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Battery Life Analysis for ESP32 LoRa

T-IOT-902

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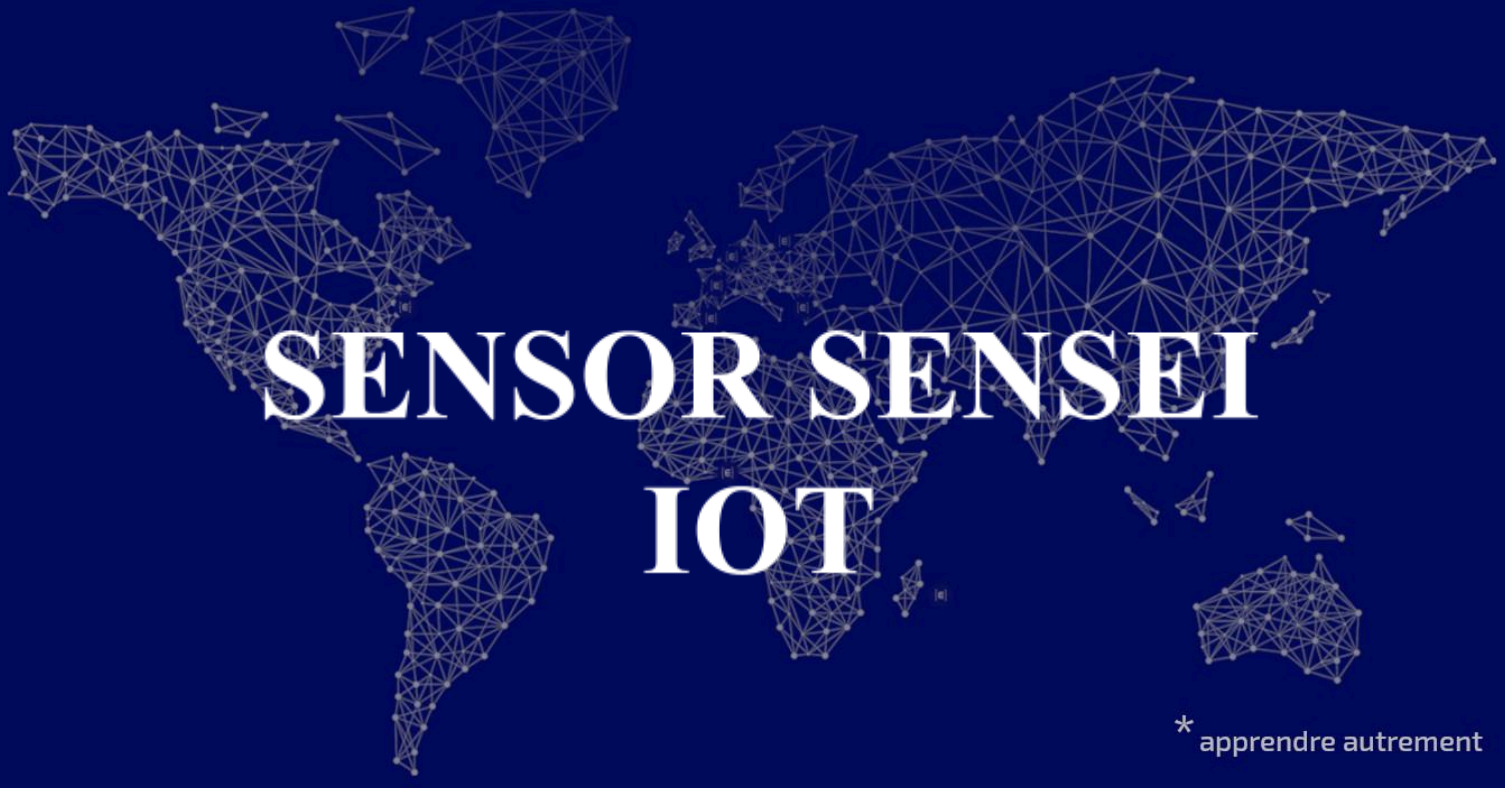

SENSOR SENSEI IOT

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System Overview

This document presents a comprehensive power consumption analysis for an environmental monitoring system based on the ESP32 with LoRa (TTGO LoRa32) platform. The system utilizes three sensor components to collect environmental data:

1. Sound Sensor (SPH0645)
2. Temperature, Pressure, and Altitude Sensor (BMP280)
3. Air Quality Sensor (Dust Sensor SKU:10500)

The system operates in an energy-efficient duty cycle, with 10 seconds in active mode followed by extended periods in deep sleep mode.

Component-Level Power Consumption

1. ESP32 with LoRa (TTGO LoRa32)

- **Active Mode:** 80 mA
    - Includes processing load and LoRa transmission current
- **Deep Sleep Mode:** 10 µA (0.01 mA)
    - LoRa module in low-power state

2. Sound Sensor (SPH0645)

- **Active Mode:** 0.8 mA
    - Operational only during 10-second measurement window
- **Deep Sleep Mode:** Negligible (0 mA)

3. Temperature, Pressure, and Altitude Sensor (BMP280)

- **Active Mode:** 2.7 µA (0.0027 mA)
    - Ultra-low power mode for quick reading
- **Deep Sleep Mode:** Negligible (0 mA)

4. Air Quality Sensor (Dust Sensor SKU:10500)

- **Active Mode:** 20 mA
    - Operational for 5 seconds within the 10-second window
- **Deep Sleep Mode:** 0.1 mA

Power Consumption Calculations

Active Period (10 seconds)

- ESP32 + LoRa: 80 mA
- Sound Sensor: 0.8 mA
- BMP280: 0.0027 mA
- Dust Sensor: 10.05 mA
    - Calculated as (20 mA × 5 s + 0.1 mA × 5 s) ÷ 10 s

Total active current: 90.85 mA

Deep Sleep Period (3590 seconds)

- ESP32 + LoRa: 0.01 mA
- Sound Sensor: 0 mA
- BMP280: 0 mA
- Dust Sensor: 0.1 mA

Total deep sleep current: 0.11 mA

Average Current Calculation

```
Average Current = (Current in Active Mode × Active Time) + (Current in Deep Sleep Mode × Deep Sleep Time) / Total time

Average Current = (90.85 mA × 10 s)+(0.11 mA × 3590 s)/ 3600s

Average Current = 908.5 mA·s + 394.9 mA·s / 3600s

Average Current = 1303.4 mA·s / 3600s
```

Average Current = 0.362 mA

Battery Life Estimation

Using a 3000 mAh Li-Ion battery VTC6:

```
Battery Lifetime (hours) = Battery Capacity (mAh)/Average Current (mA)

Battery Lifetime (hours) = 3000 mAh/ 0.362 mA
```

Battery Lifetime = 8,287.29 hours

Converting to days:

```
Battery Lifetime (days) = 8,287.29 hours/24 hours/day
```

Battery Lifetime = 345.3 days

Conclusion

The calculated battery life for this environmental monitoring system is approximately **345 days** (nearly one year) when powered by a 3000 mAh LiPo battery. This estimate assumes:

1. A duty cycle of 10 seconds active and 3590 seconds in deep sleep
2. Proper implementation of power management techniques
3. No battery self-discharge (which would reduce actual battery life)
4. Consistent environmental conditions

This long battery life makes the system suitable for long-term remote environmental monitoring applications with minimal maintenance requirements.

Conclusion

https://docs.nordicsemi.com/bundle/ncs-latest/page/zephyr/boards/lilygo/ttgo_lora32/doc/index.html

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