LOW POWER OPERATION

Introduction

The ORB-X1 has been designed to be suitable for use in application where there is no permanent power available. In these applications, it is likely that the ORB will be run off a solar panel or AA batteries. In both these cases, it is critical that the ORB be configured to achieve minimum power consumption and hence maximum operating life.

This application note discusses typical power consumption of the ORB in various modes of operation.

Figure 1 - Battery Powered ORB Monitoring Water Level

Power Basics

Before we can understand how to configure the ORB for low power, we need to understand how power is controlled in the device. The ORB-X1 exists in three states:

Sleep mode: The ORB turns off all peripherals and enters a very low power mode. The ORB is not contactable at this time and if the cover is opened, the lights will remain off. The only way to exit sleep mode is by pressing the setup or reset button or with one of the peripherals that can wake the ORB from sleep.

Measurement mode: When the ORB wakes from sleep, it starts a measurement cycle. Required peripherals are turned on and the ORB starts processing measurement data. Power consumption increases in accordance with which peripherals are turned on, what is attached to the peripherals and for how long the peripherals are kept on.

Transmit mode: Once all measurements are complete, the ORB will transmit the measured data to the Senquip Portal or other endpoint. Transmission is the most energy intense operation and as such, has the greatest impact on battery life. The power consumed during a Wi-Fi and GSM transmission are different and will also depend on factors such as distance from tower and weather conditions.

Table 1 - ORB-X1-G Typical Power Consumption

Mode	Current consumption	Power consumption
Sleep	65uA	227uW
Measurement	50mA	175mW
Transmit (WiFi)	100mA	350mW
Transmit (GSM)	150mA	525mW

As shown in Table 1, the measurement and transmit power consumption of the ORB is more than 1000 times that of sleep mode. Keeping the ORB in sleep mode for as long as possible will therefore has a massive impact on how long the ORB will be able to operate off its internal LiPo battery or replaceable AA cells.

Optimising Settings for Low Power

Before we can understand how to configure the ORB for low power, we need to understand how power is controlled in the device. The ORB-X1 exists in three states:

Base Interval

The base interval sets how often the ORB wakes up to take measurements. After each measurement cycle, the ORB returns to sleep in which state it consumes minimal power. Think carefully about how often a measurement is required. If the application is one in which the measured value changes slowly, then the base interval can be set for a longer time period; a longer time period means more time in sleep mode and longer battery life.

In an application such as measurement of a dam level, it is unlikely that there will be a significant change inside a 10 minute interval and so a setting of 1 minute would provide very little extra information but would increase the power consumption by a factor of almost 10 and reduce battery life by the same factor. In an application such as monitoring vehicle parameters, where data may change quickly, a faster base interval such as 10 seconds may be required. Applications where short base intervals are required are not suitable for battery and solar installs.

Transmit interval

The transmit interval determines how often measured data is transmitted back to the Senquip Portal or another endpoint. A transmit interval of 1 means that the measured data is always transmitted; a setting of 10 means that every tenth measurement will be transmitted. Limiting the number of transmissions will drastically increase battery life.

To limit the number of transmissions, consider whether you need every reading to be transmitted or if only an occasional report is sufficient. Remember that if an alert, warning or alarm is registered by the ORB, a transmission will be made immediately. Remember also that once the ORB is in a warning or alarm state, the rate at which data is transmitted can be changed by setting the exception interval to a different value to that of the transmit interval.

Going back to our example of the dam; it is probably ok to measure the dam level every 10 minutes but only transmit the level every hour (a setting of 6 for transmit interval). A warning level could be set at 80% full in which case a message would be sent as soon as a measurement resulted in an 80% level. The exception interval could then be set at 1 so that every measurement is then transmitted, meaning a transmission to the Senquip Portal or other endpoint every 10 minutes.

Batching Messages

As we have seen, the process of transmitting messages is by far the greatest contributor of power consumption. By measuring often and transmitting irregularly we safe power but miss data samples that may be important.

To avoid missing samples, the ORB can batch messages in internal memory and send them when the next transmission occurs. Although the time taken to transmit will be longer because there is more data to send, transmission time is saved because connecting to a network consumes much of the overall power of a transmission. Fewer connections mean less power consumed.

Optimising Peripherals for Low Power

Only use the peripherals that you need. Every additional peripheral that you turn on will add additional power during the measurement interval and will mean that the measurement interval will take longer.

Some peripherals such as the inputs, accelerometer and thermocouple use relatively little power and are very quick to measure. Other peripherals such as the serial port, current sources and GPS are power hungry and can take a long time to measure. If running off batteries or solar, please consider the use of these peripherals carefully. Each peripheral has its own setting that specifies how often it is sampled; think carefully about how often a peripheral need be activated.

Again, turning to our example of dam level measurement, it is unlikely that the location of the ORB will change and so although water level may need to be monitored on every base interval, the GPS may only need to be sampled every day or week. By considering appropriate sample times for all the peripherals on the ORB, significant energy savings can be achieved.

GPS

The GPS module and associated antenna consume significant power when enabled. Minimise the number of GPS measurements taken by increasing the GPS measurement interval. The GPS module can take many minutes to acquire a position fix during which time the GPS will be drawing maximum power. A well-positioned GPS where the enclosure is mounted with the cable down and where the top of the enclosure has a clear view of the sky will acquire a position fix much quicker and will consume much less energy. Note the Max Time setting for the GPS. This is the maximum time that the GPS will try and acquire a position fix before turning off and returning to sleep. If the

GPS has not acquired a fix within 5 minutes, it is unlikely to ever get one resulting in wasted power; a setting of 180 seconds is typical.

Current Sources

The current sources are typically connected to 4-20mA sensors such as level sensors and the ORB can provide power to those sensors based of the internal battery. A 4-20mA sensor will draw a maximum of 20mA when the sensor is full scale. The 20mA drawn by the sensor will be at a voltage of 12V, meaning a power consumption of 240mW. A sensor that is connected may require some time to turn on and provide a stable measurement. To accommodate this, the ORB allows the current sense outputs to be turned on for a time before a measurement is taken. Do not set the Start Time setting to any longer than the time it takes for your sensor to turn on and stabilise. Any additional time is simply power wasted. In low power application, consider using a voltage based, rather than current based sensor as they are typically more power efficient.

Network Connection

The ORB-X1 supports WiFi and GSM (CAT-M1 and NBIOT) network connectivity.

GSM is a higher power technology that will draw approximately 50% more power than WiFi during transmission. Additionally, GSM can take up to 30 seconds to connect and transmit whereas WiFi will almost always connect and transmit within 5 seconds.

Table 2 - WiFi and GSM Power Consumption

Transmission	Current	Time	Energy
WiFi	100mA	5 sec	0.138mAh
GSM (CAT-M1)	150mA	30 sec	1.25mAh

If you select both WiFi and GSM, the ORB will first attempt to connect via WiFi for 15 seconds and will then switch to GSM. If you know which network you are operating over, select only that network to prevent energy being wasted searching for a network that does not exist.

General Optimisations

Make sure that the Device Always on setting is not selected. If the ORB is not allowed to go to sleep, it will not be suitable for use with solar or batteries.

Make sure that the Web Server setting is not selected. Enabling the webserver will consume more energy during measurement. The webserver can always be enabled by pressing the setup button.

Where appropriate, select the Sleep on Power Loss option. When this option is selected, the ORB will go into a deep sleep (hibernate) and will only wake if power is restored and to send one transmission every 24 hours. The Sleep on Power Loss option is normally used where the ORB is connected to a vehicle battery where the vehicle may be left unused for extended periods and battery drain is a concern.

Turn of unnecessary data sources. The ORB allows for additional data such as human readable time and network diagnostics to be sent. More information means a longer transmission time which requires more power.

Senquip is constantly working on code improvements to reduce the power of your ORB. Make sure that your ORB is running the most recent firmware version.

Figure 2 - Battery Powered ORB-X1 Monitoring Filter Pressure

Conclusion

The ORB-X1 is designed to be used in applications where permanent power is not available. When correctly configured, the ORB will operate for years off AA cells. To maximise battery life, attention should be paid to how often the ORB samples and transmits and the peripherals that are used.