



LTO Batteries for LPWANs
Université Clermont Auvergne, France
July 2nd, 2026

- Nichicon Corporation
- LTO Battery Technology
- LPWAN Energy Autonomy
- Q&A + Open Discussion

A hand in a dark blue suit sleeve points towards a white hexagonal graphic. The graphic contains the text 'Nichicon Corporation' in red. The background is a blurred image of a person in a blue suit, overlaid with a faint hexagonal grid pattern.

**Nichicon
Corporation**



Head Office:	Karasumadori Oike-agaru, Nakagyo-ku, Kyoto, 604-0845 Japan
Chairman:	Ippei Takeda
President:	Katsuhiko Mori
Established:	August 1 st , 1950
Employees:	5,242 *
Net Sales:	169,724 Million Yen **
Listing:	First section of Tokyo Stock Exchange

** as of March 31st, 2025*

*** as of March 31st, 2026*



We dedicate ourselves to creating valued products that will contribute to a **brighter future for society**

We strive to attain a **better global environment**, to live up to our **ethical and social responsibilities (CSR)** and to diligently work to exceed the expectations of our customers, shareholders and employees

With heart and soul we aim to maximize our corporate value by the way of "**ko-do**" (**Think and Work**)

Capacitor Business Headquarters

Aluminum Electrolytic Capacitors

Film Capacitors

For electronic equipment & power electronics



NECST Business Headquarters
(Nichicon Energy Control System Technology)

Circuit Products & Applied Systems

For switching power supply & special accelerator power supply



4 Important Markets

Energy
Ecology
Medical
Equipment

Automotive
Railway-car related
appliances

Home
Appliances
Industrial inverters

Information &
Communication
equipment

From *manufacturing Business* to *Creation Business*
From *manufacturing* to *Koto-Zukuri* (the creation of customer expectations)

Aluminum electrolytic capacitors



SMD type



Leaded type



Snap-in terminal type



Screw terminal type

Conductive polymer aluminum solid electrolytic capacitors



Conductive polymer hybrid aluminum electrolytic capacitors



Electric double layer capacitors



Small Lithium-ion LTO-batteries



AI Ranks Nichicon As One Of The Top 3 Future Growth Companies



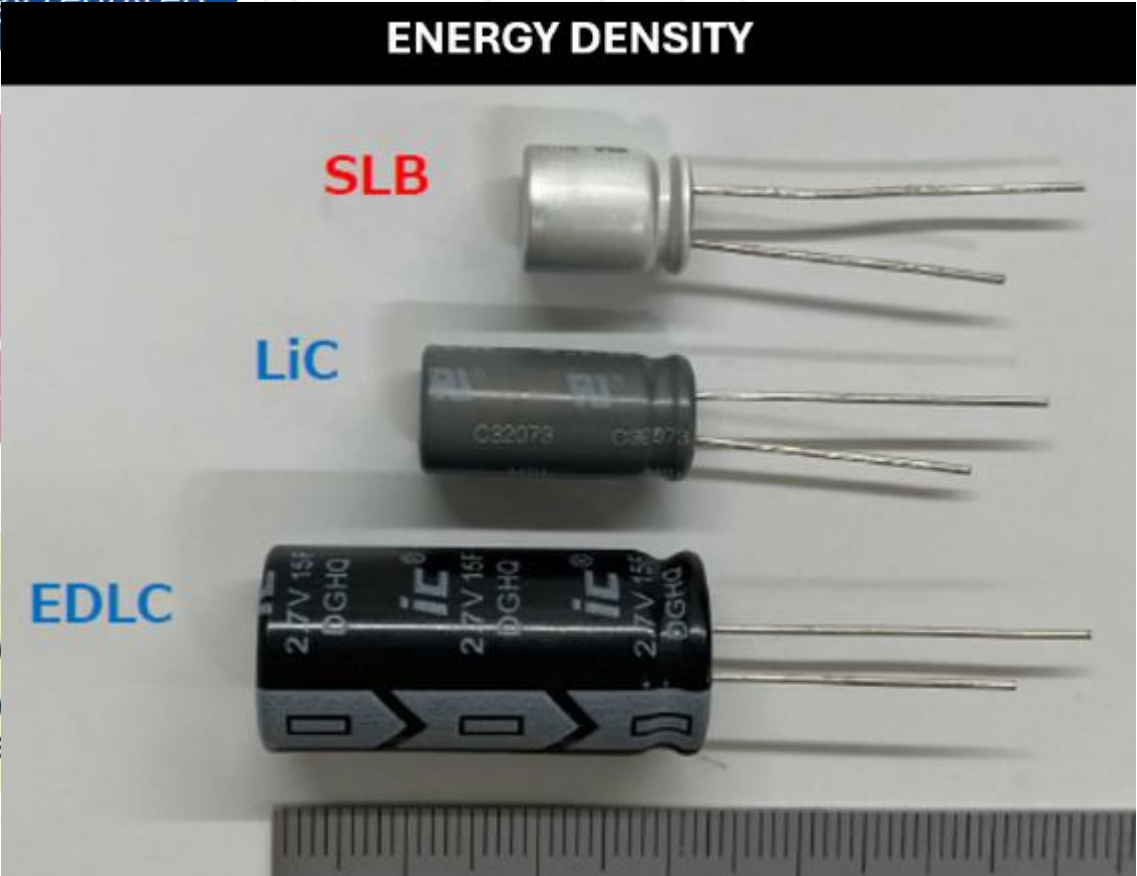
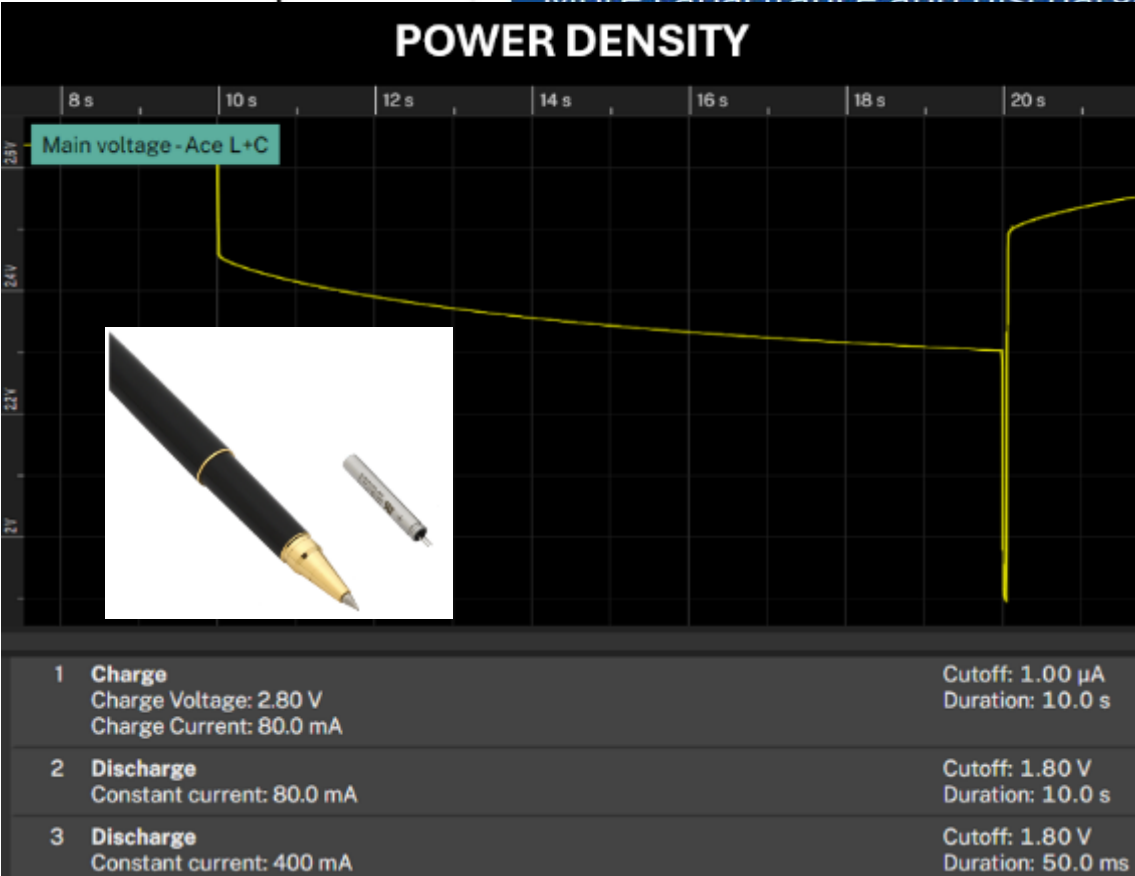
Nichicon’s core products include aluminum electrolytic capacitors, film capacitors and circuit products. A high number of positive points were achieved based on Nichicon’s products for growth fields such as energy, electric vehicles, ICT equipment and medical equipment. When the points were summed up, Nichicon was ranked in the number 3 position.

November 2020 issue (released on September 25, 2020)

A hand in a dark blue suit sleeve points towards a hexagonal grid overlay. One hexagon is highlighted in white and contains the text 'LTO Batteries' in red. The background is a blurred image of a person in a blue shirt.

LTO Batteries

LTO Batteries: Technology Positioning

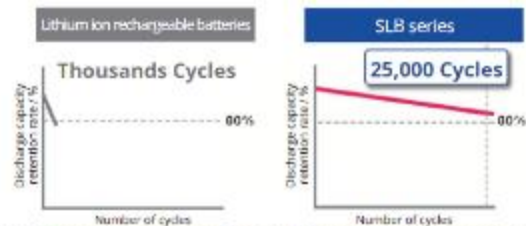


Energy Density (Wh/kg)

LTO Batteries: Main Features & Line-up

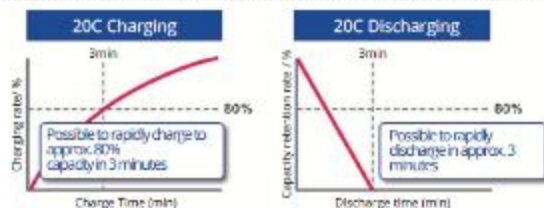
1 Long life

Maintain 80% capacity after 25,000 full charge / discharge cycles



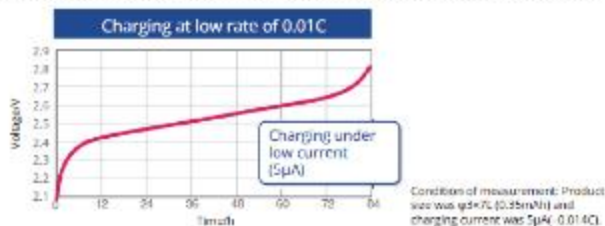
2 Rapid charge/discharge

Highest power density with large energy charge / discharge speed that outperform small supercapacitors



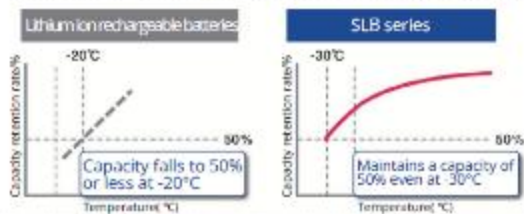
3 Low charging current

Effective charging at low rate using energy harvesting



4 Low temperatures

Possible to charge / discharge in cold regions (-30°C)



5 Safety

Extremely low possibility of explosion or ignition even when used under harsh conditions

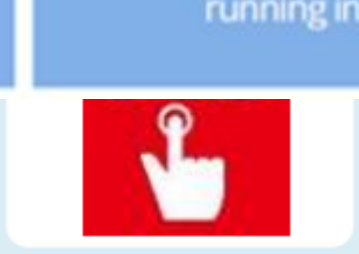
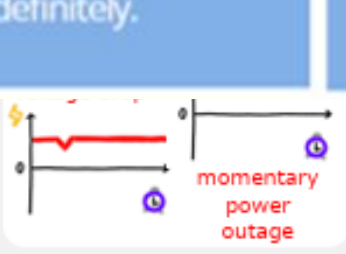
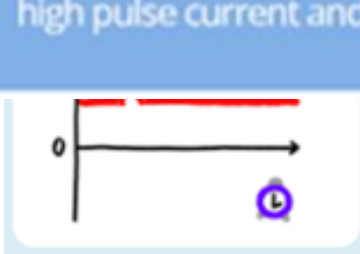


• UL1642 and IEC62133-2 : 2017 certified product.

• We have confirmed these batteries are safe with no explosions or ignition in crush, nail insertion, blunt nail, external short circuit, overcharge and forced discharge tests.



LTO Batteries: Target Markets & Areas of Application

					
 Ultra-Fast Charging Power up and get back to business in minutes. High-power 20C charge / discharge capability.	 Energy Harvesting Reliable, maintenance-free power supply. Keeps sensors and smart devices running indefinitely.	 Lifetime Extension Postpone and eliminate primary battery replacements, with best-in-class ESR support for high pulse current and voltage drop.	 Auxiliary ly ntal		
 Rechargeable toys	 Assist power suit	 Emergency call device	 Backup system	 Peak assist	 Use in cold regions

LTO Batteries: Charge & Discharge Characteristics

Item

Size : $\phi 3 \times 7 \text{L}$

Nominal capacity : 0.35mAh

Charge test conditions

Charge voltage : 2.8V

Charge rate : 0.05, 0.1, 1, 2, 5, 10, 20C

Cut-off current : Capacity $\times$ 5%

Rest : 10minutes

Test temperature : 25deg.C

Discharge test conditions

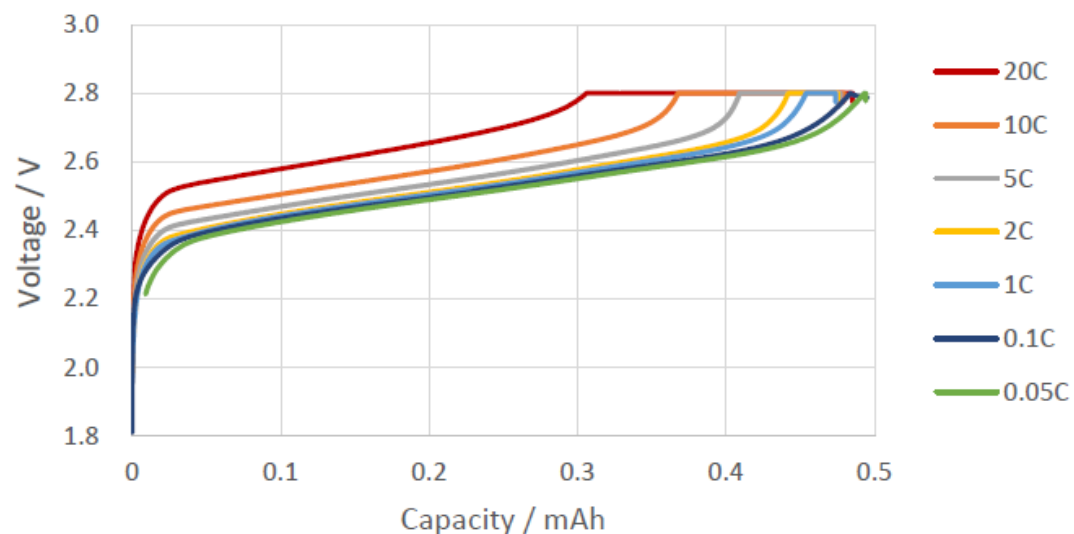
Discharge voltage : 1.8V

Discharge rate : 0.05, 0.1, 1, 2, 5, 10, 20C

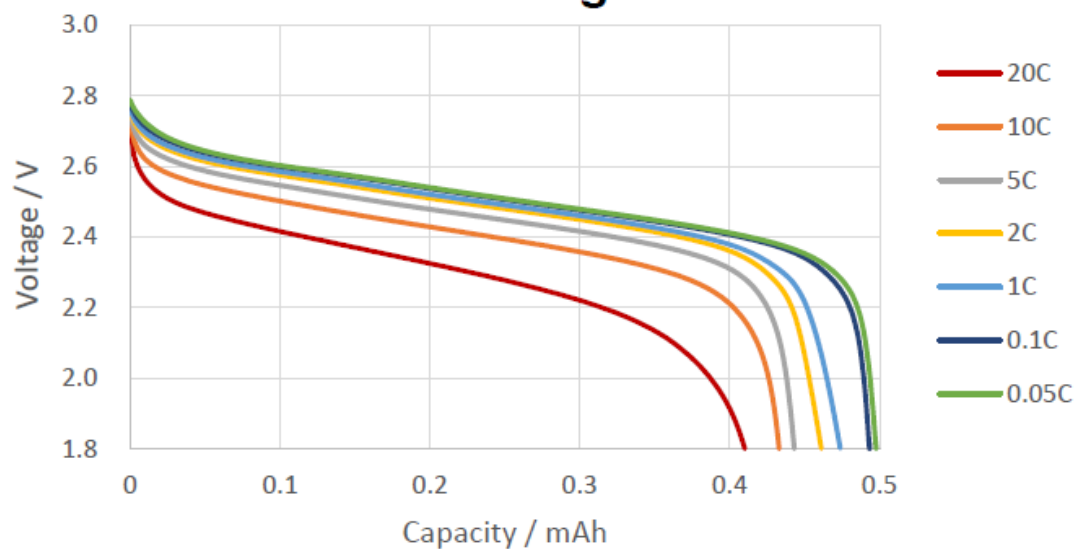
Test temperature : 25deg.C

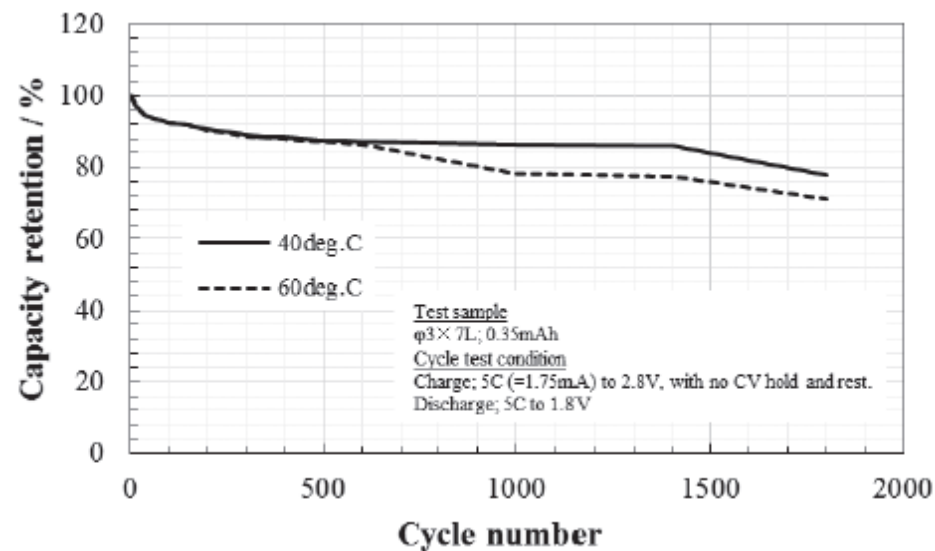
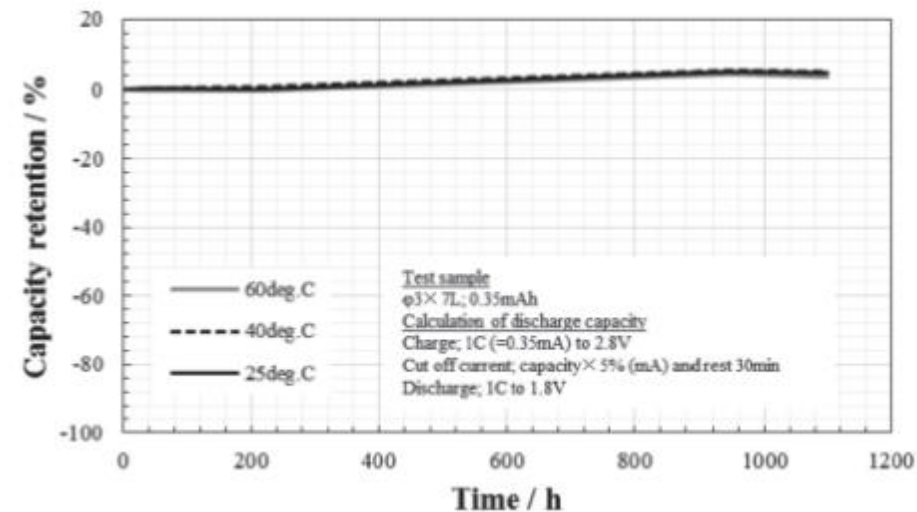


Charge



Discharge





2-3-4 Over-discharge resistance

Small li-ion rechargeable batteries are more resistant to over-discharging than standard lithium-ion rechargeable batteries. Product characteristics for this battery indicate its rated minimum voltage at 1.8V, but when subjected to a fully discharged cycle test where the battery is short-circuited for a long period of time, it could again be charged and discharged.

For example, the SLB could be used in temperature sensors for clean-energy applications. If used in energy harvesting of solar power, it could remain uncharged for a long period of time.

Figure 2-9 shows the rate of change in discharge capacity for the $\phi 3 \times 7L$ following charge/discharge cycles between 2.8V to 0V at different ambient temperatures. Although the decrease in capacity was more significant than in a test where the battery was stored fully discharged, after 1,800 cycles the battery's capacity decreased by approximately 30% at 60°C and by 22% at 40°C, indicating the product would not suddenly fail.

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LPWAN
Energy Autonomy

Leading Standards

-  LoRaWAN – Long range, low power, private networks
-  mioty – Massive scalability, interference-resistant, industrial deployments
-  NB-IoT – Cellular coverage, deep indoor penetration
-  LTE-M – Mobility support, higher throughput
-  Sigfox – Minimal power consumption, very small payloads

Common Requirements

-  Multi-year lifetime
-  Wireless transmission bursts
-  Outdoor operation
-  Energy harvesting compatibility
-  Minimal maintenance

The Power Problem

Although LPWAN nodes spend most of their lifetime in sleep mode (μA), they periodically require transmission bursts that can be hundreds of times higher than the average current.

A successful LPWAN design therefore requires more than low energy consumption—it requires an energy storage technology capable of supplying power reliably for many years.

Typical Applications

-  Smart Cities
-  Asset Tracking
-  Environmental & Temperature Monitoring
-  Smart Agriculture
-  Utility Metering
-  Industrial IoT

Fundamental Objectives

-  Ultra-low average power consumption
-  Long operating life (10–20+ years)
-  Reliable operation in harsh environments
-  High peak current delivery during wireless transmission
-  Minimal maintenance and battery replacement
-  Compatibility with energy harvesting

LTO Batteries for Autonomous LPWAN Devices



Extremely high cycle life



Exceptional peak TX current support



Reliable operation down to -40°C



Effective low current Energy Harvesting



Safety



1.) Primary Battery + LTO = Lifetime Extension

LTO handles:

- ⚡ Radio transmission peaks
- ⚡ Sensor activation surges
- ⚡ Pulse current demands
- ⚡ Low-temperature power demands

Primary battery provides:

- 🔋 Long-term energy reserve
- 🔋 Stable energy supply
- 🔋 Multi-year operating life

Main objectives

- ✅ Reduced pulse-current stress on primary cell
- ✅ Lower voltage drop during transmission
- ✅ Improved cold-temperature performance
- ✅ Better utilization of battery capacity
- ✅ Significantly extended service life
- ✅ Smaller primary battery

2.) Energy Harvesting + LTO = Infinite Lifetime

LTO handles:

- ⚡ Radio transmission peaks
- ⚡ Sensor activation surges
- ⚡ Pulse current demands
- ⚡ Low-temperature power demands
- ⚡ Energy harvesting fluctuations

Energy harvester provides:

- ☀️ Ambient energy input
- ☀️ Continuous recharge
- ☀️ Potentially unlimited lifetime

Main objectives

- ✳️ Harvest small amounts of ambient energy
- 🔋 Store energy efficiently in LTO
- ⚡ Deliver high-current transmission bursts

	Energy Harvesting + LTO	Primary Battery + LTO
Lifetime	Potentially unlimited	Very long
Maintenance	Lowest	Low
Safety	Excellent	Limited
Sustainability	Excellent	Moderate
Regulatory Position	Well positioned	Higher risk

Key Takeaway

Nichicon LTO batteries help LPWAN devices achieve what the technology ultimately promises: long-range connectivity with decades of reliable, maintenance-free operation.

LPWAN: Peak TX Current Assessment

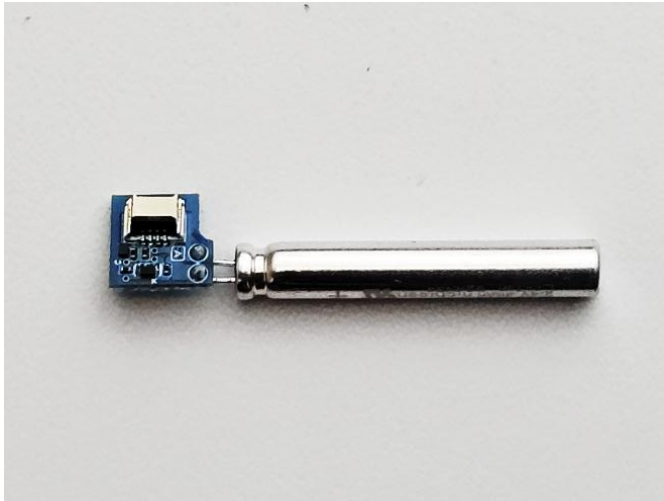
LPWAN Standard	Modem TX Current (at modem)	Typical Modem Voltage (V)	LTO Battery Current (at 2.4 V)
 mioty®	20 – 50 mA	3.3 V	30 – 76 mA
 sigfox	20 – 60 mA	3.3 V	30 – 92 mA
 LoRaWAN®	(+14 dBm) 30 – 50 mA	3.3 V	46 – 76 mA
	(+22 dBm) 80 – 140 mA		122 – 214 mA
 Wireless M-Bus	30 – 100 mA	3.3 V	46 – 153 mA
 NB-IoT	150 – 600 mA	3.8 V	264 – 1,056 mA
 LTE-M	200 – 700 mA	3.8 V	352 – 1,232 mA



Assumptions: 2.4 V LTO battery, LPWAN device supplied via DC/DC conversion where required, ~90% converter efficiency.

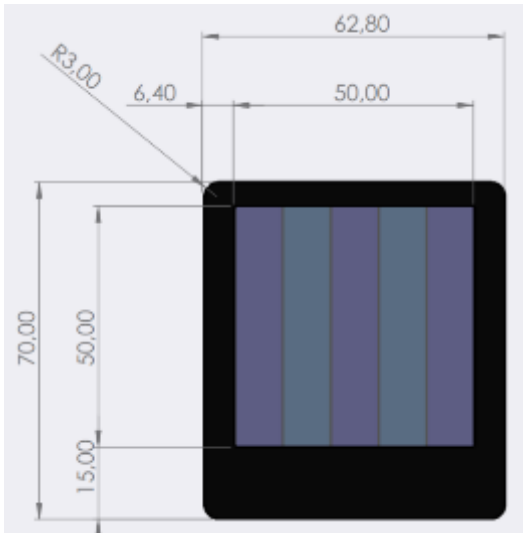


LPWAN: Use Cases – Nichicon Self-Charging-Battery (SCB)



Product Specification

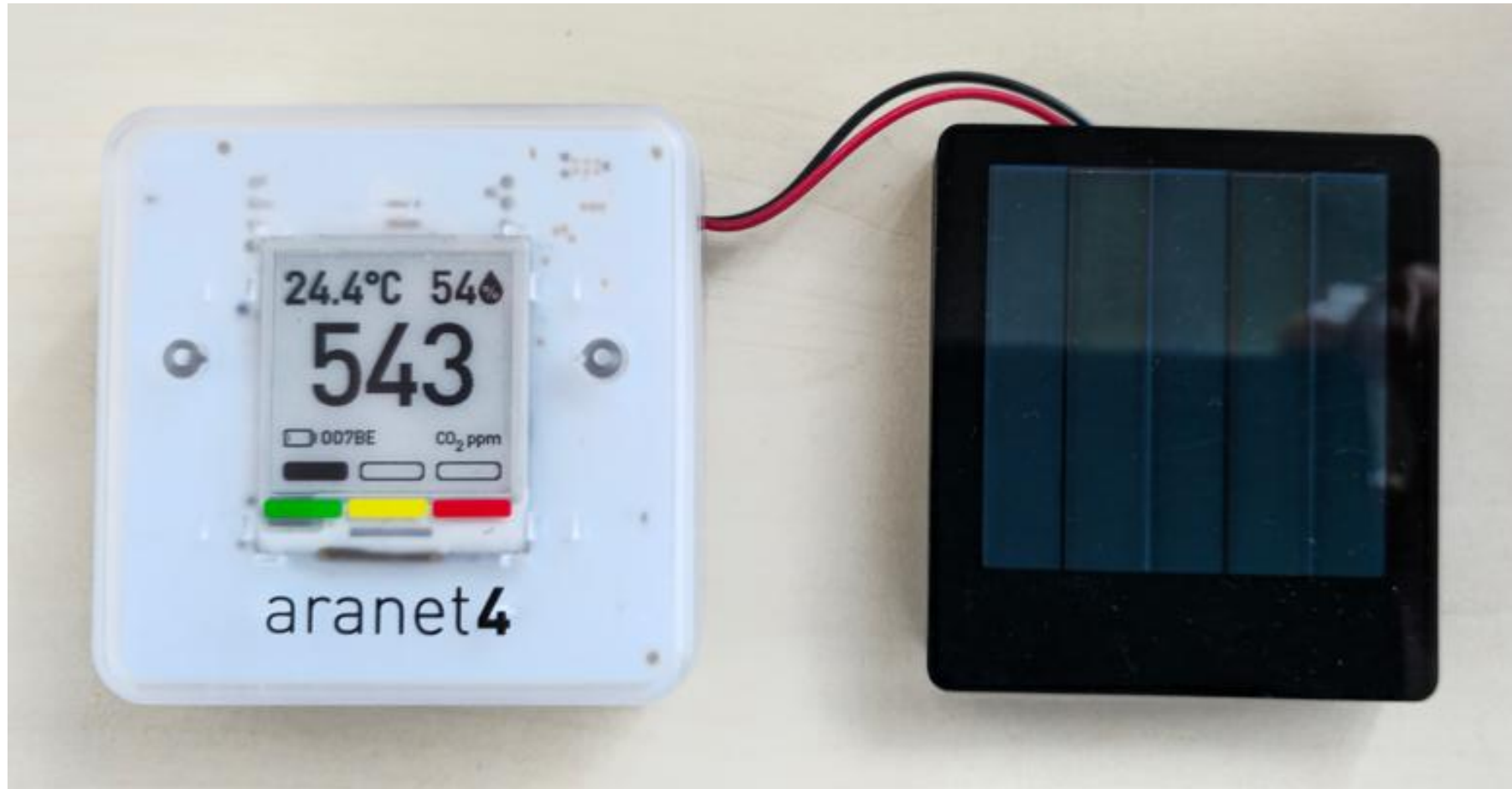
Nominal Voltage	2.4
Maximum Charge Voltage	2.835
Minimum Discharge Voltage	2.2
Max. Operational Temperature Range	-30 ~60°C
Nominal Capacity	4mAh
Typical Harvested Capacity per Year (office wall mounting 12 h)	375 mAh
Possible Harvested Capacity Over Lifetime (office desk mounting 24 h)	15000 mAh
Continuous Discharge Current	80mA (20C)
Max Short-Time Discharge Pulse Current	400mA (100C)
Weight	2.5g



Usable Capacity during 10 years (mAh)

Light Level (lux) / Light per day (hours)	8 hours	16 hours	24 hours
CR2032 Coin Cell (Reference)	250	250	250
Home Wall (50 lux)	500	1000	1500
Office Wall (250 lux)	2500	5000	7500
Office Desk (500 lux)	5000	10000	15000

LPWAN: Use Cases – SAF Tehnika CO₂ Sensor, Powered by Nichicon SCB



nichicon

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Q&A
Open Discussion

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