2. Engineering Performance Requirements

2.1 Objective

Auratus Embedded Systems will be producing a product called Fish Guard. This product shall be used to monitor the operating conditions of a water pump. This pump is used to circulate filtered water through a koi pond. There shall be sensors that will monitor the water pressure, temperature, flow rate, and conductivity at the exit of the pump. The data from these sensors shall be sampled every 10 minutes and processed in the stand-alone unit that will be mounted outside at the pump. The data shall then be converted to a digital signal and will be sent by radio transmission to a unit that is connected to the user’s PC. This home unit shall serially transmit the data to the PC. The PC shall then allow the user to view the most current data sample and the average readings for the last 24 hours. Figures 3 and 4 describe the product and shows the general environment in which it is to operate.

![Diagram](image)

Figure 3 – Outdoor Diagram

![Diagram](image)

Figure 4 – Indoor Diagram
2.2 Power Requirements and Operational Time / Life

The power of the home unit and the stand-alone unit shall be obtained from direct 110V AC at 60 Hz outlet. The home unit shall use an AC adapter supplied by Zworld that convert the AC voltage to DC of 9V input, which is regulated down to 5V on the development board. The AC adapter shall have a maximum output current of 1A. Power dissipation for the home unit shall be 3-9 watts.

In the stand-alone unit, a custom power supply shall be built to convert from AC to DC voltage. The power supply shall have an input voltage of 85-132 VAC @ 60Hz. This power supply shall have a line regulation of 48mV. The output voltage shall be 12VDC ±10% with ripple and noise at ±150mV. Depending on the voltage requirements of the sensors, the DC output of the power supply shall be regulated to 3 – 10 volts. The DC output of the power supply shall be regulated to 5V DC to power the Zworld core unit. The maximum output current of the power supply shall be 750mA. The operating temperature of this custom-built power supply shall be -10°C to 60°C. Power dissipation of the stand alone unit shall be 4-10 watts.

2.3 Packaging and Enclosure

The Fish Guard consists of two different modules, a remote unit and a home unit. Both of these units need to be packaged in rugged enclosures. Also some of our sensors may need their own enclosures, but this all depends on the final sensors we use. The home unit should be the easiest to package since we will be using the Zworld microprocessor and development board with LCD and keypad. We will thus design an enclosure around the development board that will roughly look like figure 5 below. The dimensions of the enclosure shall be 7.5 x 5.5 x 2 inches.

![Figure 5 - Home Unit Enclosure](image)

The home unit shall be very rugged and shall have openings for the LCD screen, keypad and power cord. The type of material we will use to construct the enclosure shall be sheet metal since it is relatively cheap and easy to design around with the software we have available (Solid Edge 5.0). The enclosure shall be relatively easy to open with the help of a screwdriver, this shall make the Fish Guard easy to service in the field. This unit shall always be inside, so there will be no exposure to extreme temperature or weather conditions. If needed, vents shall be added for cooling.

For the remote unit we shall be creating a rugged case that shall be able to with stand harsh weather conditions. We shall use either acrylic plastic or weather proof sheet metal. The enclosure shall waterproof since it will always be outside next to the pump. This remote unit shall be mounted on the pump itself, so it shall never come in contact with the ground, staying out of standing water. Mounting straps to tie the remote unit to the PVC pipe of the pump shall be used. The dimensions shall be 8.0 x 6.5 x 2.0 inches. Figure 6 is a sketch of the remote.
Finally, the packaging of the sensor will require extra care. Silicon caulking will be used on all openings to ensure that no moisture gets into the remote unit. We shall also use weather resistive shrink-wrap for all sensor and power wires that will be exposed to the outside elements.

2.4 Environmental Operational Requirements

The stand-alone unit shall be operating outdoors. Because of the possibility of exposure to heat and humidity, it shall be designed to withstand humidity level from 5% to 95%, non-condensing. The operating temperature shall be between 0° to 37°C. The stand-alone unit shall be placed as close to the water pump as possible, thus avoiding contact with the pond and the fish. The home unit shall operate under normal room temperature. It shall be placed in a safe location where water does not come into contact with the unit. In addition, neither the home or the stand alone unit shall have direct contact with sunlight. Increased temperature may cause malfunction during operation. The home unit shall be placed near the users PC.

2.5 Regulatory and Safety Requirements

The home unit shall be with in all safety and regulatory requirements since we will be using the existing Zworld development board. The transceiver communications circuit on both the home unit and the remote unit shall be well with in all FCC standards for communications devices. This includes the frequency range and all power requirements for signal amplification. On the remote unit we shall use an earth ground and AC voltage of 120V 60Hz. This voltage will be regulated down to 5 volts dc @ 2.0 amps on board the remote unit. By using proper grounding (Earth ground) and filtering circuits we will stay within all government regulations. We will also be using fuses in case of any current surges on the voltage supplies. The enclosures shall be made with no sharp or dangerous edges.

2.6 User Interface and Operation

The user shall interface with the Fish Guard system through the PC terminal. The user shall access the executable program that is constantly monitoring the remote unit sensor data. The program will then display the average values for the previous 24 hours. The home unit will also have a LCD display that shall list the current conditions and any system operational errors, such as a power failure, or the inability to receive data from the stand alone unit. Each unit shall also have led’s to indicate that the system is powered and running properly.

2.7 Sensor Requirements

There will be four sensors connected to the Stand Alone Unit. Each sensor shall have different design, power and signal conditioning requirements.

2.7.1 Pressure Sensor

The pressure sensor will be mounted next to the main 2" PVC pipe. The model PX260-015 from Omega Engineering shall be used. It will require that the pipe is opened and a .2 inch tube shall be routed off the pipe. The water shall then flow into the pipe and apply pressure against the diaphragm of the sensor. The other side of the diaphragm of the sensor will be the open air, so
the sensor reading will be the pressure of the pipe relative to the outside air pressure. The sensor requires a 10V DC input. It can measure pressure values between 0 to 15 PSI and will output a linear analog voltage between 0 and 100mV ±2mV. This signal will then be sent through the A/D converter in the Stand Alone Unit and finally to the microprocessor.

2.7.2 Flow Rate Sensor
The flow rate sensor that shall be used is the model 220P-2 sensor from Seametrics. The flow sensor is enclosed within its' own PVC pipe housing that matches the diameter of the pipe being used at the pump. The flow itself shall be measured by using a rotating magnet Hall-effect sensor. The signal that is sent from the flow sensor is a square wave. The pulses of the sensor output shall be counted until the sensor outputs 16 pulses. The time it takes for the sensor to output those pulses shall be stored in the microcontroller core memory.

2.7.3 Conductivity Sensor
The conductivity sensor that will be used shall be the model CDCN-104 from Omega Engineering. This sensor requires a 1” threaded insert and will be mounted in the pipe by means of an insert with an additional hole that is 90° off of the main flow line. The signal shall then be converted from analog to digital in the Stand Alone Unit.

2.7.4 Temperature Sensor
The temperature sensor is a simple thermistor that shall provide a resistance value that is proportional to the temperature of the environment that it shall be exposed in. A 2.5V reference voltage shall be applied across the sensor, after which signal conditioning and analog to digital conversion shall provide the proper data value.

2.8 Test Points / Jumpers for Product Verification and Diagnosis
We shall be using a lot of test points (pin headers) and jumpers on both of our home and remote unit. On the home unit we shall have test points on every address line data line and control line of the system bus. On the remote unit we shall again have test points on all the system buses (address, data and control lines). This shall be done with square pin headers so that it is easy to hook up a logic analyzer and diagnosis possible problems with bus cycles. We shall also have test points on both the input AC voltage and the regulated DC voltage. This will make it easy to find possible power problems. Some other areas that we shall have test points will be on the outputs of the analog sensors, before signal conditioning and after signal conditioning. This will help us to diagnose any problem associated with the sensors whether it be with the signal conditioning or the sensor itself. We shall be also have some test points on the receiver and transmitter for both communications circuits. We shall use power indication LED's so we know visually right away if the power supply circuits are powered on. Each sensor shall have a jumper to turn off or on the circuitry for that sensor since we will only be installing 3 of the 4 sensors we designed around. We don't want to have power flowing to unconnected sensor connections.

2.9 Maintenance / Repair / Test Requirements
In case of product failures, the customer shall send the defective unit back to Auratus for repair. This will let us look at our products and see how they malfunction. But before the user sends the products to Auratus for repair, customers should check the following:
1. Are the power cords plugged in securely?
2. Are the connections between the sensors and the stand-alone unit connected properly?
3. Have you checked the fuses of the power supply?
Should the problem persist, there may be a malfunction. Disconnect the entire unit and contact AES for service.