AN-018 Low Power Battery Operation

In several applications such as traffic monitoring there may not be easily accessible power and battery operation is desired. For these situations, operating at the lowest power possible is desired. This helps extend battery life, reduce the battery size/weight, and lowers overall system cost. OmniPreSense radars are relatively low power at around 1.5W. However, due to the nature of radar sensors continuously monitoring in Active mode, even 1.5W can add up to a sizable battery.

Fortunately, the OPS243 has built in circuitry that allows it to go into a very low power Hibernate mode which brings the overall average power consumed down to 250mW or less, a savings of 87% on average power consumption. This application note will describe how to use the Hibernate mode, configurations to maximize power savings, and a model for calculating overall system power dependent on detected activity.

Enabling Hibernate Mode

OmniPreSense sensors have had a low power duty cycle mode from early on but the mode did not fully maximize the possible power savings that could be achieved. The OPS243 radar sensors have specially designed circuitry to maximize power savings allowing true battery powered applications. Starting with v1.0.5 (OPS243-A) and v1.1.0 (OPS243-C), a new Hibernate mode is available that can cut average power consumption down to the 250mW.

The Hibernate mode works very similar to the current duty cycle mode but fully maximizes power savings. In both cases duty cycling is utilized to minimize power savings while constantly sensing the surrounding environment. In addition to turning off the RF power, in the new Hibernate mode the processor is turned off as well. This helps achieve uW power consumption when the sensor is not actively pulsing or processing. An additional feature of Hibernate mode is the sensor will automatically wake up and stay active if an object is detected that meets the current filtering settings (speed, magnitude, direction, range).

To enter Hibernate mode, write the command Z+ to the sensor. After a short time when no activity (set by Z>*n*) is detected meeting the required settings the sensor will enter Hibernate mode. A programmable time later (Z=*n*), the sensor will automatically wake up, send a pulse, read the received signal, process it, and determine if any object is detected meeting the required settings. If an object is detected meeting the settings, the sensor will automatically continue in Active mode reporting the details about the detected object. When the object has left the field of view or the required settings are not met, the sensor will wait a programmable time (Z>*n*) before it automatically enters Hibernate mode again.

The full listing of the commands supporting Hibernate mode are shown in Table *1*. A flow chart of Hibernate operation is shown in Figure 1.

Table 1. Hibernate Mode API Commands

Command	Name	R/W	Value
Z+	Hibernate On	Write	Turns Hibernate mode on.
Z-	Hibernate Off	Write	Turns Hibernate mode off. Note the command
Z?	Hibernate Status	Write	Reports status of Hibernate mode
Z=*n*	Hibernate Time	Write	Set value of *n* to the time in seconds for the sensor to hibernate between pulses. Ex., Z=1 will hibernate for 1 second. The values for *n* should be whole numbers. Default value is 1 second.
Z>*n*	Hibernate Delay	Write	Set value of *n* to the time in seconds to delay going into hibernate mode after active pulsing. The default time is 0.5 second. The value of *n* is a floating point. For example, use Z>1.5 to set the delay to 1.5 seconds. Longer delay times will increase the active time and reduce power savings.

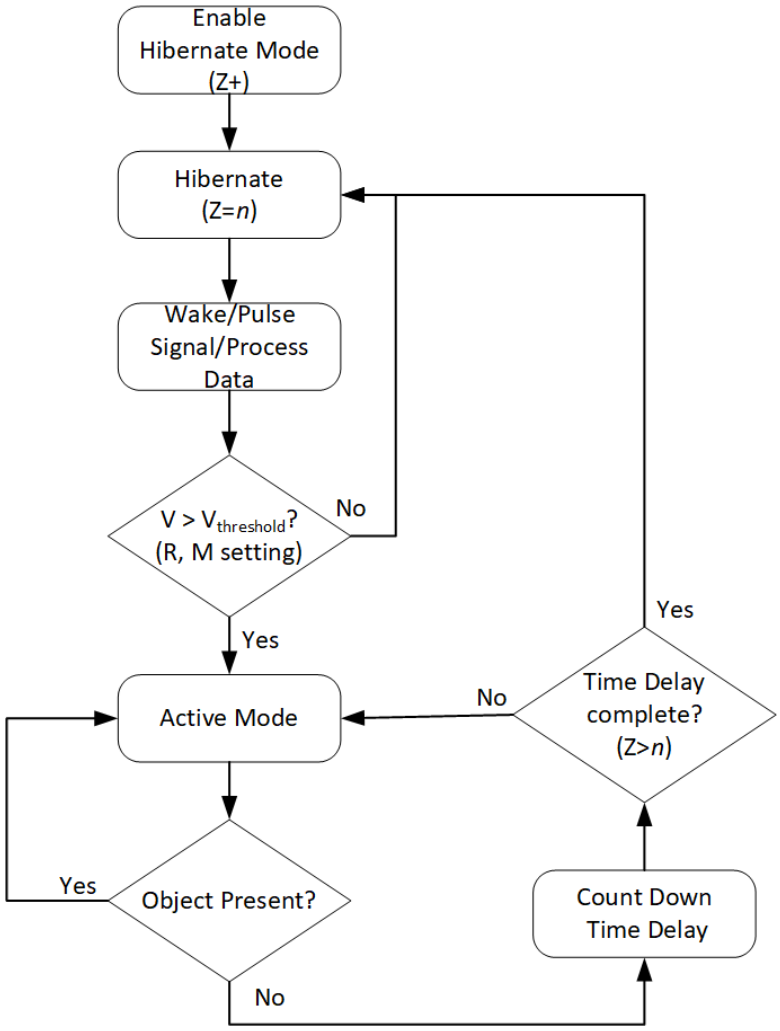

Figure 1. Speed, Range, and Magnitude Filtering

To exit Hibernate mode use the Z- command. The command needs to be received by the sensor while the sensor is in Active mode to take effect. It may be necessary to issue the Z- command multiple times to catch the sensor in Active mode. The default timing is 1 second Hibernate and approximately 200ms Active. Issuing the Z- command every 50-100ms for 1.5 seconds should ensure catching the sensor in Active mode and turning off Hibernate mode.

Power Measurements

The overall power consumption is determined by the timing set for the Hibernate mode. In its default mode, the sensor will consume approximately 250mW of power with an average current consumption of 50mA. Changing configurations settings lowers the average power to as little as 155mW or 31mA average current consumption. To optimize for the lowest power, configuration settings for hibernate time, sample rate, and buffer size can be changed. If slower speed objects such as people are planned for detection,

extending the hibernate time to 2 seconds (Z=2) significantly reduces overall power consumption. Faster objects like vehicles or drones should plan to use a 1 second hibernate time. If speed accuracy is not as critical, increasing the sampling time or decreasing buffer size will shorten the active time and overall power consumption as well. Table 2 provides a listing of typical measured power and current consumption based on different API settings.

Table 2. Power and Current Consumption

Mode	Hibernate Time (seconds)	Sample Rate	Buffer Size	Average Current Consumption (mA)	Average Power Consumption (mW)
1 (default)	1	10,000	1024	50	248
2	2	10,000	1024	31	155
3	1	20,000	1024	39	197
4	1	20,000	512	34	169

System Power Consumption Model

While the average power consumption in Hibernate mode is significantly reduced, real world system operation will exhibit higher levels of power consumption. The main factor controlling the power level is how many times the sensor detects an object and stays in active mode. This factor needs to be considered to meet the battery life requirements and set proper battery sizing.

As an example, consider a traffic monitor application in which the traffic on the road averages either 10, 50, 100, or 250 vehicles per hour. When a vehicle is detected, the sensor will be in Active mode for anywhere from 1 to 2.5 seconds depending on the speed of the vehicle and placement of the sensor. Assuming the default settings and factoring in the total active and hibernate time results in different overall power consumption as shown in Table 3.

Table 3. Traffic System Power Consumption Model

Vehicles/ Hour	Active Time (seconds)	Hibernate Time (seconds)	Total Active Current/Hr (Ahr)	Total Hibernate Current/Hr (Ahr)	Total Current/Hr (Ahr)	Average Power Consumption (mW)
10	25	3,575	0.002	0.034	0.036	180
50	125	3,475	0.005	0.033	0.038	190
100	250	3,350	0.021	0.032	0.053	265
250	625	2.975	0.052	0.028	0.080	400

The above utilizes an active time of 2.5 seconds per vehicle. Based on the above, a sensor combined with a 50,00mAHr battery and a low traffic rate could run for close to 2 months without requiring a battery charge.

Revision History

Version	Date	Description
A	December 26, 2019	Initial release.