (17)" and "Flow Rate Sensor (9)". The main product area on the right features a product image of a blue and black turbine flow sensor. The product title is "Flow Rate Sensor, Turbine, 2 GPM Max" under the brand "GEMS SENSORS". Below the title, the Zoro # (G0877091) and Mfr # (FT-110, 173933) are listed. A star rating of 0.0 with "No Reviews" and a "Write the First Review" link is shown. The price is prominently displayed as "\$144.90". To the right of the price, it says "Limited Stock" with a green exclamation mark icon. Below this, it states "Item ships from Zoro in 1 business days." and "This item ships FREE." with a link to "Shipping & Returns". At the bottom of the product area, there is a list of specifications: "Item: Flow Rate Sensor", "Type: Turbine", and "Input Power: 5 to 24 V DC @ 8mA".

Next, the bilge pump:



Rule 500 GPH Bilge Pump, 24 V Input, Submersible





Compact ultrasonic sensor in straight or right-angle housing.

- Senses from 30 to 300 mm
- Available in analog or discrete models
- Features minimal dead zone and eliminates dead zone if used in retrosonic mode
- Ideal for material handling and packaged goods applications, such as bottling or liquid level detection and control for small containers
- Available in straight or right-angle versions with a wide variety of mounting hardware for enhance sensing versatility
- Offers programmable background suppression
- Compensates for temperature, for greatest sensing accuracy
- Simplifies setup with push-button and remote TEACH-mode programming
- Shows status during setup and operation, using highly visible LEDs indicators

S18UUAQ BANNER ENGINEERING ULTRASONIC, VOLTAGE QD SENSOR



S18UUAQ

Price: \$285.00

Manufacturer SKU: S18UUAQ

Manufacturer ID: 02700

 This item qualifies for
FREE SHIPPING over \$300!

Availability: Usually Ships in 3 to 5 Business Days

Part Number: S18UUAQ

Qty:

ADD TO CART

These hand valves contribute the 'load' on the process. As they are opened wide, the bilge pump has difficulty and finally can't keep up with the outflow:



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