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Final Report: Condensate Collection

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Condensate Collection Group

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The Condensate Collection Group had two main deliverables that it addressed throughout the year. The first deliverable was to verify the functionality of an existing condensate calculator. This calculator has the ability to predict the amount of water condensation that can be captured from an air conditioning system in a building such as a hotel. The second deliverable was to design a condensate recycling system that will be installed at a Drury Hotel facility, near the San Antonio Airport. For both deliverables detailed plans were developed to accomplish the required tasks. However, because of time-constraints, the system has yet to be built at the Drury hotel. Also, data was not been collected to verify the calculator. Nevertheless, the group is confident that when the system is installed according to the plan, it will be fully functional. Furthermore, pursuing the plans to collect data to verify the SAWS calculator will complete the second deliverable and allow evaluation of the calculator.

Executive Summary

Our senior design group worked in the field of condensate collection for recycling purposes. Financial support for the project was provided by the San Antonio Water System (SAWS) and the Trinity University Engineering Department. The client for the project was the Drury Hotel chain. Our condensate collection design group has addressed two main deliverables to submit to SAWS. The first one was to verify the functionality of an existing calculator that has the ability to predict the amount of water condensation that can be captured from an air conditioning system in a building such as a hotel. The second deliverable was to design a condensate recycling system that will be installed at Drury's facility, near the San Antonio Airport.

The final condensate collection system design includes a pump that will be controlled using an EchoPod sonar liquid level detection device. The condensate will be stored in an existing basin that will be covered with Pond Shield waterproof epoxy. A flow meter will also be used to determine the flow to the cooling tower. To collect the required data to confirm the calculator numerous data loggers will be used. The data loggers will record the temperature and humidity entering and leaving the air handlers. They will also record height readings from the EchoPod, which will translate into amounts of condensate in the basin. A detailed testing plan has been included, although the group was unable to perform the tests described. Incorporated in the testing is an account for how the hotel showers will affect the amount of condensate produced.

Though the system that has been designed it has not been installed and tested and the data analysis methods have not been executed; the plan that has been developed meets the criteria set forth at the beginning of the project. The design accomplishes the objectives of the system while operating within the constraints of the project and maintaining the level of quality that is desired. The constraints to which the design has been tailored consist of its ability to operate within the specs of the Drury Hotel A/C system including the volume of condensate that it can handle and the distances that the condensate must be transported, as well as the accuracy with which measurements must be made for condensate prediction models. As designed, the system appears to accomplish these goals. Beyond these objectives, the quality of our design plans have been evaluated with respect to the criteria of cost effectiveness, safety, aesthetic value, durability,

extent of maintenance, and ease of operation. The design meets expectations for all of these criteria.

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1 Introduction

Our senior design group worked in the field of condensate collection for water conservation purposes. Financial support for the project was provided by the San Antonio Water System (SAWS) and the Trinity University Engineering Department. The client for the project was Drury Hotel. Our condensate collection design group addressed two project goals. The first goal was to design a condensate recycling system that will be installed at Drury's facility near the San Antonio Airport. The second was to verify the functionality of an existing calculator proposed by San Antonio Water System (SAWS) that has the ability to predict the amount of water condensation that can be captured from an air conditioning system in a building such as that of a hotel. The group produced a detailed design for the collection system to be implemented at the airport hotel location, which includes components for data collection to verify the calculator's function.

2 System Design

The main components of the system that will be placed at the Drury Hotel airport location are detailed in section 2.1, Design Plan. In section 2.1 each component is described along with justification for its selection. Section 2.2 describes the current status of the system.

2.1 Design Plan

The design for the condensate collection system that is to be built at the Drury Hotel airport location includes a piping scheme from the condensate collection point to a basin with a level control mechanism, a pump, a flow meter, a pressure gauge, and a piping scheme from the pump to the cooling tower. Figure 1 shows a model of the system including the basin, pump, level control, and flow meter.

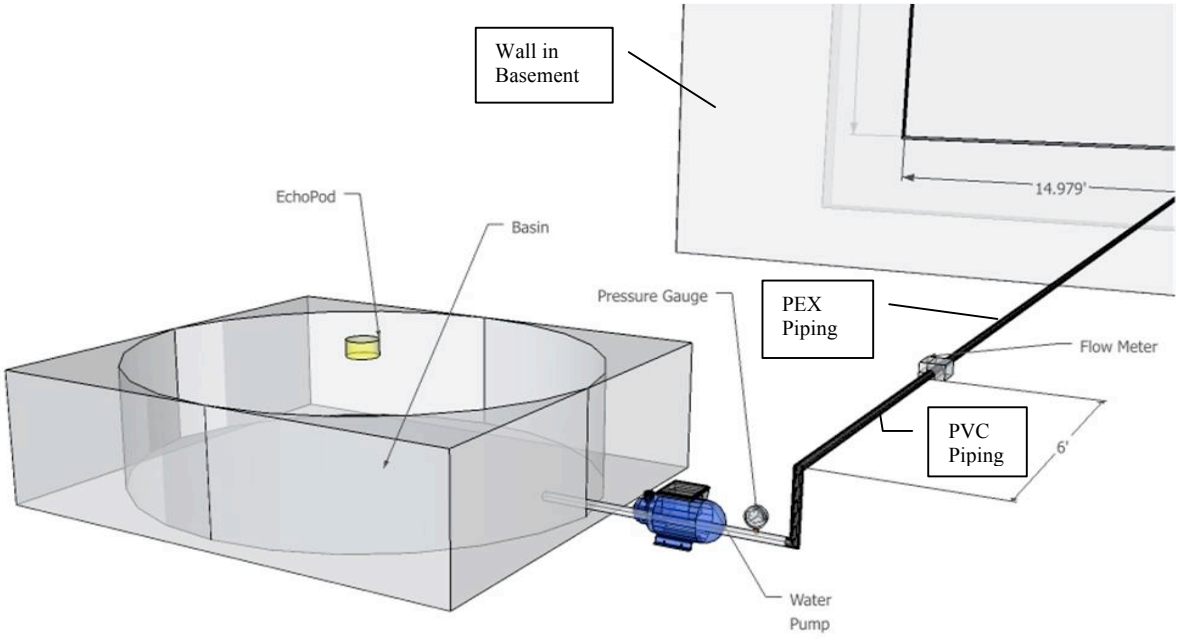


Figure 1: Design Model

Preexisting drain pipes from multiple sources gravity feed condensate to an underground well. The water transport from input of the well to the storage basin will be accomplished by 16 feet of polyvinyl chloride (PVC) pipe. The basin will consist of a pre-existing concrete vessel with an estimated volume of roughly 1000 gallons. The design for our application calls for the

basin to be coated with Pond Armor waterproof sealant and covered by a custom plastic cover from CoverUs to keep out dust and other contaminants. The water flow from the basin to the chilling tower will be powered by a Grundfos ¾ hp multistage centrifugal pump. The pump will be controlled by signals from an EchoPod sonar liquid level detecting device. The EchoPod will activate the pumps power supply when it reads a water level above a predetermined value that will be correlated to the desired condensate volume and will disengage the pump after the water level has dropped to the desired level. In order to verify the operating parameters to which the piping system has been designed, a Granger pressure gauge will be installed in the piping just after the pump to read maximum pressure in the piping system.

The piping from the pump to the chilling tower will begin with approximately 15 feet of 1-1/2 inch PVC pipe which will travel a vertical distance of 6 feet and 2 inches. A GF Signet 515 Rotor-X Paddle Wheel Flow Sensor will be placed 1 foot from the end of the PVC section (i.e., 14 ft downstream of pump) to measure the flow rate of water being delivered from the pump to the tower. Following the PVC will be 86 feet of 1-1/2 in hePEX Plus tubing which will travel a vertical distance of 10 feet and extend to the north wall of the front building of the hotel. PEX tubing was chosen because of its ease of installation. The he designation denotes an oxygen barrier which prevents oxygen from seeping into the water flow and rusting fittings and other system components. However, PEX is not suitable for outdoor applications since it degrades with exposure to the sun's radiation. From the north wall of the front building, 1-1/2 inch PVC pipe will extend under the second building and across to the parking garage to transport the condensate to the chilling tower. It will run 320 feet including a vertical distance of 70 feet. The EchoPod and flow sensor will deliver readings via 20 mA cables to a HOBO 4-channel External Data Logger to provide continuous condensate production rate data.

For a detailed list of specific vendors used, along with a breakdown of all system components needed, please see Appendix B. Also in Appendix F, there are figures that show how the pipes went from the basement to the cooling tower, and on top of the parking garage.

2.2 Current System Status

The system has yet to be built. The various parts are being reviewed by the involved parties and awaiting order. Some proposals for changes have been made by contacts from Drury. One proposed change is that the basin be coated with an existing tarp rather than Pond Armor sealant;

this is being considered. Another proposal is that, rather than logging information from the various sensors in the design, an external data collection system be installed.

3 Methods

To aid in the understanding of how well the system operates, a system testing plan was made. This plan includes procedures to test all major system components. A plan was also designed to verify the accuracy of the SAWS condensate prediction calculator. However, if the calculator is found not to be accurate, the plan is to use a regression model on the data to develop a new model.

3.1 System Testing Plan

System components must be tested to prove that they function properly before installation. To begin, the storage basin must be tested to ensure that it does not leak with the existing liner. If no leaks are detected, it might be optimal to use the current liner rather than the Pond Shield epoxy. If the existing liner leaks, the same test would be necessary after the Pond Shield is applied. In order to test if the reservoir leaks, it will be filled with water to a specified level. Once the basin is filled, it will be left alone for 72 hours and then checked to see if the water level stayed the same. If the level drops significantly it is because the basin leaks; if the water drops a very small amount it will be assumed that it is due to water evaporation. To confirm that any small drop in level is due to evaporation, an additional test will be performed simultaneously. This test involves a clear glass that is filled with water. A height measurement will be taken of the water in the glass, and, at the end of the 72 hours, another height measurement will be taken. If the difference in the height of the water in the glass correlates to that of the water in the basin after taking into account differences in volume and surface area, it will be assumed that the height difference in the basin is from evaporation.

The piping is the second system that must be tested. There are two types of tests to which this system will be submitted. The first test is a visual inspection of possible leaks through the system, particularly at joints. The second test consists of verifying that the pressure level inside the pipe is below the pipe ratings provided by the manufacturer. A pressure gage from Grainger will be used to measure the maximum pressure. The pressure gauge will be located at the pump outlet.

The control system must also be tested before installation at the Drury Hotel facilities. It is important to see if the on/off features of the system work according to the specifications. In order

to verify this, a plastic barrel will be filled with water and the control system will be implemented to test whether it turns on when the water reaches a predetermined level and turns off if the water is below a lower predetermined level. The water will be removed from the plastic barrel via a hole at the bottom. A rubber plug will be used to keep the water in the tank while it is being filled. Once water has reached the top the plug will be removed and the water will be allowed to drain out. To test if the EchoPod is functioning properly, it will be hooked up to a LED light instead of the pump. When the LED is on, it will simulate the pump being on. When the water reaches the predetermined upper limit, the EchoPod should registers 20 mA, and the LED should be turned on. The LED should stay on until the water level reaches the lower level where the EchoPod should register 4 mA. When the LED is off, it will simulate the pump being off, and this should occur once the water level reaches that lower limit and continue until the tank is refilled to the upper limit. The LED is being used instead of the pump because it won't be possible to run the pump during this simulation.

To test if the flow meter works properly, a simulation of the system will be done. This will be accomplished by using pressurized water from a hose (most likely a garden hose). A five gallon bucket will be placed at the end of the flow meter to collect the water. Once the bucket has been filled, the flow meter will be checked to make sure it registers the five gallons that ran thru it. In addition to measuring the total volume of flow the meter also measures the flow rate. Therefore a stopwatch will be used to measure the duration of the test. The measured time value will be used in correlation with the total volume measurement to determine the average flow rate of the hose water. If the hose is kept at a constant setting this value should serve as an accurate benchmark to gauge the accuracy of the flow rate reading output of the meter.

The final critical component of the system is a pump. It is not feasible to test this component before installation because it would be very expensive to simulate the same amount of head loss and other conditions that the pump will need to operate under. The Collection Design Group will assume that the pump operates properly according to the manufacture's specs and verify so with in-situ flow rate measurements once installed.

3.2 System Testing Status

Unfortunately, the system has yet to be tested. The main reason is that most of the system components have not been received yet. The only component that has been ordered and received is the pump, and since the pipes have not been installed, it is not possible to test the pump.

3.3 Shower loads

The amount of moisture produced by the showers in the hotel will affect the amount of condensate collected. Even though exhaust fans are present in the bathrooms, it is expected that they will not be able to remove all of the moisture from air, and this will cause additional condensate to form in the air conditioning system located in each room. The current SAWS calculator only accounts for the main building air handlers. Since each guest room at the hotel has its own air conditioning unit that drips condensate to the main tank, any major contributions of condensate to the room units must be evaluated to see how they affect the total amount of condensate collected.

To get an estimate of how much condensate will be produced in each room, a simple experiment will be conducted. The equipment needed for the experiment will be two temperature and humidity data loggers. One data logger will be placed at the entrance of the room's air conditioning unit, and the other will be placed at the exit. Figure 2 shows the placement of the data loggers relative to the air conditioning unit in the guest room.

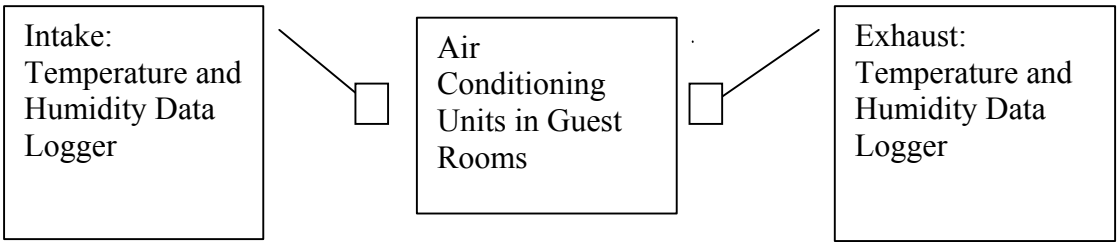


Figure 2: Shower Testing Schematic

The shower will then be run for a pre-determined amount of time, with the exhaust fan either on or off, and the bathroom door either open or closed. Table 1 below shows a set of possible tests that would be run.

Table 1: Test Matrix

Shower Run Time (minutes)	Bathroom Door	Exhaust Fan
5	Open	On
5	Closed	Off
5	Open	Off
5	Closed	On
10	Open	On
10	Closed	Off
10	Open	Off
10	Closed	On
15	Open	On
15	Closed	Off
15	Open	Off
15	Closed	On
20	Open	On
20	Closed	Off
20	Open	Off
20	Closed	On

After the temperature and humidity data is collected for each test, the condensate calculator from SAWS will be used to see how much condensate production is predicted. The next step will be to determine what factors do not affect how much condensate is collected from the room. For instance, having the bathroom door open verses closed might not significantly change the amount of condensate generated. The last step will be to use this data to determine correction factors for the condensate calculations to account for this extra moisture in the air. Alternately, the data could show that these condensate amounts are negligible compared to condensate collection from the much larger building air handling units.

3.4 Data Collection Measurement Testing

While small errors in measurements may not make a large difference in the condensate generation calculations over short time periods, the errors can grow significantly with propagation to longer lengths of time. For example, according to the calculator provided by SAWS, with a system operating at 3.5 tons and 25% outside air, a one degree difference in the measured temperature of outside air results in approximately a 0.8 difference in gallons produced per day. This is 24 gallon difference over the course of a month. In a five ton system operating at 30% outside air, this is a 42 gallon difference. Being able to verify that the measurements taken on the system are accurate is pertinent to the task of evaluating the calculator. More information on the SAWS condensate calculator is found in Appendix D.

3.4.1 Measurement Testing Plan

To verify the temperature and humidity measurements taken by Drury's automatic system, an external data logger will be used. The proposed data logger is an Omega OM-DLTH that is capable of storing up to 8,000 temperature and humidity measurements (5). To program and read the measurements, the data logger will be synchronized with a computer (5). It has a temperature accuracy of ± 2 °F (±1 °C) and resolution of 0.1 °F, with a humidity accuracy of ± 2 % and resolution of 0.1 % (5).

Once the data loggers have been properly programmed, they will be placed inside two of the Drury's HVAC intake and exhaust airflows. They will be left to record data for two days, collecting data every minute. Once the data has been collected, the data will be uploaded onto a computer and compared to the data sent from the Drury system. For the system data to be considered accurate it must fit within the accuracy range of the Omega data logger.

The next variable that must be verified with respect to the Drury system data is the percentage of outside air. To accomplish this task, an indoor air quality monitor such as the TSI Q-Trak 7565 will be used. One reason the TSI is an ideal choice for use as a verification tool is the accuracy with which it reads the carbon dioxide, ± 3 %, and the temperature, ± 1 °F (±0.6 °C) (4). It works by taking three carbon dioxide or temperature measurements at predetermined locations (4). Since the device must be moved in order to take the proper measurements at three different prediction locations, it is not possible to take continuous data. Instead, over a two-day period, 20 sets of these measurements will be taken. The results will then be compared to Drury

system data, and as long as it is within the accuracy range of the Drury system, the air quality monitor will be declared accurate. The reason the air quality monitor percentage of outside air will be used to verify calculation instead of the Drury system measurement is that it is more accurate. The percentage of outside air is an important measurement for the reason that it helps determine how much moisture is present in the air.

The last measurement that must be verified is the rate at which condensate is collected. An ultrasonic non-contact level switch, the EchoPod, will be used to verify the flow meter measurements, because of the EchoPod's level of accuracy and ability to log data (7). By using this ultrasonic sensor, continuous tank level monitoring will be accomplished. Unlike the other data verification methods, this one will remain in use the entire time that data is being collected. This will not only allow for verification of the flow meter, by comparing its collection amount to the flow meters recorded amount, but it will also help with more accurate condensate production monitoring and evaluation or development of a prediction model. This can be better explained by looking at Figure 3 and Eq. 1

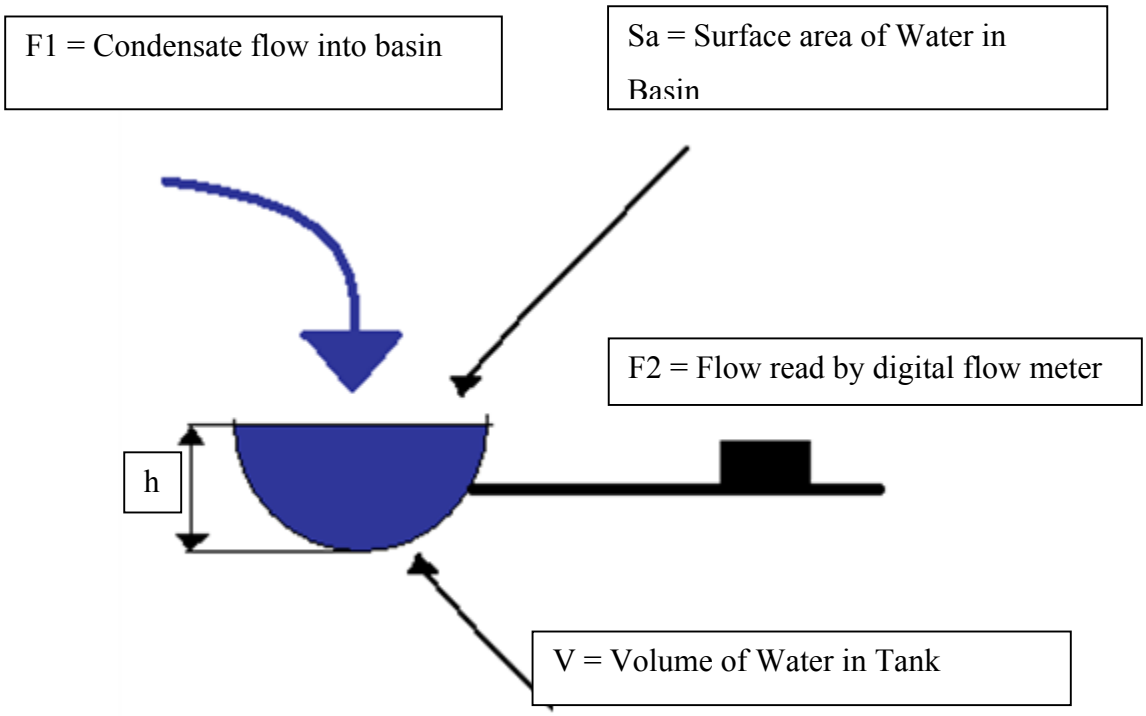


Figure 3: Relationship of Condensate In and Out

$$F_1 = F_2 + \frac{dV}{dt} = F_2 + \left(\frac{dh}{dt}\right)^{*}\left(\frac{dS_a}{dt}\right) \quad \textbf{(1)}$$

By using both the flow meter and EchoPod, it will be possible to gather continuous data for the volume of condensate entering the basin, whether the pump is running or not.

3.4.2 Measurement Testing Status

Unfortunately, the measurement testing plan has yet to be implemented. The main reason is that none of the required system components have been ordered.

3.5 How the Condensate Calculator will be Verified

The condensate volume and condition data collected from the various sources will be used to qualify the condensate calculator. The condition data is the input temperature, input humidity, output temperature, output humidity and tonnage. The various sources of condensate where data will be collected are the individual room units and the large air handlers. Data sets will be plugged into the calculator, and the corresponding condensate production data will be compared to the calculated value. This will either verify the calculator's operation or challenge its accuracy. If the values do not correspond, a new mathematical model for the condensate production with respect to the relevant variables will be developed, possibly with the help of a program like Minitab.

The decision was made to use a regression model as opposed to correlation. The use of a correlation model is inappropriate, because it makes no prior assumption as to whether one variable is dependent on the others (1). It tests for the interdependence of the variables, and it is not concerned with the nature of the relationship between the variables. It simply estimates the degree of association between the variables. It is clear that for our application, regression is more suitable because there is a clear one-way causal effect. It is intuitively apparent that the amount of condensate generated is directly dependent on the other measured variables, such as interior relative humidity. There are a variety of regression models that can be used in analyzing data. Selection of the correct model is based upon the attributes of the data.

Once data has been collected, the first step will be to examine the data and analyze it for any measurement error. In a controlled experiment, this step is much more rigorous because it is the

designer's responsibility to purposefully manage the independent or predictor variables (2). In our case, we do not have control of the predictor variables. Nevertheless, we need to check for any extreme outliers, data points that do not follow any initially apparent trends. The group can do this by making separate scatter plots of the response variable (i.e., amount of condensate collected) verses each predictor variable. If extreme outliers exist, there is some justification for removing them from the data before attempting regression analysis (2). However, there must be very strong evidence that the data is unreliable. If data does not seem to follow any trend, data collection may need to be redone.

The next step is to filter the predictor variables. All of the measured predictor variables may not be needed to create the most accurate regression model. Omission of one or more variables may actually lead to a more accurate model (1). Having too many predictor variables is often the cause of what is known as an over-fitted model. An over-fitted model has larger variances, which is a very undesirable trait for our project. An over-fitted model can also worsen the predictability of the model. Although many different diagnostics can be used, such as d-fits and Cook's distance, we have decided to utilize a best subset regression, a convenient yet powerful Minitab diagnostic (2). This method involves investigating all of the models created from all possible combinations of predictor variables. It compares the coefficient of determination, R^2, to find the most accurate model. R^2 is a statistical measure of how precisely the regression line approximates the measured data points. An R^2 of 1.0 indicates that the regression line perfectly fits the data (3). Minitab first checks all models that have only one predictor variable included, and the two models with the highest R^2 are selected. Next, all models that have only two predictor variables are checked; the two models with the highest R^2 are again chosen (2). This process continues until every possible combination of predictor variables has been taken into account. Once this analysis is completed, the model with the highest R^2 is chosen for the final analysis.

Once the number of predictor variables is filtered down, an optimal regression model will be selected. The only way to do this is via trial and error. The data will be entered into a Minitab worksheet and multiple regression models will be created. The models that will be used are: multiple linear regression, multiple polynomial regression, multiple nonlinear regression, fitted line regression, and a stepwise regression (2). The optimal case will be selected based on R^2, mean squared error, normality plots, and residual plots. An optimal model will have the highest

R^2 value, the lowest mean squared error, a normality plot that best fits a bell-shaped curve, and the residual plot with the most consistent random errors.

The final regression model will generate an equation relating the dependent value (condensate generated) to the relevant predictor values. A wide variety of inputs will be entered into this equation generating a range of predicted values. The exact same input values will also be entered into the SAWS calculator. The two sets of predictions will be analyzed to gauge the accuracy of the SAWS calculator.

4 Results

In an attempt to verify the SAWS condensate calculator, the Condensate Collection Group tried to find other data sources. The reasoning behind this decision was that we wanted additional data besides that from the two hotels to prove the accuracy of the SAWS calculator. In San Antonio, Sea World is currently collecting condensate from three of its building. This seemed like a great data source because each of the buildings is different from the others and from the system at either Drury hotel. However, upon further evaluation of the data from Sea World, it was discovered that they were not recording the type of information that would be required to verify the SAWS calculator. This was most unfortunate for the group, because data collection never happened at either of the Drury hotel locations.

4.1 Sea World Data

Currently Sea World has three condensate collection systems setup at their San Antonio locations. Each of the systems is independent of each other and stores it own condensate. The first system is a 170 ton system located at the Game Center. This location is different than the other two at Sea World because its doors are constantly open to the outside. The next condensate collection system is located at the Voyagers building and is a smaller system at 95 tons. The last condensate collection system is at the Sea Star Restaurant. All three systems operate with an intake of 100% outside air.

4.2 Problems with Data

There were many problems trying to use the data from Sea World to verify the condensate prediction calculator from SAWS. First off, Sea World did not know the percentages of humidity leaving the air handlers or temperatures at any of the three locations. For this reason it was estimated that the temperature was most likely around 54, because the industry standard is to have it 20 degrees below the building set point. As for the humidity, we assumed an average humidity leaving the air handler to be about 30%. This assumption was made after talking to air condition companies in the San Antonio area. In addition, they were not recording the input conditions into the air handlers. However, this was not as much of a problem because we were able to get this data from www.wunderground.com.

Nevertheless, the biggest problem with the data we received from Sea World was that it was not clear what the numbers represented. It was originally thought that it was a daily reading of how much condensate was collected; however, this was not the case. At Sea World they have massive storage tanks that are able to hold condensate for several days at a time. Furthermore, they are not constantly taking water from the tanks, but only when the water is needed. For instance, they will use the condensate water to fill a fountain or for some irrigation.

One reason this is a problem is that it is impossible for us to know how much water was collected every day. Since they are pulling out water randomly, it is not known how much was produced at that day's average temperature and humidity. Even on the days that they do pull out condensate water, it is not known if it is all of the condensate in the tank or just a portion. This is significant because it negates the possibility of a prediction being made over a longer time span. For example, it is not possible to average the data over the time since the last withdrawal of condensate. If it were possible, then a prediction could be made by knowing that they gather so much condensate at certain conditions. Since it is not known how much condensate was left, if any, a reasonable prediction is not possible.

5 Conclusions and Recommendations

Evaluation of project goals upon the completion of the project reveals that the Condensate Collection Group has had much success, but also some failures. For instance, the final condensate collection system design and SAWS calculator verification plan together were under budget. In addition, the design system meets all the constraints and criteria set forth in the beginning of the project. However, one of the biggest failures was not having the condensate collection system at the airport installed yet. In addition, the SAWS calculator verification plan never was able to be completed. Even with these failures the Condensate Collection Group learned a lot in the field of condensate recovery and gained a understanding of how it is to work as an engineer after graduation.

5.1 Budget

Included in the budget is a $5000 BTU meter. However, the use of this meter is not described in the report. The meter was ordered to attain an accurate measurement of the active tonnage of the chiller. The original plan to verify the SAWS calculator called for this tonnage measurement to be one of the direct input variables into the calculator. However, upon discovery of the details of the system, it became evident that the use of this meter output is not suitable as an input variable. The assumption made by the calculator is that 1 ton of air conditioning is equivalent to 350 ft^3/minute. This assumption is valid for ascertaining an estimated flow rate of an air handling unit from the manufacture's specification for tonnage. However the load on the chiller represents the combination of the sensible and latent heat load of the entire system. Without knowing the proportion of the chiller that is dedicated to latent heat it is impossible to relate the tonnage of the chiller to the amount of condensate produced.

As mentioned in the introduction our group received $20,000 for SAWS in addition to the $1,200 from Trinity University. The money from Trinity was only used to pay for a few small items, such as parking fees downtown and adapters for data collection efforts last semester. The group planned to use the rest of the money to pay for incidentals during the testing stage of the project. This would allow the group to order what was needed faster, because it would not require going thru SAWS or Drury first for reimbursement. The total amount of Trinity's budget

used was $33.98 which left $1166.02. The only expense left for Trinity to pay for is the printing cost of the final report. This cost is conservatively estimated at $50.

SAWS is paying for the system and data collection that have been referred to in this report. The total cost to SAWS will be around $17,013 which will leave $2,987. The reason why this is not the final cost is that Drury is still ordering parts, and if they do not cost the same as what we estimated, then it will change the final amount. In addition, the cost of labor included in the budget is only an estimate. To finalize this cost, we would need to know who the Drury wants to use as a contractor. A budget break down can be found in appendix A.

5.2 Project Objectives

Though the system that has been designed has not been installed and tested, and the data analysis methods have not been executed, the plan that has been developed seems to meet the criteria set forth at the beginning of the project. The design accomplishes the objectives of the system while operating within the constraints of the project and maintaining the level of quality that is desired. The constraints to which the design has been tailored include its ability to operate within the specs of the Drury Hotel air conditioning system, including the volume of condensate that it can support and the distances that the condensate must be transported, as well as the accuracy with which measurements must be made for condensate prediction models. As designed, the system seems to accomplish these goals. Beyond these objectives, the quality of our design plans have been evaluated with respect to the criteria of cost effectiveness, safety, aesthetic value, durability, extent of maintenance, and ease of operation. The design meets expectations for all of these criteria.

5.3 Recommendations for Future Systems

Upon completion of the project the Condensate Collection Group has some recommendations for future work. These recommendations focus both on the physical system itself along with SAWS calculator verification. It also includes explanations of some conservation advantages of using the condensate in the building cooling towers, instead of for irrigation.

5.3.1 Insulation of Pipes

A typical use for A/C condensate runoff is for irrigation purposes. One unique aspect of our project is that the collected water will be used as make-up water in the facility's cooling tower. This is beneficial because in addition to conserving water and saving the company from spending money on city water, it saves energy. The condensate comes off the air conditioning units at cool temperatures. Directing this water to the cooling towers in the place of city water, which is at higher temperatures, reduces the temperature of the water in the cooling system and the amount of energy used by the tower. To further improve the condensate collection system with regards to this energy saving aspect of the design, we recommend that insulation of the water be considered more heavily in the design of piping and storage units.

5.3.2 Mineral Content of Condensate Water

Another advantage of using condensate as make-up water to the cooling tower system is the lower mineral content of the water as compared to that of the city water. Build up of minerals in a cooling tower system from input water sources and from processes in the tower necessitate the draw-off of water from the system. Coupled with the input of fresh water, this prevents the mineral contents from growing too large. Since condensate has lower mineral content than water from city pipes, its use may reduce the amount of draw-off necessary, and thus reduce the amount of make-up needed, further lowering the water usage. We recommend that the mineral content of the condensate be studied further along with its effect on the required water consumption of the cooling tower system.

5.3.3 Professional Air Balancer

Another way to ascertain the percentage of outside air and system tonnage in addition to those methods mentioned in Section 3.4 is to hire a professional air balancer. A professional air balancer would be able to give the most accurate prediction of how much outside air each air handler is taking in along with its tonnage. The main reason our design group did not use this method was the cost. It was estimated that it would cost around $1,800 for the Drury Plaza Hotel, located downtown, and about the same for the Drury Hotel located at the airport. This would put us over budget. However, the accuracy that would come from this method might be worth it to SAWS for future data collection.

6 Bibliography

1. **Gaten, Ted.** On-line statistics: Regression. *University of Leicester.* [Online] 05 23, 2002. [Cited: 11 18, 2008.] www.le.ac.uk/bl/gat/virualfc/Stats/regression/refr1.html.

2. Regression Tutorials. *Middle Tennessee State University.* [Online] [Cited: 11 15, 2008.] mtsu32.mtsu.edu:11308/regression/index.htm .

3. **Layfield, Dom.** R-Squared. *Six Sigma.* [Online] 03 3, 2007. [Cited: 19 2008, 2008.] www.isixsigma.com/dictionary/R-Square-319.htm.

4. Operation and Service Manual. *TSI.* [Online] [Cited: April 9, 2009.] http://tsi.com/uploadedFiles/Product_Information/Literature/Manuals/1980574B-7565-Q-Trak.pdf.

5. **Omega Engineering INC.** *OM-DLTH User's Guide.* s.l. : Stamford, 1999.

6. Household Moisture Sources. *Home Energy Saver.* [Online] Lawrence Berkeley National Laboratory . [Cited: April 24, 2009.] http://hes.lbl.gov/hes/makingithappen/no_regrets/moisturesources.html.

7. Flowline, Flowline Level, Flowline Liquid Level Switches, Flowline Liquid Level Transmitters. *Burt Process Equipment, Manufacturer and Distributor of Fluid Handling Equipment.* [Online] [Cited: April 24, 2009.] http://flowlinecompany.com/home.html.

8. **Wilcut, Eddie.** *Air Conditioning Condensate Guidebook.* San Antonio : SAWS, 2008.

9. —. HVAC Condensate Calculator. San Antonio : SAWS, 2008.

A Budget

Income

Date	Sponsor	Description	Budgeted Amount	Actual Amount
9/2/2008	Engr Dept	Seed Money	$1,200	$1,200
1/20/2009	SWAS	Seed Money	$20,000	$20,000
Total Income				$21,200

Expenses

							Status (Check one)			
Date	**Vendor**	**PO #**	**Item Description**	**(Planned/ Pending/**	**Budgeted Amount**	**Actual Amount**	**DeptPO**	**PCARD**	**Reimburse-ment**	**Responable Party for Payment**
11/20/2008	Best Buy		Dynex denger changer kit	Clear	$13.99	$13.99			X	Trinity
11/20/2008	Amano		Parking Ticket	Clear	$10	$10.00			X	Trinity
12/2/2008	Radioshack		Null Modm	Clear	$9.99	$9.99			X	Trinity
11/5/2008	Omicron		BTU Meter	Clear	$5,000	$5,000			X	SAWS
3/2/2009	Grainger		PVC piping,fitings, and Insulation	Pending	$1,200	$866			X	SAWS
3/2/2009	Pex Supply		PEX piping and fitings	Pending	$0	$441			X	SAWS
3/2/2009	ShortRun Pro		Brackets	Pending	$20.00				X	SAWS
3/2/2009	Larry Wunsch & Assoc, INC.		Pump	Pending	$1,000.00	$943.00			X	SAWS
3/2/2009	Subcontractor		Work	Pending	$4,000.00	$4,000.00			X	SAWS
3/2/2009	Acumen Instruments		Data Logger	Pending	$570.00	$570.00			X	SAWS
3/2/2009	Pond Armor		Pond Shield	Pending	$280.00	$344.83			X	SAWS
3/2/2009	Flow Line Options Corp.		EchoPod and software	Pending		$789.00			X	SAWS
3/2/2009	OnSet		Data Loggers and CO_2 Meters	Pending		$2,266.00			X	SAWS
3/2/2009	Instrumart		Digital Flow Meter for airport location	Pending	$550.00	$896.70			X	SAWS
3/2/2009	Instrumart		Digital Flow Meter for downtown location	Pending	$550.00	$896.70			X	SAWS
5/27/2009	Ginny's Printing		Final Report Printing Cost	Pending	$50.00		X			Trinity
Total Expenses					$13,254	$17,047				

Budget Remaining	$4,152.68

Figure A-1: Final Budget

B Bill of Materials & List of Vendors

Table B-1: List of Vendors Used

Name	Address	Phone Number	Website	Supplied
Acumen Instruments	2625 N. Loop Drive Suite 2200 Ames, IA 50010	(515) 296-5366	www.acumeninstruments.com	Serial Data Logger
OnSet	PO Box 3450 Pocasset, MA 02559	(800) 564-4377	www.onsetcomp.com	Data Loggers
Flow Line Options	9009 Freeway Drive #4 Macedonia, OH 44056	(877) 356-5463	www.flowlineoptions.com	EchoPod
Instrumart	8 Leroy Road Williston, VT 05495	(800) 884-4967	www.instrumart.com	Flow Meter
PexSupply	P.O. Box 522 Farmingdale, NY 11735	(888) 757-4774	www.PexSupply.com	PEX Pipe
Pond Armor	860-A East Stowell Road Santa Maria, CA 93454	(800) 716-1545	www.pondarmor.com/	Pond Shield
Larry Wunsch & Assoc, INC	120 Interloop Rd. San Antonio, TX, 78216	(210) 349-5244	www.lwai.net	Grundfos Pump
Grainger	5011 Rittiman Rd. San Antonio, TX 78218-4638	(210) 654-4020	www.grainger.com	PVC Pipe
Dawson Associates, Inc.	922-B Hurricane Shoals Rd. Lawrenceville, GA 30043	(800) 282-4782	www.dawsonassoc.com	Air Quality Monitor

Table B-2: Bill of Materials

Supplier	CATALOG/PART #	DESCRIPTION	Qty	UNIT COST	EXTENDED COST
Acumen Instruments	DataBridge SDR2-CF	Serial Data Recorder	1	$570.00	$570.00
OnSet	U12-006	HOBO 4-Channel External Data Logger	5	$105	$525
	Cable-4-20 mA	4-20 mA cable	3	$25	$75
	BHW-PRO-xxx	HOBOware Pro Software	1	$89	$89
	TEL-7001	Telaire 7001 CO2 Sensor	3	$465	$1,395
	Cable-CO2	CO2 Senor to Logger Cable	3	$29	$87
Flow Line Options Corp.	DL14-00	EchoPod Level Switch-Controller-Transmitter	2	$368	$736
	LI99-1001	EchoPod Programming FOB with WEBCAL Software	1	$53	$53
Instrumart	3-3810-P0	GF Signet 515 Rotor-X Paddle Wheel Flow Sensor	1	$234.90	$234.90
	PV8T015F	GF Signet Installation Fittings	1	$120.00	$120.00
	3-8550-2P	GF Signet 8550 Flow Transmitter	1	$491.40	$491.40
	2246303	GF Signet 8050 Universal Mounting Kit	1	$50.40	$50.40
PexSupply	A1141500	1-1/2" hePEX plus - (100 ft. coil)	1	$399.95	$339.95
	G4521515	ProPEX DZR Brass Male Threaded Adapter, 1-1/2" PEX x 1-1/2" NPT	2	$20.43	$40.86
Larry Wunsch & Assoc, INC	CR3-4	Grundfos Multi-Stage pump, ¾ hp	1	$943.00	$943
Grainger	GMT67	Pipe Size 2 In, Length 10 Feet, Schedule 40, Material of Construction PVC,	34	$12.46	$423.64
	1WKH2	Coupling,PVC,1 1/2 In	30	$0.68	$20.40
	1WJZ9	Elbow,90 Deg,PVC,1 1/2 In	10	$2.30	$23.00
	1WKC1	Elbow,45 Deg,PVC,1 1/2 In	2	$1.18	$2.36
Dawson Associates, Inc.	TSI-7565	Q-Trak Plus Model 7565	1	$2,795.00	$2,795.00

C Gantt Chart

ID	Task Name	Duration	Start	Finish
1	Develop Problem Statement	14 days?	Thu 8/28/08	Tue 9/16/08
2	Project Description Presentation	0 days	Thu 9/18/08	Thu 9/18/08
3	Project Description Memo	0 days	Thu 9/25/08	Thu 9/25/08
4	Develop Alternative Solutions	29 days?	Thu 9/18/08	Tue 10/28/08
5	Alternative Solutions Report	0 days	Tue 10/28/08	Tue 10/28/08
6	Design of Chosen Solution	44 days?	Mon 11/3/08	Thu 1/1/09
7	Design Report	0 days	Tue 11/25/08	Tue 11/25/08
8	Fall Technical Presentation	0 days	Tue 12/2/08	Tue 12/2/08
9	Parts Ordering Deadline	0 days	Fri 12/12/08	Fri 12/12/08
10				
11	**Set-up Site Visits (Downtown)**	**4 days?**	**Thu 9/25/08**	**Tue 9/30/08**
12	Determine what DAQ is available	4 days?	Thu 9/25/08	Tue 9/30/08
13	Contact Gregg	4 days?	Thu 9/25/08	Tue 9/30/08
14	Parameters and Variables	4 days?	Thu 9/25/08	Tue 9/30/08
15	Hotel Information	4 days?	Thu 9/25/08	Tue 9/30/08
16	**Data Collection at Drury (downtown)**	**14 days**	**Mon 10/20/08**	**Thu 11/6/08**
17	Collect Data from Site	14 days	Mon 10/20/08	Thu 11/6/08
18	Log Data	14 days	Mon 10/20/08	Thu 11/6/08
19	Check accuracy of data	4 days	Mon 10/20/08	Thu 10/23/08
20	Review process	3 days	Tue 10/21/08	Thu 10/23/08
21	**Data Reducation (Downtown)**	**10 days?**	**Fri 11/7/08**	**Thu 11/20/08**
22	Reduce Data	5 days?	Fri 11/7/08	Thu 11/13/08
23	Compare with Model	5 days	Fri 11/14/08	Thu 11/20/08
24	**Chilling Tower Usage**	**13 days?**	**Thu 11/13/08**	**Mon 12/1/08**
25	Determine requirement water amount	7 days	Fri 11/21/08	Mon 12/1/08
26	Make sure possible	7 days?	Thu 11/13/08	Fri 11/21/08
27				
28	**Design System**	**4 days?**	**Tue 12/2/08**	**Fri 12/5/08**
29	Research Existing Systems	4 days?	Tue 12/2/08	Fri 12/5/08
30	Determine Tank Size	4 days	Tue 12/2/08	Fri 12/5/08
31	Determine Pump	4 days?	Tue 12/2/08	Fri 12/5/08
32	Determine Piping	4 days?	Tue 12/2/08	Fri 12/5/08
33	Do analysis on system to determine best des	4 days?	Tue 12/2/08	Fri 12/5/08

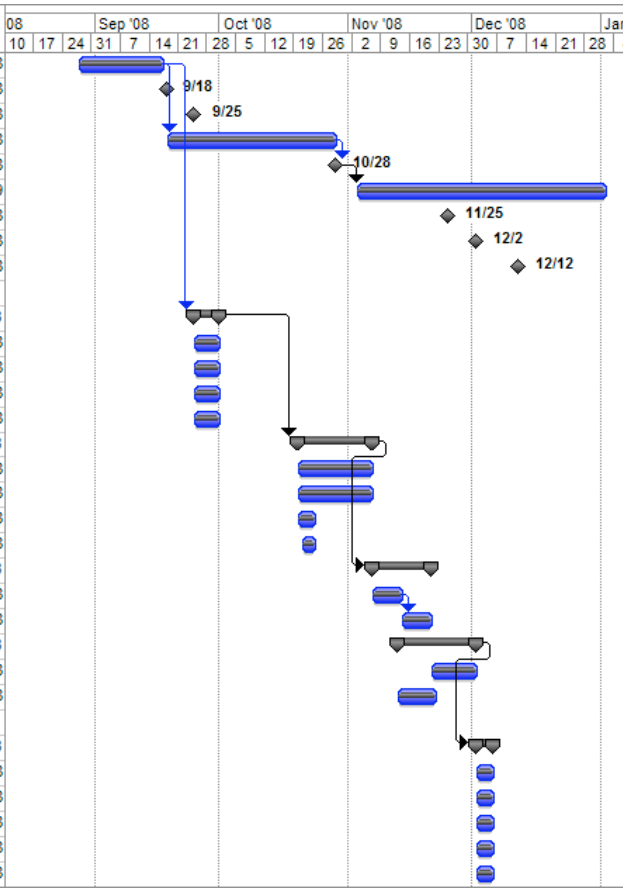


Figure C-1: Gantt Chart from First Semester

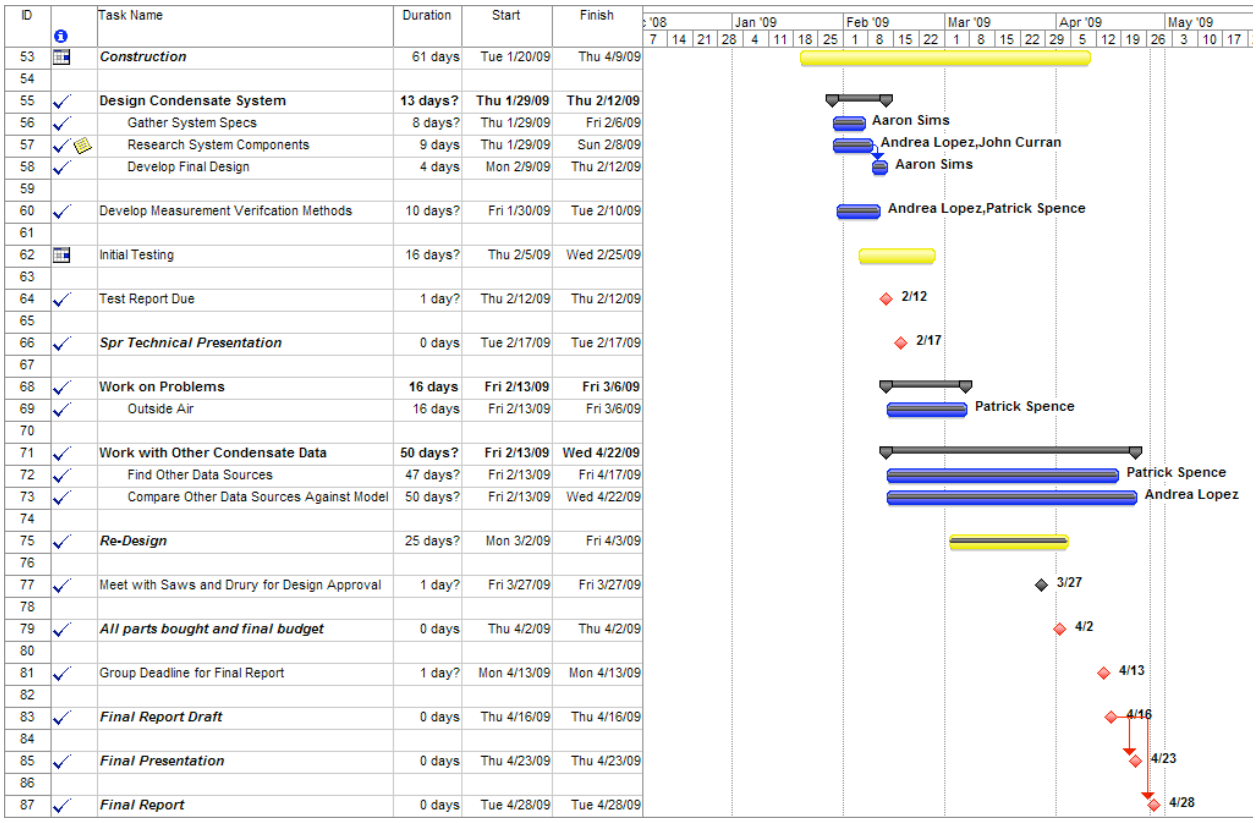


Figure C-2: Gnatt Chart from Second Semester

D SAWS Condensate Calculator

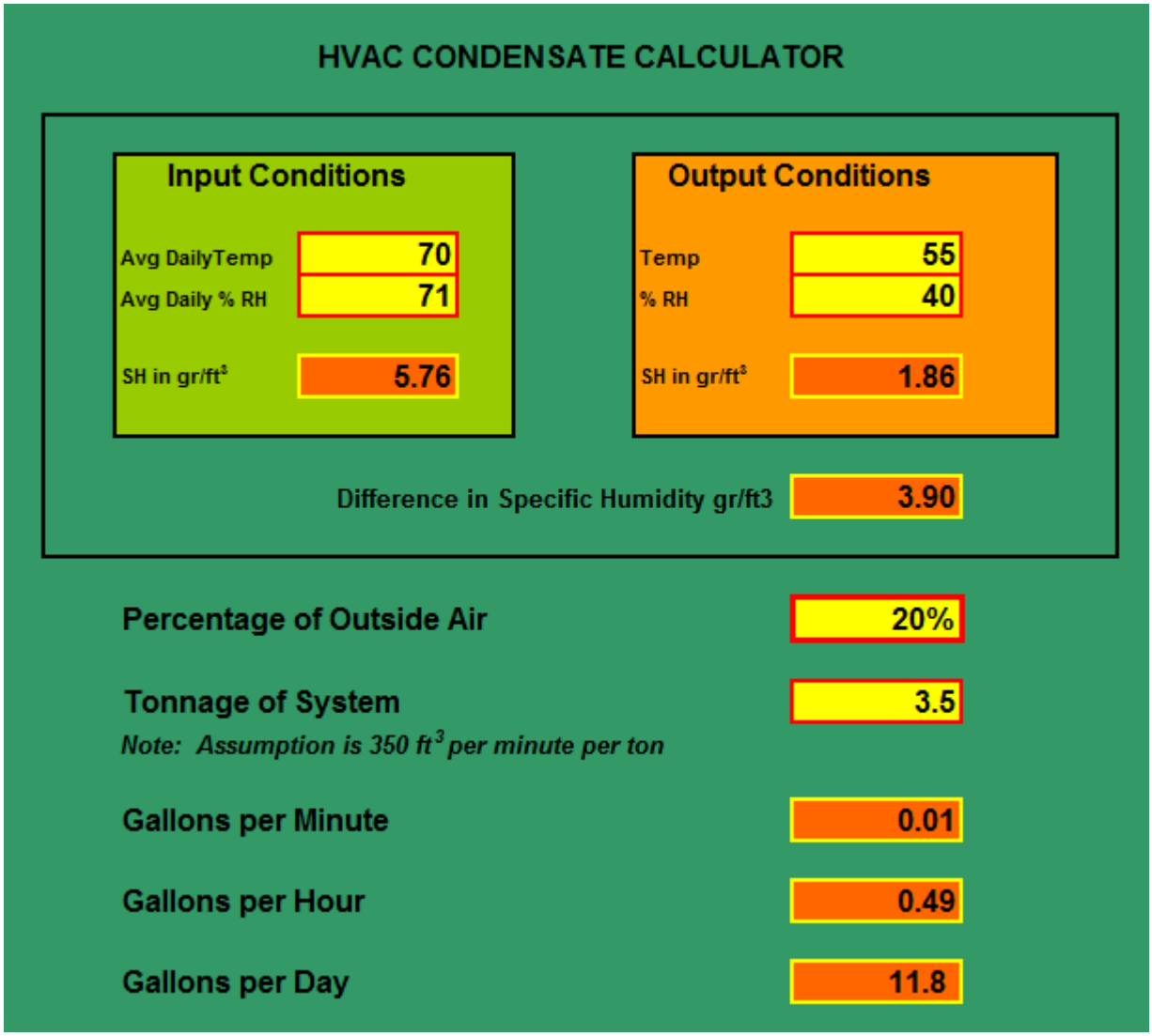


Figure D-1: SAWS Condensate Prediction Calculator (9)

Conversion Factors:

1 lb of Water = 7,000 Grains of Moisture (8)

1 Gallon of Water weights 8.33 Pounds (8)

The equations for gallons per minute of condensate is:

$$Gallons\ per\ Minute = \frac{Difference\ in\ SH \times (350 \times Tonnage) \times \%\ Outside\ Air \times (50/100)}{7000 \times 8.33}$$

Figure D-2 below was used to develop the specific humidity equation used in the SAWS calculator.

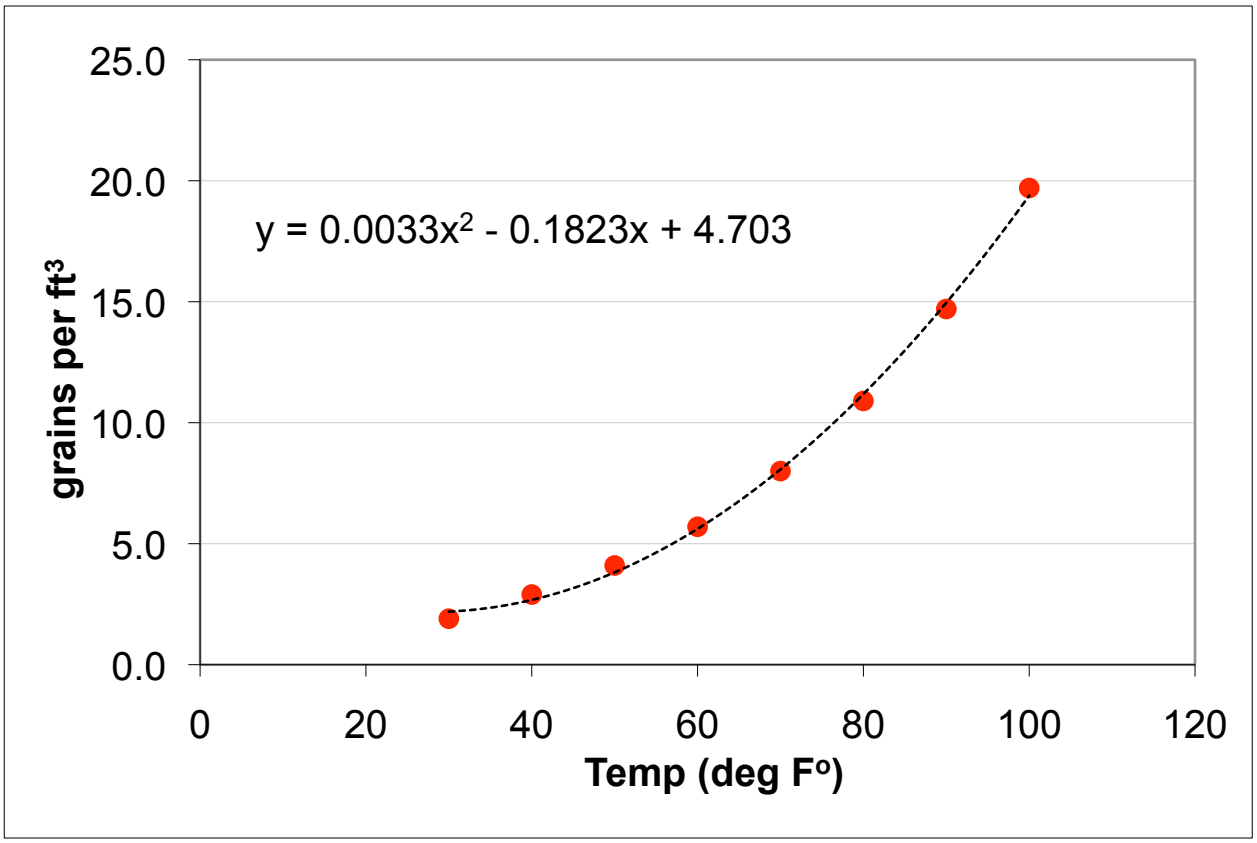
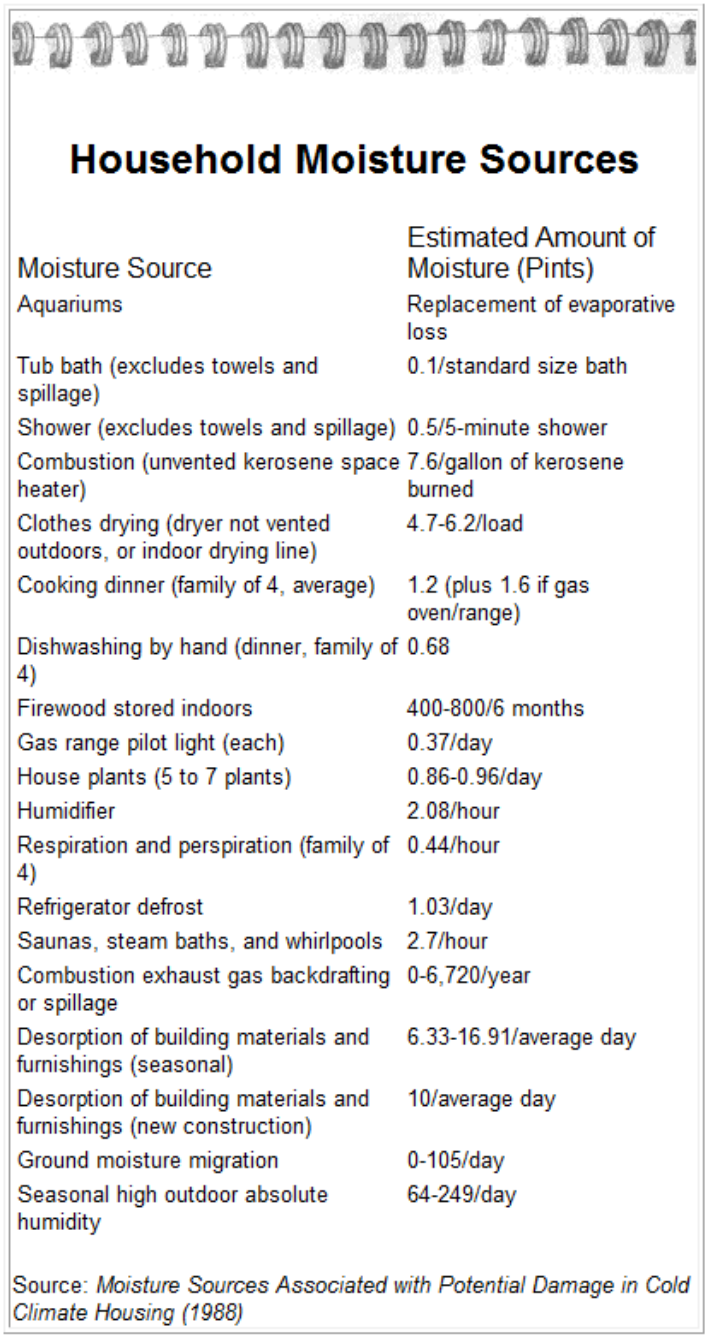


Figure D-2: Relationship Between Temperature and Grains of Moisture in the Air (9)

The specific humidity equation in the SAWS calculator is:

$$SH = \frac{\mathrm{Re}\,lativeHumdity}{100} \times 0.0033 \times Temp^2 - 0.1823 \times Temp + 4.703$$

E Other Sources of Error



Household Moisture Sources

Moisture Source	Estimated Amount of Moisture (Pints)
Aquariums	Replacement of evaporative loss
Tub bath (excludes towels and spillage)	0.1/standard size bath
Shower (excludes towels and spillage)	0.5/5-minute shower
Combustion (unvented kerosene space heater)	7.6/gallon of kerosene burned
Clothes drying (dryer not vented outdoors, or indoor drying line)	4.7-6.2/load
Cooking dinner (family of 4, average)	1.2 (plus 1.6 if gas oven/range)
Dishwashing by hand (dinner, family of 4)	0.68
Firewood stored indoors	400-800/6 months
Gas range pilot light (each)	0.37/day
House plants (5 to 7 plants)	0.86-0.96/day
Humidifier	2.08/hour
Respiration and perspiration (family of 4)	0.44/hour
Refrigerator defrost	1.03/day
Saunas, steam baths, and whirlpools	2.7/hour
Combustion exhaust gas backdrafting or spillage	0-6,720/year
Desorption of building materials and furnishings (seasonal)	6.33-16.91/average day
Desorption of building materials and furnishings (new construction)	10/average day
Ground moisture migration	0-105/day
Seasonal high outdoor absolute humidity	64-249/day

Source: *Moisture Sources Associated with Potential Damage in Cold Climate Housing (1988)*

Figure E-1: Sources and Amounts of Extra Moisture in the Air (6)

F System Schematic

The red line in the picture represents where the pipes would be laid. The only different between this picture and what will actually happen is the pipes will be hidden behind the bushes and underneath the building.

Figure F-1: Pipe Carrying Condensate Water to Cooling Tower

Figure F-2: Pipe Carrying Condensate Water to Cooling Tower

Figure F-3: Pipe Carrying Condensate Water to Cooling Tower

Figure F-4: Pipe Carrying Condensate Water to Cooling Tower, Location Second Floor of Parking Garage

Figure F-5: Pipe Carrying Condensate Water at the Cooling Tower

G Design Package

Engineering Science Department Requisition
SENIOR DESIGN TEAM - Trinity University

Date: 03 / 02 / 2009

Vendor Information		Request Information	
Company Name:	Acumen Instruments	**CHECK ONE**	□ Reimbursement
Attention/CONTACT:			■ Please Order
Street Address:	2625 N. Loop Drive Suite 2200	For Departmental Use Only	
City, State, Zip:	Ames, IA 50010	Date Processed:	__ / __ / ____ □ **JMM** □ **EAA**
Phone #:	(515) 296-5366	Ordered:	□ Using PCARD
FAX #:	(515) 233-3554		□ Using DPO#_____
Web Address:	www.acumeninstruments.com	Method:	□ By phone
			□ By FAX
			□ By Web

Required Del. Date As soon as possible
Deliver: X **Yes** ___ **No**
Pick-up: ___ **Yes** X **No**

Departmental Information

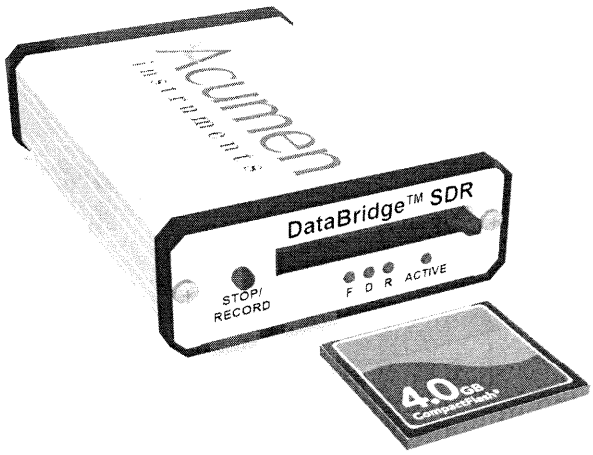
Address: Trinity University Engineering
Central Receiving
607 Kings Court
San Antonio TX 78212-7200
Tax ID# 74-11-09633

CATALOG/PART #	DESCRIPTION	Qty	UNIT COST	EXTENDED COST
DataBridge SDR2-CF	Serial Data Recorder	1	$570.00	$570.00
	Shipping Cost			$7.90
			Total	$577.90

Team Contact Name: Patrick Spence
Team Contact Student ID #:
Team Contact Phone #: (325) 725-4288

Project Name: Condensate Collection
Approved by ADVISOR:

DataBridge™ SDR2-CF
Serial Data Recorder



- Low-power
- Low-cost
- Small footprint
- Zero development time
- Records PC-compatible files

Acumen Instruments Corporation's DataBridge™ SDR2-CF is an improved version of the SDR-CF. It's the easy way to add convenient data storage to any device or system.

Like the SDR-CF, the SDR2-CF captures data from any device equipped with a serial port and stores it in a PC-compatible file on a CompactFlash card.

No programming required.

The SDR2-CF is a hardware solution that is ready to deploy. Unlike competing solutions, no programming is required, and you don't need to install special application software. All configuration is done using terminal software via your computer's serial port.

Because the SDR2-CF records data to PC-compatible files, your files appear on a standard drive letter and can be read with any CompactFlash card reader. The SDR2-CF adds support for the FAT32 file system for even greater compatibility.

If you already use a computer or laptop for data collection, the SDR2-CF is a convenient drop-in replacement.

Even lower power consumption.

The SDR2-CF offers significant power savings over PC's, laptops, and embedded PC's, so batteries last 100 to 1000 times longer and no heat is generated. The SDR2-CF now also operates from a wider input voltage range, further simplifying system integration.

For applications that demand it, the SDR2-CF also offers a low-power mode that further cuts power consumption and the ability to disable LED indicators for even more battery life.

The flexibility you need.

At Acumen, we know every application has unique requirements. For devices that require it, the SDR2-CF can send commands or messages to the attached device on initialization, shutdown, or at specific intervals. You also control when files are opened/closed, file naming, and date/time stamping.

With the SDR2-CF, we've gone a step further. The SDR2-CF now supports arbitrary data port baud rates up to 921,600 baud, the ability to send break characters to a device, and output messages with embedded binary codes.

Using the SDR2-CF's configuration port, you can connect to a computer to control and monitor your recording, download files, change recording settings, or communicate with your device using serial passthrough mode.

Industry standard storage technology.

The SDR2-CF gives you access to industry-standard CompactFlash solid-state storage media. You benefit from competitive pricing, assured compatibility with your PC, and almost unlimited data capacity.

Options for OEMs.

A circuit board-only version of the SDR2-CF, the SDR2-OEM-CF, is available for integration with your product. Customizations and quantity discounts are also available.

See it for yourself.

The DataBridge SDR2-CF starter kit includes everything you need to begin right away. See our website or contact Acumen Instruments Corporation for details.

Acumen™ instruments

Acumen Instruments Corporation 2625 N. Loop Drive Suite 2200 Ames, IA 50010
Voice: 515-296-5366 Fax: 515-233-3554 www.acumeninstruments.com

DataBridge™ SDR2-CF
Serial Data Recorder

Specifications

Data rates
50 to 921600 bps

Data formats
7/8 data bits
none/even/odd parity
1/2 stop bits

Handshaking modes
RTS/CTS (hardware handshaking)

Data buffering
576 kBytes

File format
PC-compatible Windows (FAT16 or FAT32 file system)

Storage device compatibility
Devices conforming to the CompactFlash specification

Electrical interface
ATA (True IDE Mode)

Storage capacity
Limited only by storage device

Power requirements
5 to 30 VDC unregulated
350 mW (normal recording mode)
250 mW (low power mode)
100 mW (idle)

Operating temperature
-40° to +85° Celsius (industrial temperature range)

Physical Characteristics

Dimensions
4.875" L × 3.375" W × 1.250" H
(12.4 cm × 8.57 cm × 3.12 cm)

Weight
8.5 oz (241 grams) without CF card

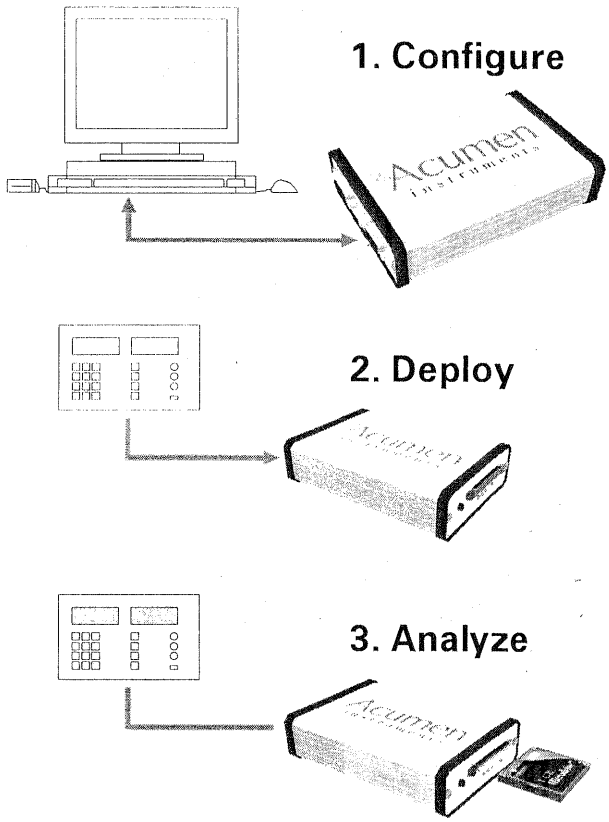
Enclosure
Extruded aluminum

Serial connectors
DB9 male (DTE data port)
DB9 female (DCE configuration port)

Drive connectors
CF connector with ejector

Media Options

Solid-state media
up to 64 GB CompactFlash media
(limited only by FAT32 file system)



Notable Features

Device control
Serial passthrough mode
(converts between baud rates if needed)
Send break character to data port

Data safety
Holdup circuit assures data integrity when power is unexpectedly lost

Power-up modes
Resume recording w/new filename, append to file

Scheduled file closing
1 second to 136 years or 1 byte to 4 GB

Time stamping
Optional date/time stamping of recorded data lines

Output messages
Ten 256-byte strings, 1 second to 136 year output interval
(messages can also be sent at initialization or shutdown)

Download protocols
YModem batch, ASCII text

Acumen™ instruments

Acumen Instruments Corporation 2625 N. Loop Drive Suite 2200 Ames, IA 50010
Voice: 515-296-5366 Fax: 515-233-3554 www.acumeninstruments.com

Engineering Science Department Requisition
SENIOR DESIGN TEAM - Trinity University

Date: 03 /02 /2009

Vendor Information		Request Information	
Company Name:	Pond Armor	**CHECK ONE**	□ Reimbursement
Attention/CONTACT:			■ Please Order
Street Address:	860-A East Stowell Road	For Departmental Use Only	
City, State, Zip:	Santa Maria, CA 93454	Date Processed: __ / __ / ____	□ **JMM** □ **EAA**
Phone #:	(800) 716-1545	Ordered:	□ Using PCARD
FAX #:	(805) 922-4580		□ Using DPO#_____
Web Address:	http://www.pondarmor.com/	Method:	□ By phone
			□ By FAX
			□ By Web

Required Del. Date As soon as possible
Deliver: X **Yes** ___ **No**
Pick-up: ___ **Yes** X **No**

Departmental Information

Address: Trinity University Engineering
Central Receiving
607 Kings Court
San Antonio TX 78212-7200
Tax ID# 74-11-09633

CATALOG/PART #	DESCRIPTION	Qty	UNIT COST	EXTENDED COST
SKU-PSE-GAL	Pond Shield Epoxy 1.5 Gallon Kit, Color: Black	1	$319.80	$319.80
	Shipping Cost			$25.03
			Total	$344.83

Team Contact Name: Patrick Spence
Team Contact Student ID #:
Team Contact Phone #: (325) 725-4288

Project Name: Condensate Collection
Approved by ADVISOR:

Pond Armor®

Non-Toxic Epoxy & Polyurea Pond Liners & Sealers

-- Category --

Search for relevant information within our web site.

- What is Pond Shield?
- Pond Shield FAQ
- Surface Preparation
- Applying Pond Shield
- Pond Armor Pictures
- Pond Armor Videos
- Tips & Tricks
- Online Store
- Spray Information
- Find Retailers & Installers

Look in the summer issue of Ponds Magazine and Water Garden News which feature great information on Pond Shield. You'll also see pictures of one of our own retailer/installers Ben Case from Down to Earth Designs applying Pond Shield on a local project of his.

POND ARMOR ONLINE WEB STORE

Pond Shield Epoxy

Designed for use on structured ponds or water features constructed of concrete, stone, block, brick, steel, aluminum, wood, Gunite, Shotcrete, rock, tile and many more surfaces.
No primers necessary, just prep the surface and coat with Pond Shield epoxy.

1.5 Quart	1.5 Gallon	3 Gallon
		
Coverage - 60 SqFt (10 mil thickness)	**Coverage - 240 SqFt** (10 mil thickness)	**Coverage - 480 SqFt** (10 mil thickness)
$79.95	**$319.80**	**$639.60**
Color - Please Select -	**Color** - Please Select -	**Color** - Please Select -
Quantity: 1 Add to Cart	**Quantity:** 1 Add to Cart	**Quantity:** 1 Add to Cart

Proper preparation and application can yield 25+ years of service life

View Cart/Checkout

Please enjoy your shopping experience! Secure online transactions provided by Thawte Authentic Site Security. Shopping cart provided by SecureNetShop.com.

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Engineering Science Department Requisition
SENIOR DESIGN TEAM - Trinity University

Date: 3 / 4 / 2009

Vendor Information		Request Information	
Company Name:	Grainger	**CHECK ONE**	□ Reimbursement
Attention/CONTACT:			■ Please Order
Street Address:		For Departmental Use Only	
City, State, Zip:		Date Processed: __ / __ / ____	□ JMM □ EAA
Phone #:	800-323-0620	Ordered:	□ Using PCARD
FAX #:			□ Using DPO#_____
Web Address:	www.grainger.com	Method:	□ By phone
			□ By FAX
			□ By Web

Departmental Information

Address: Trinity University Engineering
Central Receiving
607 Kings Court
San Antonio TX 78212-7200
Tax ID# 74-11-09633

Required Del. Date A.S.A.P.
Deliver: X Yes ___ No
Pick-up: ___ Yes X No

CATALOG/PART #	DESCRIPTION	Qty	UNIT COST	EXTENDED COST
GMT67	Pipe Size 2 In, Length 10 Feet, Schedule 40, Material of Construction PVC,	34	$12.46	$423.64
1WKH2	Coupling,PVC,1 1/2 In	30	$0.68	$20.40
1WJZ9	Elbow,90 Deg,PVC,1 1/2 In	10	$2.30	$23.00
1WKC1	Elbow,45 Deg,PVC,1 1/2 In	2	$1.18	$2.36
2KUE5	Pipe Insulation,Semi-Slit,2 In, 6 Ft	70	$5.67	$396.90
	Shipping Cost			$0.00
			Total	$866.30

Team Contact Name: John Curran
Team Contact Student ID #:
Team Contact Phone #: 210 557 4010

Project Name: Condensate Collection
Approved by ADVISOR:

Engineering Science Department Requisition
SENIOR DESIGN TEAM - Trinity University

Date: 03 / 04 / 2009

Vendor Information		Request Information	
Company Name:	PexSupply	**CHECK ONE**	□ Reimbursement
Attention/CONTACT:			■ Please Order
Street Address:		For Departmental Use Only	
City, State, Zip:	Long Island, New York	Date Processed:	__ / __ / ____ □ **JMM** □ **EAA**
Phone #:	1-888-757-4774	Ordered:	□ Using PCARD
FAX #:	631-393-2859		□ Using DPO#_____
Web Address:	PexSupply.com	Method:	□ By phone
			□ By FAX
			□ By Web

Required Del. Date ASAP
Deliver: X **Yes** ___ **No**
Pick-up: ___ **Yes** X **No**

Departmental Information

Address: Trinity University Engineering
Central Receiving
607 Kings Court
San Antonio TX 78212-7200
Tax ID# 74-11-09633

CATALOG/PART #	DESCRIPTION	Qty	UNIT COST	EXTENDED COST
A1141500	1-1/2" hePEX plus - (100 ft. coil)	1	$399.95	$339.95
G4521515	ProPEX DZR Brass Male Threaded Adapter, 1-1/2"	2	$20.43	$40.86
	Shipping Cost			0.00
			Total	$440.81

Team Contact Name: John Curran
Team Contact Student ID #:
Team Contact Phone #: 210 557 4010

Project Name: **Condensate Collection**

Approved by ADVISOR:

ProPEX® DZR Brass Male Threaded Adapter

Submittal Information
Revision A: Feb. 1, 2008

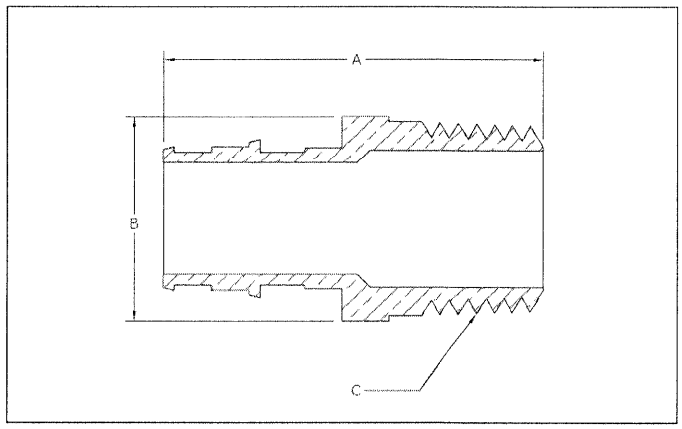
Project Information

Job Name:

Location:	Part No. Ordered:
Engineer:	Date Submitted:
Contractor:	Submitted By:
Manufacturer's Representative:	Approved By:

Technical Data

Material: Dezincification-Resistant Brass (DZR)



Product Information and Application Use

The ProPEX® DZR Brass Male Threaded Adapter connects Uponor ProPEX tubing to male NPT threads.[1] DZR brass fittings are safe for direct burial in soil.

✓ Description	Part Number	A	B	C	Weight
☐ ProPEX DZR Brass Male Threaded Adapter, ¾" PEX x ¾" NPT	G4527575	2.02"	1⅛" HEX	¾" NPT	0.25 lbs.
☐ ProPEX DZR Brass Male Threaded Adapter, 1" PEX x 1" NPT	G4521010	2.46"	1⅜" HEX	1" NPT	0.45 lbs.
☐ ProPEX DZR Brass Male Threaded Adapter, 1¼" PEX x 1¼" NPT	G4521313	2.72"	1¾" HEX	1¼" NPT	0.75 lbs.
☐ ProPEX DZR Brass Male Threaded Adapter, 1½" PEX x 1½" NPT	G4521515	2.98"	2" HEX	1½" NPT	0.80 lbs.
☐ ProPEX DZR Brass Male Threaded Adapter, 2" PEX x 2" NPT	G4522020	3.86"	2½" HEX	2" NPT	1.90 lbs.

Installation

Use the appropriate Uponor ProPEX Ring for the tubing. Refer to the AQUAPEX Professional Plumbing Installation Handbook or the Uponor Radiant Installation Handbook for additional information.

Standards

CAN/CSA B137.5; ASTM F877; ASTM F1960

Codes

IPC; UPC; NSPC; NPC of Canada

Listings

IAPMO 3558; HUD MR 1269; ICC ESR 1099; ANSI/NSF 14- and 61-certified

Related Applications

PEX-a Plumbing Systems
Radiant Heating and Cooling Systems

Contact Information

Uponor, Inc.
5925 148th Street West
Apple Valley, MN 55124 USA
Phone: (800) 321-4739
Fax: (952) 891-2008
www.uponor-usa.com

Uponor Ltd.
655 Park Street
Regina, SK S4N 5N1 CANADA
Phone: (888) 994-7726
Fax: (800) 638-9517
www.uponor.ca

[1]ProPEX® is a registered trademark of Uponor, Inc. ProPEX™ is a trademark of Uponor Ltd.

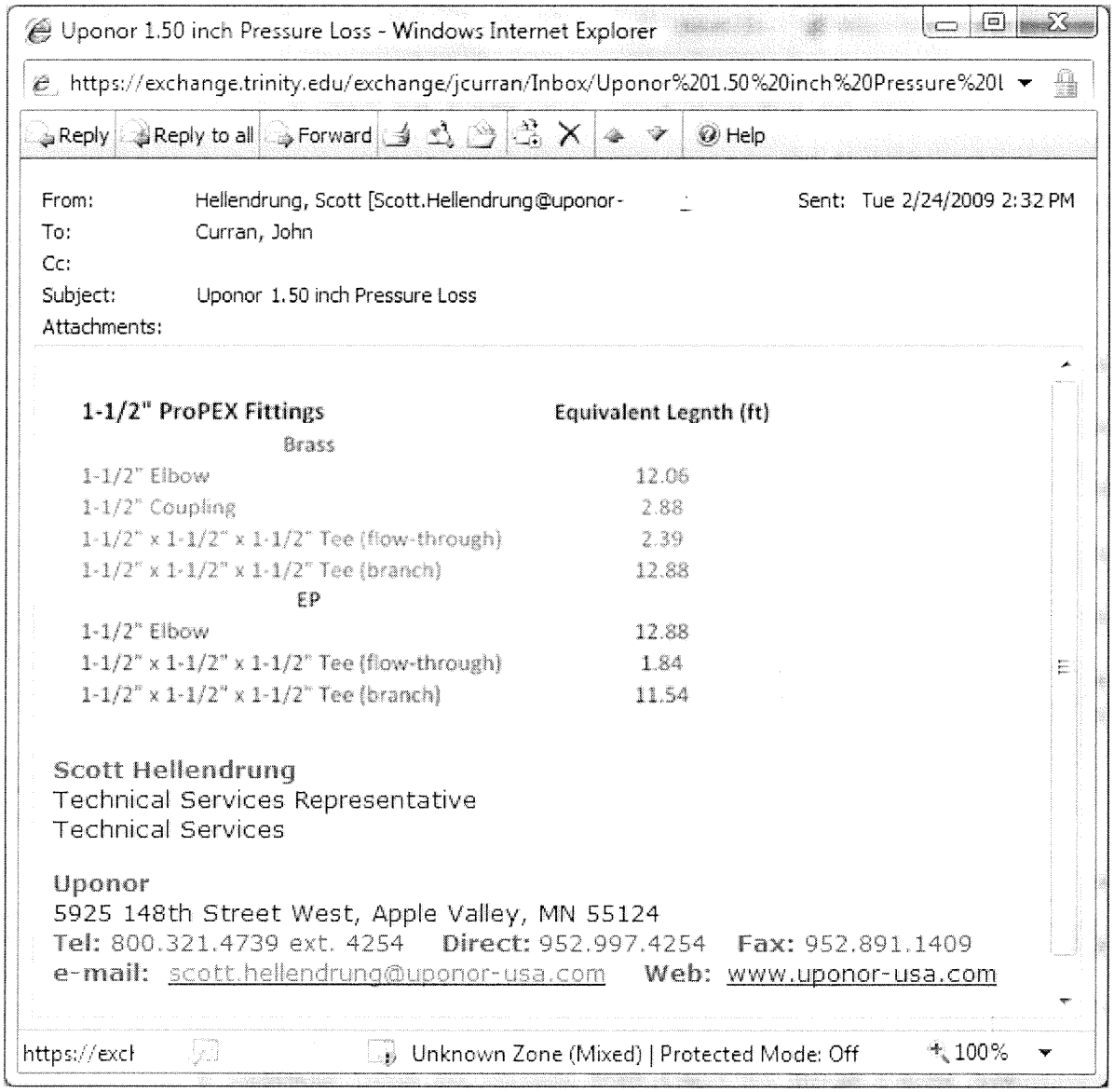
100% Water

PRESSURE LOSS PER FOOT
1 1/2" AQUAPEX

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
5.0	0.00674	0.00639	0.00610	0.00590	0.00575	0.00563
5.2	0.00723	0.00685	0.00655	0.00633	0.00617	0.00605
5.4	0.00774	0.00733	0.00701	0.00677	0.00660	0.00647
5.6	0.00826	0.00783	0.00748	0.00723	0.00705	0.00691
5.8	0.00879	0.00833	0.00797	0.00770	0.00751	0.00736
6.0	0.00935	0.00886	0.00847	0.00818	0.00798	0.00782
6.2	0.00991	0.00939	0.00898	0.00868	0.00847	0.00829
6.4	0.01049	0.00994	0.00951	0.00919	0.00896	0.00878
6.6	0.01109	0.01051	0.01005	0.00971	0.00947	0.00928
6.8	0.01170	0.01109	0.01060	0.01025	0.01000	0.00979
7.0	0.01232	0.01168	0.01117	0.01080	0.01053	0.01032
7.2	0.01296	0.01229	0.01175	0.01136	0.01108	0.01086
7.4	0.01361	0.01291	0.01234	0.01193	0.01164	0.01140
7.6	0.01428	0.01354	0.01295	0.01252	0.01221	0.01197
7.8	0.01496	0.01419	0.01357	0.01311	0.01280	0.01254
8.0	0.01566	0.01485	0.01420	0.01373	0.01339	0.01312
8.2	0.01637	0.01552	0.01484	0.01435	0.01400	0.01372
8.4	0.01709	0.01621	0.01550	0.01499	0.01462	0.01433
8.6	0.01783	0.01691	0.01617	0.01563	0.01525	0.01495
8.8	0.01858	0.01762	0.01686	0.01629	0.01590	0.01558
9.0	0.01935	0.01835	0.01755	0.01697	0.01656	0.01622
9.2	0.02013	0.01909	0.01826	0.01765	0.01722	0.01688
9.4	0.02092	0.01984	0.01898	0.01835	0.01790	0.01755
9.6	0.02173	0.02061	0.01971	0.01906	0.01860	0.01822
9.8	0.02255	0.02138	0.02046	0.01978	0.01930	0.01891
10.0	0.02338	0.02218	0.02121	0.02051	0.02002	0.01962
10.2	0.02423	0.02298	0.02198	0.02126	0.02074	0.02033
10.4	0.02509	0.02380	0.02277	0.02201	0.02148	0.02105
10.6	0.02596	0.02463	0.02356	0.02278	0.02223	0.02179
10.8	0.02685	0.02547	0.02437	0.02356	0.02299	0.02253
11.0	0.02775	0.02632	0.02519	0.02435	0.02377	0.02329
11.2	0.02866	0.02719	0.02602	0.02516	0.02455	0.02406
11.4	0.02959	0.02807	0.02686	0.02597	0.02535	0.02484
11.6	0.03053	0.02896	0.02771	0.02680	0.02615	0.02563
11.8	0.03148	0.02987	0.02858	0.02764	0.02697	0.02644
12.0	0.03245	0.03078	0.02946	0.02849	0.02780	0.02725
12.2	0.03343	0.03171	0.03035	0.02935	0.02864	0.02807
12.4	0.03442	0.03266	0.03125	0.03022	0.02950	0.02891
12.6	0.03542	0.03361	0.03216	0.03111	0.03036	0.02976
12.8	0.03644	0.03458	0.03309	0.03200	0.03123	0.03061
13.0	0.03747	0.03556	0.03403	0.03291	0.03212	0.03148
13.2	0.03851	0.03655	0.03498	0.03383	0.03302	0.03236
13.4	0.03957	0.03755	0.03594	0.03476	0.03392	0.03325
13.6	0.04064	0.03856	0.03691	0.03570	0.03484	0.03415
13.8	0.04172	0.03959	0.03789	0.03665	0.03577	0.03506
14.0	0.04281	0.04063	0.03889	0.03762	0.03671	0.03599
14.2	0.04392	0.04168	0.03990	0.03859	0.03767	0.03692
14.4	0.04504	0.04275	0.04092	0.03958	0.03863	0.03786
14.6	0.04617	0.04382	0.04195	0.04057	0.03960	0.03882
14.8	0.04732	0.04491	0.04299	0.04158	0.04059	0.03978

PRESSURE LOSS PER FOOT
1 1/2" AQUAPEX

	Head (Feet of Water) Per Foot of Tubing					
gpm	80°F	100°F	120°F	140°F	160°F	180°F
15.0	0.04847	0.04601	0.04404	0.04260	0.04158	0.04076
15.2	0.04964	0.04712	0.04511	0.04363	0.04259	0.04175
15.4	0.05082	0.04824	0.04618	0.04467	0.04361	0.04274
15.6	0.05202	0.04938	0.04727	0.04572	0.04463	0.04375
15.8	0.05322	0.05052	0.04837	0.04679	0.04567	0.04477
16.0	0.05444	0.05168	0.04948	0.04786	0.04672	0.04580
16.2	0.05567	0.05285	0.05060	0.04895	0.04778	0.04684
16.4	0.05692	0.05403	0.05173	0.05004	0.04885	0.04789
16.6	0.05817	0.05523	0.05287	0.05115	0.04993	0.04895
16.8	0.05944	0.05643	0.05403	0.05227	0.05102	0.05002
17.0	0.06072	0.05765	0.05519	0.05340	0.05213	0.05110
17.2	0.06201	0.05888	0.05637	0.05454	0.05324	0.05219
17.4	0.06332	0.06012	0.05756	0.05569	0.05436	0.05329
17.6	0.06464	0.06137	0.05876	0.05685	0.05549	0.05440
17.8	0.06596	0.06263	0.05997	0.05802	0.05664	0.05552
18.0	0.06731	0.06390	0.06119	0.05920	0.05779	0.05666
18.2	0.06866	0.06519	0.06242	0.06039	0.05896	0.05780
18.4	0.07002	0.06649	0.06367	0.06160	0.06013	0.05895
18.6	0.07140	0.06780	0.06492	0.06281	0.06132	0.06011
18.8	0.07279	0.06912	0.06618	0.06404	0.06252	0.06129
19.0	0.07419	0.07045	0.06746	0.06527	0.06372	0.06247
19.2	0.07560	0.07179	0.06875	0.06652	0.06494	0.06366
19.4	0.07703	0.07314	0.07005	0.06778	0.06617	0.06487
19.6	0.07846	0.07451	0.07136	0.06904	0.06741	0.06608
19.8	0.07991	0.07589	0.07267	0.07032	0.06865	0.06731
20.0	0.08137	0.07728	0.07401	0.07161	0.06991	0.06854
20.2	0.08284	0.07867	0.07535	0.07291	0.07118	0.06978
20.4	0.08433	0.08009	0.07670	0.07422	0.07246	0.07104
20.6	0.08582	0.08151	0.07806	0.07554	0.07375	0.07230
20.8	0.08733	0.08294	0.07944	0.07687	0.07505	0.07358
21.0	0.08885	0.08439	0.08082	0.07821	0.07636	0.07486
21.2	0.09038	0.08584	0.08222	0.07956	0.07768	0.07616
21.4	0.09192	0.08731	0.08362	0.08092	0.07901	0.07746
21.6	0.09348	0.08878	0.08504	0.08229	0.08035	0.07877
21.8	0.09504	0.09027	0.08647	0.08367	0.08170	0.08010
22.0	0.09662	0.09177	0.08790	0.08507	0.08306	0.08143
22.2	0.09821	0.09328	0.08935	0.08647	0.08443	0.08278
22.4	0.09981	0.09481	0.09081	0.08788	0.08581	0.08413
22.6	0.10142	0.09634	0.09228	0.08931	0.08720	0.08549
22.8	0.10305	0.09788	0.09376	0.09074	0.08860	0.08687
23.0	0.10468	0.09944	0.09525	0.09218	0.09001	0.08825
23.2	0.10633	0.10101	0.09675	0.09364	0.09143	0.08964
23.4	0.10799	0.10258	0.09827	0.09510	0.09286	0.09105
23.6	0.10966	0.10417	0.09979	0.09658	0.09430	0.09246
23.8	0.11134	0.10577	0.10132	0.09806	0.09575	0.09388
24.0	0.11303	0.10738	0.10287	0.09956	0.09721	0.09531
24.2	0.11474	0.10900	0.10442	0.10106	0.09868	0.09676
24.4	0.11645	0.11063	0.10599	0.10258	0.10016	0.09821
24.6	0.11818	0.11227	0.10756	0.10410	0.10165	0.09967
24.8	0.11992	0.11393	0.10915	0.10564	0.10315	0.10114
25.0	0.12167	0.11559	0.11074	0.10718	0.10466	0.10262


Uponor 1.50 inch Pressure Loss - Windows Internet Explorer
https://exchange.trinity.edu/exchange/jcurran/Inbox/Uponor%201.50%20inch%20Pressure%20l
Reply
Reply to all
Forward
Help
From: Hellendrung, Scott [Scott.Hellendrung@uponor-
Sent: Tue 2/24/2009 2:32 PM
To: Curran, John
Cc:
Subject: Uponor 1.50 inch Pressure Loss
Attachments:
1-1/2" ProPEX Fittings
Equivalent Legnth (ft)
Brass
1-1/2" Elbow 12.06
1-1/2" Coupling 2.88
1-1/2" x 1-1/2" x 1-1/2" Tee (flow-through) 2.39
1-1/2" x 1-1/2" x 1-1/2" Tee (branch) 12.88
EP
1-1/2" Elbow 12.88
1-1/2" x 1-1/2" x 1-1/2" Tee (flow-through) 1.84
1-1/2" x 1-1/2" x 1-1/2" Tee (branch) 11.54
Scott Hellendrung
Technical Services Representative
Technical Services
Uponor
5925 148th Street West, Apple Valley, MN 55124
Tel: 800.321.4739 ext. 4254 Direct: 952.997.4254 Fax: 952.891.1409
e-mail: scott.hellendrung@uponor-usa.com Web: www.uponor-usa.com
https://excl
Unknown Zone (Mixed) | Protected Mode: Off
100%

Engineering Science Department Requisition
SENIOR DESIGN TEAM - Trinity University

Date: 03 / 02 / 2009

Vendor Information		Request Information	
Company Name:	Flow Line Options Corp.	**CHECK ONE**	□ Reimbursement
Attention/CONTACT:	Dave		■ Please Order
Street Address:	9009 Freeway Drive #4	For Departmental Use Only	
City, State, Zip:	Macedonia, OH 44056	Date Processed: __ / __ / ____	□ **JMM** □ **EAA**
Phone #:	(877) 356-5463	Ordered:	□ Using PCARD
FAX #:	(330) 468-0185		□ Using DPO#_____
Web Address:	http://flowlineoptions.com	Method:	□ By phone
			□ By FAX
			□ By Web

Required Del. Date	**As soon as possible**	**Departmental Information**	
Deliver:	**X Yes** ____ **No**	Address:	Trinity University Engineering
Pick-up:	____ **Yes** **X No**		Central Receiving
			607 Kings Court
			San Antonio TX 78212-7200
		Tax	ID# 74-11-09633

CATALOG/PART #	DESCRIPTION	Qty	UNIT COST	EXTENDED COST
DL14-00	EchoPod Level Switch-Controller-Transmitter	2	$368	$736
LI99-1001	EchoPod Programming FOB with WEBCAL Software	1	$53	$53
	Shipping Cost			
			Total	$789

Team Contact Name:	Patrick Spence	**Project Name:**	Condensate Collection
Team Contact Student ID #:			
Team Contact Phone #:	(325) 725-4288	**Approved by ADVISOR:**	

EchoPod Ultrasonic Level Switch, Controller and Transmitter for low-cost, non-contacting monitoring and/or controlling of small tanks

See EchoPod Domestic Well Tank Level System

Unique Features

- **Only non-contacting, ultrasonic device to monitor small tanks and sumps with a 49.2" (1.25m) range.**
- **Provides switch, controller and transmitter capabilities in economical, compact unit**
- **First device to continuously monitor via a 4-20 mA analog output AND 4 independently programmable alarm and control setpoints**

Additional Advantages

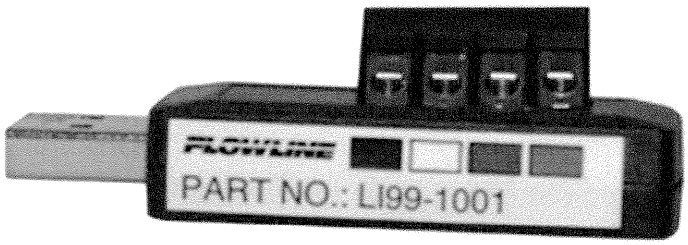
- The rugged PVDF enclosure is well suited for a wide range of corrosive, waste or slurry type media, and can be broadly selected for atmospheric day tank, process vessel or dispenser, pump lift station and waste sump applications. Level indication can be monitored via a local display or controlled through a PLC.
- Replaces floats, capacitance and resistive rods that foul, corrode and coat
- Priced at the same or less than floats, capacitance and resistive rods
- Echopod includes an internal duplex pump controller
- WebCal® software allows for easy Windows based set-up (Flo-Corp will provide the unit programmed to our specs)
- Software includes wiring schematic/diagram of customized system wiring and connections; will print and save to file instrument tag and setup information

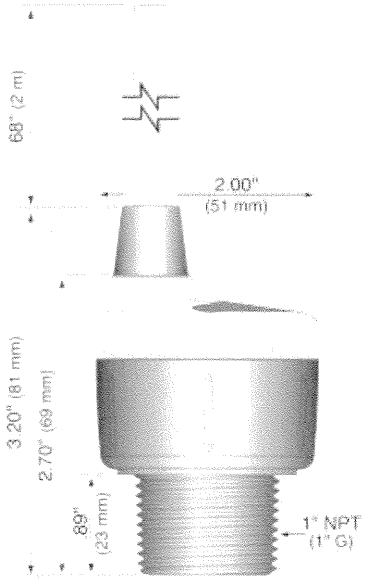
Description

EchoPod is a general purpose non-contact ultrasonic level switch, controller and transmitter for small tanks 49.2" (1.25 m) or less. Maintenance free, the EchoPod reduces tank system hardware through simplicity and consolidation. It is well suited for corrosive and dirty applications with its non-metallic housing and transducer.

EchoPod Programming FOB

The EchoPod programming FOB is designed for programming the EchoPod level transmitter/switch/controller with easy-to-use WebCal software (comes free with purchase of programming FOB). Simply wire the EchoPod to the programming FOB and plug it into your PC via the standard USB port and the installed software will instantly recognize the EchoPod to be programmed. Set-up takes minutes.





Range:	49.2" (1.25m)
Accuracy:	0.125" (3 mm)
Resolution:	0.019" (0.5 mm)
Dead band:	2" (5 cm)
Supply voltage:	24 VDC (loop)
Loop resistance:	400Ω max
Consumption:	35 mA maximum
Signal output:	4-20mA, two-wire (when loop powered)
Contact type:	(4) SPST relays 1A
Loop fail-safety:	4 mA, 20 mA, 21 mA, 22 mA or hold last
Relay fail-safety:	Power loss: Hold last Power on: Open, close or hold last
Hysteresis:	Selectable
Configuration:	WebCal® PC Windows® software interface
Temp. comp.:	Automatic over range
Temperature:	F: -4° to 140° C: -20° to 60°
Pressure:	Atmospheric
Enclosure:	NEMA 4X encapsulated, corrosion resistant & submersable
Encl. material:	PC/ABS FR
Strain relief mat.:	Santoprene
Trans. material:	PVDF
Cable length:	4'(1.2m)
Cable jacket mat.:	PVC
Process mount:	1" NPT (1" G)
Mount. gasket:	Viton®
Classification:	General purpose

Approvals: CE

Complete Specs

EchoPod Ultrasonic Level Switch, Controller and Transmitter

Payments are processed on a secure server.

Quantity	Model	Description	Price, $U.S.
2	DL14-00	EchoPod Level Switch-Controller-Transmitter, supplied programmed to your specs by Flo-Corp	$368
1	LI99-1001	EchoPod Programming FOB with WEBCAL Software	$53

Add to Cart Clear

Check Cart

Other Level Sensor Products

Matrix of Level Sensor Products

Level Transmitter Application Success Stories

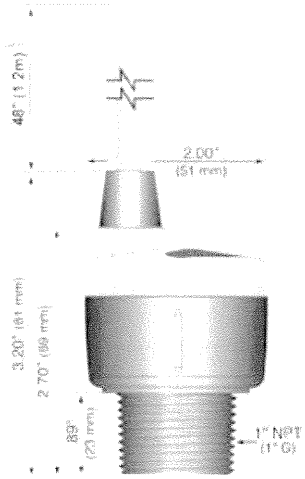
Flow Line Options Corp. (Flo-Corp)
9009 Freeway Drive #4
Macedonia, OH 44056
Phone: 1-877-FLO-LINE (877-356-5463) or 330-468-0180
Fax: 330-468-0185
E-mail

EchoPod®

Ultrasonic Level Switch, Controller and Transmitter

Introducing EchoPod

Flowline introduces EchoPod, an innovative level sensor that replaces floats, conductance and pressure sensors that fail due to dirty, sticking and scaling media in small tanks 49.2" (1.25 m) or less. EchoPod, a general purpose sensor, combines non-contact switch, controller and transmitter capabilities in one package. Combining 4 relays, 4-20 mA output and pump/valve control in one small sensor allows EchoPod to be your total solution. Maintenance free, EchoPod reduces tank system hardware through simplicity and consolidation. Additionally, EchoPod is well suited for corrosive and dirty applications with its non-metallic housing and transducer. EchoPod provides a total solution for fluid handling and automation. The time to "Think Small and Win Big" is now, and it's with EchoPod.



U.S. Patent #: 7,098,669

Specifications

Range:	49.2" (1.25 m)
Accuracy:	0.125" (3 mm)
Resolution:	0.019" (0.5 mm)
Beam width:	2" (5 cm)
Dead band:	2" (5 cm)
Supply voltage:	24 VDC (loop)
Loop resistance:	400Ω max
Consumption:	35 mA maximum
Signal output:	4-20 mA, two-wire (when loop powered)
Contact type:	(4) SPST relays 1A
Loop fail-safety:	4 mA, 20 mA, 21 mA, 22 mA or hold last
Relay fail-safety:	Power loss: Hold last Power on: Open, close or hold last
Hysteresis:	Selectable
Configuration:	WebCal® PC Windows® software interface
Temp. comp.:	Automatic over range
Temperature:	F: 20° to 140° C: -7° to 60°
Pressure:	Atmospheric
Enclosure:	NEMA 4X encapsulated, corrosion resistant & submersible
Encl. material:	PC/ABS FR
Strain relief mat.:	Santoprene
Trans. material:	PVDF
Cable length:	48" (1.2 m)
Cable jacket mat.:	Polyurethane
Process mount:	1" NPT (1" G)
Mount. gasket:	Viton®
Classification:	General purpose
Approvals:	CE

Description

EchoPod, a general purpose non-contact ultrasonic level switch, controller and transmitter for small tanks 49.2" (1.25 m) or less. EchoPod enables flexible design applications for system integration or retrofit of floats, conductance and pressure sensors. Well suited for fluid handling and chemical feed applications integrating process or control automation of small tanks mounted on tools, skids or machines. The rugged PVDF enclosure is well suited for a wide range of corrosive, waste or slurry type media, and can be broadly selected for atmospheric day tank, process vessel or dispenser, pump lift station and waste sump applications. Level indication can be monitored via a local display or controlled through a PLC.

Advantages

- ☑ Provides switch, controller and transmitter capabilities
- ☑ Replacement of multi-point float, conductivity and pressure level switches
- ☑ WebCal, an innovative PC user interface that provides fast and accurate configuration
- ☑ Compact sensor with 2" dead band and beam width optimized for small tank applications 49.2" (1.25 m) or less

EchoPod® Ordering

DL14- ☐☐

Process mount (1)
- 0 NPT (US)
- 1 G (Metric)

Fob USB interface (2)
- 0 Without Fob
- 1 With Fob

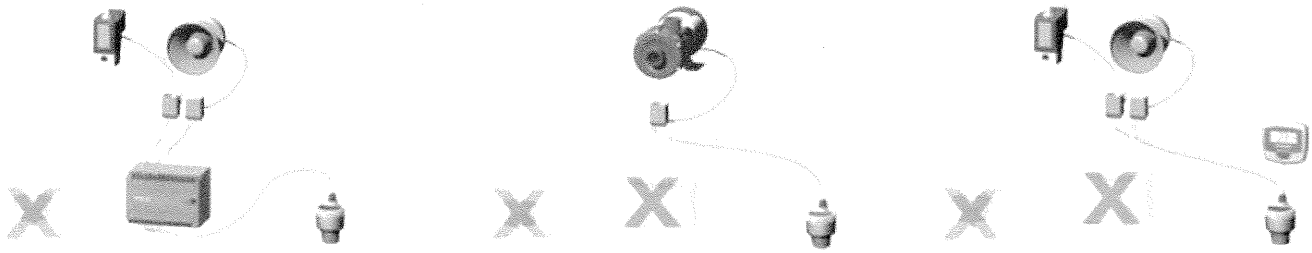
Ordering Notes

1) EchoPod can not be configured without the Fob USB interface tool (LI99-1001) and WebCal. One Fob will configure all EchoPods.
2) WebCal is a free download from our website at www.flowline.com/webcal (Windows® XP Compatible).

EchoPod®

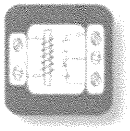
Ultrasonic Level Switch, Controller and Transmitter

Functions



Switch

4 programmable relays
High or low alarms



Control

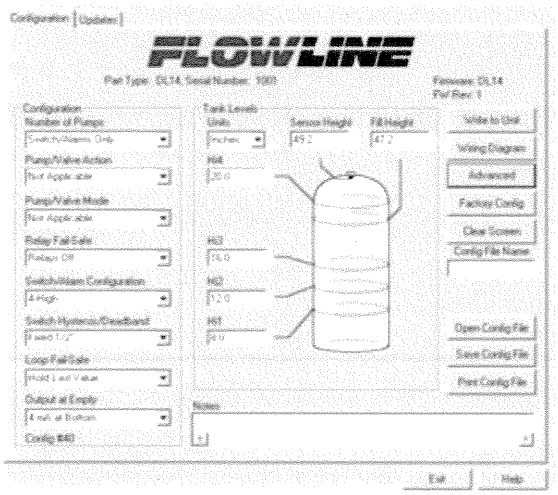
1 or 2 pump/valve operation
Simplex, duplex and lead/lag

Transmitter

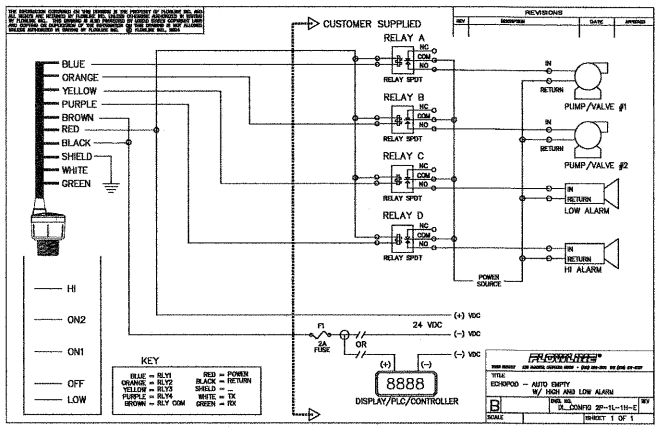
4-20 mA output
Reversible 4-20 mA output

WebCal™

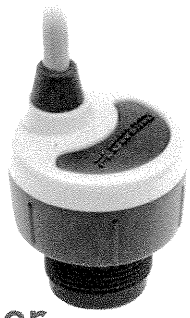
Simple software configuration through WebCal, using USB connectivity, enables flexible system integration or retrofit for suitable applications. WebCal's user interface makes configuration quick and simple for even novice computer users. By entering your application requirements through pre-programed menus, WebCal will accurately configure EchoPod to your application requirements every time. Additionally, WebCal provides a printed wiring schematic and file management system that saves your configuration for back-up, technical assistance or additional applications. To get more information on Web-Cal, go to http://www.flowline.com/webcal.



Example Wiring Diagram



Flow Line Options



EchoPod Ultrasonic Level Switch, Controller and Transmitter

Features & Benefits

- Only non-contacting,ultrasonic device to monitor small tanks and sumps with a 49.2 (1.25m) range.
- Provides switch, controller and transmitter capabilities in economical, compact unit
- First device to continuously monitor via a 4-20 mA analog output AND 4 independently programmable alarm and control setpoints
- The rugged PVDF enclosure is well suited for a wide range of corrosive, waste or slurry type media, and can be broadly selected for atmospheric day tank, process vessel or dispenser, pump lift station and waste sump applications. Level indication can be monitored via a local display or controlled through a PLC.
- Replaces floats, capacitance and resistve rods that foul, corrode and coat
- Priced at the same or less than floats, capacitance and resistive rods
- Echopod includes and internal duplex pump controller
- WebCal® software allows for easy Windows based set-up (Flo-Corp will provide the unit programmed to our specs
- Software includes wiring schematic/diagram of customized system wiring and connection; will print and save to file intstrument tag and setup information

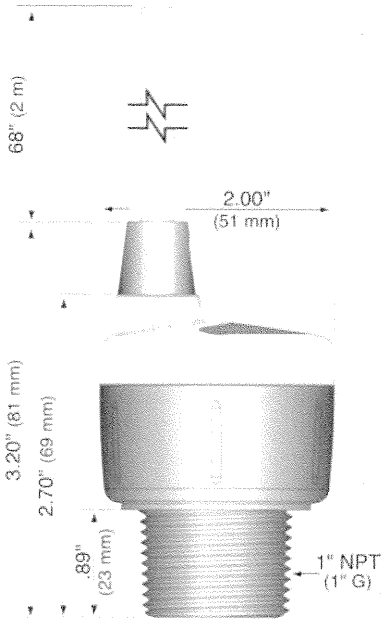
Specifications

Range	49.2" (1.25m)
Accuracy	0.125" (3 mm)
Resolution	0.019" (0.5 mm)
Dead Band	2" (5 cm)
Supply Voltage	24 VDC (loop)
Loop resistance	400Ω max
Consumption	35 mA maximum
Signal output	4-20mA, two-wire (when loop powered)
Contact type	(4) SPST relays 1A
Loop fail-safety	4 mA, 20 mA, 21 mA, 22 mA or hold last
Relay fail-safety	Power loss: Hold last Power on: Open, close or hold last
Hysteresis	Selectable
Configuration	WebCal® PC Windows® software
Temp. Comp.	Automatic over range
Temperature	F: -4° to 140°C: -20° to 60°
Pressure	Atmospheric
Enclosure	NEMA 4X encapsulated, corrosion resistant & submersable
Encl. material	PC/ABS FR
Strain relief mat.	Santoprene
Trans. material	PVDF
Cable length	4' (1.2 m)
Cable jacket mat.	PVC
Process mount	1" NPT (1" G)
Mount. gasket	Viton®
Classification	General Purpose
Approvals	CE

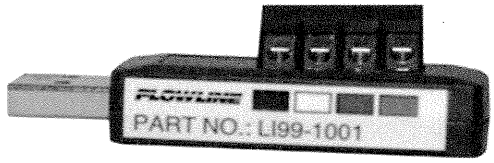
Description

EchoPod is a general purpose non-contact ultrasonic level switch, controller and transmitter for small tanks 49.2" (1.25m) or less. Maintenance free, the EchoPod reduces tank system hardware through simplicity and consolidation. It is well suited for corrosive and dirty applications with its non-metallic housing and transducer.

Dimensions



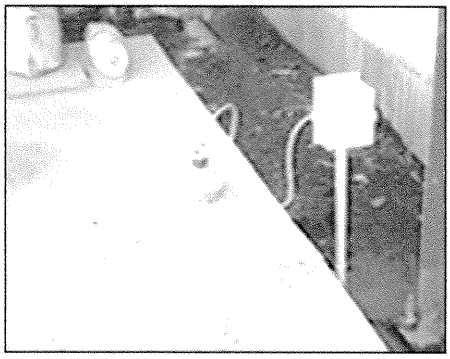
EchoPod Programming FOB



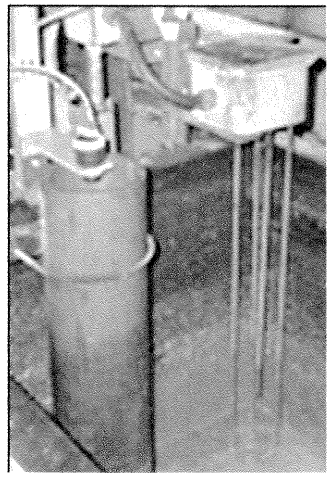
Description

The EchoPod Programming FOB is designed for programming the EchoPod level transmitter/switch/controller with easy-to-use WEBCAL software (comes free with purchase of programming FOB). Simply wire the EchoPod to the programming FOB and plug it into your PC via the standard USB port and the installed software will instantly recognize the EchoPod to be programmed. Set-up takes minutes.

Application Photos



EchoPod controls cooling tower sump level



EchoPod measures level in a stand pipe

Engineering Science Department Requisition
SENIOR DESIGN TEAM - Trinity University

Date: 03 / 02 / 2009

Vendor Information		**Request Information**	
Company Name:	OnSet	**CHECK ONE**	□ Reimbursement
Attention/CONTACT:			■ Please Order
Street Address:	PO Box 3450	For Departmental Use Only	
City, State, Zip:	Pocasset, MA 02559	Date Processed:	__ / __ / ____ □ **JMM** □ **EAA**
Phone #:	(800) 564-4377	Ordered:	□ Using PCARD
FAX #:	(508) 759-9100		□ Using DPO#_____
Web Address:	Http://www.onsetcomp.com	Method:	□ By phone
			□ By FAX
			□ By Web

Required Del. Date	**As soon as possible**
Deliver:	**X Yes** ___ **No**
Pick-up:	___ **Yes** **X No**

Departmental Information

Address: Trinity University Engineering
Central Receiving
607 Kings Court
San Antonio TX 78212-7200
Tax ID# 74-11-09633

CATALOG/PART #	DESCRIPTION	Qty	UNIT COST	EXTENDED COST
U12-006	HOBO 4-Channel External Data Logger	2	$105	$210
Cable-4-20 mA	4-20 mA cable	3	$25	$75
BHW-PRO-xxx	HOBOware Pro Software	1	$89	$89
TEL-7001	Telaire 7001 CO2 Sensor	3	$465	$1,395
H08-002-02	HOBO Temp/External Channel Data Logger	3	$95	$285
			Subtotal	$2,054

Team Contact Name:	Patrick Spence	**Project Name:**	Condensate Collection
Team Contact Student ID #:			
Team Contact Phone #:	(325) 725-4288	**Approved by ADVISOR:**	

Engineering Science Department Requisition
SENIOR DESIGN TEAM - Trinity University

Date: 03 / 02 / 2009

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Web Address:	Http://www.onsetcomp.com	Method:	□ By phone
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			□ By Web

Required Del. Date	**As soon as possible**
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Pick-up:	___ **Yes** **X No**

Departmental Information

Address: Trinity University Engineering
Central Receiving
607 Kings Court
San Antonio TX 78212-7200
Tax ID# 74-11-09633

CATALOG/PART #	DESCRIPTION	Qty	UNIT COST	EXTENDED COST
BCP4.3-ON	BoxCar Pro 4.3 Starter Kit	1	$125	$125
Cable-CO2	CO2 Senor to Logger Cable	3	$29	$87
	Shipping Cost			$0
			Total	$2,266

Team Contact Name:	Patrick Spence	**Project Name:**	Condensate Collection
Team Contact Student ID #:			
Team Contact Phone #:	(325) 725-4288	**Approved by ADVISOR:**	

HOBO® U12 4-External Channel Data Logger (Part # U12-006)

Inside this package:

- HOBO U12 4-External Channel Data Logger
- Mounting kit with magnet, hook and loop tape, tie-wrap mount, tie wrap, and two screws.

Doc # 8161-C, MAN-U12-006
Onset Computer Corporation

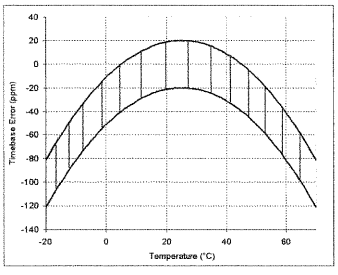
Thank you for purchasing a HOBO data logger. With proper care, it will give you years of accurate and reliable measurements.

The HOBO U12 4-External Channel data logger has a 12-bit resolution and can record up to 43,000 measurements or events. The four external channels accept a variety of sensors, including temperature and split-core AC current sensors as well as 4-20 mA and voltage input cables (sold separately). The logger uses a direct USB interface for launching and data readout by a computer.

An Onset software starter kit is required for logger operation. Visit www.onsetcomp.com for compatible software.

Specifications

Measurement range	External input channels (see sensor manual): 0 to 2.5 DC Volts
Accuracy (logger only)	± 2 mV ± 2.5% of absolute reading ± 2 mV ± 1% of reading for logger-powered sensors
Resolution	0.6 mV
Time accuracy	± 1 minute per month at 25°C (77°F), see Plot A
Operating range	-20 to 70°C (-4° to 158°F)
Operating temperature	Logging: -20° to 70°C (-4° to 158°F) Launch/readout: 0° to 50°C (32° to 122°F), per USB specification
Humidity range	0 to 95% RH, non-condensing
Battery life	1 year typical use (see "Battery" details on next page)
Memory	64K bytes (43,000 12-bit measurements)
Weight	46 g (1.6 oz)
Dimensions	58 x 74 x 22 mm (2.3 x 2.9 x 0.9 inches)
CE	The CE Marking identifies this product as complying with all relevant directives in the European Union (EU).



Plot A

4-20mA input cable

This cable (part number CABLE-4-20mA) measures current from 0 to 20.1 mA. Do not expose to current above 20 mA or to negative current. Do not cut off the end of the gray cable where it connects to the blue and yellow wires, as it contains the precision resistor required for current measurement.

Voltage input cable

The logger's external inputs can accept the voltage input cable (Onset part number CABLE-2.5-STEREO), which allows a voltage to be recorded. The input line must not be exposed to signals below 0 V or above 2.5 V.

Voltage Input Cable Connections	
Wire	**Connection**
Red	Switched 2.5 V output

When using multiple voltage and/or current inputs, the (-) from your current source(s) and the 0 V line of your voltage source(s) are tied together at the logger. If these lines are at different voltage potentials, this may cause inaccurate readings or even damage your logger. Keep in mind that these lines may also be tied to earth ground through your PC interface cable when connected to your computer. Special precautions may be necessary if any of your voltage or current source common lines are not tied to earth ground. Input isolators may be needed in industrial environments to prevent errors caused by ground loops.

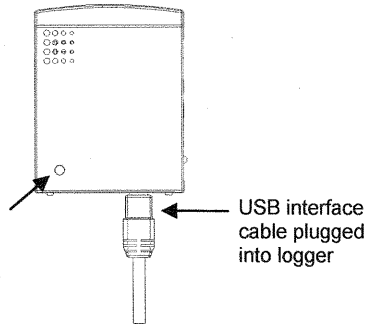
Other external sensors

Onset has a range of external temperature sensors, AC current sensors, and cables for incorporating other sensors that are compatible with the U12 4-External Channel Data Logger. Measurement specifications for using Onset temperature and AC current sensors with this logger are provided in the sensor manuals. For compatible sensors, refer to the HOBO catalog, contact Onset Computer Corporation, or contact an Onset Authorized Dealer.

Connecting the logger

The U-Family logger requires an Onset-supplied USB interface cable to connect to the computer. If possible, avoid connecting at temperatures below 0°C (32°F) or above 50°C (122°F).

1. Plug the large end of the USB interface cable into a USB port on the computer.
2. Plug the small end of the USB interface cable into the bottom of the logger, as shown in the following diagram.



If the logger has never been connected to the computer before, it may take a few seconds for the new hardware to be detected. Use the logger software to launch and read out the logger.

Important: If you configure the logger to start with a button start, be sure to press and hold down the button on the front of the logger for at least three seconds when you want to begin logging data.

Be sure to plug the external sensors into the side of the logger before

Note! Static electricity may cause the logger to stop logging. To avoid electrostatic discharge, transport the logger in an anti-static bag, and ground yourself by touching an unpainted metal surface before handling the logger. For more information about electrostatic discharge, visit our website at http://www.onsetcomp.com/Support/support.html.

Sample and event logging

The logger can record two types of data: samples and events. Samples are the sensor measurements recorded at each logging interval (for example, the temperature every minute). Events are independent occurrences triggered by a logger activity. Examples of events recorded asynchronously during deployment include when the logger is connected to the host, when the battery is low, the end of a data file once the logger is stopped, and button pushes.

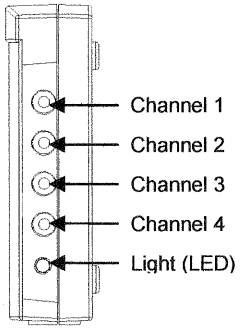
Press and hold down the button on the front of the logger for at least one second to record an event. Both a button up and down event will be recorded. This is useful if you want to mark the datafile at a particular point. For example, if the logger is located in an incubator, you might press the button each time the door is opened.

The logger stores 64K of data, and can record up to 43,000 samples and events combined.

Operation

A light (LED) on the side of the logger confirms logger operation.

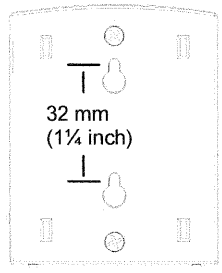
The following table explains when the logger blinks during logger operation:



When:	The light:
The logger is logging	Blinks once every one to four seconds (the shorter the logging interval, the faster the light blinks); blinks when logging a sample
The logger is awaiting a start because it was launched in Start At Interval, Delayed Start, or Button Start mode	Blinks once every eight seconds until launch begins
The button on the logger is being pushed for a Button Start launch	Blinks once every second while pressing the button and then flashes rapidly once you release the button. The light then reverts to a blinking pattern based on the logging interval

Mounting

There are four ways to mount the logger using the materials in the mounting kit included with the logger:



- Use the hook and loop tape to affix the logger to a surface.
- Attach the magnet, then place the logger on a magnetic surface.
- Use the tie wrap and tie wrap mount to tie the logger to an object.
- Fasten the logger to a surface with the two Phillips-head screws. The back of the logger has two inserts for the screws, 32 mm (1¼ inches) apart.

Battery

The logger requires one 3-Volt CR-2032 lithium battery. Expected battery life varies based on the temperature and the frequency at which the logger is recording data (the logging interval). A new battery will typically last one year with logging intervals greater than one minute. Deployments in extremely cold or hot temperatures or logging intervals faster than one minute may significantly reduce battery life. Onset recommends that you install a fresh battery before every deployment if temperatures below 0°C (32°F) are expected.

To replace the battery:

1. Disconnect the logger from the computer.
2. Unscrew the logger case.
3. Lift the circuit board and carefully push the battery out with a small blunt instrument, or pull it out with your fingernail.
4. Insert a new battery, positive side facing up.
5. Carefully realign the logger case and re-fasten the screws.

⚠ WARNING: Do not cut open, incinerate, heat above 85°C (185°F), or recharge the lithium battery. The battery may explode if the logger is exposed to extreme heat or conditions that could damage or destroy the battery case. Do not dispose of the logger or battery in fire. Do not expose the contents of the battery to water. Dispose of the battery according to local regulations for lithium batteries.

Service and Support

HOBO products are easy to use and reliable. In the unlikely event that you have a problem with this instrument, contact the company where you bought the logger: Onset or an Onset Authorized Dealer. Before calling, you can evaluate and often solve the problem if you write down the events that led to the problem (are you doing anything differently?) and if you visit the Technical Support section of the Onset web site at www.onsetcomp.com/support.html. When contacting Onset, ask for technical support and be prepared to provide the product number and serial number for the logger and software version in question. Also completely describe the problem or question. The more information you provide, the faster and more accurately we will be able to respond.

Onset Computer Corporation
470 MacArthur Blvd., Bourne, MA 02532
Mailing: PO Box 3450, Pocasset, MA 02559-3450
Phone: 1-800-LOGGERS (1-800-564-4377) or 508-759-9500
Fax: 508-759-9100
E-mail: loggerhelp@onsetcomp.com
Internet: www.onsetcomp.com

Warranty

Onset Computer Corporation (Onset) warrants to the original end-user purchaser for a period of **one year** from the date of original purchase that the HOBO® product(s) purchased will be free from defect in material and workmanship. During the warranty period Onset will, at its option, either repair or replace products that prove to be defective in material or workmanship. This

Indemnification. Products supplied by Onset are not designed, intended, or authorized for use as components intended for surgical implant or ingestion into the body or other applications involving life-support, or for any application in which the failure of the Onset-supplied product could create or contribute to a situation where personal injury or death may occur. Products supplied by Onset are not designed, intended, or authorized for use in or with any nuclear installation or activity. Products supplied by Onset are not designed, intended, or authorized for use in any aeronautical or related application. Should any Onset-supplied product or equipment be used in any application involving surgical implant or ingestion, life-support, or where failure of the product could lead to personal injury or death, or should any Onset-supplied product or equipment be used in or with any nuclear installation or activity, or in or with any aeronautical or related application or activity, Purchaser will indemnify Onset and hold Onset harmless from any liability or damage whatsoever arising out of the use of the product and/or equipment in such manner.

Returns

Please direct all warranty claims and repair requests to place of purchase.

Before returning a failed unit directly to Onset, you must obtain a Return Merchandise Authorization (RMA) number from Onset. You must provide proof that you purchased the Onset product(s) directly from Onset (purchase order number or Onset invoice number). Onset will issue an RMA number that is valid for 30 days. You must ship the product(s), properly packaged against further damage, to Onset (at your expense) with the RMA number marked clearly on the outside of the package. Onset is not responsible for any package that is returned

telaire® 7001

Telaire® 7001

Carbon Dioxide and Temperature Monitor with Ventilation Rate Displayed in CFM/Person

Equipped with Telaire's patented dual beam Absorption Infrared™ technology, the Telaire® 7001 is an easy-to-use CO_2/temperature monitor designed for use in residential or commercial applications. With the ability to display CO_2 readings and calculate outside air ventilation rates in cfm/person the monitor is an ideal tool for: identifying energy saving opportunities in over-ventilated spaces, determining if air quality complaints are due to insufficient ventilation, or locating the presence of combustion fumes generated from vehicles and appliances. If you wish to record CO_2 concentration for further analysis Telaire® offers CO_2View™ software that allows you to log concentrations directly to a PC. For remote monitoring Telaire® offers a Datalogging Kit that easily attaches to the back of the 7001.

TELAIRE

Specifications

Method
Dual Beam Absorption Infrared™

Sample Method
Diffusion or flow through (50 - 100 ml/min)

Warranty
18 months parts and labor

Performance

CO_2 Channel

Measurement Range
0-4,000 ppm voltage output
0-10,000 ppm display

Sensitivity
± 1 ppm

Accuracy
±50 ppm or ±5% of reading (up to 1.5% or 15,000 ppm), whichever is greater

Repeatability
±20 ppm

Temperature Dependence
±0.1% of reading per °C or ±2 ppm per °C, whichever is greater, referenced to 25°C

Pressure Dependence:
0.13% of reading per mm Hg
(Corrected via user input for elevation)

Annual Drift
± 20 ppm typical

Response Time
<60 seconds for 90% of step change

Warm-Up Time
<60 seconds at 22°C

Operating Conditions
32-122°F (0-50°C)
0-95% RH, non-condensing

Storage Temperatures
-40 to 140°F (-40 to 60°C)

Calibration Interval
12 months, offset adjustment using single gas at 0-1000 ppm CO2. Full factory calibration available

Temperature Channel

Temperature Range

Voltage output	32 to 104°F (0 to 40°C)
Display	32 to 122°F (0 to 50°C)

Display Resolution
0.1°F (0.1°C)

Display Options
°F, °C, or Off. Set with panel button.

Accuracy
±2°F (±1°C)

Response Time
20-30 minutes (case must equilibrate with environment)

Calibration Interval
12 months, offset adjustment using temperature standard at 50 to 86°F (10 to 30°C). Full factory calibration available

Output - Analog

CO_2
0-4 VDC, 1mV/ppm (4,000 ppm max)

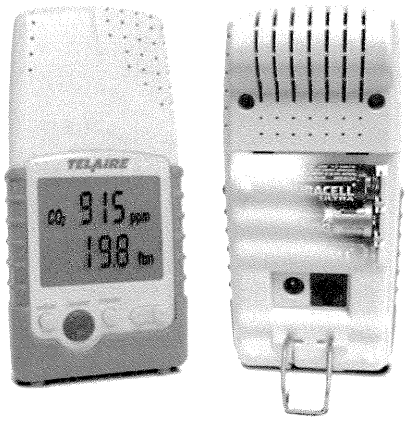
Temperature
0-4 VDC linear, 32-104°F (0-40°C)

Output Impedance
100 Ohms

Wiring Connection
Via RJ-45 to DB9 serial port cable (for use with CO_2View™ PC Graphing Software)

Applications

- Identify areas with low or substandard ventilation.
- Identify hidden energy savings in over-ventilated spaces.
- Determine if ventilation is a factor in air quality complaints.
- Locate the presence of combustion fumes from vehicles and appliances.
- Use as a reference to calibrate wall mounted CO_2 sensors.



Accessories/Ordering Information

62933 International Power Supply

62285 Cable -RJ-45 to DB-9

Factory Calibration
Call 805-685-4000 for a RMA number

2070 Cable
Voltage Output cable, includes 2 pigtail leads for connecting to 3rd party devices

2075 Calibration Kit
Regulator, tubing and gas. Perform up to 20 calibrations.

2080 CO_2View™
Graphing Software for logging CO_2 concentrations directly to a PC.

2077 Hobo Datalogger Kit
Small Datalogger that velcro's to the back of the 7001. Includes CO_2 input with additional temp and relative humidity measurement, graphing software and all necessary connection cables.

Specifications (cont)

Display
LCD with independent CO_2/Temperature readings (panel buttons set elevation, °F/°C, calibration functions)

Power Supply

Battery Type
Four AA batteries, not included

Battery Operation
80 hours (alkaline)

External
6 VDC from external AC/DC adapter, included

Power Requirements
100 mA Peak, 20 mA average from 6V

Certification
FCC Class 15 Part B

Features/Benefits

- Patented dual beam, Absorption Infrared™ gas sensor ensures long term stability and durability.
- Large, easy to read display. Temperature displayed in °F or °C. CO_2 displayed in ppm. Easily adjusted for altitude changes.
- Fast, simple calibration using external port and display. Calibrate with ambient air or bottled gas.
- Calibrate, set elevation, change °F or °C using on-board controls or optional computer interface (UIP Kit model 2072)
- Flip out stand for desktop monitoring.
- Voltage output via RJ45 connector provides easy interface to most dataloggers.
- Plug In AC power adaptor.
- Operates for up to 80 hours on 4 AA alkaline batteries. (not included).
- Displays cfm-per-person ventilation rate based on CO_2 inside outside differential reading.

About the CFM/Person Ventilation Rate Measurement

The 7001 will calculate the outside air ventilation rate to a space based on the inside/outside CO_2 differential readings. Outside readings can be established by measuring outside levels and holding the "enter" button on the sensor for 5 seconds. The outside reading can also be manually set using the on-board keypad and display (default 400 ppm).

Accurate interpretation of the Ventilation Rate indicator requires a measuring 2 to 3 hours after occupancy has stabilized in a space or at a peak in daily CO_2 concentrations. In other conditions the indicator may tend to over estimate ventilation rates.

The Ventilation Rate display assumes a people activity level in the measured space similar to a office type environment (1.2. MET). If higher levels of activity are present the indicator may tend to under estimate ventilation levels.

TELAIRE

6860 Cortona Drive, Suite B, Goleta, CA 93117 **P**- 805-685-4000 **F**- 805-685-0015
www.telaire.com

Covered by United States Patents:
5,060,508 / 5,163,332 / 6,255,653
Other Patents Pending

HOBO® H8 Family User's Manual

Requires Onset Computer Corporation's BoxCar® Pro or BoxCar® 3.6 or later software and PC cable for operation.

Inside this package

The HOBO H8 Family of loggers are shipped with:

1. One HOBO H8 logger (part number H08-001-02, H08-002-02, H08-003-02, H08-004-02, or H08-007-02)
2. Mounting Accessories:
   Magnet
   Hook and loop tape
   Double-sided tape

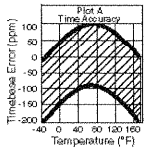
Thank you for buying a HOBO data logger. With proper care it will give you years of accurate and reliable measurements.

This manual covers the HOBO H8 family of products. All members share a common feature set, store 7944 time-stamped measurements and are compatible with the HOBO Shuttle allowing for convenient retrieval of field data. The measurements available on each model are:

Model	Part Number	Temp	RH	Light	External
HOBO Temp	H08-001-02	✔			
HOBO Temp/External	H08-002-02	✔			✔
HOBO RH/Temp	H08-003-02	✔	✔		
HOBO RH/Temp/Light/External	H08-004-02	✔	✔	✔	✔
HOBO RH/Temp/2x External	H08-007-02	✔	✔		✔(2)

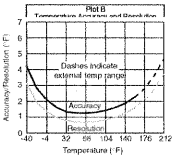
Common Specifications

Operating range (logger): -20°C to +70°C (-4°F to +158°F),
0 - 95% RH non-condensing
Time accuracy: approx. ±1 minute per week (±100 ppm at ↕20°C or ↕68°F), full dependance shown in Plot A
Measurement capacity: 7944 measurements total, stored in non-volatile memory
Size: 2.4" x 1.9" x 0.8"
Weight: approximately 1 oz.
Battery: CR-2032 (lithium) user-replaceable
Battery life (continuous use): 1 year
Storage temperature: -40°C to +75°C (-40°F to +167°F)

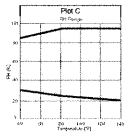


Measurement Specifications

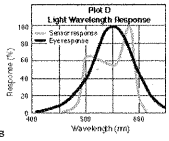
Temperature - Each HOBO H8 logger has an internal temperature sensor on a 4 inch wire which is mounted on the circuit board inside the snap lid case. Typically, the sensor is left inside the case and measures ambient air temperature over the operating range of the logger, -20°C to +70°C (-4°F to +158°F) with a response time of about 15 minutes in still air typical to 90%. The internal sensor can be placed outside the case when a shorter response time is needed (less than 1 minute in air and about 2 seconds in water typical to 90%). The temperature sensor is capable of measuring temperature from -40°C to +120°C (-40°F to +248°F) when extended from the case (see **Using the sensor outside the box** for more information). The HOBO's temperature resolution and accuracy are shown in Plot B. This error includes the measurement uncertainty due to the sensor resolution.



Relative Humidity - The HOBO's user-replaceable relative humidity sensor is temperature compensated, and the logger's relative humidity accuracy is ±5% over the entire +5°C to +50°C (+41°F to +122°F) operating range of the sensor when used with BoxCar Pro 4.3 or BoxCar 3.7.3 or later version. NOTE: Accuracy specifications reflect improvements made to BoxCar Pro 4.3 and BoxCar 3.7.3. Earlier software versions provide ± 5% accuracy except in elevated humidity environments (60% to 95% non-condensing and non-fogging where accuracy is ±10%). Upgrading to BoxCar Pro 4.3 or BoxCar 3.7.3 or later version will bring all current and old data file accuracy to ±5% for the full operating range. The relative humidity sensor's operating RH range is 25% to 95% at +25°C (+77°F) for logging intervals of 10 seconds or longer. Full dependance shown in Plot C. RH sensor drift is < 1% per year. **NOTE: The HOBO's RH sensor will be damaged by condensation. It must not be exposed to fog, mist or other condensing conditions!**



Light Intensity - The HOBO's light intensity sensor approximates the sensitivity of the human eye. The sensor's response versus light wavelength is shown in Plot D (gray line), along with the eye response (black line). The nominal range is 2 to 600 footcandles (lumens/ft²); maximum value can vary from 300 to 900 footcandles (lumens/ft²). The sensor's angular response is roughly cosine dependent, with 0° being directly above the sensor.



External Input with Onset Sensors - The HOBO H8 loggers accept a range of Onset temperature and AC current sensors. For compatible sensors, see the HOBO catalog, contact Onset or contact your Onset authorized dealer.

When using multiple voltage inputs, current inputs, or a combination of both input types, keep in mind that the (-) from your current source(s) and the (0V) line of your voltage source(s) will be tied together when installed on the logger. The lines must be at the same voltage potential or inaccurate readings or even damage to the logger may occur. At the logger, the common line that these external sensors share is not connected to the ground of the logger's PC interface cable jack. The (-) line of any 4-20mA cable or the (0V) line of any Voltage input cable should be kept floating or isolated from ground to avoid damaging your logger, especially when the PC interface cable is also connected.

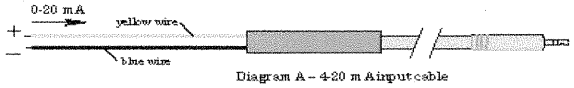


Diagram A – 4-20 mA input cable

4-20 mA Input cable - This cable (part number CABLE-4-20mA) measures currents from 0 to 20.1 mA. The accuracy is ±0.1mA ±3% of reading. The 4-20 mA cable must be connected such that the current flows through, and with the proper polarity, as shown in Diagram A. Do not expose to current above 20 mA or negative current. Do not cut off the end of the gray cable where it connects to the blue and yellow wires as that contains the precision resistor required for current measurement.

Voltage Input Cable Connections	
red wire	switched 2.5 V output
white wire	voltage input
black wire	0 volts

External Input for Sensors with Voltage Output The external port can alternatively accommodate a voltage input cable (Onset part number CABLE-2.5-Stereo) which allows a single voltage input to be recorded. This input reads 0 to 2.5 DC volts, with a ±0.1 μA maximum leakage between measurements and a ±0.4 μA during sensor measurements (5.4 ms each). The accuracy is ±10 mV ±3% of reading. Input impedance is 10kΩ. The input line should not be exposed to signals below 0 volts or above 2.5 volts.

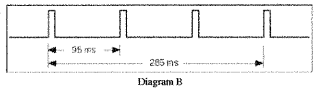


Diagram B

Switched 2.5 V Output - This signal can be used to power a sensor directly (like the H8's external temperature sensor) or it can be used to trigger an external circuit. External sensors should draw no more than 2 mA when powered. The switched 2.5 V output blinks on for about 5.4 ms every time a measurement is made of any channel. A logger with four channels enabled will cause four blinks after each measurement interval expires. The external channels are the last of the blinks whether one, two, three or four channels are enabled. The four enabled channels example is shown in Diagram B.

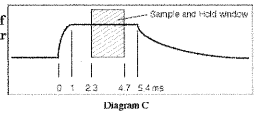


Diagram C

Details of the blink - The input is sampled at a specific point in each blink in Diagram C. The start of the sample window is 2.3 ms after the beginning of the blink, and end 2.4 ms later.

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Connecting the Communications Cable and Launching

A Starter Kit, which includes a PC interface cable and software, is required to operate your logger. Connect the interface cable into the 3.5 mm jack on the logger and into a working serial port of your computer. Install and start the logger's software. Select **Launch...** under **Logger** on the menu bar and a launch dialog box will be provided. For a complete explanation on installing the software and launching your logger, please refer to the software manual.

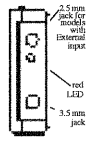

Diagram D

Operation Indicator

The HOBO data loggers have a red LED that blinks while they are logging. The LED blinks brightly at every measurement, and weakly every two seconds if the interval between measurements is longer than two seconds. The blinking LED is most visible when viewed straight on, as shown in Diagram D.

Operation on Computers Equipped with a Power Conservation Mode

Many newer computers, especially laptops, have a power conservation feature which shuts the serial port off after a short period of time. If a HOBO or StowAway logger is still connected to the serial port when this happens, the logger will shut off. Test to see if you will be affected by the power conservation feature. Using BoxCar, launch your logger from the computer that you are testing. If you are using a laptop, it may behave differently when running off battery versus running off the power plug; please test both. After launch, leave the logger attached to the PC interface cable and watch the LED to see if it remains blinking. When a logger is actively logging, the LED will blink faintly every 2 seconds. If the power management is causing a problem, the LED will stop blinking within one minute. When you are using a HOBO Pro logger, the LED is located under the PC interface cable, and is not visible when the cable is plugged in. To test a HOBO Pro, launch the logger to take readings at 10 second intervals. Leave the logger attached to the interface cable for one minute. You can either remove the interface cable at this point and check the LED status, or download the datafile to see how many points were collected. If power management is causing the logger to shut off, you will only see one data point in the file. To resolve power conservation shut off of the serial port, BoxCar Pro 4.0, 4.1, and 4.2.x customers should download the free BoxCar Pro 4.2.10.1 upgrade patch. Similarly, BoxCar 3.6 and 3.7.1 customers should download the free BoxCar 3.7.2 upgrade patch. Both are available for free on our website under Support and Upgrades, Software Upgrades and Utilities.

Note: layout is slightly different for RH/Temp/2x External

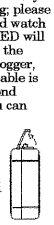
Diagram E

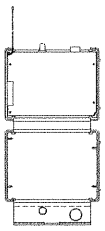
Diagram F

Mounting Options

Included with your HOBO H8 data logger are three options for mounting it on location: a magnet, hook and loop tape, and double-sided tape. These can be stuck on the back of your HOBO. When using the magnet, note that it works best on flat surfaces.

Readout

Reconnect the HOBO data logger to the PC interface cable, start the logger software, select **Readout** under **Logger** on the menu bar and the data will be displayed in a graphical or tabular form. For a complete explanation on reading out your logger, please refer to the software manual.

Using the Sensor Outside the Box

In normal operation, the HOBO's internal temperature sensor should be left inside the case. To use the sensor outside the case, open the snap-lid case as shown in Diagram E and remove the circuit board. Unwind the four inch sensor wire from the circuit board and place the board back into the case. When closing the case, make sure the sensor is aligned in the small notch in the case as shown in Diagram F and press the snap-lid closed. ***Be careful, the sensor is fragile and easily damaged!*** When using the sensor outside the box the logger must still be kept within its operating range of -20°C to +70°C (-4°F to +158°F).

Battery


Battery Holder

Diagram G

Keep it Dry

Your HOBO data logger is meant for **indoor use only** and can be permanently damaged by corrosion if it gets wet. Protect it from water or condensation, which will damage the RH sensor. If the sensor does get wet it will need to be replaced (Onset part number HUM-UPS-500).

Changing the Battery

We recommend changing the HOBO's battery when its level is less than 30% (battery level is displayed on the host computer during Launch, Readout or on the HOBO Shuttle after data offload). Data stored in the HOBO will not be lost when removing the battery. To change the battery, open the case, lift the circuit board and remove the battery by carefully pushing it out with a small screwdriver or other small, blunt instrument. Be sure to install the battery with the printed side away from the HOBO's circuit board as shown in Diagram G. The logger's red LED will blink a number of times after the battery has been installed. If you will not be using the logger right away, bring the logger to the launch window of BoxCar Pro or BoxCar and then select cancel or you can offload the data. This action puts the logger into its low power state to conserve your battery power. **Note: Do not cut open, incinerate, heat above +85°C (+185°F) or recharge lithium battery. Dispose per local regulations.**

Service and Support

HOBO® products are easy to use and reliable. In the unlikely event that you have a problem with the hardware or software, please read the following.

Who do I contact?

Contact the company that you bought the loggers from: Onset Computer Corporation or an Onset Authorized Dealer.

Before calling, you can evaluate and often solve your problem if you try the following:

1. Read this manual and the ReadMe file on the software disk. It may only take a few moments to get the answers you need.

2. Write down the events that led to the problem. Have you changed anything in your computer recently? Are you doing anything differently?

When contacting Onset Computer Corporation, please indicate that you need Technical Support for HOBO® products.

Be prepared to:
1. Provide the product number which is found on the bottom of the logger, the software version and serial number if present on the diskette.
2. Provide details on the hardware and software configuration of your computer including: manufacturer, model number, peripherals, and version of operating system.
3. Completely describe the problem or question. The more information you provide, the faster and more accurately we will be able to respond.

NOTE: Onset allows one technical support contact for each software license.

Onset Technical Support

Onset Computer Corporation
470 MacArthur Blvd., Bourne, MA 02532
Mailing: PO Box 3450, Pocasset, MA 02559-3450
1-800-LOGGERS (1-800-564-4377)
Phone: (508) 759-9500
Fax: (508) 759-9100
e-mail: loggerhelp@onsetcomp.com

Warranty

The HOBO® products are warranted to be free from defects in material and workmanship for a period of one year from the date of original purchase. During the warranty period Onset will, at its option, either repair or replace products that prove to be defective. This warranty is void if the Onset products have been damaged by customer error or negligence or if there has been an unauthorized modification.

Returning Products to Onset

Direct all warranty claims to place of purchase. Before returning a failed unit, you must obtain a Return Merchandise Authorization (RMA) number from Onset. You must provide proof that you purchased the Onset product(s) directly from Onset (purchase order number or Onset invoice number). Onset will issue an RMA number that is valid for 30 days. You must ship the product(s), properly packaged against further damage, to Onset (at your expense) with the RMA number marked clearly on the outside of the package. Onset is not responsible for any package that is returned without a valid RMA number or for the loss of the package by any shipping company. Loggers must be clean and free of any toxins before they are sent back to Onset or they may be returned to you.

Repair Policy

Products that are returned after the warranty period or that are damaged by the customer as specified in the warranty provisions can be returned to Onset with a valid RMA number for evaluation.

Please contact Onset for more information and prices on:

ASAP Repair Policy

Onset will expedite the repair of a returned product.

Data-back™ Service

HOBO® data loggers store data in nonvolatile EEPROM memory. Onset will, if possible, recover your data to a disk.

Tune Up™ Service

Onset will examine and retest any HOBO® data logger.

30500-5 JAN 1998

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FREE Shipping For Online OrdersOver $200**

Note: Did you purchase the necessary data logger, software, and/or cable?

Many of the devices on our website require other items in order to operate and are sold separately. If these items are needed, details will be available from tabbed links in the Product Information window under "Required Items". Most instances require only one software and cable purchase for any quantity of loggers.

delete	Qty	Item	Price Each	Total
☐	3	CABLE-4-20mA	25.00	75.00
☐	2	U12-006	105.00	210.00
☐	1	BHW-PRO-DLD Windows Platform - Download Only	89.00	89.00
☐	3	TEL-7001	465.00	1,395.00
☐	3	H08-002-02	95.00	285.00
☐	3	CABLE-CO2	29.00	87.00
☐	1	BCP4.3-ON	125.00	125.00

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Mailing: PO Box 3450, Pocasset, MA 02559-3450
Street: 470 MacArthur Blvd., Bourne, MA 02532
Tel: 1-800-LOGGERS, 1-508-564-4377, 508-759-9500
Fax: 508-759-9100

Engineering Science Department Requisition
SENIOR DESIGN TEAM - Trinity University

Date: 03 / 02 / 2009

Vendor Information		Request Information	
Company Name:	Instrumart	**CHECK ONE**	□ Reimbursement
Attention/CONTACT:			■ Please Order
Street Address:	8 Leroy Road	For Departmental Use Only	
City, State, Zip:	**Williston, VT 05495**	Date Processed:	__ / __ / ____ □ **JMM** □ **EAA**
Phone #:	**(800) 884-4967**	Ordered:	□ Using PCARD
FAX #:	**(802) 863-1193**		□ Using DPO#_____
Web Address:	**http://www.instrumart.com**	Method:	□ By phone
			□ By FAX
			□ By Web

Required Del. Date	**As soon as possible**	
Deliver:	**X Yes**	**___ No**
Pick-up:	**___ Yes**	**X No**

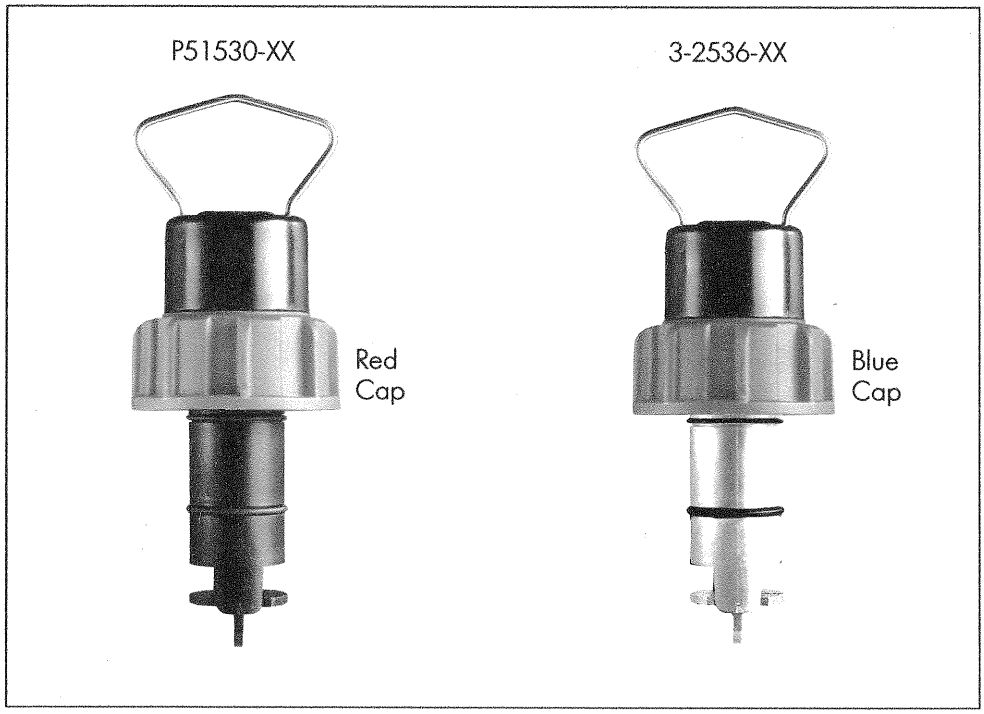
Departmental Information

Address: Trinity University Engineering
Central Receiving
607 Kings Court
San Antonio TX 78212-7200
Tax ID# 74-11-09633

CATALOG/PART #	DESCRIPTION	Qty	UNIT COST	EXTENDED COST
3-3810-P0	GF Signet 515 Rotor-X Paddle Wheel Flow Sensor	1	$234.90	$234.90
PV8T015F	GF Signet Installation Fittings	1	$120.00	$120.00
3-8550-2P	GF Signet 8550 Flow Transmitter	1	$491.40	$491.40
3-8050	GF Signet 8050 Universal Mounting Kit	1	$50.40	$50.40
	Shipping Cost			$0.00
			Total	$896.70

Team Contact Name:	Patrick Spence	**Project Name:**	Condensate Collection
Team Contact Student ID #:			
Team Contact Phone #:	(325) 725-4288	**Approved by ADVISOR:**	

+GF+ SIGNET 515/2536 Rotor-X Flow Sensors



Features

- **PVDF or Polypropylene molded sensor body**
- **Simple insertion design**
- **Separate versions for remote and integral installations**
- **Wide Turndown Ratio of 66:1 for 2536, 20:1 for 515**
- **Use with comprehensive line of fittings from DN15 to DN1000 (0.5 to 36 in.)**
- **Process Ready Signal (3-2536-XX)**
- **Extended length for wet-tap installations available**

Application

- **Pure Water Production**
- **Filtration Systems**
- **Chemical Production**
- **Liquid Delivery Systems**
- **Pump Protection**
- **Scrubbers**

Description

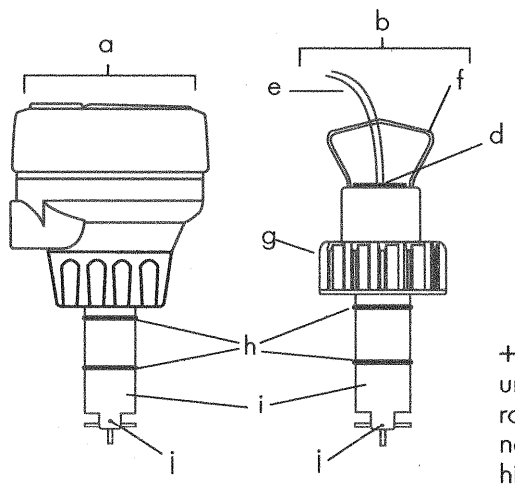
Simple and reliable, Rotor-X paddlewheel flow sensors deliver time-honored performance. These highly repeatable, rugged sensors offer exceptional value with little or no maintenance required. Installation is simple with +GF+ SIGNET's comprehensive line of fittings for all pipe materials in sizes from DN15 to DN1000 (0.5 to 36 in.). Output signal of the 515 is a sinusoidal frequency capable of driving a self-powered flowmeter (3-5090). The 3-2536 has a process-ready open-collector signal and can operate to flows as low as 0.1 m/s (0.3 ft/s).

Technical Features

a) Integral mount sensor (8510/8512) shown with field-mount transmitter (sold separately)
b) Remote mount sensor (515/2536)
c) Open cell rotor and rotor pins available in variety of material options (sleeved rotor available for abrasive solutions)
d) 1/2 in. NPT conduit connection
e) 7.6m/25 ft. cable standard, extendable up to 60m/200 ft. (515) or 305m/1,000 ft. (2536)
f) Large bail for sensor removal
g) Glass-filled PP ring nut with provision for lead seal installation
h) Dual O-ring seal (FPM standard, EPR and Kalrez® available)
i) One-piece injection molded (black glass-filled PP or natural PVDF) sensor body
j) Rotor pin

Options

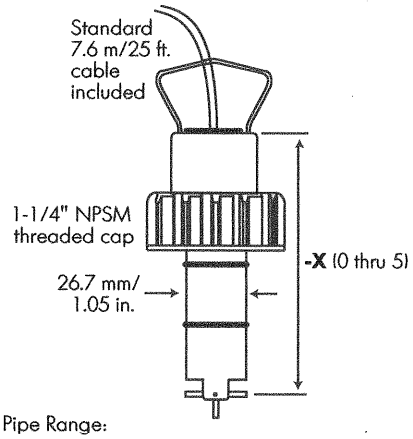
Rotor-X Sensors	Instrument Options: 8550-1	8550-2	8550-3	8550-XP	5090	5075	5100	5500	5600	9010
515	●	●	●	●	●	●	●	●	●	●
8510	●	●	●							
2536	●	●	●	●		●		●	●	●
8512	●	●	●							



+GF+ SIGNET's unique "open-cell" rotor design eliminates cavitation at higher flow rates.

Dimensions

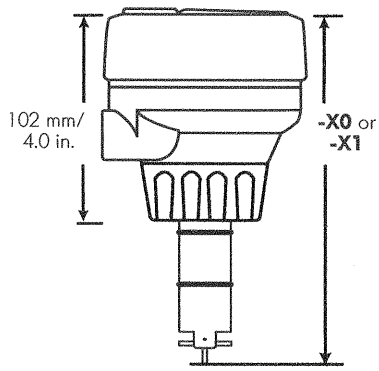
515/2536 Sensor



Pipe Range:

1/2 to 4 in.	**-X**0 = 104 mm/4.1 in.	
5 to 8 in.	**-X**1 = 137 mm/5.4 in.	
10" and up	**-X**2 = 213 mm/8.4 in.	
1/2 to 4 in.	**-X**3 = 297 mm/11.7 in.	Wet-tap Lengths
5 to 8 in.	**-X**4 = 333 mm/13.1 in.	
10" and up	**-X**5 = 409 mm/16.1 in.	

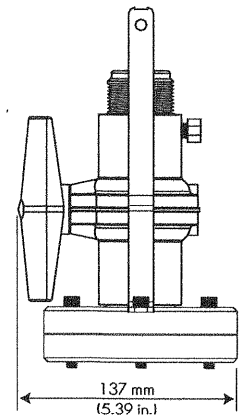
8512 Integral Sensor with Transmitter (sold separately)

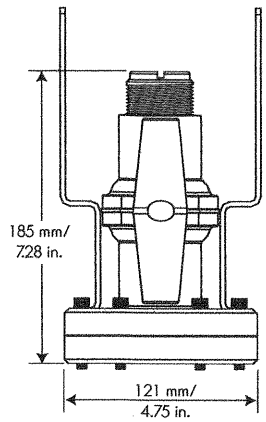


-X0 = 152 mm/6.0 in.
-X1 = 185 mm/7.3 in.

3519 Wet Tap Assembly

(see catalog page for details)





Fitting Types

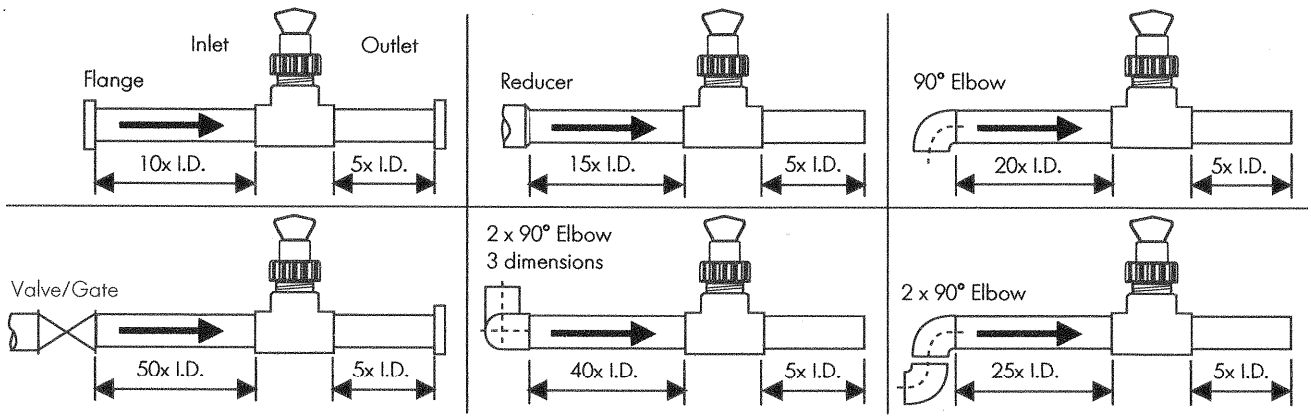
Refer to Fittings section of +GF+ SIGNET catalog for a complete listing of part numbers

Type	Description
Plastic tees	• 0.5 to 4 inch versions • PVC or CPVC
PVC Glue-on Saddles	• Available in 10 and 12 inch sizes only • Cut 2-1/2 inch hole in pipe • Weld in place using solvent cement
PVC Saddles	• 2 to 4 inch, cut 1-7/16 inch hole in pipe • 6 to 8 inch, cut 2-1/4 inch hole in pipe
PP Clamp-on Saddles	• Available in 10 and 12 inch sizes only • Cut 2-1/4 inch hole in pipe
Iron Strap-on saddles	• 2 to 4 inch, cut 1-7/16 inch hole in pipe • Over 4 inch, cut 2-1/4 inch hole in pipe • Special order 12 in. to 36 in.

Type	Description
Iron, Carbon Steel, 316 SS Threaded tees	• 0.5 to 2 in. versions • Mounts on threaded pipe ends
Carbon steel & stainless steel Weld-on Weldolets	• 2 to 4 inch, cut 1-7/16 inch hole in pipe • Over 4 inch, cut 2-1/4 inch hole in pipe
Fiberglass tees & saddles: FPT FPS	• 1.5 in. to 8 in. PVDF insert • > 8 in. PVC insert • Special order 12 in. to 36 in.
Metric Wafer Fitting	• For pipes DN 65 to 200 mm • PP or PVDF
Metric Union Fitting	• For pipes from DN 15 to 50 mm • PP or PVDF

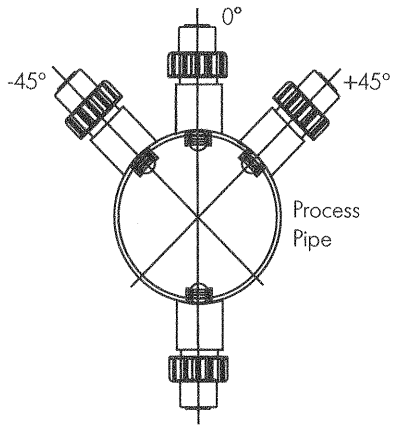
Installation

- Six common installation configurations are shown here as guidelines to help you select the best location in your piping system for a paddlewheel flow sensor.
- Always maximize distance between sensors and pump sources.



Sensor Mounting Position

- Horizontal pipe runs: Mount sensor in a vertical position for best performance, or at a maximum 45° angle to avoid air bubbles (pipe must be full). Do not mount the sensor on the bottom of the pipe if sedimentation is likely.
- Vertical pipe runs: Mount sensor in any orientation. Upward flow is preferred to ensure full pipe.



Maximum Operating Pressure/Temperature

515 Sensor:

Glass-filled Polypropylene Body:

12.5 bar (180 psi) max. @ 20°C (68°F)

1.7 bar (25 psi) max. @ 90°C (194°F)

PVDF Body:

14 bar (200 psi) max. @ 20°C (68°F)

1.7 bar (25 psi) max. @ 100°C (212°F)

2536 Sensor:

Polypropylene Body:

12.5 bar (180 psi) max. @ 20°C (68°F)

1.7 bar (25 psi) max. @ 85°C (185°F)

PVDF Body:

14 bar (200 psi) max. @ 20°C (68°F)

1.7 bar (25 psi) max. @ 85°C (185°F)

3519 Wet-Tap:

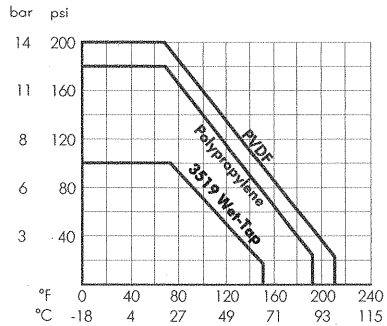
7 bar (100psi) max. @ -18° to 20°C (0° to 68°F)

1.4 bar (20 psi) max. @ 66°C (150°F)

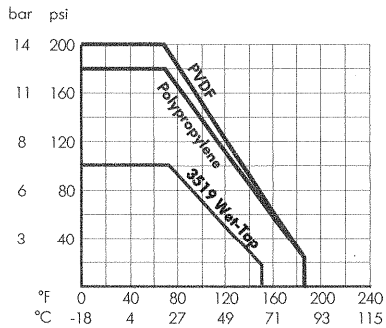
Note: Wet-tap max. installation/removal pressure:

1.7 bar (25 psi) @ 22°C (72°F).

515 Sensor

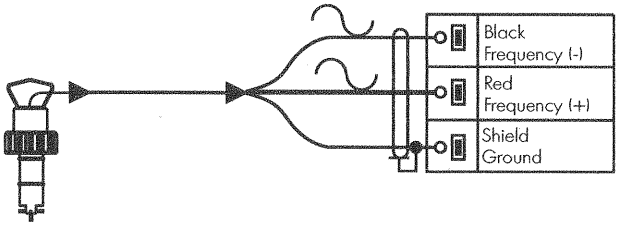


2536 Sensor

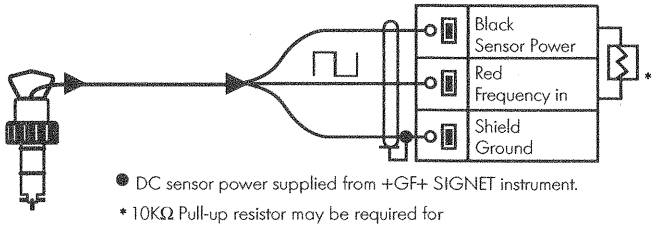


Wiring

515 Sensor Connection to +GF+ SIGNET Instruments



2536 Sensor Connection to +GF+ SIGNET Instruments



● DC sensor power supplied from +GF+ SIGNET instrument.

* 10KΩ Pull-up resistor may be required for non +GF+ SIGNET brand instrument

Technical Data

General (for both 515 & 2536)

Pipe Size Range: 15 to 1000 mm (0.5 to 36 in.)
Linearity: ±1% of full range
Repeatability: ±0.5% of full range
Minimum Reynolds Number Required: 4500
Wetted Materials:

Sensor Body:	Glass-filled Polypropylene (black) or PVDF (natural)
O-rings:	FPM-Viton® (std) or EPDM or FPM-Kalrez®
Pin:	Titanium or Hastelloy-C or PVDF; other material options available
Rotor:	Black PVDF or Natural PVDF; optional Tefzel with or w/o Fluoraloy B® sleeve

Cable Type: 2-conductor twisted pair with shield (22 AWG)

Shipping Weight:			
	-X0	0.454 kg	1 lb.
	-X1	0.476 kg	1.04 lbs.
	-X2	0.680 kg	1.50 lbs.
	-X3	0.794 kg	1.75 lbs.
	-X4	0.850 kg	1.87 lbs.
	-X5	1 kg	2.20 lbs.
	3519	1.3 kg	2.86 lbs.

Standards and Approvals (for both 515 & 2536):

- Manufactured under ISO 9001 and ISO 14001
- CE

General (515 Only)

Flow Rate Range: 0.3 to 6 m/s (1 to 20 ft./s)
Pipe Size Range: DN15 to DN1000 (0.5 to 36 in.)
Cable Length: 7.6 m (25 ft.) standard/60 m (200 ft.) maximum
Signal:
Frequency: 19.7 Hz per m/s nominal (6 Hz per ft/s)
Amplitude: 3.3 V p/p per m/s nominal (1 V p/p per ft/s)
Source Impedance: 8 Ω

Standards and Approvals (515 only):

- FM Class I, II, II/Div./groups A-G

General (2536 Only)

Flow Rate Range: 0.1 to 6 m/s (0.3 to 20 ft./s)
Pipe Size Range: DN15 to DN1000 (0.5 to 36 in.)
Cable Length: 7.6 m (25 ft.) standard/305 m (1,000 ft.) maximum
Signal:
Frequency: 49Hz per m/s nominal (15 Hz per ft/s nominal)
Supply voltage: 3.5 to 24 VDC regulated
Supply current: <1.5 mA @ 3.3 to 6 VDC
<20 mA @ 6 to 24 VDC
Output Type: Open collector transistor, sinking
Output Current: 10 mA max.

Ordering Information

515/8510-XX (Sinusoidal)

Mfr. Part No.	Code	Pipe Sizes	Body	Rotor/Pin
Remote				
P51530-H0	198 801 659	0.5 to 4 in.	Polypro	Blk PVDF/Hastelloy-C
P51530-P0	198 801 620	0.5 to 4 in.	Polypro	Blk PVDF/Titanium
P51530-P1	198 801 621	5 to 8 in.	Polypro	Blk PVDF/Titanium
P51530-P2	198 801 622	10 to 36 in.	Polypro	Blk PVDF/Titanium
Remote Wet-Tap				
P51530-P3	198 840 310	0.5 to 4 in.	Polypro	Blk PVDF/Titanium
P51530-P4	198 840 311	5 to 8 in.	Polypro	Blk PVDF/Titanium
P51530-P5	198 840 312	10 to 36 in.	Polypro	Blk PVDF/Titanium
Remote				
P51530-S0	198 801 661	0.5 to 4 in.	Polypro	Blk PVDF/Natural PVDF
P51530-T0	198 801 663	0.5 to 4 in.	Natural PVDF	Natural PVDF
P51530-T1	198 801 664	5 to 8 in.	Natural PVDF	Natural PVDF
P51530-V0	198 801 623	0.5 to 4 in.	Natural PVDF	Nat. PVDF/Hastelloy-C
P51530-V1	198 801 624	5 to 8 in.	Natural PVDF	Nat. PVDF/Hastelloy-C
P51530-V2	198 801 625	10 to 36 in.	Natural PVDF	Nat. PVDF/Hastelloy-C
Integral				
3-8510-P0	198 864 504	0.5 to 4 in.	Polypro	Blk PVDF/Titanium
3-8510-P1	198 864 505	5 to 8 in.	Polypro	Blk PVDF/Titanium
3-8510-T0	159 000 622	0.5 to 4 in.	Natural PVDF	Natural PVDF
3-8510-V0	198 864 506	0.5 to 4 in.	Natural PVDF	Nat. PVDF/Hastelloy-C
2536/8512-XX (Open-Collector)				
Remote				
3-2536-P0	198 840 143	0.5 to 4 in.	Polypro	Blk PVDF/Titanium
3-2536-P1	198 840 144	5 to 8 in.	Polypro	Blk PVDF/Titanium
3-2536-P2	198 840 145	10 to 36 in.	Polypro	Blk PVDF/Titanium
3-2536-T0	198 840 149	0.5 to 4 in.	Natural PVDF	Natural PVDF
3-2536-V0	198 840 146	0.5 to 4 in.	Natural PVDF	Nat. PVDF/Hastelloy-C
3-2536-V1	198 840 147	5 to 8 in.	Natural PVDF	Nat. PVDF/Hastelloy-C
Remote Wet-Tap				
3-2536-P3	159 000 758	0.5 to 4 in.	Polypro	Blk PVDF/Titanium
3-2536-P4	159 000 759	5 to 8 in.	Polypro	Blk PVDF/Titanium
3-2536-P5	159 000 760	10 to 36 in.	Polypro	Blk PVDF/Titanium
Integral				
3-8512-P0	198 864 513	0.5 to 4 in.	Polypro	Blk PVDF/Titanium
3-8512-P1	198 864 514	5 to 8 in.	Polypro	Blk PVDF/Titanium
3-8512-T0	198 864 518	0.5 to 4 in.	Natural PVDF	Natural PVDF
3-8512-V0	198 864 516	0.5 to 4 in.	Natural PVDF	Nat. PVDF/Hastelloy-C
Wet-Tap Sensor and Valve Assembly (Fitting Separate)				
Remote Wet-Tap				
3519/515-P3	159 000 819	0.5 to 4 in.	Polypro	Blk PVDF/Titanium
3519/515-P4	159 000 820	5 to 8 in.	Polypro	Blk PVDF/Titanium
3519/515-P5	159 000 821	10 to 36 in.	Polypro	Blk PVDF/Titanium
3519/2536-P3	159 000 822	0.5 to 4 in.	Polypro	Blk PVDF/Titanium
3519/2536-P4	159 000 823	5 to 8 in.	Polypro	Blk PVDF/Titanium
3519/2536-P5	159 000 824	10 to 36 in.	Polypro	Blk PVDF/Titanium

Accessories

Mfr. Part. No.	Code	Description
Rotors 515/8510-XX		
M1538-2	198 801 181	Rotor, PVDF Black
P51547-3	159 000 474	Rotor, PVDF Natural
M1538-4	198 820 018	Rotor, Tefzel®
P51550-3	198 820 043	Rotor and Pin, PVDF Natural
3-0515.322-1	198 820 059	Sleeved Rotor, PVDF Black
3-0515.322-2	198 820 060	Sleeved Rotor, PVDF Natural
3-0515.322-3	198 820 017	Sleeved Rotor, Tefzel®

Accessories (continued)

Mfr. Part No.	Code	Description
Rotors 2536/8512-XX		
3-2536.320-1	198 820 052	Rotor, PVDF Black
3-2536.320-2	159 000 272	Rotor, PVDF Natural
3-2536.320-3	159 000 273	Rotor, Tefzel®
3-2536.321	198 820 054	Rotor and Pin, PVDF Natural
3-2536.322-1	198 820 056	Sleeved Rotor, PVDF Black
3-2536.322-2	198 820 057	Sleeved Rotor, PVDF Natural
3-2536.322-3	198 820 058	Sleeved Rotor, Tefzel®
Rotor Pins		
M1546-1	198 801 182	Pin, Titanium
M1546-2	198 801 183	Pin, Hastelloy-C
M1546-3	198 820 014	Pin, Tantalum
M1546-4	198 820 015	Pin, Stainless Steel
P51545	198 820 016	Pin, Ceramic
O-Rings		
1220-0021	198 801 186	O-Ring, FPM-Viton®
1224-0021	198 820 006	O-Ring, EPDM
1228-0021	198 820 007	O-Ring, FPM-Kalrez®
Miscellaneous		
P31536	198 840 201	Sensor Plug, Polypro
P31536-1	198 840 202	Sensor Plug, PVDF Metric
P31536-2	159 000 649	Sensor Plug, PVDF
P31542	198 801 630	Sensor Cap, Red (for use w/515)
P31542-3	159 000 464	Sensor Cap, Blue (for use w/2536)
P31934	159 000 466	Conduit Cap
P51589	159 000 476	Conduit Adapter Kit
5523-0222	159 000 392	Cable (per foot), 2 cond. w/shield, 22 AWG
3-8051	159 000 187	Transmitter Integral Adapter

Engineering Specifications for both 515 and 2536 Flow Sensors

- The flow sensor shall use a four-blade, open-cell rotor design using insertion paddlewheel technology.
- Linearity of the output signal with respect to flow rate shall be ±1 % of full range.
- Measurement repeatability of the output signal with respect to flow rate shall be ±0.5 % of full range.
- The sensor body shall be made of injection-molded polypropylene (PP) that shall accommodate up to 12.5 bar @ 20°C (180 psi @ 68°F) and 1.7 bar @ 90°C (25 psi @ 194°F). As an alternative, the sensor shall be made of injection-molded polyvinylidene fluoride (PVDF) that shall accommodate up to 14 bar @ 20°C (200 psi @ 68°F) and 1.7 bar @ 100°C (25 psi @ 212°F).
- The sensor shall attach to a pipe via a variety of insertion-style installation fittings supplied by the flow sensor manufacturer. Attachment shall use a 1-1/4 X 11-1/2 NPSM threaded cap. Sealing shall be accomplished with a double O-ring seal. O-rings shall be made of FPM-Viton®, FPM-Kalrez® or EPDM.
- The sensor shall be equipped with 0.5 in. female conduit connection.

Engineering Specifications for +GF+ SIGNET 515 Rotor-X Flow Sensor

- The sensor shall require no electrical power.
- The sensor shall provide an output signal of 3.3 V p-p per m/s nominal (1 V p-p per ft/s) at a frequency of 19.7 Hz per m/s nominal (6 Hz per ft/s) from 0.3 to 6 m/s (1 to 20 ft/s).
- Output shall be via a twisted pair, foil-shielded cable with drain wire. Supplied cable shall be at least 7.6 m (25 ft) long, with a maximum allowable length of 60 m (200 ft).
- The operating range of the sensor shall accommodate nominal flow rates from 0.3 to 6 m/s (1 to 20 ft/s).
- The sensor shall meet appropriate CE standards and FM standards for Classes 1, 11 and 111, Division I/Groups A-G.

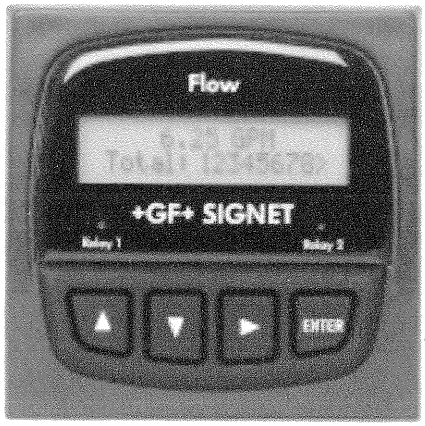
Engineering Specifications for +GF+ SIGNET 2536 Low Flow Sensor

- The sensor shall operate with a power input of 3.3 to 6VDC @ <1.5 mA or from 6 to 24 VDC @ <20 mA.
- The sensor output shall provide an open-collector pulse at a frequency of 49.2 Hz per m/s nominal (15 Hz per ft/s).
- Output shall be via a twisted pair, foil-shielded cable with drain wire. Supplied cable shall be at least 7.6 m (25 ft) long, with a maximum allowable length of 305 m (1000 ft).
- The operating range of the sensor shall accommodate nominal flow rates from 0.1 to 6 m/s (0.3 to 20 ft/s).
- The sensor shall meet appropriate CE standards.

+GF+ SIGNET 8550 Flow Transmitters

3-8550-X (Field)

3-8550-XP (Panel)



Features

- **Permanent & resettable totalizers**
- **Scaleable outputs**
- **Relay options**
- **Mounting versatility**
- **2 x 16 character dot matrix LCD**
- **NEMA 4X enclosure with self-healing window**
- **Large pushbuttons**
- **Numbered terminals**
- **Output simulation for complete system testing**

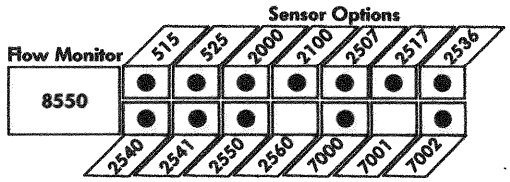
Application

- **Flow control and monitoring**
- **Filtration or softener regeneration**
- **Effluent totalization**
- **Pump protection**
- **Feed pump pulsing**
- **Ratio control**
- **Water distribution**
- **Leak detection**

Description

+GF+ SIGNET 8550 Flow Transmitters are advanced instruments that convert the signal from all +GF+ SIGNET flow sensors into a 4 to 20 mA signal for long distance transmission. Configuration flexibility is maximized with single or dual input/output, two optional relays for process control, two packaging options for integral/pipe mount or panel installation, and scalability for virtually any flow range or engineering unit. State-of-the-art electronic design ensures long-term reliability, signal stability, and simple user setup and operation.

Options

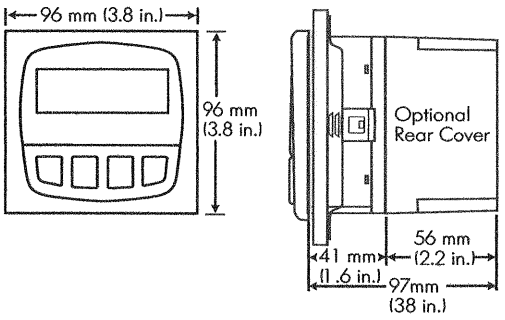


Technical Features

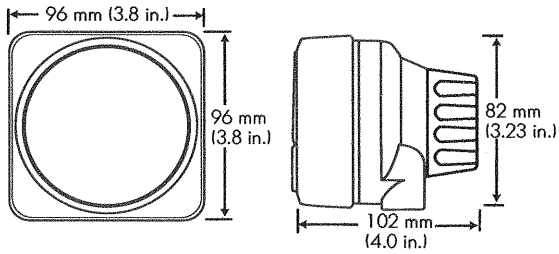
Mounting Version	Part No.	Wire Power	Sensor Input	4 to 20 mA Output	Open Collector/ Relay
Field 	3-8550-1	2/4 non-powered and powered sensors	1	1	1 O.C. Hi, Lo, Pulse Freq or Off
	3-8550-2	4 non-powered and powered sensors	1	1	2 Relays Hi, Lo, Pulse or Off
	3-8550-3	2/4 non-powered and powered sensors	2	2 Sensor 1, Sensor 2 or delta Flow	2 O.C.'s Hi, Lo, Pulse Freq or Off
Panel 	3-8550-1P	2/4 non-powered and powered sensors	1	1	1 O.C. Hi, Lo, Pulse Freq or Off
	3-8550-2P	4 non-powered and powered sensors	1	1	2 Relays Hi, Lo, Pulse or Off
	3-8550-3P	2/4 non-powered and powered sensors	2	2 Sensor 1, Sensor 2 or delta Flow	2 O.C.'s Hi, Lo, Pulse Freq or Off

Dimensions

Panel Mount



Integral/Universal Mount

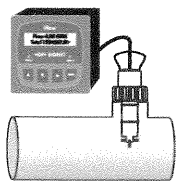


Installation

The transmitter is available in a panel mount or a field version. The field version is mounted to the sensor using the integral mount kit (3-8051) or you may select the universal mount kit (3-8050) to mount the transmitter on a surface near the sensor.

1. Panel Mount

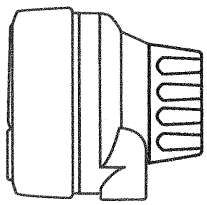
3-8550-XP



All panel mount transmitters (3-8550-XP) include a mounting bracket and gasket for a NEMA 4X watertight panel installation. Panel mount transmitters fit into a standard 1/4 DIN panel cutout.

2. Integral Mount

3-8051Kit

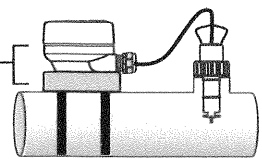


The Integral Mount Kit (3-8051) can be ordered separately and includes a conduit base, locking ring, and integral adapter for mounting the transmitter directly onto a sensor.

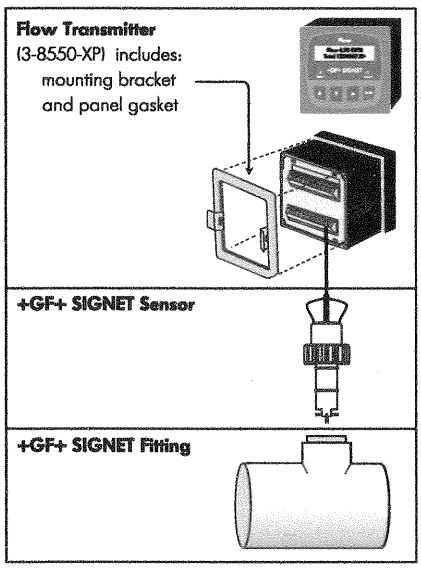
3. Universal Mount

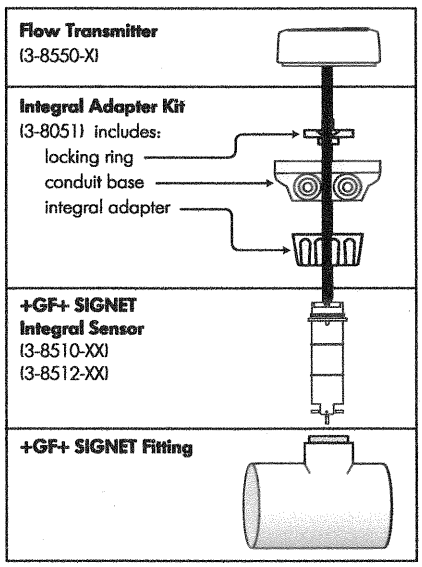
3-8550-X Transmitter

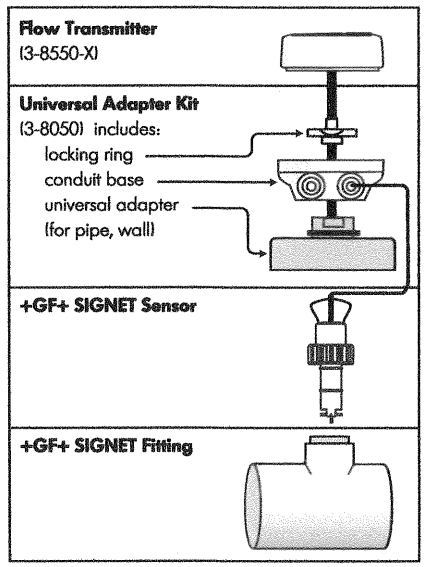
3-8050 Kit



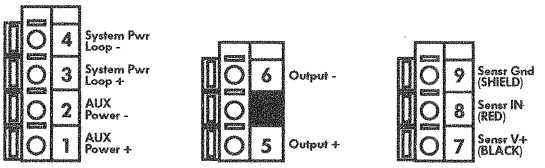
The Universal Mount Kit (3-8050) can be ordered separately and includes a conduit base, locking ring, and universal adapter for mounting the transmitter on a pipe, wall, or other stationary surface.



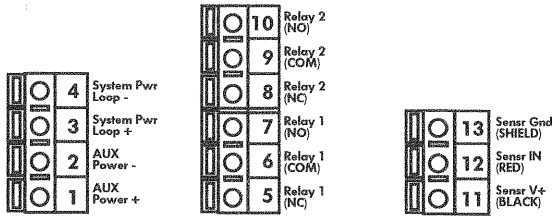




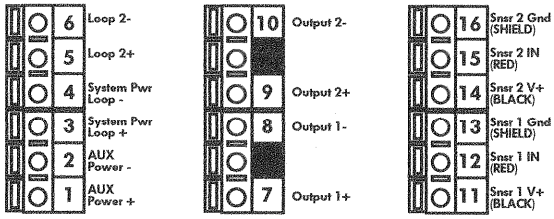
Rear Terminal View



Terminal 8550-1



Terminal 8550-2



Terminal 8550-3

Note: The terminal blocks are not labeled on the back of the unit. An adhesive label is supplied with terminal descriptions to serve as a remote terminal display.

Technical Data

General

Compatibility:
+GF+ SIGNET Flow Sensors with frequency outputs (all except 2560 and 7001)
Accuracy: ± 0.5% of reading @ 25°C
Enclosure:
- Rating: NEMA 4X/IP65 front
- Case: PBT
- Panel Case Gasket: Neoprene
- Window: Polyurethane coated polycarbonate
- Keypad: Sealed 4-key silicone rubber
- Shipping Weight: 0.325kg (0.8 lbs.)

Display:
- Alphanumeric 2 x 16 LCD
- Update rate: 1 second
- Contrast: User selectable, 5 levels

Environmental

Operating temperature:
-10 to 70°C (14 to 158°F)
Storage temperature:
-15 to 80°C (5 to 176°F)
Relative humidity:
0 to 95%, non-condensing

Standards and Approvals

- CE, UL listed
- Manufactured under ISO 9001 and ISO 14001
- NEMA 4X and IP65

Electrical

Power:
- 12 to 24 VDC ±10%, regulated
  (-1) 61 mA max.; (-2) 200 mA max.; (-3) 122 mA max.

Sensor Input:
- Range: 0.5 to 1500 Hz
- Sensor power:
  2-wire: 1.5 mA @ 5 VDC ± 1%
  3 or 4 wire: 20 mA @ 5 VDC ± 1%
- Optically isolated from current loop
- Short circuit protected

Current output:
- 4 to 20 mA, isolated, fully adjustable and reversible
- Max loop impedance:
  50Ω max. @ 12 V,
  325Ω max. @ 18 V,
  600Ω max. @ 24 V
- Update rate: 100 ms
- Accuracy: ±0.03 mA

Relay output:
- Mechanical SPDT contacts: Hi, Lo, Pulse, Off
- Maximum voltage rating: 5 A @ 30 VDC, 5 A @ 250 VAC resistive load
- Hysteresis: User selectable
- Max 300 pulses/min.

Open-collector output: Hi, Lo, Pulse, Off
- Open-collector, optically isolated, 50 mA max. sink, 30 VDC max. pull-up voltage.
- Max 300 pulses/min.
- Hysteresis: User selectable

Ordering Information

Mfr. Part No.	Code	Description
3-8550-1	159 000 047	Flow transmitter, Field mount
3-8550-1P	159 000 048	Flow transmitter, Panel mount
3-8550-2	159 000 049	Flow transmitter, Field mount with relays
3-8550-2P	159 000 050	Flow transmitter, Panel mount with relays
3-8550-3	159 000 051	Flow transmitter, Field mount with dual input/output
3-8550-3P	159 000 052	Flow transmitter, Panel mount with dual input/output

Accessories

Mfr. Part No.	Code	Description
3-8050	159 000 184	Universal mounting kit
3-8050.395	159 000 186	Transmitter NEMA 4X cover
3-8051	159 000 187	Flow Integral Mnt NPT
3-8052	159 000 188	3/4 in. Integral Mounting Kit
3-8050.396	159 000 617	RC Filter kit (for relay use)
3-8050.392	159 000 640	Model 200 retro-fit adapter
3-0000.596	159 000 641	Heavy duty wall mount bracket
3-5000.598	198 840 225	Surface Mount Bracket
3-9000.392	159 000 368	Liquid tight connector kit for rear cover (includes 3 connectors)
3-9000.392-1	159 000 839	Liquid tight connector kit, NPT (1 piece)
3-9000.392-2	159 000 841	Liquid tight connector kit, PG13.5 (1 piece)

Engineering Specifications

- The transmitter shall meet appropriate CE, & UL standards.
- The transmitter shall be manufactured under ISO 9001 and ISO 14001 certified processes.
- The transmitter shall be field or panel mountable.
- The transmitter shall have flow rate and dual totalization capability.
- The display units shall be fully scaleable.
- The device shall meet NEMA 4X and IP65 standards.
- The operating voltage shall be 12 to 24 VDC.
- The transmitter shall have a 4 to 20 mA output with an open collector output, 5 to 30 VDC or a 4 to 20 mA output with 2 relays, or dual 4 to 20 mA output with dual open collector with delta capability.
- The transmitter shall have simulate capability.
- The transmitter shall be +GF+ SIGNET 8550 Flow Transmitter.

Engineering Science Department Requisition

SENIOR DESIGN TEAM - Trinity University

Date: 3 / 4 / 2009

Vendor Information

Company Name:	Larry Wunsch & Assoc, INC
Attention/CONTACT:	Allen Burns
Street Address:	120 Interloop Rd.
City, State, Zip:	San Antonio, TX, 78216
Phone #:	210-349-5244
FAX #:	210-349-6129
Web Address:	www.lwai.net

Request Information

CHECK ONE □ Reimbursement

■ Please Order

For Departmental Use Only

Date Processed: __ / __ / ____ □ **JMM** □ **EAA**

Ordered: □ Using PCARD

□ Using DPO#_____

Method: □ By phone

□ By FAX

□ By Web

Required Del. Date A.S.A.P.

Deliver: X **Yes** ___ **No**

Pick-up: ___ **Yes** X **No**

Departmental Information

Address: Trinity University Engineering
Central Receiving
607 Kings Court
San Antonio TX 78212-7200

Tax ID# 74-11-09633

CATALOG/PART #	DESCRIPTION	Qty	UNIT COST	EXTENDED COST
CR3-4	Grundfos Multi-Stage pump, ¾ hp	1	$943.00	
	Shipping Cost			
			Total	$943.00

Team Contact Name: John Curran

Team Contact Student ID #:

Team Contact Phone #: 210 557 4010

Project Name: Condensate Collection

Approved by ADVISOR:

LARRY WUNSCH & ASSOC., INC.
LWA
20 Years of Service

120 Interloop Rd.
San Antonio, Tx 78216-7042
Phone: 210-349-5244
Fax: 210-349-6129

5214 Burleson Rd #106
Austin, Tx 78744-1223
Phone: 512-326-9114
Fax: 512-326-9116

www.lwai.net

ATTN: JOHN CURRAN

QUOTATION

DATE 3-4-09

CUSTOMER TRINITY UNIV.

PROJECT

1- GRUNDFOS MODEL CR3-4 MULTI-STAGE PUMP, 3/4HP, 115/230/1φ, 17 GPM @ 85' HEAD

$943.00

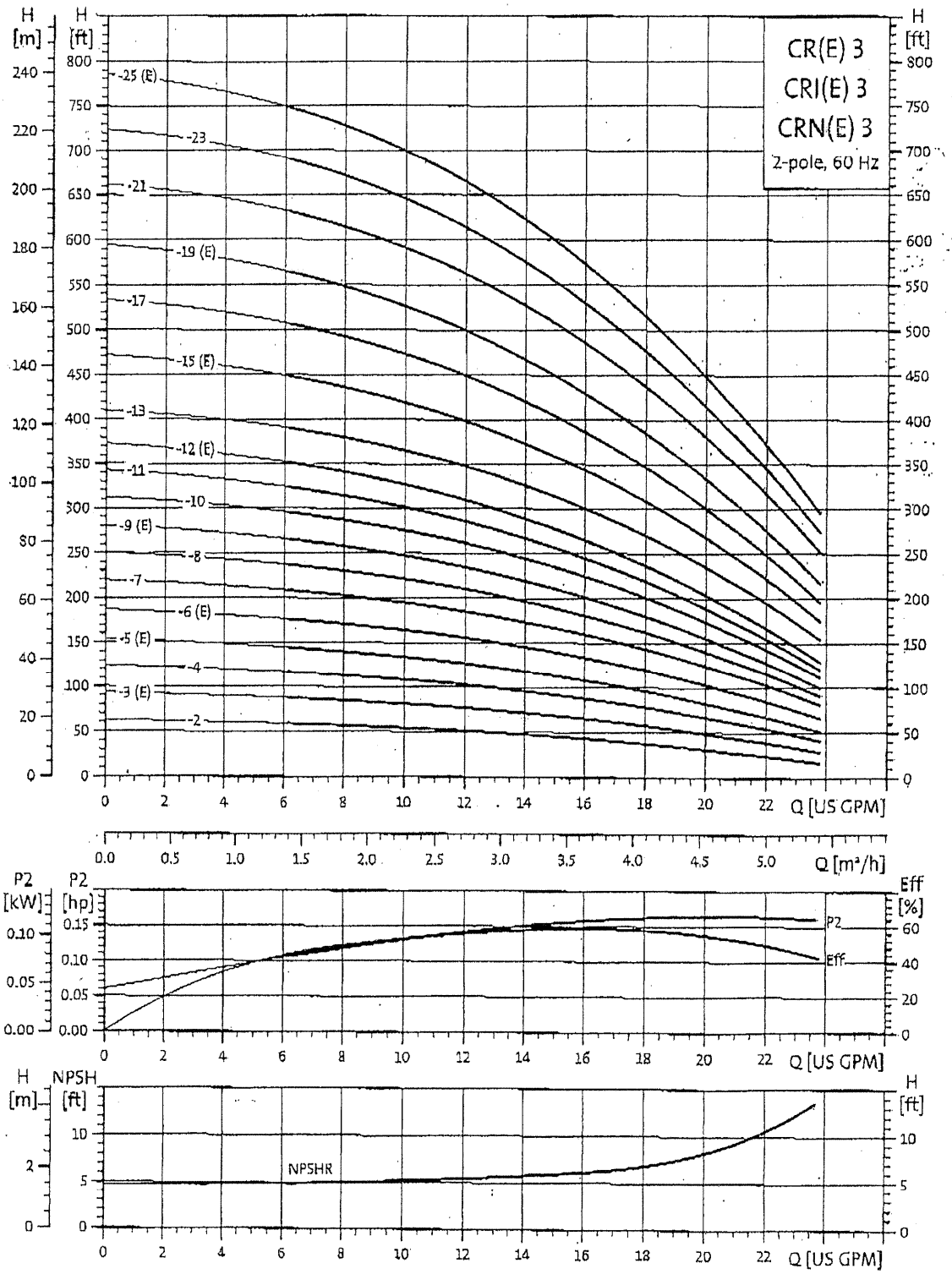
7-10 days lead time

Quote # AB 34091024

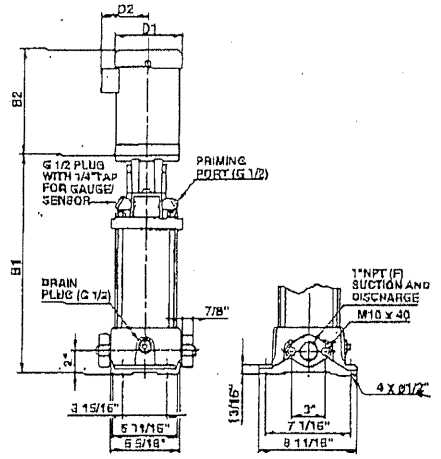
Thanks for your consideration

Allen Burns
ab@lwai.net

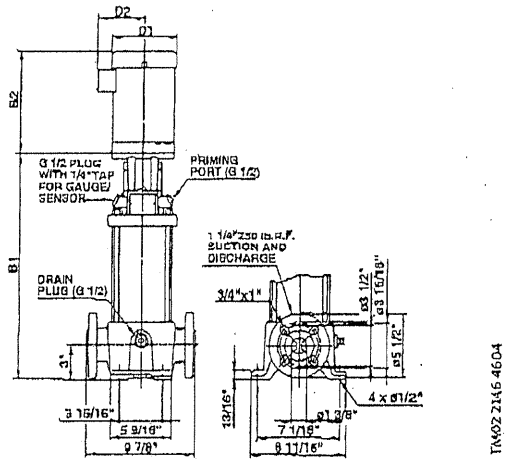
Performance curves



Dimensional sketches



TM02 2147 4604



TM02 2146 4604

Dimensions and weights

Pump type	Hp	Ph	Voltage	NEMA Frame size	Oval B1	ANSI B1	ODP D1	ODP D2	TEFC D1	TEFC D2	Oval ODP B1+B2	Oval TEFC B1+B2	ANSI ODP B1+B2	ANSI TEFC B1+B2	Oval Ship Wt.[1] [lbs.]	ANSI Ship Wt.[1] [lbs.]	MLE D1	MLE D2	Oval MLE B1+B2	ANSI MLE B1+B2	Oval Ship Wt.[1] [lbs.]	ANSI Ship Wt.[1] [lbs.]
CR 3-2	1/3	1	115/230	56C	11	12	5 3/4	4 7/8	6 1/4	5	20 3/8	20 3/8	21 3/8	21 3/8	53	62	-	-	-	-		
		3	208-230/460	56C	11	12	6 1/4	4 1/2	6 1/4	5	20 1/2	20 3/8	21 1/2	21 3/8	53	62	-	-	-	-		
CR(E) 3-3	1/2	1	115/230	56C	11	12	5 3/4	4 7/8	6 1/4	5	20 3/8	20 3/8	21 3/8	21 3/8	52	61	5 1/2	5 1/2	18 1/2	19 1/2	54	63
		3	208-230/460	56C	11	12	6 1/4	4 1/2	6 1/4	5	20 1/4	20 3/8	21 1/4	21 3/8	52	61	-	-	-	-	-	-
CR 3-4	3/4	1	115/208-230	56C	11 3/4	12 3/4	6 1/4	4 7/8	6 1/4	5	22 3/4	21 3/4	23 3/4	22 3/4	55	64	-	-	-	-	-	-
		3	208-230/460	56C	11 3/4	12 3/4	6 1/4	4 1/2	6 1/4	5	22 1/4	21 1/8	22 1/4	22 1/8	55	64	-	-	-	-	-	-
CR(E) 3-5	3/4	1	115/208-230	56C	12 1/2	13 1/2	6 1/4	4 7/8	6 1/4	5	23 1/2	22 1/2	24 1/2	23 1/2	55	64	5 1/2	5 1/2	20	21	57	66
		3	208-230/460	56C	12 1/2	13 1/2	6 1/4	4 1/2	6 1/4	5	22	21 7/8	23	22 7/8	55	64	-	-	-	-	-	-
CR(E) 3-6	1	1	115/208-230*	56C	13 1/8	14 1/8	7 1/4	5 5/8	7 1/4	5 3/4	24 3/8	24 3/8	25 3/8	25 3/8	57	66	5 1/2	5 1/2	22 1/4	23 1/4	60	69
		3	208-230/460	56C	13 1/8	14 1/8	7 1/4	5 5/8	7 1/4	5 3/4	22 5/8	23 3/8	23 5/8	24 3/8	57	66	7	6 5/8	24 5/8	25 5/8	73	82
CR 3-7	1 1/2	1	115/208-230	56C	13 7/8	14 7/8	7 1/4	5 5/8	7 1/4	5 3/4	25 5/8	25 5/8	26 5/8	26 5/8	65	75	-	-	-	-	-	-
		3	208-230/460	56C	13 7/8	14 7/8	7 1/4	5 5/8	7 1/4	5 3/4	24 5/8	24 5/8	25 5/8	25 5/8	65	75	-	-	-	-	-	-
CR 3-8	1 1/2	1	115/208-230	56C	14 5/8	15 5/8	7 1/4	5 5/8	7 1/4	5 3/4	26 3/8	26 3/8	27 3/8	27 3/8	67	77	-	-	-	-	-	-
		3	208-230/460	56C	14 5/8	15 5/8	7 1/4	5 5/8	7 1/4	5 3/4	25 3/8	25 3/8	26 3/8	26 3/8	67	77	-	-	-	-	-	-
CR(E) 3-9	1 1/2	1	115/208-230	56C	15 1/4	16 1/4	7 1/4	5 5/8	7 1/4	5 3/4	27	27	28	28	68	79	5 1/2	5 1/2	24 3/8	25 3/8	69	78
		3	208-230/460	56C	15 1/4	16 3/4	7 1/4	5 5/8	7 1/4	5 3/4	26	26	27	27	68	79	7	6 5/8	26 3/4	27 3/4	81	91
CR 3-10	2	1	115/208-230*	56C	16	17	7 1/4	5 5/8	7 1/4	5 3/4	27 3/4	28 5/8	28 3/4	29 5/8	74	85	-	-	-	-	-	-
		3	208-230/460	56C	16	17	7 1/4	5 5/8	7 1/4	5 3/4	26 3/4	27 3/4	27 3/4	28 3/4	74	85	-	-	-	-	-	-
CR 3-11	2	1	115/208-230*	56C	16 3/4	17 3/4	7 1/4	5 5/8	7 1/4	5 3/4	28 1/2	29 3/8	29 1/2	30 3/8	77	86	-	-	-	-	-	-
		3	208-230/460	56C	16 3/4	17 3/4	7 1/4	5 5/8	7 1/4	5 3/4	27 1/2	28 1/2	28 1/2	29 1/2	77	86	-	-	-	-	-	-
CR(E) 3-12	2	1	115/208-230*	56C	17 3/8	18 3/8	7 1/4	5 5/8	7 1/4	5 3/4	29 1/8	30	30 1/8	31	78	87	-	-	-	-	-	-
		3	208-230/460	56C	17 3/8	18 3/8	7 1/4	5 5/8	7 1/4	5 3/4	28 1/8	29 1/8	29 1/8	30 1/8	78	87	7	6 5/8	28 7/8	29 7/8	98	107
CR 3-13	3	1	115/208-230	182TC	19 1/4	20 1/8	8 1/2	6 3/4	8 5/8	6 7/8	33 3/4	33 3/4	34 5/8	34 5/8	95	104	-	-	-	-	-	-
		3	208-230/460	182TC	19 1/4	20 1/8	7 1/4	5 5/8	8 5/8	6 7/8	30 5/8	31 3/4	31 1/2	32 5/8	95	104	-	-	-	-	-	-
CR(E) 3-15	3	1	115/208-230	182TC	20 5/8	21 5/8	8 1/2	6 3/4	8 5/8	6 7/8	35 1/8	35 1/8	36 1/8	36 1/8	96	105	-	-	-	-	-	-
		3	208-230/460	182TC	20 5/8	21 5/8	7 1/4	5 5/8	8 5/8	6 7/8	32	33 1/8	33	34 1/8	96	105	7	6 5/8	34	35	111	120
CR 3-17	3	1	115/208-230	182TC	22	23	8 1/2	6 3/4	8 5/8	6 7/8	36 1/2	36 1/2	37 1/2	37 1/2	97	106	-	-	-	-	-	-
		3	208-230/460	182TC	22	23	7 1/4	5 5/8	8 5/8	6 7/8	33 3/8	34 1/2	34 3/8	35 1/2	97	106	-	-	-	-	-	-
CR(E) 3-19	3	1	115/208-230	182TC	-	24 3/8	8 1/2	6 3/4	8 5/8	6 7/8	-	-	38 7/8	38 7/8	-	107	-	-	-	-	-	-
		3	208-230/460	182TC	-	24 3/8	7 1/4	5 5/8	8 5/8	6 7/8	-	-	35 3/4	36 7/8	-	107	7	6 5/8	-	37 3/4		123
CR 3-21	5	1	208-230	182TC	-	25 7/8	10 5/8	7 3/8	10 5/8	7 1/2	-	-	41 1/4	41 1/4	-	116	-	-	-	-	-	-
		3	208-230/460	182TC	-	25 7/8	7 1/4	5 5/8	8 1/2	6	-	-	40	41 7/8	-	116	-	-	-	-	-	-
CR 3-23	5	1	208-230	182TC	-	27 1/4	10 5/8	7 3/8	10 5/8	7 1/2	-	-	42 5/8	42 5/8	-	118	-	-	-	-	-	-
		3	208-230/460	182TC	-	27 1/4	7 1/4	5 5/8	8 1/2	6	-	-	41 3/8	43 1/4	-	118	-	-	-	-	-	-
CR(E) 3-25	5	1	208-230	182TC	-	28 5/8	10 5/8	7 3/8	10 5/8	7 1/2	-	-	44	44	-	121	-	-	-	-	-	-
		3	208-230/460	182TC	-	28 5/8	7 1/4	5 5/8	8 1/2	6	-	-	42 3/4	44 5/8	-	121	8 2/3	7 1/2	-	44 1/8		162

* TEFC voltage is 115/230

[1] Weights based on pump with ODP motor (see price list for individual weights)

All dimensions in inches unless otherwise noted.