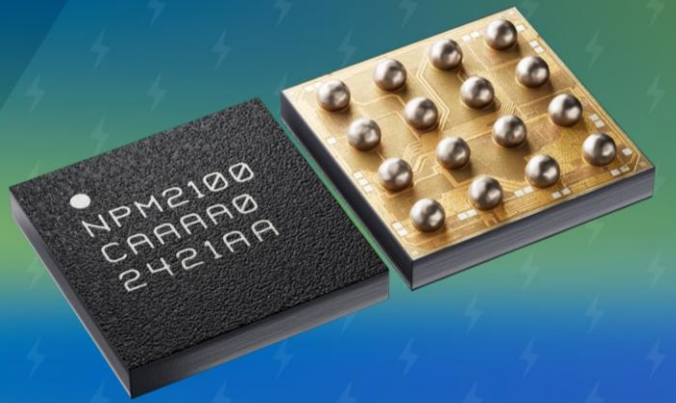


nPM2100 PMIC

A complete energy saving toolbox for non-rechargeable products

April 2025

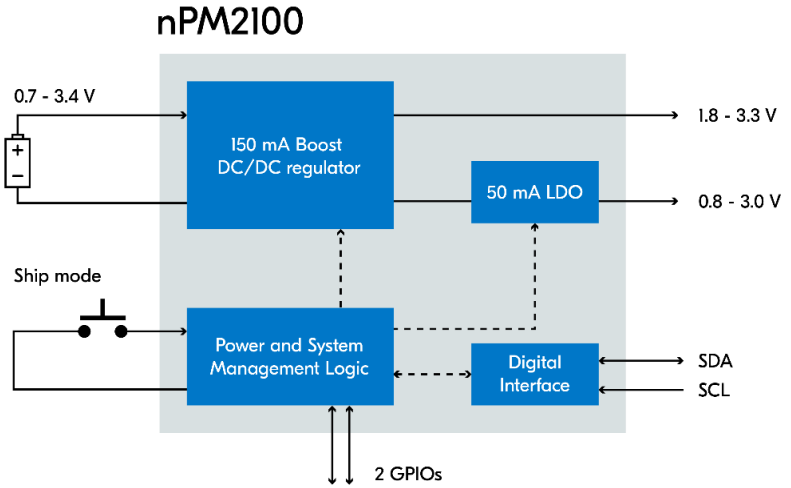
Such a waste …

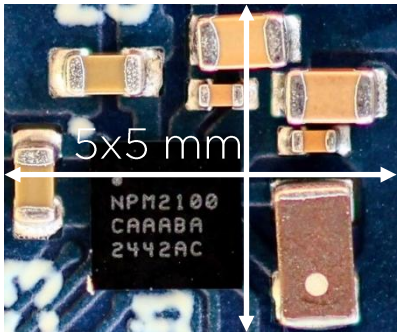
- 28,000,000,000 batteries thrown away every year and growing
- The energy needed to manufacture a battery is on average 50x the energy it carries

1. https://cordis.europa.eu/article/id/430457-up-to-78-million-batteries-will-be-discarded-daily-by-2025-researchers-warn
2. *Hill, Marquita K. (2004)*. Understanding Environmental Pollution: A Primer. *Cambridge University Press. pp. 274. ISBN 0521527260*.

nPM2100

- Primary cell PMIC for Bluetooth Low Energy applications
- Dedicated energy saving circuitry extends battery life
  - Ultra-efficient boost converter
    - 95% @ 70mA (2.7-> 3.0V)
    - 90% @ 10µA (2.7 -> 3.0V)
  - Fuel gauge
    - 5% accuracy towards end of battery life for AA and $LiMnO_2$
  - 175nA hibernate mode with timed wakeup or button press
  - 35nA ship mode with wakeup on button press or connection break
- Ultra-compact solution
  - Minium configuration: 6 passives (3x 0201 + 2x 0402 + 1x 0403)
  - 1.9x1.9 WLCSP or 4x4mm QFN





Use cases

Compatible batteries

Primary cell:

Any 1.5 V to 3 V nominal combination of non-rechargeable batteries

Compatible technologies

Bluetooth®

THREAD

matter

zigbee

Low-power wireless:

Any low-power application with maximum current draw < 150 mA

Compatible applications

IoT and wearables:

Computer peripherals and remote controls

Smart home sensors

Bluetooth asset tracking

Health/medical monitoring

Industrial sensors

Compatible host devices

nRF52 Series

nRF53 Series

nRF54 Series

Any I^2C-master compatible device

Primary cell challenges

- Finding an efficient AND flexible boost converter
- Estimating reliably how much energy is left
- Achieving ultra-low standby power
- Shipping products with the battery inserted

Power & system management all-in-one

95% efficient
Boost converter

LDO/Load
switch

35 nA Ship
mode

175 nA
Hibernate

Accurate fuel
gauge

Recovery from
failed boot

Hard reset

Watchdog timer

2x GPIOs

Configurable
through TWI

Essential features for better end-user experience

Failed boot recovery – Power cycle devices that hang before the watchdog is enabled

Hard reset – Use hardware-enabled buttons to power cycle a frozen device

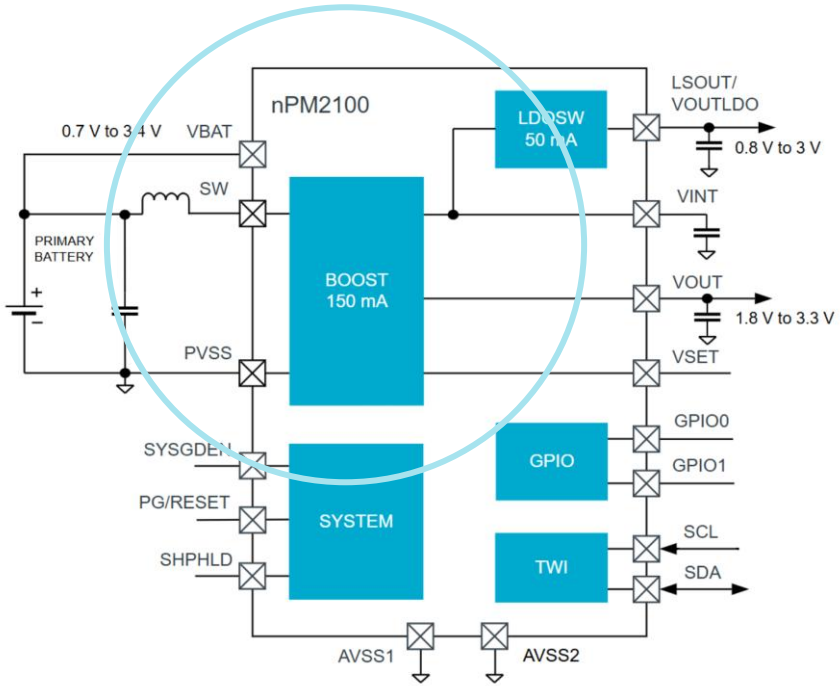
35nA Ship mode – Ultra low-power state with multiple wake-up options

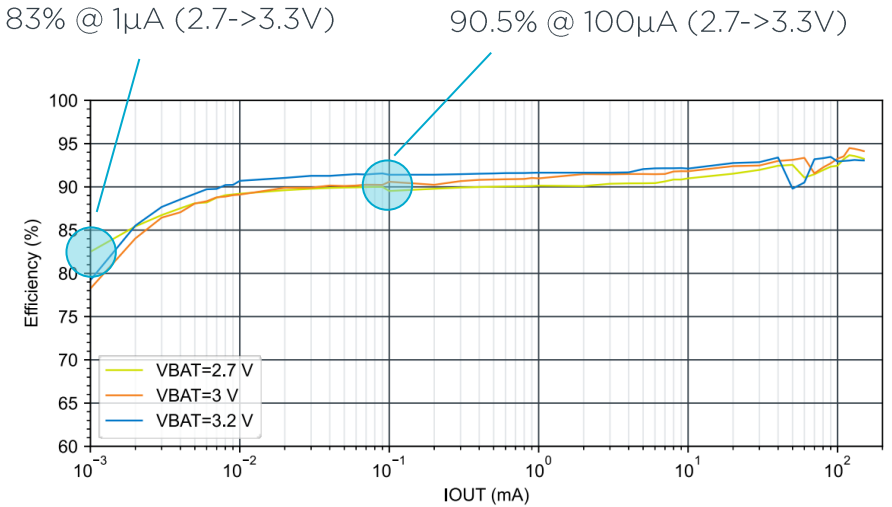
Hibernate – Run a timer at 175 nA to enable even lower-power deep sleep

Watchdog timer – Automatic recovery from software failures during runtime

Fuel gauge – Uniquely accurate battery life estimations for primary cell powered devices

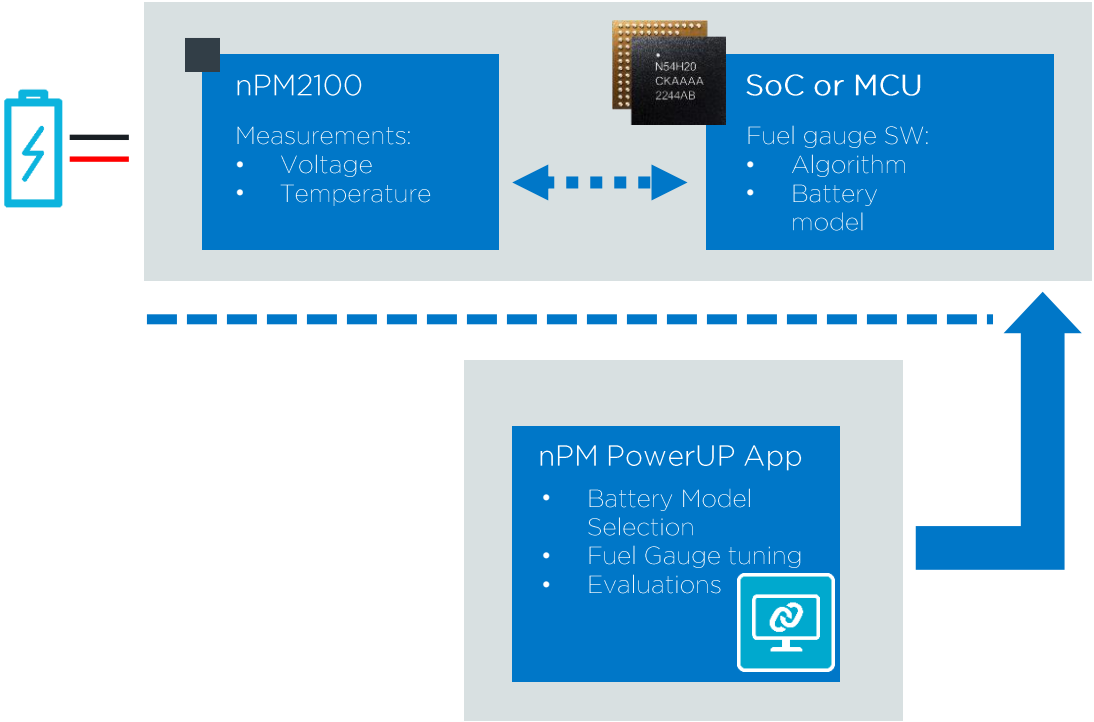
Hyper-efficient battery boosting

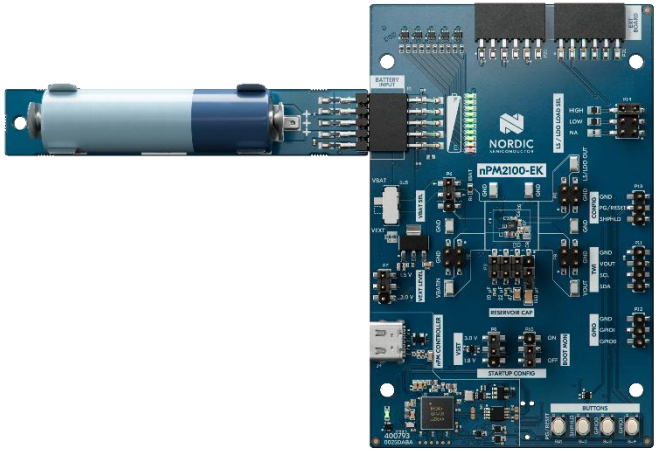




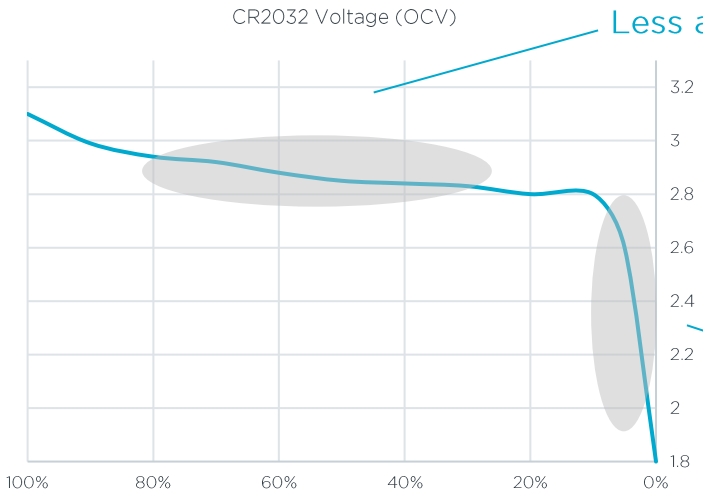
Pass-through auto or controlled via TWI

nPM2100 fuel gauging system

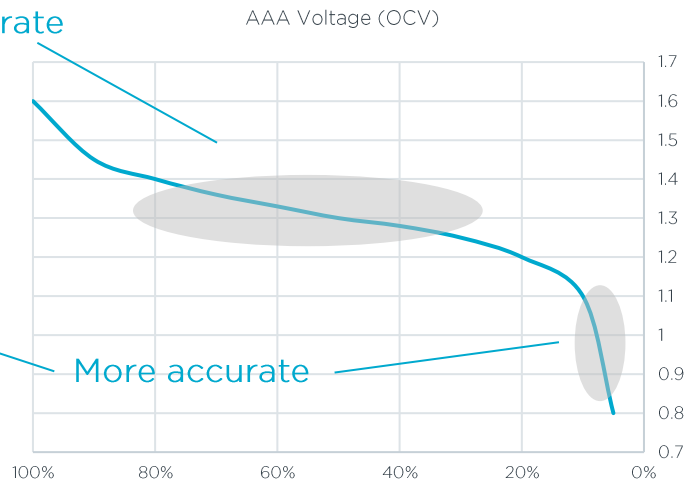




Primary cell fuel gauging



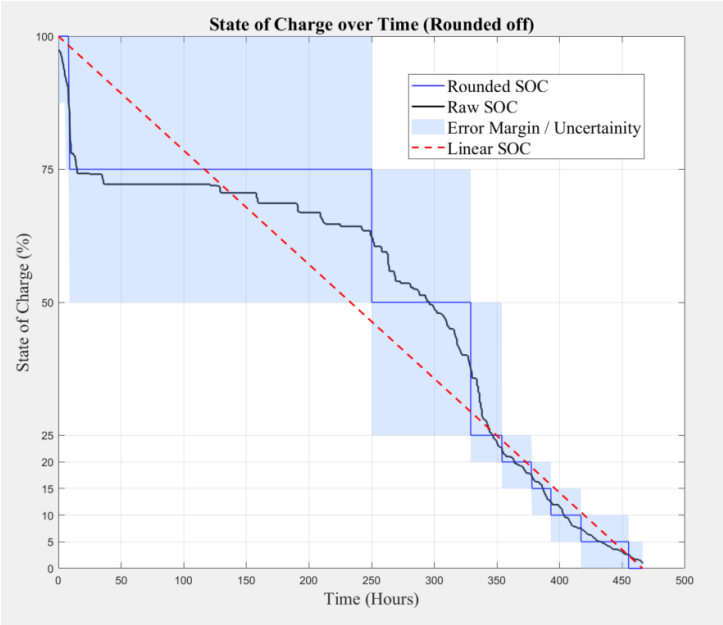
$LiMnO_2$

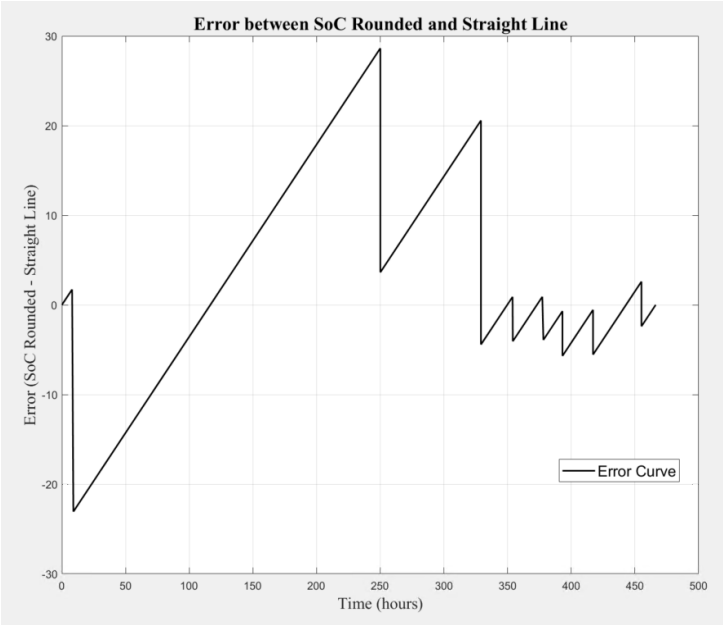


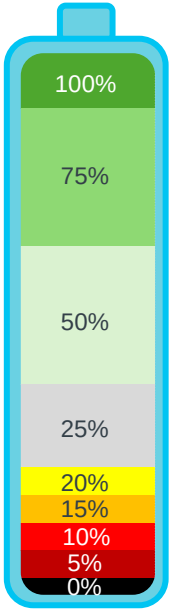
Alkaline

$LiMnO_2$ Fuel Gauge Reporting

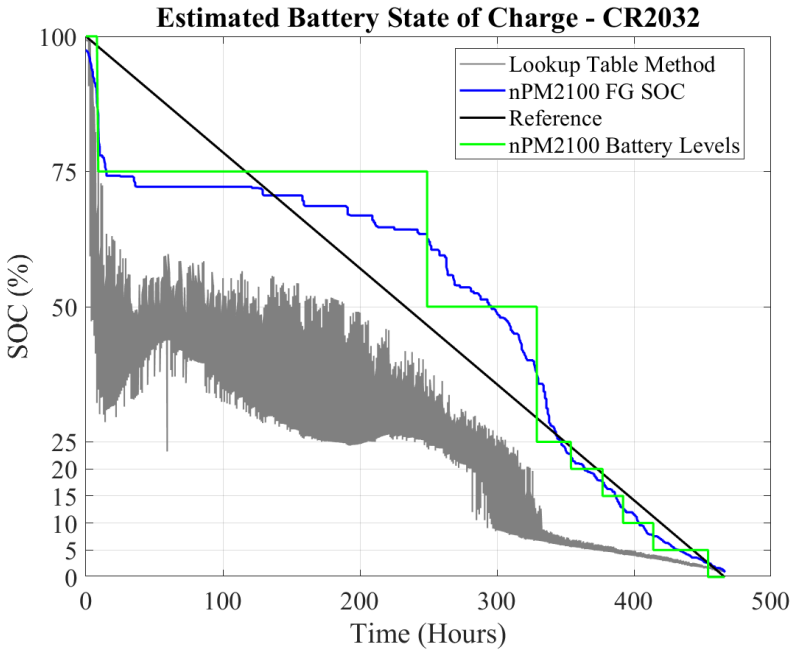
Step granularity reflects estimate precision

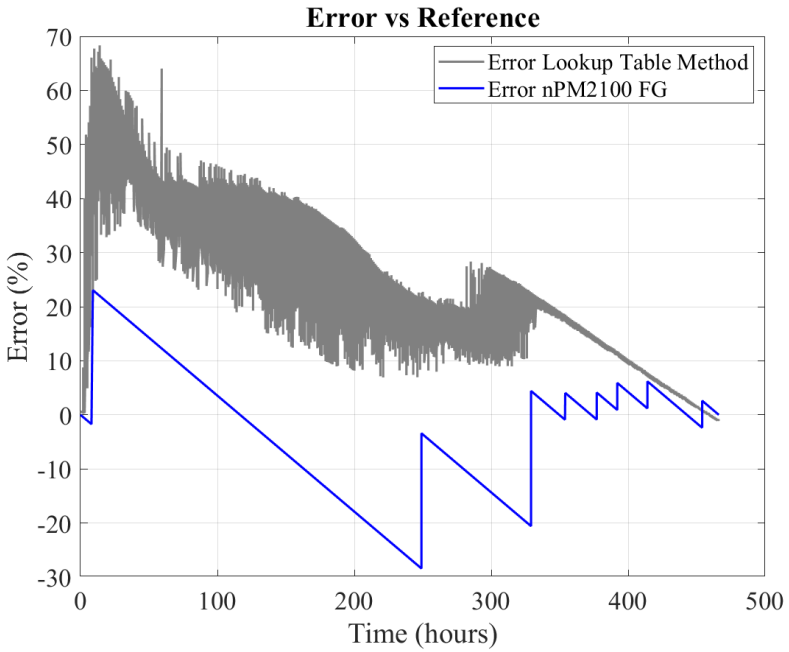




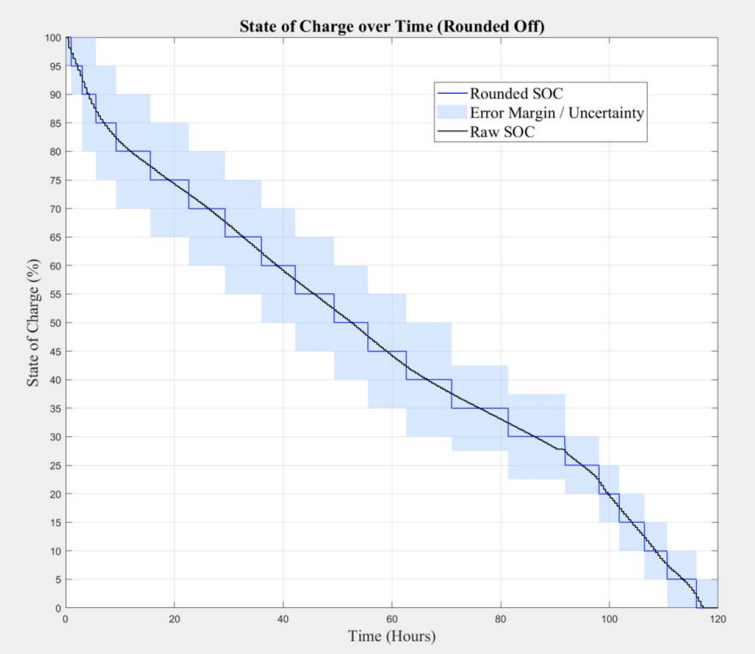


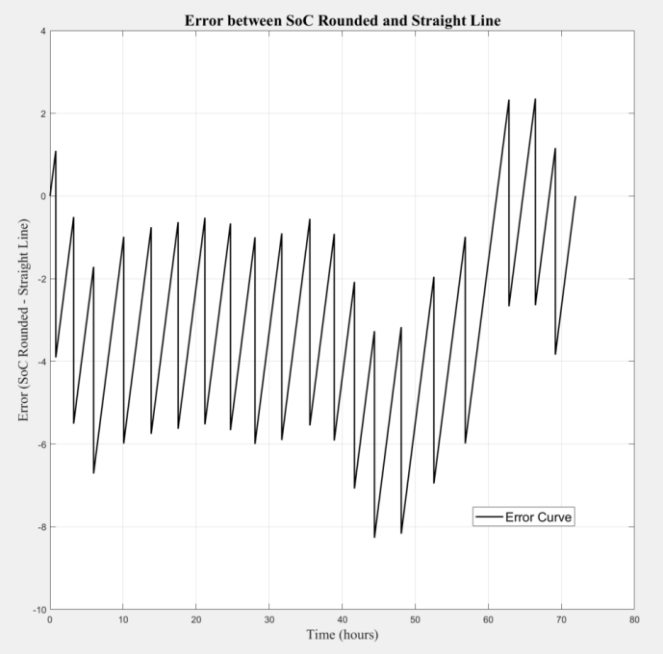
CR2032 fuel gauge vs look-up table

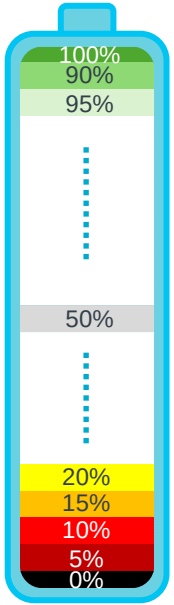




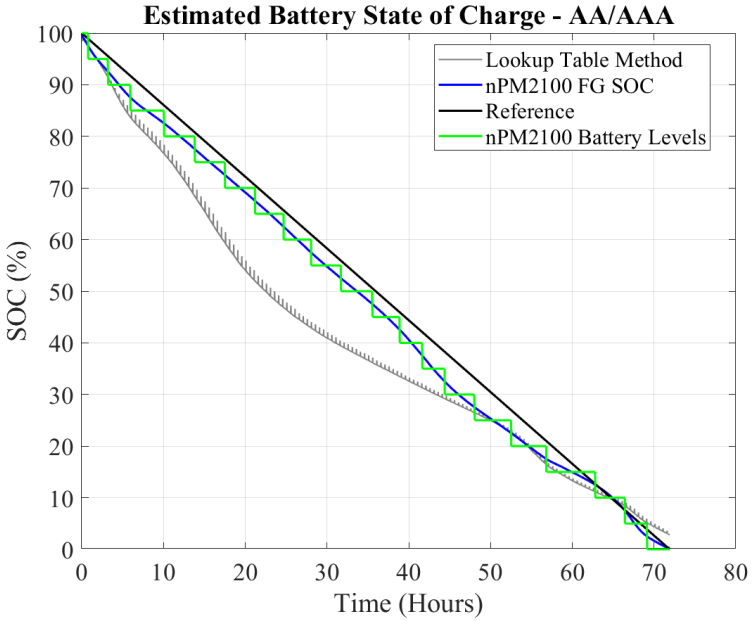
AA and AAA fuel gauge reporting

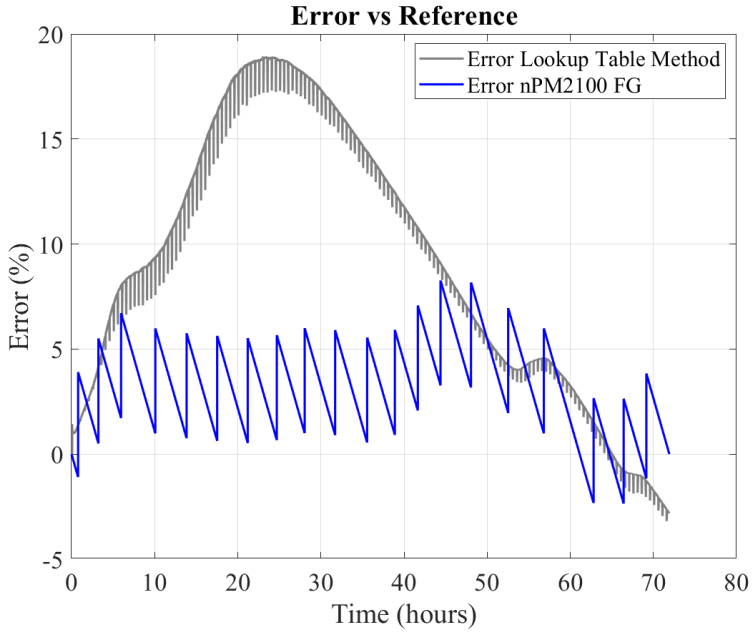




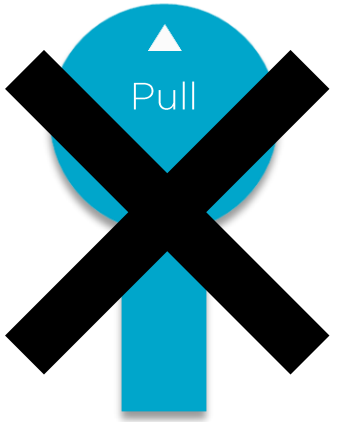


AA/AAA fuel gauge vs look-up table





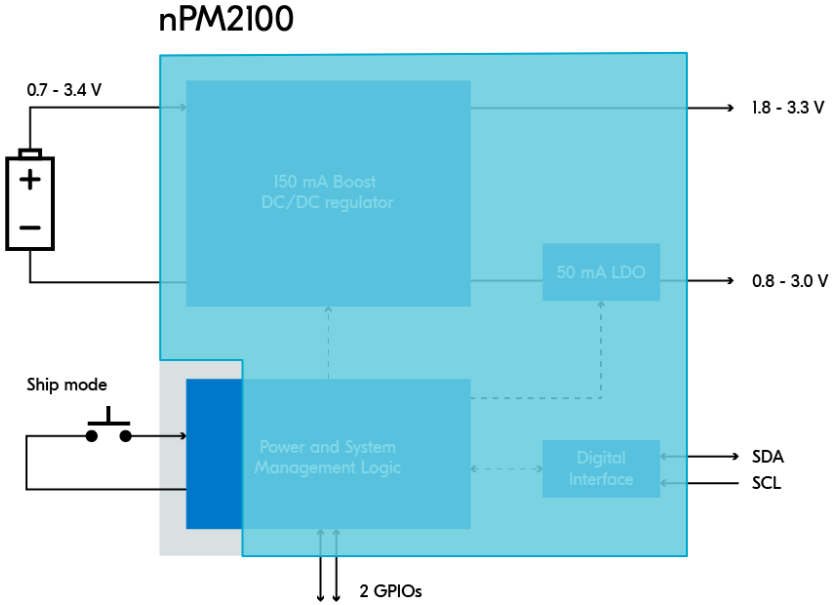
Shipping product with battery inserted



35nA ship mode

Insert battery without losing shelf life

- Enter via TWI or button press
- Wake up from
  - Button press
  - Break a connection (Break-to-wake – 65 nA)

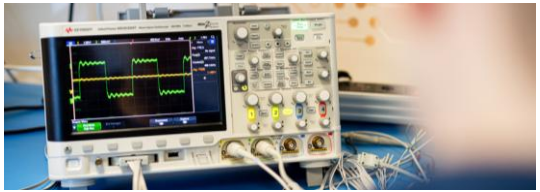


Ship mode wakeup options

Bonus Feature: Ship Mode as System on/off

Implements a system on/off switch using one single button

Fully hardware enabled – no software needed

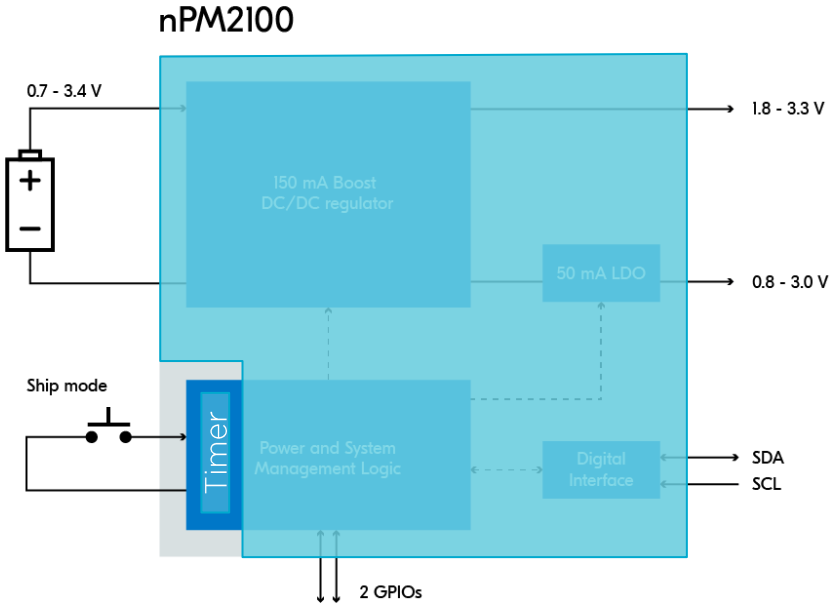


Same 35 nA I_Q as normal Ship mode

170nA Hibernate mode

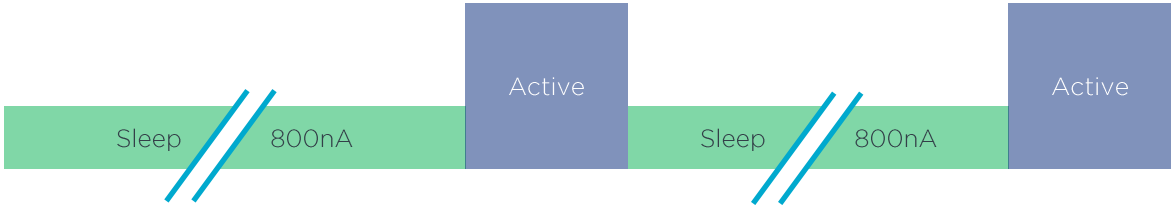
Wake up on a timer

- Configurable wakeup time
  - 16 ms – 74.5 hours
  - Enter via TWI
- Wake up from
  - Button press
  - Timer expiration



Hibernate mode on nRF54L15

- Option 1: nRF54L15 timed hibernate (System OFF w/ RTC)



- Example 2: Use nPM2100 with timed hibernate

Longer battery life starts at 85s wakeup intervals and increases

Battery life extension for Bluetooth LE, advertising only:

2.5 minutes:	+25%
4 minutes:	+50%
9 minutes:	2x
One hour:	3x

Summary

1. The nPM2100 increases battery life for primary cell powered Bluetooth applications
2. Important power saving features include, ultra-efficient boost converter, fuel gauge and ultra-low power ship and hibernate modes
3. The nPM2100 also offers important system supervisory functions