

# Buoy Energy Budget Manual

## Spreadsheet functionality

The Buoy Energy Budget spreadsheet estimates the duration of operation of the buoy system based on expected power supply conditions and expected energy use per module. Different scenarios can be tested by changing parameters for each module.

## Spreadsheet limitations

This spreadsheet is useful for basic estimations. However, it does have many limitations that could be improved upon:

- **This spreadsheet can only be used for this particular system.** Modules cannot be added easily (the spreadsheet would have to be redesigned to allow for more modules).
- **The power supply is assumed to be constant.** The spreadsheet gives no way to specify a power supply with changing characteristics. Also, the power supply is assumed to be an array of batteries in parallel. Different configurations cannot be tested.
- **Multiple scenarios cannot be tested simultaneously.** The spreadsheet does have many customizable settings. However, different configurations of the settings cannot be compared at the same time. Only a single configuration can be tested.

## Data tables sheet

The *Data tables* sheet contains the power consumption data for each module in the buoy system. The data is taken from the data sheets of each module. The tables should be updated with practical measurements of current draws. The Gyro power consumption table will be looked at as an example:

Gyro						
Notes						
FXAS21002						
Parameters						
Voltage supply	3.3					
ODR (Hz)	12.5					
Power consumption						
Process	Description	Average supply current (A)	Average power consumption (W)	Duration (s)	Peak current (A)	Notes
Active mode	Active	0.0027	0.010692	0	0.0027	
Ready mode	Ready	0.0016	0.006336	0	0.0016	
Standby mode	Standby	0.000028	0.00011088	0	0.000028	
Ready to Active	Transition from Ready mode to Active mode	0.0027	0.010692	0.085	0.0027	
Standby to Active	Transition from Standby mode to Active mode	0.0027	0.010692	0.14	0.0027	

## Parameters table

Parameters	
Voltage supply	3.3
ODR (Hz)	12.5

The *Parameters* table has two parameters. Changing the voltage supply will change the calculation of average power consumption. Changing the ODR will change the duration of the Ready to Active process and Standby to active processes, since they are dependent on ODR.

Other modules' *Parameters* tables have only a voltage supply parameter.

## Power consumption table

Power consumption						
Process	Description	Average supply current (A)	Average power consumption (W)	Duration (s)	Peak current (A)	Notes
Active mode	Active	0.0027	0.010692	0	0.0027	
Ready mode	Ready	0.0016	0.006336	0	0.0016	
Standby mode	Standby	0.0000028	0.000011088	0	0.0000028	
Ready to Active	Transition from Ready mode to Active mode	0.0027	0.010692	0.085	0.0027	
Standby to Active	Transition from Standby mode to Active mode	0.0027	0.010692	0.14	0.0027	

The *Power consumption* table is a collection of all the processes the module is expected to be in.

Each process represents a different mode of operation, with unique current draw characteristics. There should be a process for every moment of the module's expected operation. For example, if the module is powered down, a process should represent this.

All the columns in the Power consumption table can be edited, except the Average power consumption which should not be changed. A description of each column is as follows:

- **Process:** The name of the process.
- **Description:** A basic description of the process.
- **Average supply current:** The average supply current in amps over the course of the process.
- **Average power consumption:** This value is calculated as  $[average\ supply\ current] \times [supply\ voltage] \times 1.2$ . Note that a factor of 1.2 is included here.
- **Duration:** The expected duration of the process in seconds. This parameter is only necessary if the process has a definite length, such as 'Ready to Active' mode in the above table. Otherwise, if the process has an indefinite length, it can be left blank.
- **Peak current:** The maximum current in amps expected over the course of the process.
- **Notes:** Extra information can be added here. If the word 'error' appears in the Notes column, the cell will be highlighted red. An example is shown below:

0	*error* no standby mode specified on datasheet
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## Adding and removing processes

To add a process, right click anywhere on the table and select *Insert > Table Rows above* or *Insert > Table Row below*. An empty row will be appear, and data can be added to each column.

To remove a process, right click on the row you wish to remove and select *Delete > Table Rows*.

## Procedures Sheet

The *Procedures* sheet is made up of two sections:

1. Schedule tables
2. Energy summary

In the *Procedures* sheet, editable cells are shaded yellow as shown below:

es	4
)	2.8
h)	1
	88
	88.2

All non-yellow cells are calculated automatically and should not be edited.

## Schedule tables

Each module has a schedule of operation over the four hour cycle. The schedule shows what process the module is in at every moment in the cycle. The Gyro schedule is given as an example:

Gyro								
Power data	Gyro data							
Device	Process	Time (s)	Energy used (J)	Average current (mA)	Peak current (mA)	Start	End	Notes
Gyro	Standby to Active	0.14	0.00149688	3.24	3.24	00:00:00	00:00:00	
Gyro	Active mode	900	9.6228	3.24	3.24	00:00:00	00:15:00	
Gyro	Standby mode	13500	0.149688	0.00336	0.00336	00:15:00	04:00:00	
Total		14400.14	9.77398488	3.24	3.24			

Above each module's schedule table is a hyperlink to its power consumption table. For example, clicking [Gyro data](#) above the Gyro schedule table will open the Gyro's power consumption table in the *Data tables* sheet. A description of each column is as follows:

- **Device:** The device name.
- **Process:** The process name corresponding to a process given in the particular module's power consumption table. The desired process can be selected from a drop down list or typed manually. The drop menu is shown below:

Process	Time (s)
Standby to Active	0.14
Active mode	900
Ready mode	13500
Standby mode	14400.14
Ready to Active	900
Standby to Active	0.14

When a new process is added to the module's power consumption table, it will become available in the process drop down list. If a process is removed, it will also be removed from the drop down list.

Changing the process will cause the other parameters in the row to change to match the selected process.

- **Time:** The duration in seconds of the process. By default, this value will match the Duration value from the module's power consumption table. However, if the duration of a process is not definite it can be changed to any value.

The sum of values in the Time column should add up to 14400 seconds (or four hours) to accurately represent the four hour cycle.

- **Energy used:** The energy in joules consumed by the module during the process
- **Average current:** Average supply current in mA.
- **Peak current:** Max supply current in mA.
- **Start:** The start time of the process where 00:00:00 is the start of the four hour cycle and 04:00:00 is the end.
- **End:** The end time of the process.

### Adding or removing processes

To add a procedure to the schedule, right click anywhere on the schedule table and select *Insert > Table Rows above* or *Insert > Table Row below*. A new row will be added. The Process and Time parameters can then be changed / edited.

To remove a procedure, right click on its row and select *Delete > Table Rows*.

### Energy summary

The energy summary section has three outputs:

- Expected operation duration (in days)
- Peak current versus time chart
- Average current versus time chart

### Including or excluding modules in calculation

The first table in the energy summary gives the total energy used for each module over the four hour cycle:

Device	Total energy used (J)	Include in calculation
Gyro	9.77	<input checked="" type="checkbox"/>
Acc_Mag	0.39	<input checked="" type="checkbox"/>
Temp Sensor	0.10	<input checked="" type="checkbox"/>
GPS	4.99	<input checked="" type="checkbox"/>
Rockblock	118.30	<input checked="" type="checkbox"/>
Microcontroller	76.01	<input checked="" type="checkbox"/>
<b>Total (per 4 hours)</b>	<b>209.57</b>	

The check box in the final column can be unchecked to exclude a module from the calculation of expected operation, as well as from the peak current and average current charts.

### Expected operation calculation

The *Expected operation calculation* table has 4 parameters:

- **Number of batteries:** The number of batteries *in parallel*.

- Battery voltage: Expected voltage output of each battery.
- Battery charge: Expected charge in Ah of each battery.
- Efficiency: Expected efficiency of the step-up converter. This efficiency applies to all modules in the calculation.

The **Expected operation** in days is calculated from these parameters and the **Total energy used per cycle**.

#### Peak current and average current schedules

The peak current schedule and average current schedules show respectively the peak current and average current drawn from the supply at any moment in the four hour cycle. The schedules are divided into 5 minute intervals.

In each schedule, the peak or average current is given for each module. A total is also given. The Total column is colour coded so that higher current values have redder cells and lower current values have greener cells. This makes it easy to see at a glance when the current draw is the highest. An example is given below:

54	0.66696
54	0.66696
54	0.66696
54	78.54696
5.4	104.40696
5.4	26.40696