Starting a Pump Based on Well Level Using an ORB-X1

Introduction

The ORB-X1 is a sensor gateway allowing for data logging, alarming, device interfacing, and simple control operations on both powered and unpowered installations. The ORB has a wide array of internal sensors and can interface with almost any industrial sensor or system. This document outlines how a simple reservoir system could be automated using an ORB-X1 and level sensor. Whilst the system would be completely automated, measured system data could be sent to a server anywhere in the world or integrated into an existing SCADA or control system.

System Configuration

The system discussed in this document is summarised in Figure 1. The aim of the system is to automatically fill the reservoir based on the measured water level. The principal could however be applied to any system where a device needs to be controlled based on feedback from a sensor and is particularly applicable where the active device is either in an on or off state. Other similar applications include:

- Charging batteries for lighting plants where the generator is on or off.
- Maintaining pressure in an air receiver tank.
- Maintaining boiler temperature with an electrical element.
- Any system where a solenoid or relay is switched based on measurement feedback.

We will assume that our reservoir is 10m deep. The water level is measured using a differential pressure sensor that is placed in the tank. The pressure sensor reads 1V when the water level is 0m and 5V when the water level is 10m. Input 1 on the ORB will be used to measure the water level.

We assume that permanent power is available and that the pump will be turned on when the contacts of a relay are shorted. The relay will be activated using the ORB-X1 open collector output.

Water level measurements are to be taken every minute. We want the pump to switch on when the water level is 2m and turn off at 8m. An alarm is to be sent vis email and SMS if the water level falls below 1m or rises above 9m.

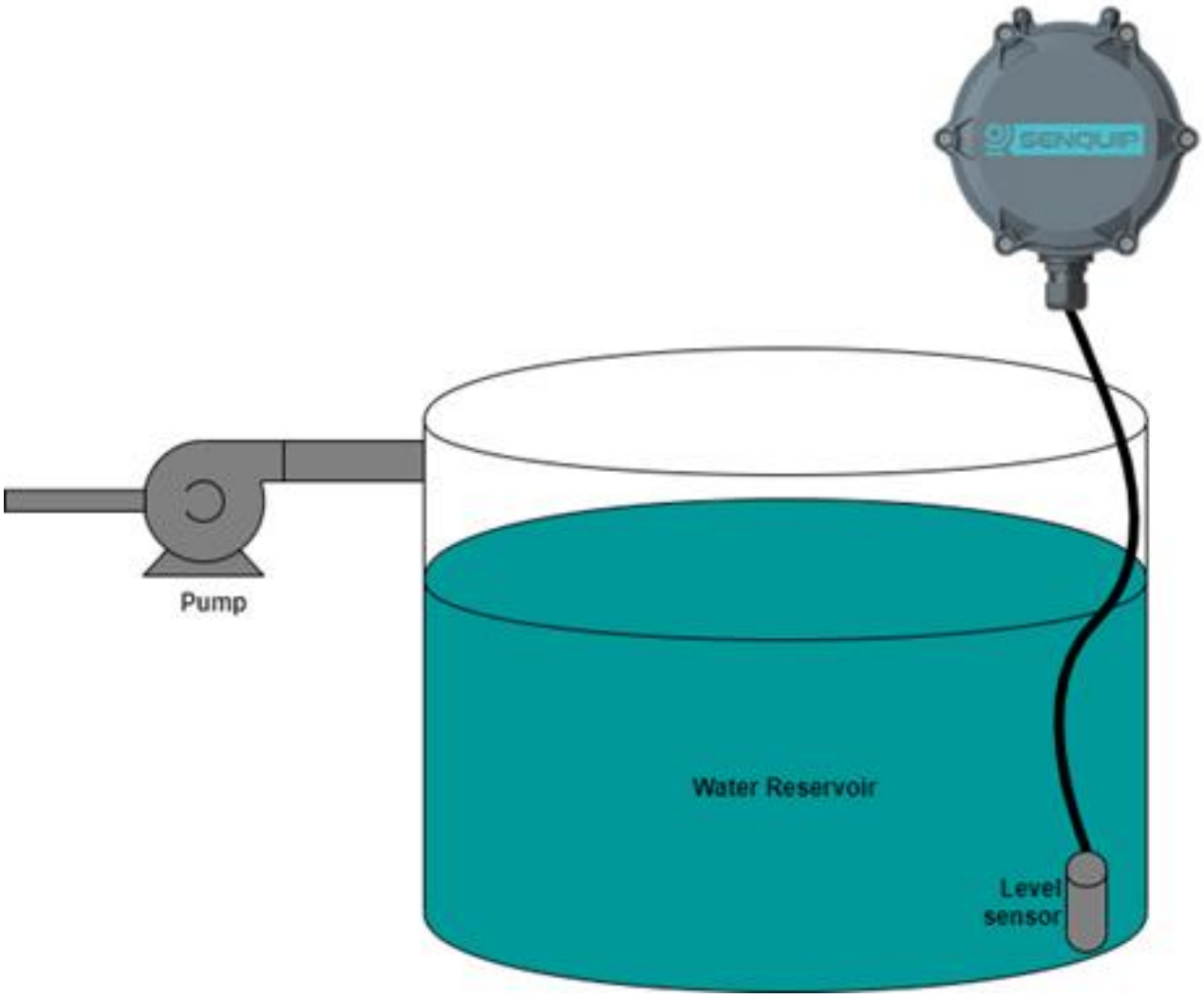


Figure 1 - System Overview

If this application were for an unpowered site, some modifications would be made to reduce power consumption and reliance on the external power. Examples of power savings could include:

- Use voltage output sensors, rather than current output sensors.
- Powering the level sensor from a switchable source on the ORB-X1 and only powering it when a measurement is required.
- Using a latching relay to hold the outfield device on without needing to ORB to be awake.
- Reducing the level sensor sample rate to the minimum required.

- Only transmitting level when above or below a critical level or batching measurements and transmitting less regularly.

In this implementation, a 1-5V output sensor is used; the ORB could just as easily talk to a 4-20mA, MODBUS or other level sensor and the same principles would apply. If the pump has electronic start control, it may be able to be started directly from the ORB open collector output.

Wiring Diagram

The wiring for the automated reservoir system is shown in Figure 2 - Wiring Diagram for ORB-X1Figure 2. The ORB-X1 is designed to tolerate a wide range of input voltages and so is suitable for use with 60V solar installations

Pin 1: Positive voltage in

Pin 2: Negative voltage in (Ground)

Pin 8: Input 1

Pin 10: Output (Open collector)

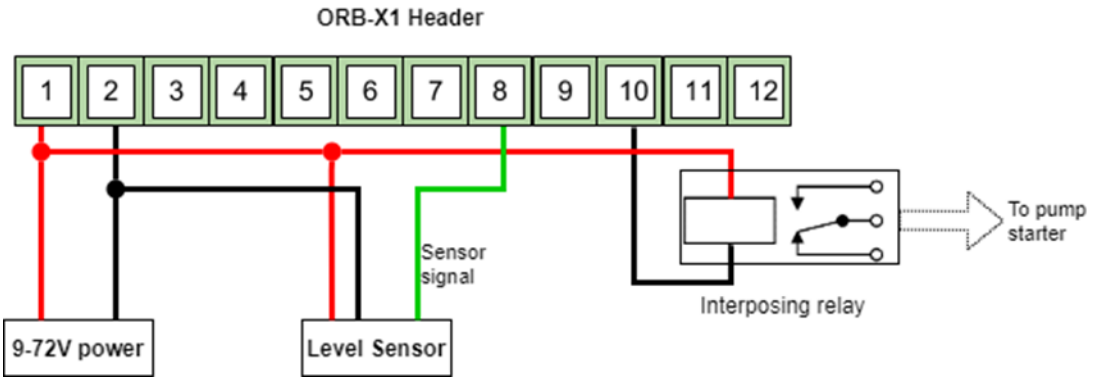


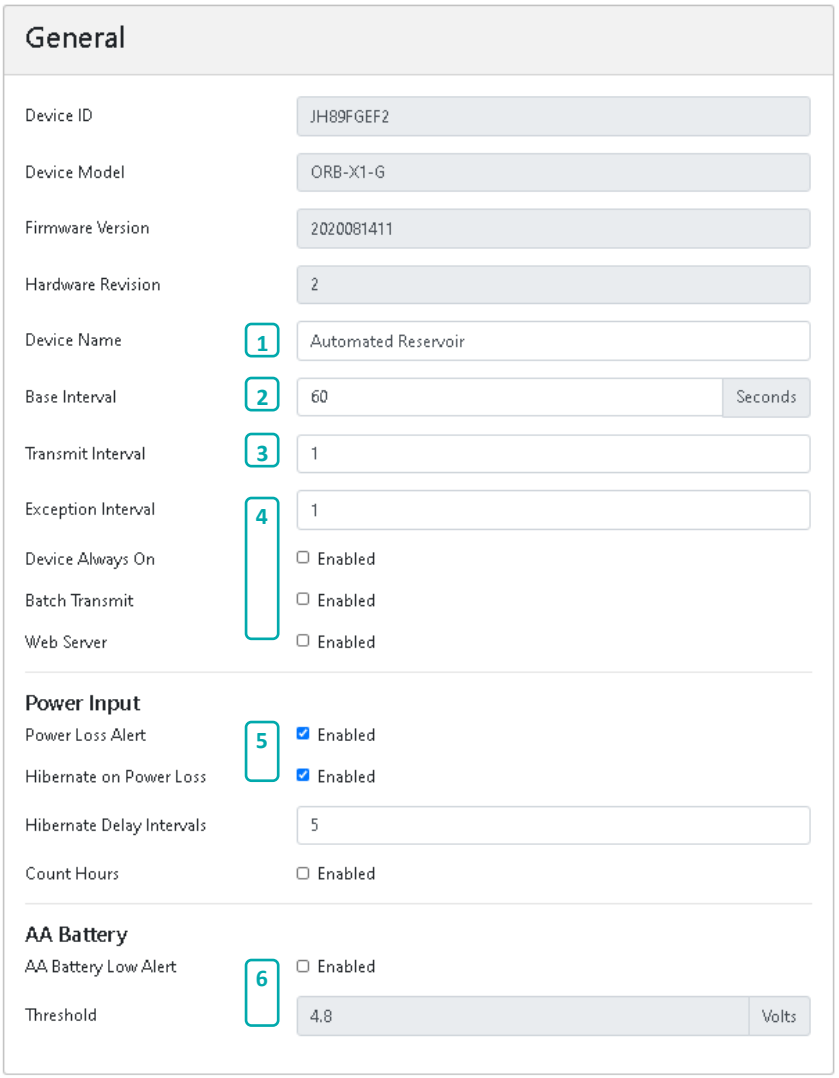
Figure 2 - Wiring Diagram for ORB-X1

ORB Configuration

Only the settings applicable to this application note will be discussed. For a full description of all ORB settings, please see the ORB User Guide: http://docs.senquip.com/orbx1ug/index.html.

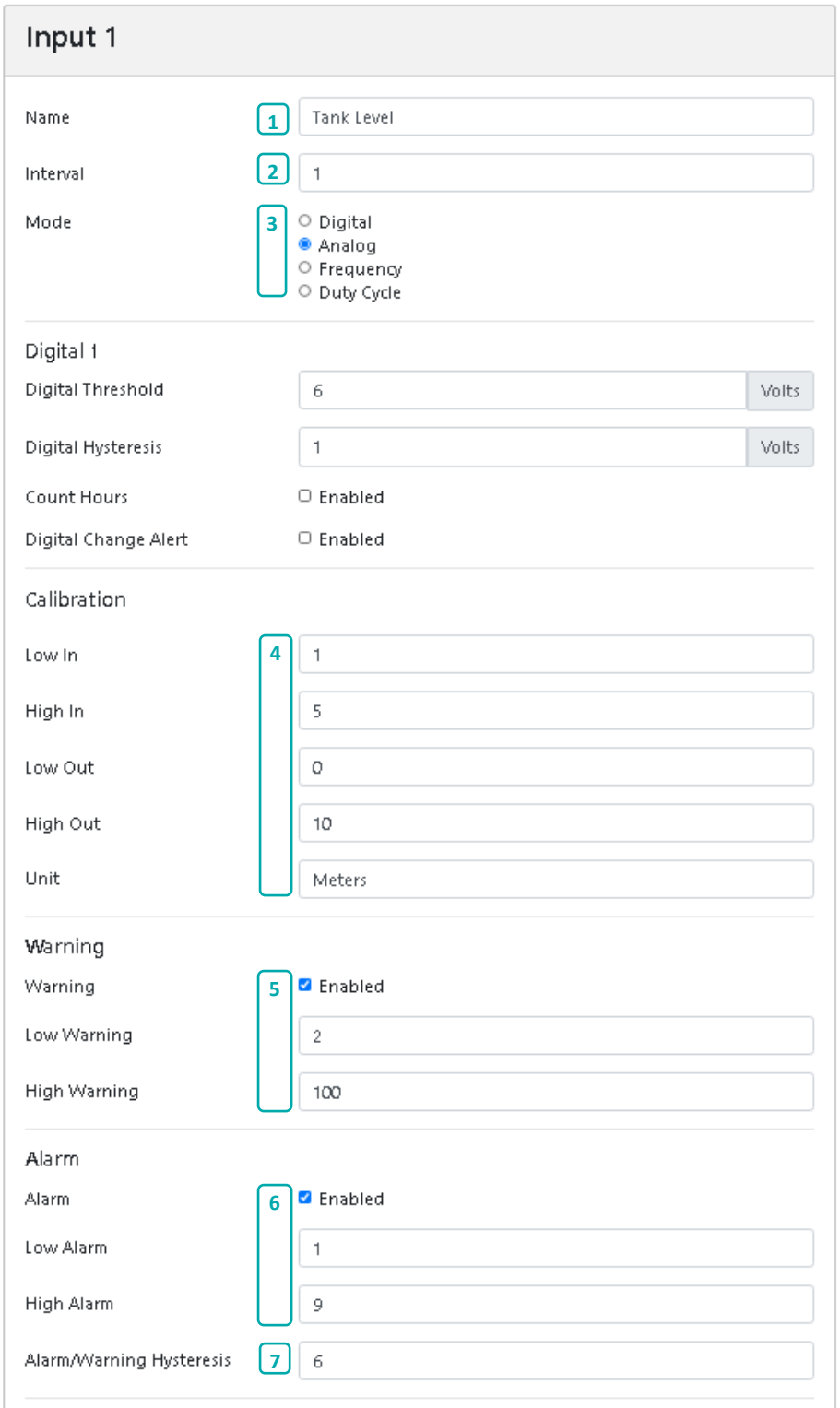
The following general settings are applied.

1. Give the ORB a name that is meaningful to the user, in this case, “Automated Resevouir .”
2. As per the user requirements, the ORB is set to wake up every 1 minute (60 seconds), report the level and then return to sleep.
3. Set the Transmit Interval to 1 so that the level is sent each time the ORB wakes up.
4. There are no warnings or alarms used in this application that require updates to be sent faster than the normal 1 minute update and so the Exception Interval is set to be the same as the transit interval. Note that if alerts are more important than actual levels, that the transmit interval could be set to only transmit say once a day. The ORB would wake every minute, check the levels and only transmit if there was a warning or alarm. Power would be saved in this way. If the Exception Interval was set to 1, then the ORB would transmit on every measurement whilst a warning or alarm was current.
5. The *Device Always On* and *Web Server Always On* options are both not ticked in order to save power.
6. If AA batteries are being used as a backup to power the ORB, then an alert should be set for when the batteries are low.


General
Device ID
JH89FGEF2
Device Model
ORB-X1-G
Firmware Version
2020081411
Hardware Revision
2
Device Name
1
Automated Reservoir
Base Interval
2
60
Seconds
Transmit Interval
3
1
Exception Interval
4
1
Device Always On
Enabled
Batch Transmit
Enabled
Web Server
Enabled
Power Input
Power Loss Alert
5
Enabled
Hibernate on Power Loss
Enabled
Hibernate Delay Intervals
5
Count Hours
Enabled
AA Battery
AA Battery Low Alert
6
Enabled
Threshold
4.8
Volts

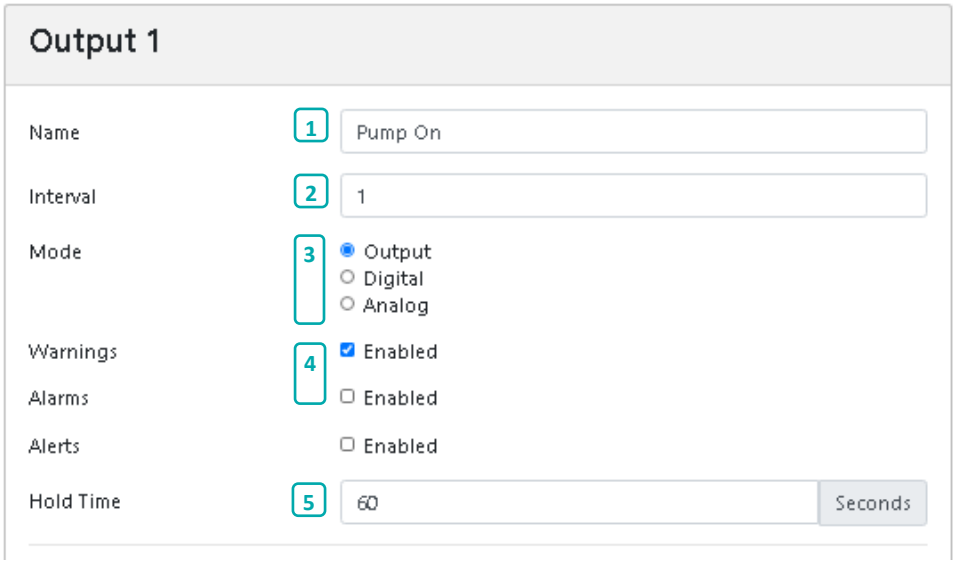
Input 1 is being used to measure the output from the water level sensor and is configured as follows:

1. Give the peripheral a name that is meaningful to the user, in this case, “Tank Level.”
2. As per the user requirements, the ORB is to measure water level every 1 minute (60 seconds) and since the base interval is 1 minute, the peripheral is set to be measured on every interval.
3. The level sensor gives an anolog output from 1-5V and so Input 1 is set in *analog mode*.
4. Calibration is used to convert the 1-5V output to a 0-10m level. In this instance an measurement of 1V represents 0m or water and a measurement of 5V represents 10m of water. A unit of “Meters” is applied to the calibrated value.
5. Warnings are enabled and will be used to turn on the pump when the water level reaches 2m. To enable a warning when the water level falls to 2m, enter a low warning level of 2. The ORB includes optional hysteresis with all warnings and alarms. Hysteresis changes the threshold when a warning or alarm is active. In this case, hysteresis of 6 is used so that although a warning will become active at 2m, it will only become inactive at 2m+6m = 8m, the water level at which we want the pump to turn off. The uppder warning level is not used and so is set to an impossible value; in this case 100m.
6. Alarms are enabled and are set to less than 1m or greater than 9m water level.
7. Hysteresis is set to 6m as described in point 5.


Input 1
Name
1
Tank Level
Interval
2
1
Mode
3
Digital
Analog
Frequency
Duty Cycle
Digital 1
Digital Threshold
6
Volts
Digital Hysteresis
1
Volts
Count Hours
Enabled
Digital Change Alert
Enabled
Calibration
Low In
4
1
High In
5
Low Out
0
High Out
10
Unit
Meters
Warning
Warning
5
Enabled
Low Warning
2
High Warning
100
Alarm
Alarm
6
Enabled
Low Alarm
1
High Alarm
9
Alarm/Warning Hysteresis
7
6

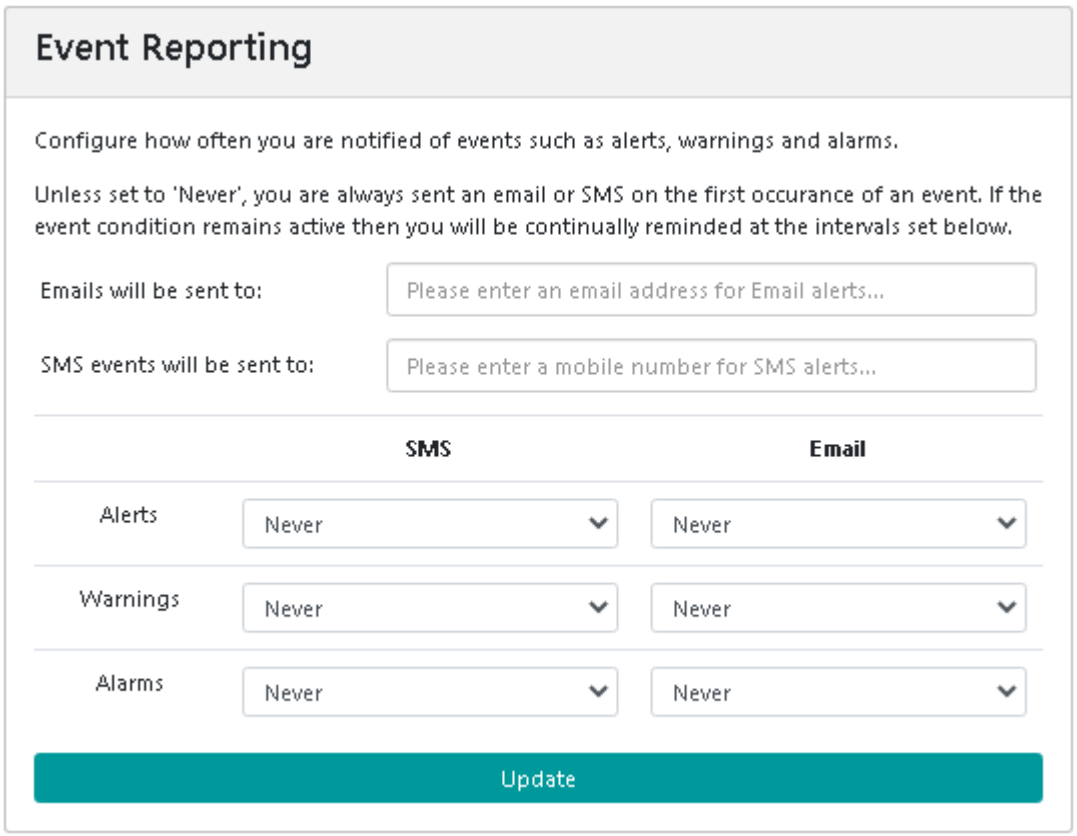
The output on the ORB is used to switch the pump on and is configured as follows:

1. Give the peripheral a name that is meaningful to the user, in this case, “Pump On.”
2. To ensure that the output is active on every interval, it is set to 1. This setting is more meaniunful when applied to other functions of this pin.
3. The *Output 1* pin is being used as an output. The pin can also act as an analog or digital input..
4. The output pin is configured to only turn on for warnings.
5. Once the output is turned on, it must stay on for the entire interval and so the hold time is set to 1 minute. There is an interesting opportunity here to only turn the pump on for a period of each interval. This does not make sense in this application but can be useful as a further safety in other systems.



Note: Ensure that any additional configuration options do not trigger warnings. The ORB’s output is configured to turn the pump on when any warning is active. Use alerts and alarms instead.

Event reporting via SMS and email is configured using the Events tab:



System Extensions

The following extensions could be added to this system to extend its functionality:

- If the pump is controlled by a smart motor drive you could communicate with the drive via Modbus to get detailed information on the pump status such as run hours, start counters, run status etc.
- If the pump has a ‘pump running’ signal available this could be wired in to Input 2 on the ORB to verify that the start-signal and pump is working as expected.
- A thermocouple could measure pump temperature and provide alerts.
- This system could be integrated with an external SCADA or control system via MQTT
- An SMS could be configured to send a message whenever the pump has been started.
- The ORB configuration detailed in this document could be applied to switching of any device based of sensor data.

Conclusion

The ORB-X1 can be used to monitor and control simple systems like pumps without the need for additional hardware. Data measured can be sent to a server or SCADA system anywhere in the world, and alarms can be sent when the solution is not working as expected.