Atmel MCU Wireless

AT07995 - Battery Life Calculator for ZigBee End Device

APPLICATION NOTE

Introduction

This application note guides customers to evaluate low power consumption of ATmega256RFR2 device using *Battery Life Calculator* tool running Atmel® BitCloud® ZigBee® Pro SDK.

The *Battery Life Calculator* tool provides the flexibility to calculate battery life time by configuring hardware and device behavior parameters based on a specific product requirement.

Features

- Atmel ZigBee End Device low power performance
- Battery life calculator tool
- Application specific scenario selection
- Current consumption percentage

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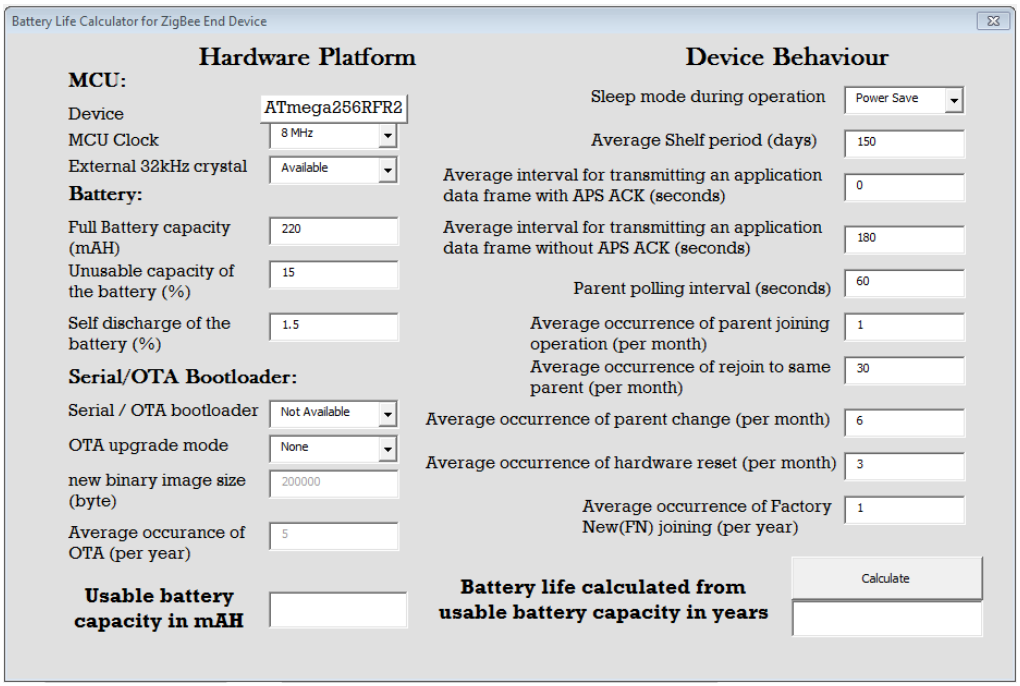
1. Getting Started with Battery Life Calculator

To get started with *Battery Life Calculator* tool,

1. Download the attachment zip file containing `AT07995_Battery_life_calculator.xlsm` file.
2. Open the file using Microsoft® Office 2013.
3. Click on **Enable Content** to allow the execution of Macros in excel sheet.

4. **File** > **Options** > **Trust Center** > **Trust Center Settings** > **Macro Settings** > **Enable All Macros**.
5. Click the Microsoft Excel® spreadsheet window in Task Bar to open Battery life calculator tool.

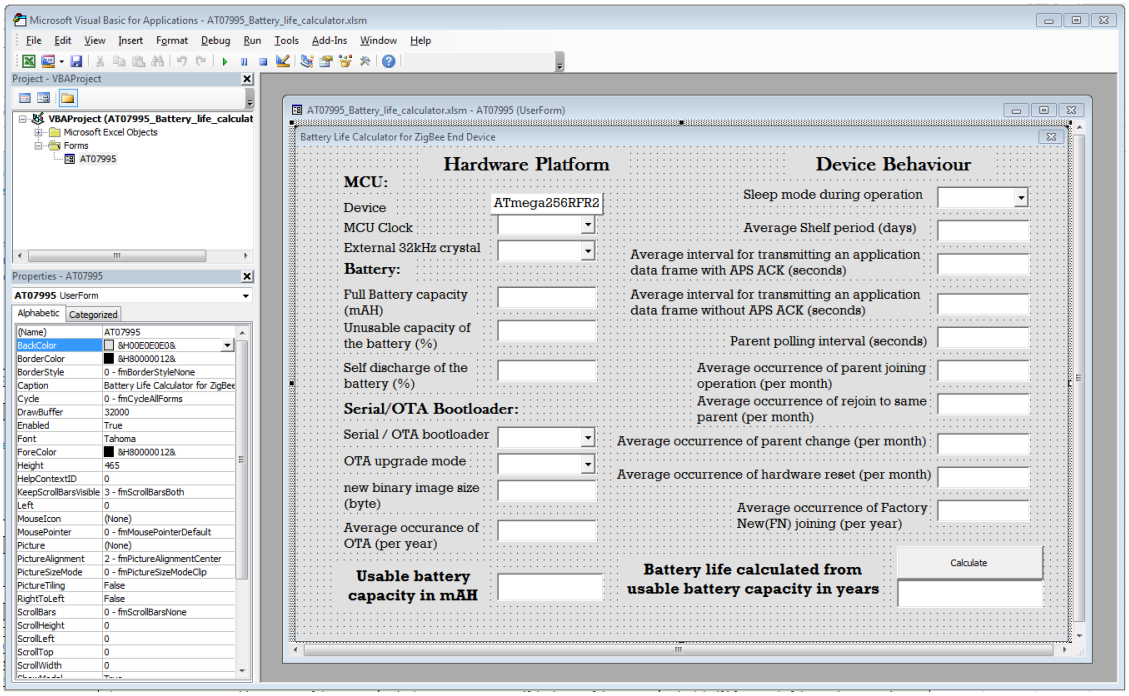
Figure 1-1. Battery Life Calculator Tool



To view the corresponding Visual Basic code,

1. Close Battery life Calculator window.
2. Select the `AT07995_Battery_life_calculator` excel sheet.
3. Press **ALT + F11**.
4. Go to **Forms** >**AT07995**.

Figure 1-2. Battery Life Calculator Visual Basic Editor



Limitations:

- Other Excel spreadsheets cannot be opened, simultaneously.
- For editing the Excel sheet power consumption numbers, the battery life calculator window must be closed.
- If GUI window is closed, only option to re-invoke battery life calculator is to restart.
- Only common scenarios are considered in this battery life calculator example.
- This tool has only been validated on Microsoft Office 2013.

2. Hardware Platform Configuration Options

MCU Clock Frequency

- Provides option to choose either 8MHz or 16MHz clock frequency selection for the MCU
- Depending on the clock frequency selection the power consumption of device is included accordingly during battery life calculation

Serial/OTA Bootloader

- Depending on availability of bootloader in the application, corresponding option is chosen
- Presence of bootloader will consume more power due to bootloader initialization

Full Battery Capacity

- Depending on end product's battery specification user have to input corresponding value
- Field accepts unit of battery capacity as mAh. If the battery capacity is not specified in mAh, appropriate conversion is required.

Self-discharge of the Battery

- A battery performs well when new. But the capacity begins to reduce with use and time.
- Depending on the battery type and characteristics, the user must specify the amount of charge leaked due to self-discharge in percentage format

Usable Capacity of the Battery

- To ensure reliable operation over many years, the design engineers shall include a reserve and below which battery is marked as dead
- In general 15-20% of battery capacity would be considered as unusable
- Depending on the battery type and characteristics, the user may have to specify the unusable capacity of the battery in percentage format

Figure 2-1. Battery Capacity

External 32kHz Crystal

- Based on the product hardware specification, the design may or may not have an external 32kHz crystal for periodic wake-up during sleep state
- Option are selected depending on the availability of external 32kHz crystal

3. Device Behavior Configuration Options

Sleep Mode During Operation

- Provides option to choose the sleep modes (i.e. Power Save or Power Down) of ATmega256RFR2 based on application requirement
- External 32kHz crystal should be set to "Available" for enabling "Power Save" mode option

Average Shelf-period

- Shelf period is the length of time during which a product may be stored in point of sale or warehouse before being actually deployed or installed
- This parameter will be non-zero, only when the product is shipped along with battery
- This parameter will be zero for products which require battery installing at the time of deployment or installation
- Field takes average shelf period in terms of days. So, a proper conversion is required before entering if this value is not in days.

For example, if the average shelf period of a product is 5 years (i.e. 5 x 365 = 1825 days), then input value will be 1825.

Average Interval for Transmitting an Application Data Frame with APS ACK

- If application feature requests for a periodic transmission of application data frame with an APS acknowledgment then this field will be non-zero
- Otherwise value of this field must be zero
- Field takes average interval for transmitting an application data frame with APS ACK in terms of seconds. So, proper conversion is required before entering the duration.

For example, if average interval for transmitting an application data frame with APS ACK is once an hour (i.e. 1 hour = 3600 seconds). Then the input value will be 3600.

Average Interval for Transmitting an Application Data Frame without APS ACK

- A battery performs well when new but the capacity begins to fade with use and time
- Depending on the battery type and characteristics user have to input the amount charge leaked due to self-discharge in percentage format

Parent Polling Interval

- If the end device application periodically polls its parent then parent polling interval will be non-zero
- Otherwise this field needs to be entered as zero
- Field takes parent polling interval in terms of seconds, so a proper conversion is required before entering the duration

For example, if parent polling interval is once an hour (i.e. 1 hour = 3600 seconds), then input value will be 3600.

Average Occurrence of Parent Joining

- It is necessary that a ZigBee end device enters a ZigBee network by joining any one of potential parent node
- Parent joining event shall happen multiple times depending on the application requirement

- Field takes average occurrence of parent joining event happening per month. So, a proper conversion is required before entering the number of occurrence.

For example, if the average occurrence of parent joining is once in two month, then input value will be 0.5.

Average Occurrence of Rejoin to Same Parent

- Sometime due to environmental condition, ZigBee end device might lose its parent and tries to rejoin the same parent
- Rejoin to same parent event shall happen multiple times over the life time
- Field takes average occurrence of rejoin to same parent event happening per month. So, a proper conversion is required before entering the number of occurrence.

For example, if the average occurrence of rejoin to parent is once in two months, then the input value will be 0.5.

Average Occurrence of Parent Change

- In a ZigBee network, the ZigBee end device might not be able to reach its parent node under such circumstances. The ZigBee end device will search for other potential parent node.
- Parent change event shall happen multiple times depending multiple factors like broken parent node, environment condition, out of coverage range, etc.
- Field takes average occurrence of parent change event happening per month, so proper conversion is required before entering the number of occurrence

For example, If the average occurrence of parent change is once in two months, then input value will be 0.5.

Average Occurrence of Hardware Reset

- User might be required to reset the hardware multiple times during the product life cycle
- Field takes average occurrence of hardware reset happening per month, so proper conversion is required before entering the number of occurrence

For example, if the average occurrence of hardware reset is once per month, then input value will be 1.

Average Occurrence of Factory New Joining

- The user might want to make the product factory new state multiple times during the product life cycle
- Field takes average occurrence of factory new joining happening per month, so proper conversion is required before entering the number of occurrence

For example, if average occurrence of hardware reset is once per month, then input value will be 1.

OTA Upgrade Mode

- The application might support Over-The-Air upgrade feature or not
- Based on that it is required to choose either "None" or "Block Mode" for Over the Air upgrade
- Serial/OTA bootloader should be set to "Available" for enabling "Block Mode" option

New Binary Image Size

- Depending on the new application firmware image size, the number of transmission frames will vary

- The user has to enter new binary image size in terms of bytes, so proper conversion is required before entering the number of occurrence
- Serial/OTA bootloader should be set to "Available" and "Block Mode" option should be chosen in OTA upgrade mode for enabling New binary image size

For example, if new binary image size is 200k, then input value will be 200000.

Average Occurrence of Over The Air upgrade

- Depending on the product requirement, Over-The-Air firmware upgrade should happen multiple times during the product life time
- The user has to enter average occurrence of Over-The-Air upgrade happening per year, so proper conversion is required before entering the number of occurrence
- Serial/OTA bootloader should be set to "Available" and "Block Mode" option should be chosen in OTA upgrade mode for enabling Average occurrence of Over-The-Air upgrade

For example, if the average occurrence of Over The Air upgrade is 5 times per year, then input value will be 5.

4. Configuration Options Dependencies

Serial/OTA Bootloader Availability

- If “Not Available”, then OTA upgrade mode has only “None” as option
- If “Available”, then OTA upgrade mode has both “None” and “Block Mode” options

OTA Upgrade Mode Selection

- If “None”, then new binary image size and Average occurrence of OTA options will be grayed
- If “Block Mode”, then new binary image size and Average occurrence of OTA options accepts user inputs

External 32kHz Availability

- If “Not Available”, the Sleep mode during operation has only “Power Down” as option
- If “Available”, the Sleep mode during option has both “Power Down” and “Power Save” options

5. Formula and Calculations

In the Excel calculation, all scenarios are normalized for a number of occurrence happening over a period of a year. The following scenarios are explained in AT03663: Power Consumption of ZigBee End Device application notes.

Power on Initialization

Power on initialization occurrence based on two different user inputs,

- Average occurrence of Factory New (FN) joining
- Average occurrence of hardware reset

Average occurrence of Power on initialization events = Average occurrence of Factory New (FN) joining + Average occurrence of hardware reset

Classical Join

Classical Join is a network association procedure and the occurrence of it is based on two different user inputs,

- Average occurrence of Factory New (FN) joining
- Average occurrence of parent joining

Average occurrence of Classical Join events = Average occurrence of Factory New (FN) joining + Average occurrence of parent joining.

Rejoin to Parent

Rejoin to parent event occurrence depends on two different user inputs,

- Average occurrence of rejoin to same parent
- Average occurrence of hardware reset

Average occurrence of Rejoin to parent events = Average occurrence of rejoin to same parent + Average occurrence of hardware reset.

6. Application Usage

The following screenshots show various application usage configurations.

Figure 6-1. Application Running at 8MHz without OTA Bootloader

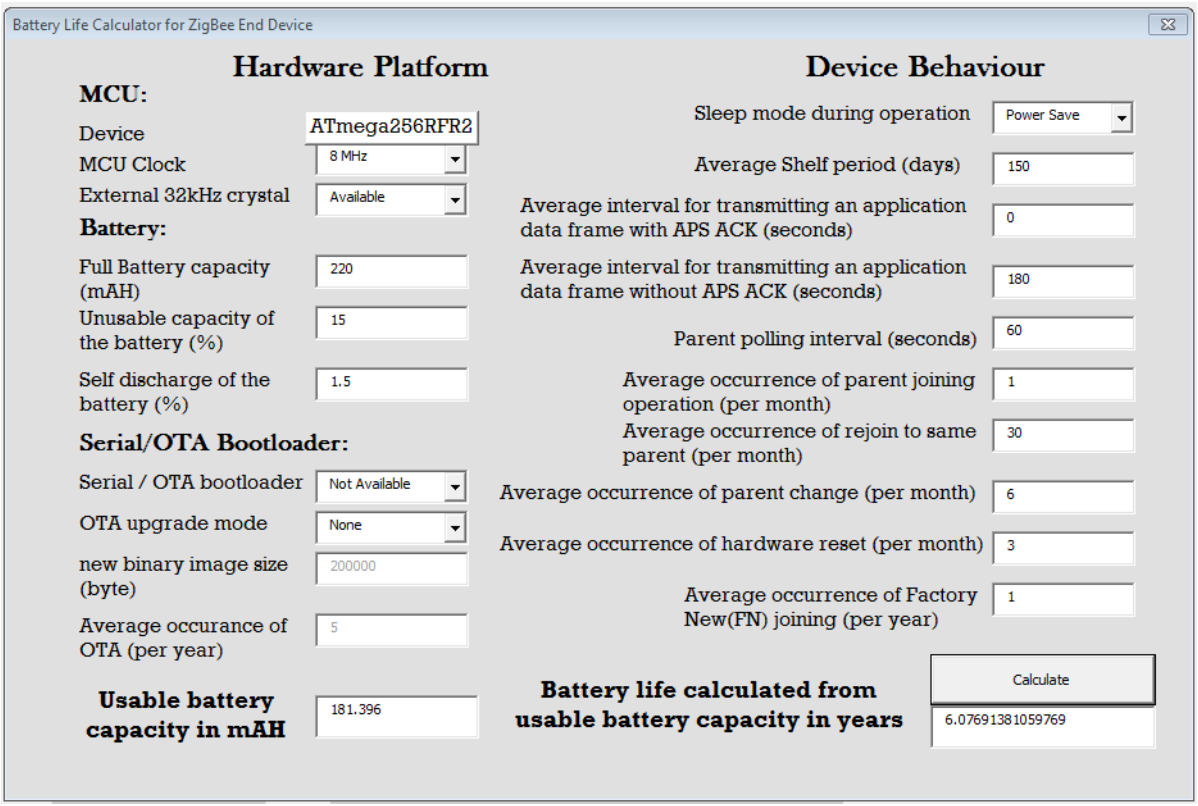


Figure 6-2. Application running at 16MHz without OTA bootloader

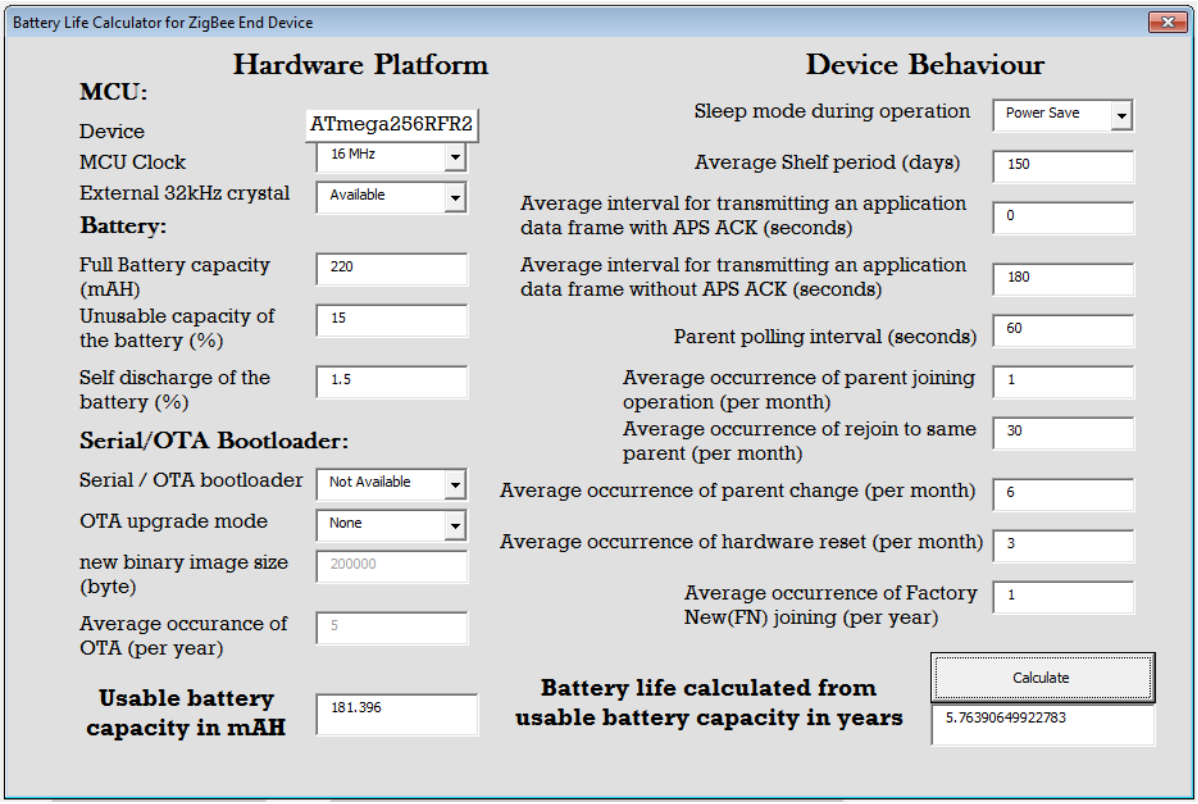


Figure 6-3. Application Running at 8MHz with OTA Bootloader

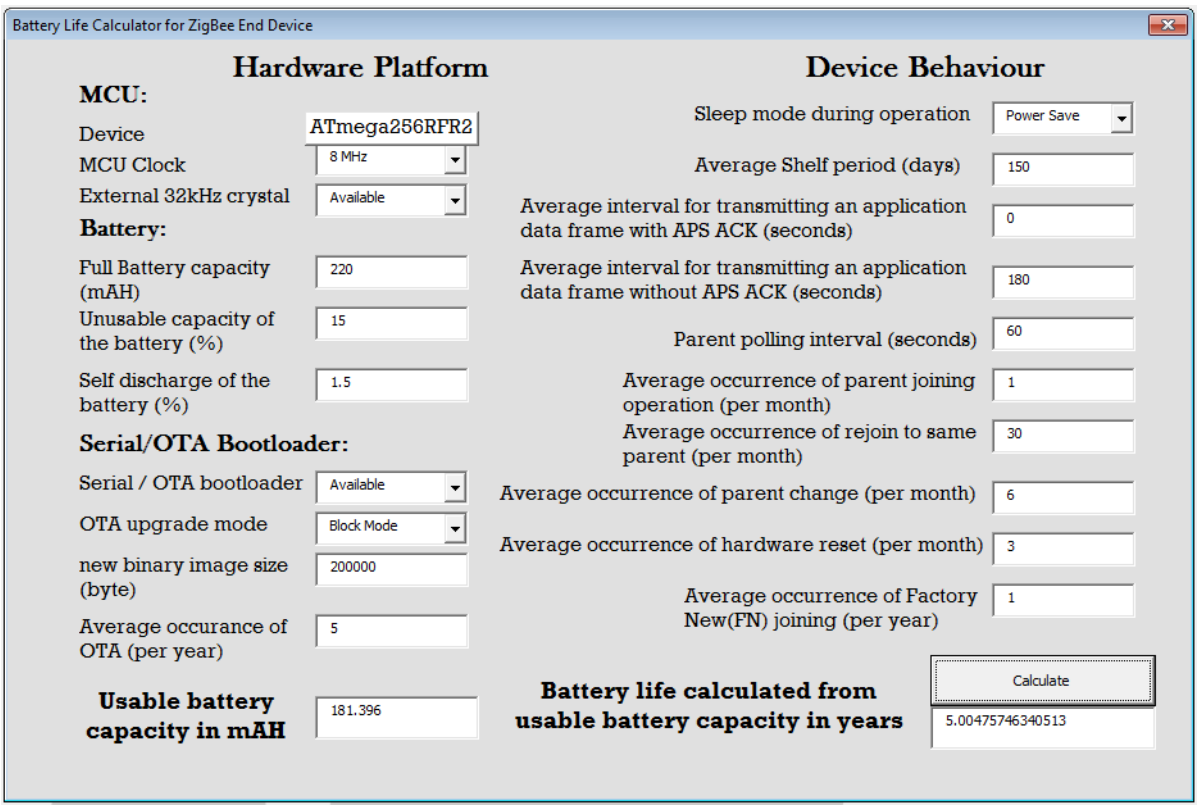
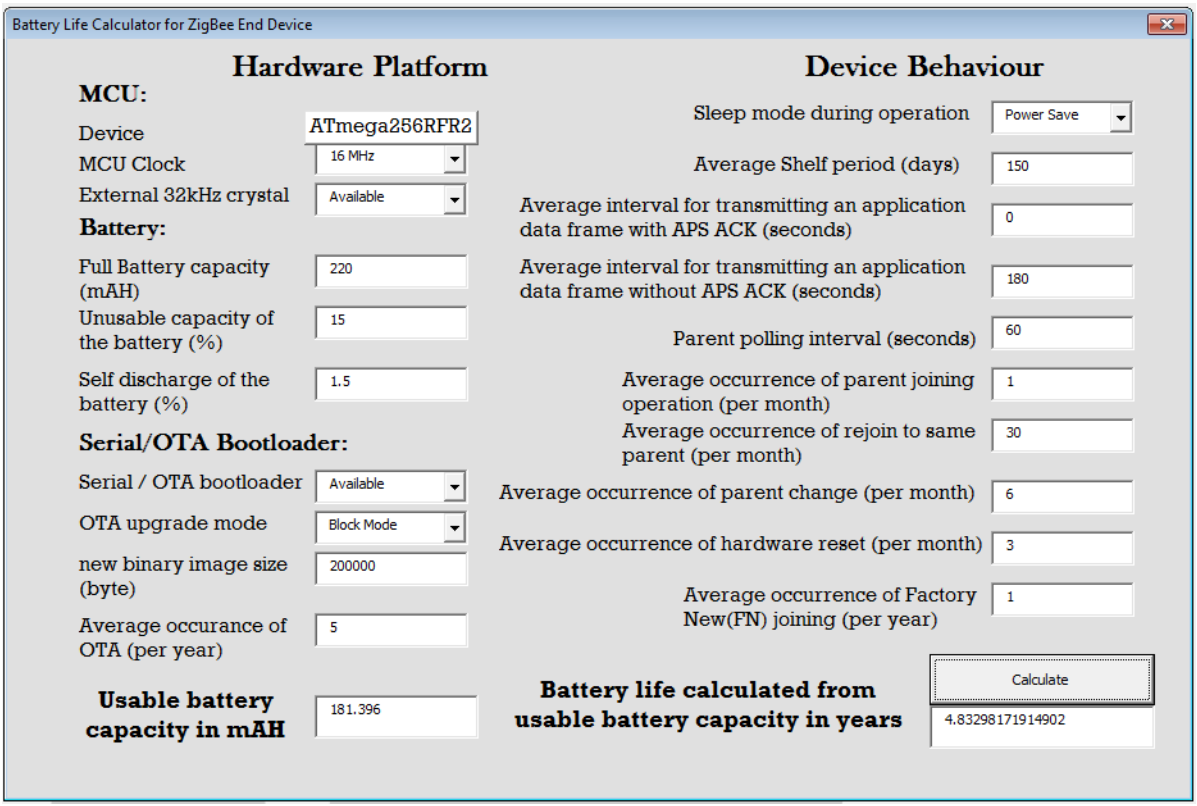


Figure 6-4. Application Running at 16MHz with OTA Bootloader



7. Percentage Breakdown

The percentage breakdown of the battery capacity is available in the **Percentage Breakdown** sheet of `Battery_life_calculator.xlsm` file.

Note: Close the battery life calculator window for editing the power consumption numbers in the Excel spread sheet.

Figure 7-1. Percentage Breakdown for Application Running at 8MHz without OTA Bootloader

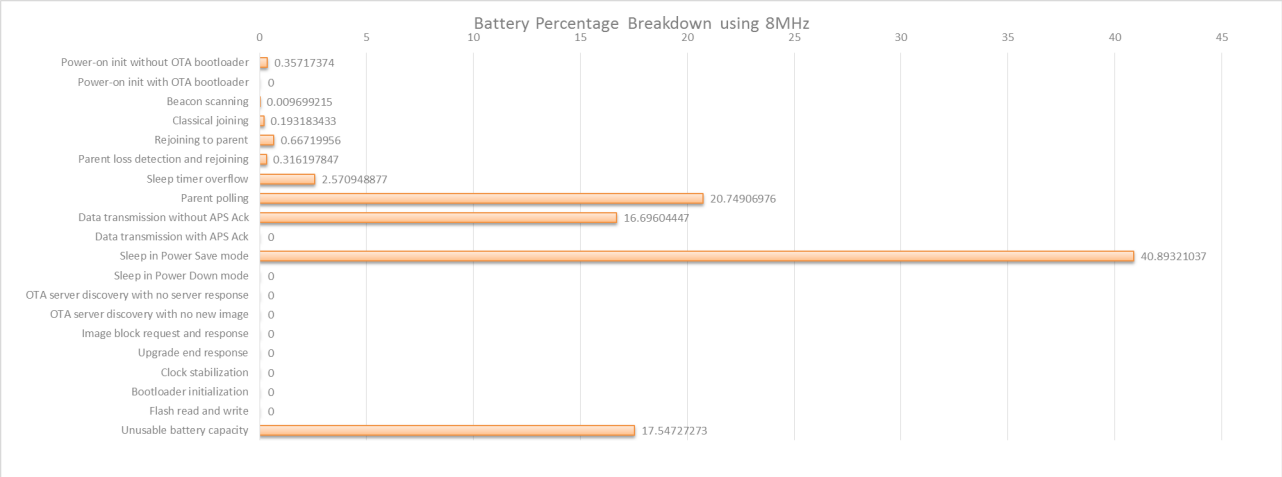
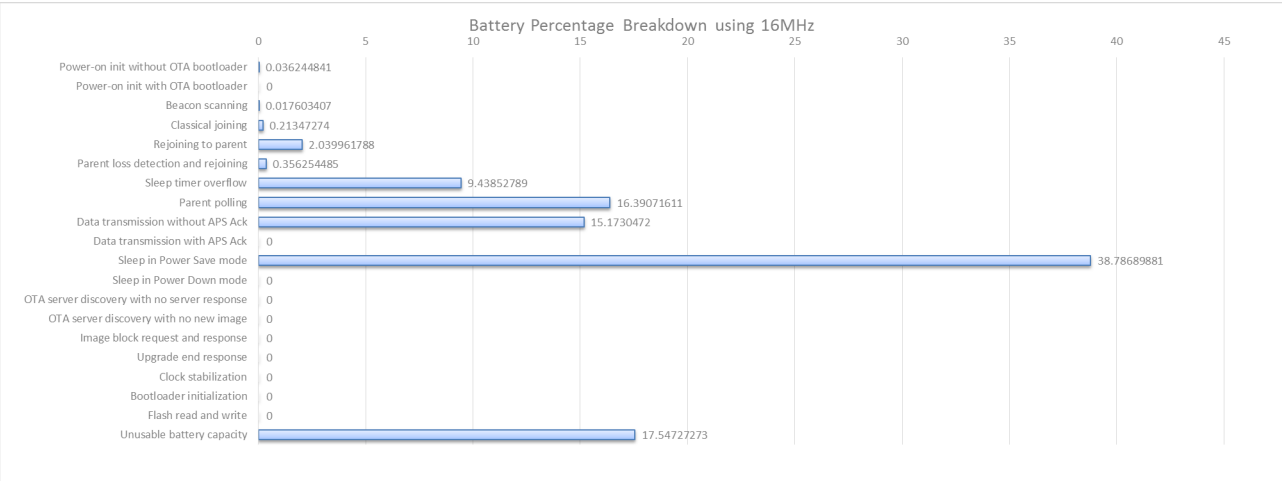


Figure 7-2. Percentage Breakdown for Application Running at 16MHz without OTA Bootloader



8. Related Documents

1. AT03663: Power Consumption of ZigBee End Device.
2. ATmega256RFR2 datasheet.
3. BitCloud ZigBee Pro SDK for megaRFR2.

9. Revision History

Doc Rev.	Date	Comments
42653A	02/2016	Initial document release.

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