ROHM SEMICONDUCTOR

Electronics for the Future

ROHM Develops the First Silicon Capacitors [BTD1RVFL Series]

Achieving the industry's smallest* size in a mass-produced surface mount package contributes to greater space savings in smartphones and other compact devices

November 2, 2023
ROHM Co., Ltd.
Marketing Communication Department

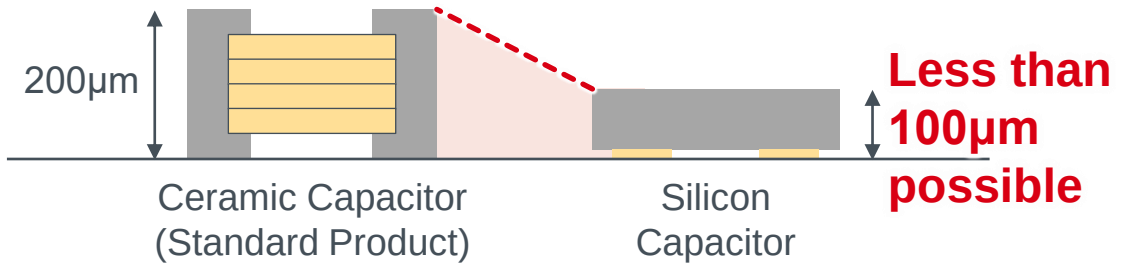
* ROHM November 2, 2023 study

Silicon Capacitor Design

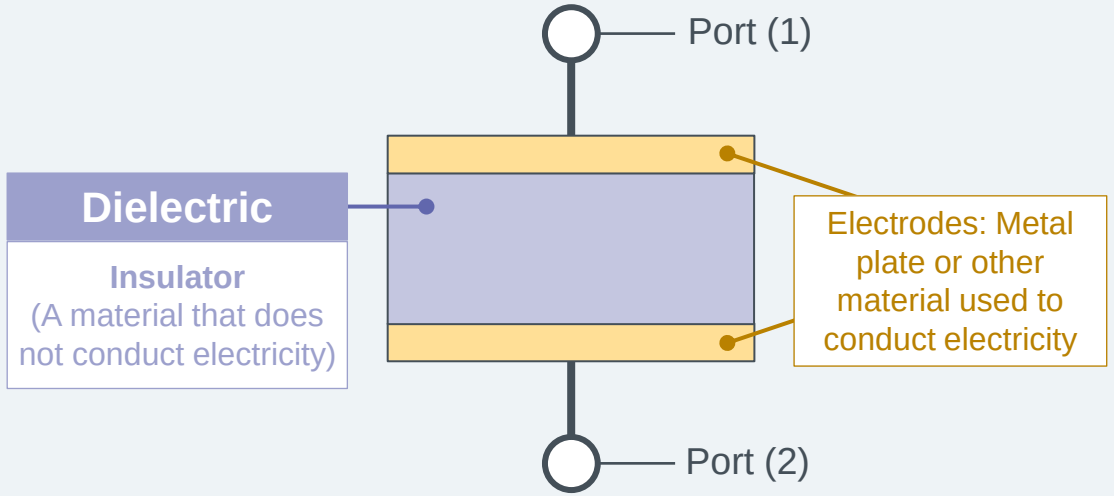
Features

- Silicon is a simple process that makes it possible to easily adjust the thickness
  → Easy to form trench and other internal structures
  → **Easy to increase the capacitance per substrate unit area**
- **Lower profile is possible using IC thin-film processes**
- **Small capacitance fluctuations due to temperature**
- Superior high frequency characteristics
- Exceedingly low bias characteristics
- High reliability

01005 (0.1inch×0.05inch / 0.4mm×0.2mm) Size Height Comparison



Structural Diagram



Silicon capacitors
use silicon oxide or nitride as the dielectric
(Ceramic capacitors use ceramic)

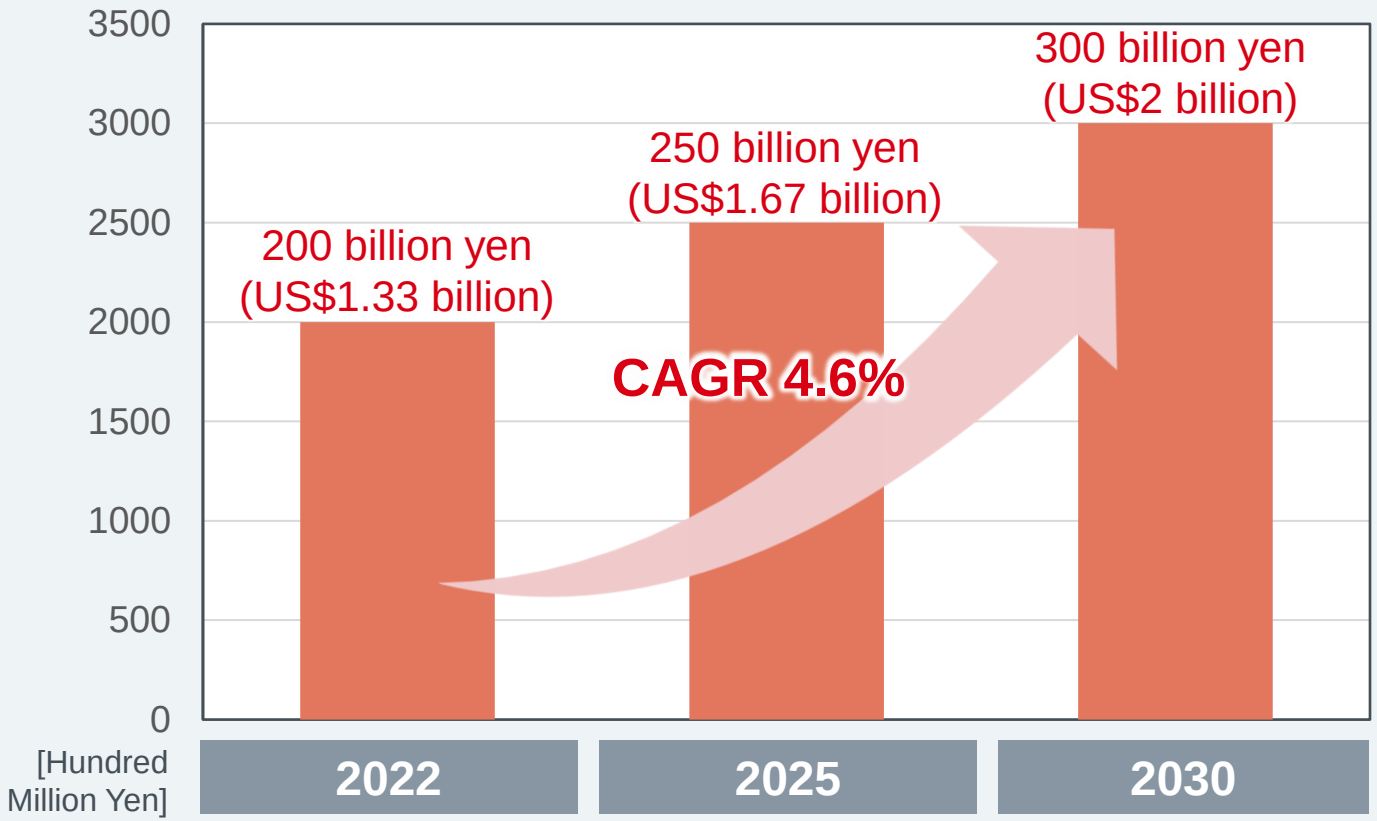
The ability to store an electric charge is called capacitance

$$\text{Capacitance} = \text{Relative Permittivity of the Dielectric} \times \frac{\text{Dielectric Surface Area}}{\text{Dielectric Thickness}}$$

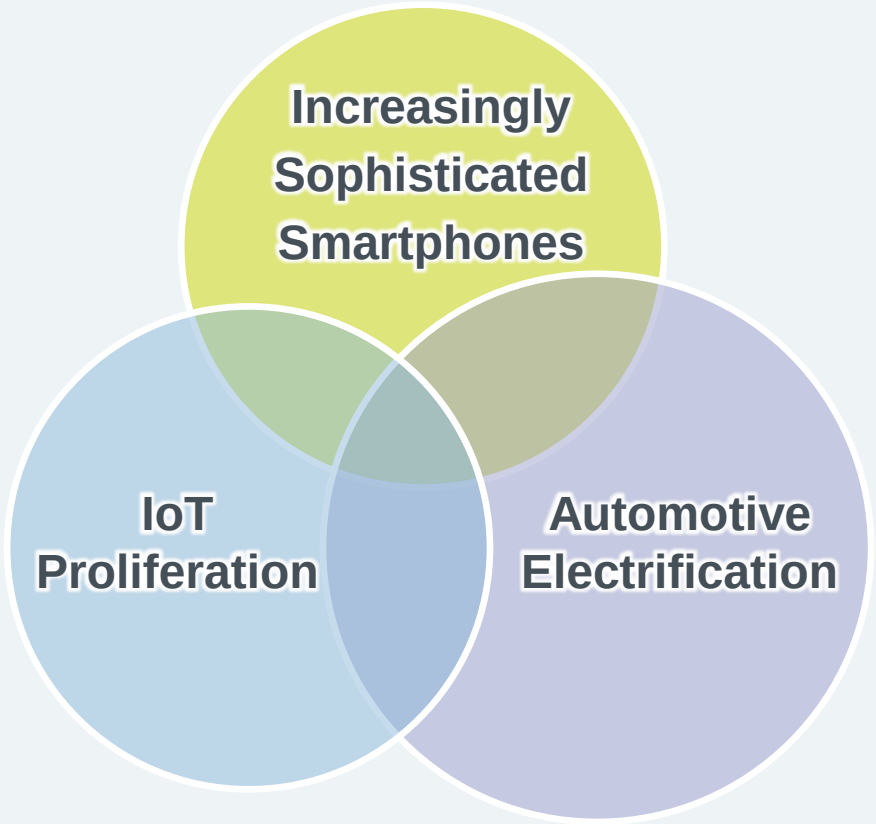
Market Forecast for Silicon Capacitors

Market Forecast for the Next 10 Years

*ROHM study



Breakdown of Market Expansion



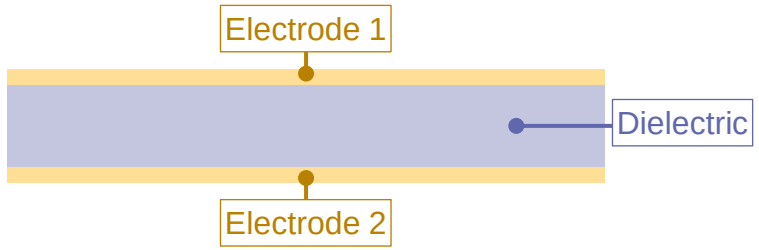
The market is expanding from smartphones and wearables to industrial equipment such as base stations and servers

ROHM Silicon Capacitor Technology

Trench Structure Leverages Semiconductor Process Technology

Parallel Plate Capacitor

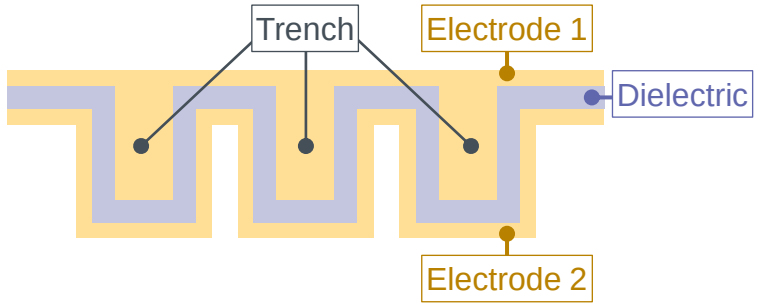
Two electrodes are positioned in parallel



$$\text{Capacitance} = \text{Relative Permittivity of the Dielectric} \times \frac{\text{Dielectric Surface Area}}{\text{Dielectric Thickness}}$$

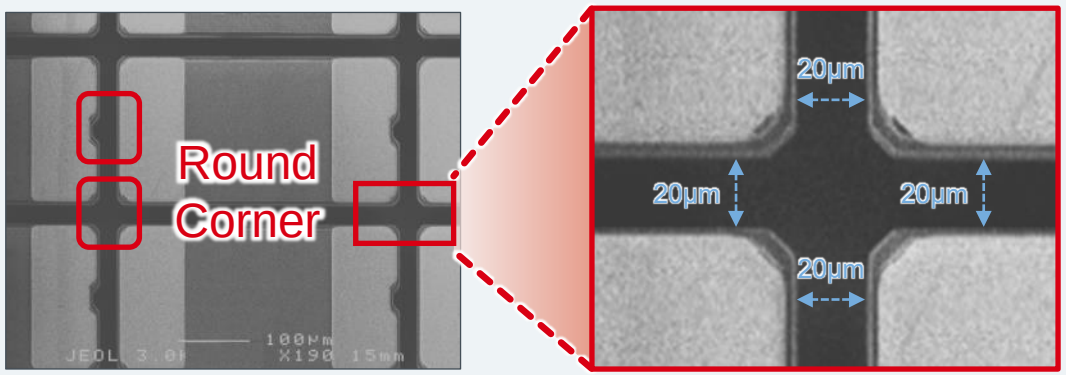
Trench Capacitor

Forming trenches increases capacitance by expanding the surface areas of the electrodes and dielectric



Ultra-Compact RASMID™ Series

RASMID



Micro-miniaturization along with remarkable dimensional accuracy (within ±10μm) are achieved using proprietary technologies that break away from convention.
This contributes to improved functionality in smartphones and wearable devices requiring smaller, thinner components.

ROHM silicon capacitors utilize proprietary technology to increase capacitance, improve dimensional precision, and enhance reliability

ROHM's Silicon Capacitor Strategy

Grow

Significantly extend sales in core growth businesses

- Power Devices
- Automotive ICs

Evolve

Achieve qualitative transformation, including shift to higher value-added products and market outside of Japan

- **General-Purpose Devices**
- Consumer ICs

Create

Plant new seeds for growth for FY2025 and beyond

- GaN / Power Modules
- Self-Driving Support Modules

Leveraging silicon semiconductor processing technology cultivated over many years in the development of silicon capacitors allows us to provide high value-added products that achieve superior performance in a smaller form factor

New Products ROHM's First Silicon Capacitor (BTD1RVFL Series)

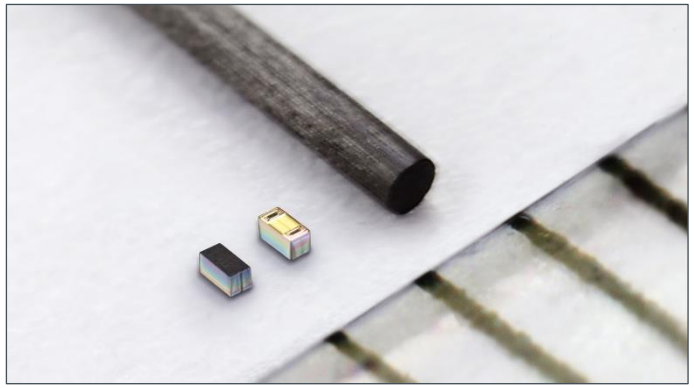
Features

- **The industry's smallest* mass-produced surface mount type**
- **High accuracy dimensional tolerance**
- **Superior mounting strength**
- **Exceptional ESD resistance (built-in TVS protection element)**

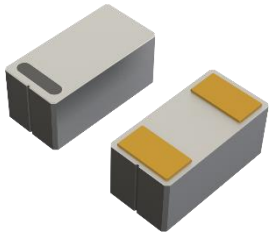
*ROHM November 2, 2023 study

Application Examples

- Smartphones
- Wearables
- Compact IoT devices
- Optical transceivers, etc.



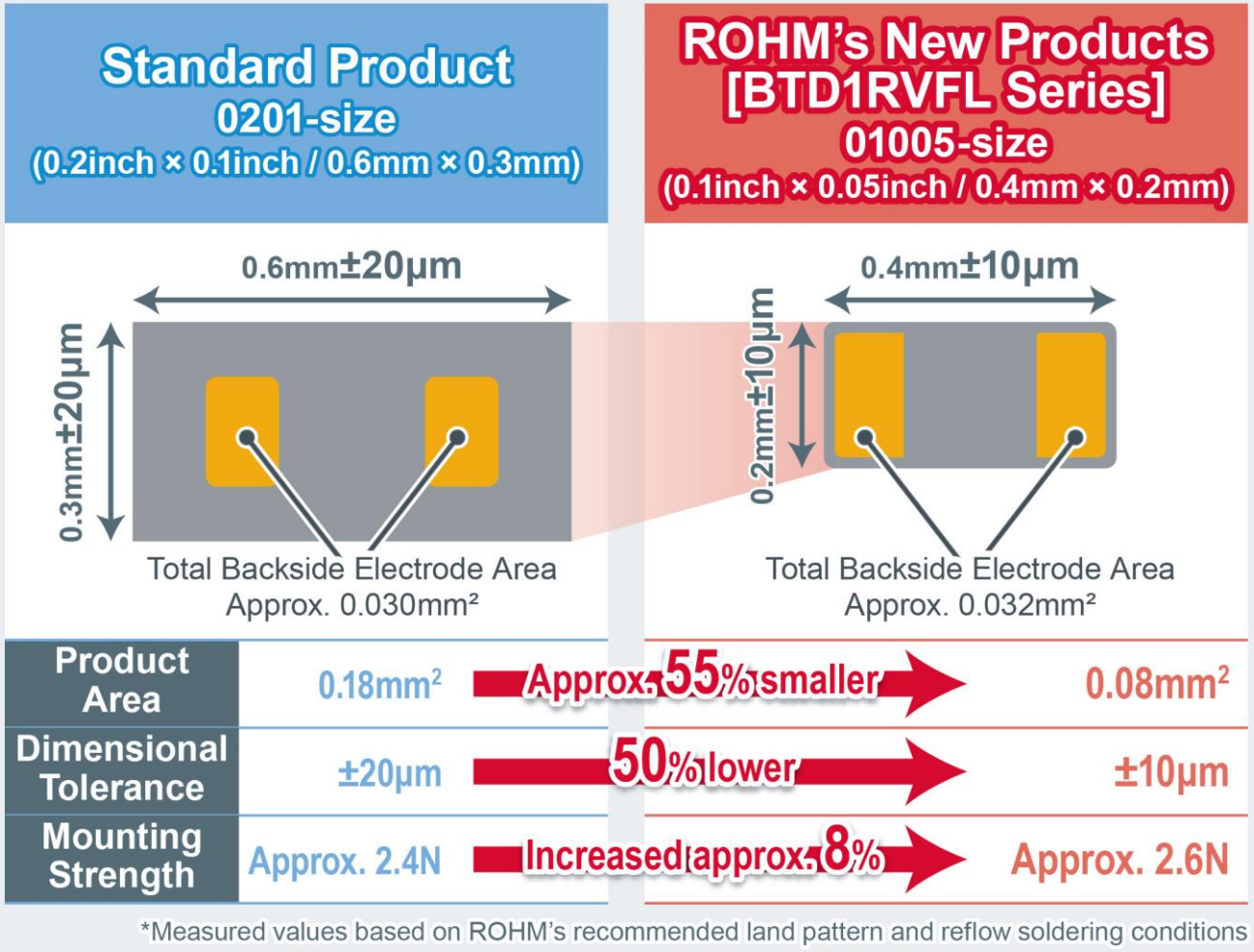
Product Photo
(Size comparison next to 0.5mm pencil lead)

Part No.	Rated Voltage [V]	Breakdown Voltage [V]	Capacitance [pF]	Capacitance Tolerance [%]	Temperature Coefficient [ppm/°C]	ESD Resistance [kV]	Operating Temperature [°C]	Size inch [mm]	Package [mm]
New BTD1RVFL102	3.6	8.2 to 9.2	1000	±15	0±250	±8	-55 to +150	01005 [0402]	 DSN0402-2 (0.4×0.2×0.185)
☆ BTD1RVFL681			680						
New BTD1RVFL471			470						
☆ BTD1RVFL331			330						
☆ BTD1RVFL221			220						
☆ BTD1RVFL151			150						
☆ BTD1RVFL101			100						

☆ : Under development

Feature 1: Combines a Small Size with Exceptional Dimensional Tolerance and Superior Mounting Strength

Comparison of Silicon Capacitor Package Size and Mounting Strength

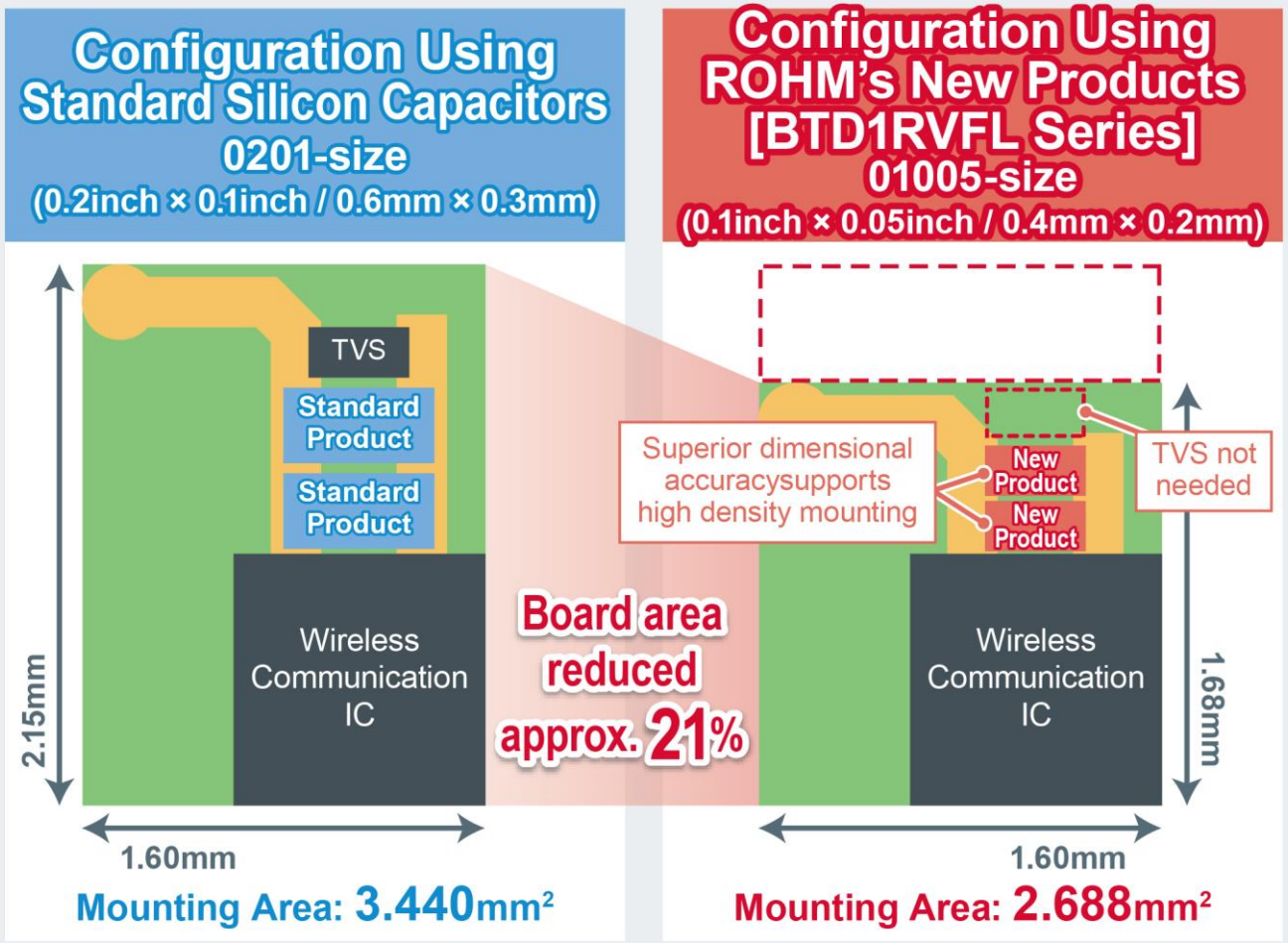


Ensures the same mounting strength as standard products while reducing size

Higher dimensional precision contributes to improved mounting accuracy

Feature 2: Reduces Mounting Area Through Greater Miniaturization that Supports High-Density Mounting

Mounting Area Comparison in Communication Circuit



Greater miniaturization combined with higher dimensional accuracy and integrated ESD protection improves space savings by reducing mounting area

Future Product Development

We are developing products for market demands, including support for higher frequencies and an expanded lineup

Market Requirements	**Miniaturization, for high frequency, high withstand voltage, high reliability, multiple product types**

Products

New Products — Mass production from August 2023

1st Gen. Si-Cap

BTD1RVFL Series

- 01005-size
  (0.1inch × 0.05inch / 0.4mm × 0.2mm)
- High dimensional accuracy (within ±10μm)
- High mounting strength
- Built-in TVS diode

Under Development — Sample shipment scheduled September 2024

2nd Gen. Si-Cap

High Frequency Type

- 01005-size
  (0.1inch × 0.05inch / 0.4mm × 0.2mm)
- High frequency support
- Low ESR
- Low loss

Planned — Sample shipment scheduled September 2025

3rd Gen. Si-Cap

High Voltage / High Reliability Models

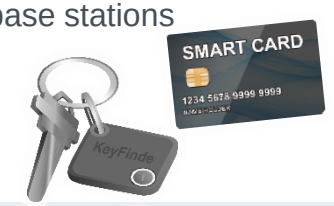
- Larger capacitances
- Higher breakdown voltages / reliability
- Wide range of product sizes

*Lineup expansion scheduled for 2026 and beyond

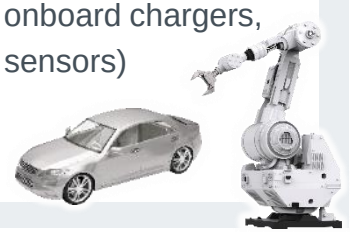
Application Examples

- Smartphones
- Wearables
- Compact IoT devices
- Optical transceivers

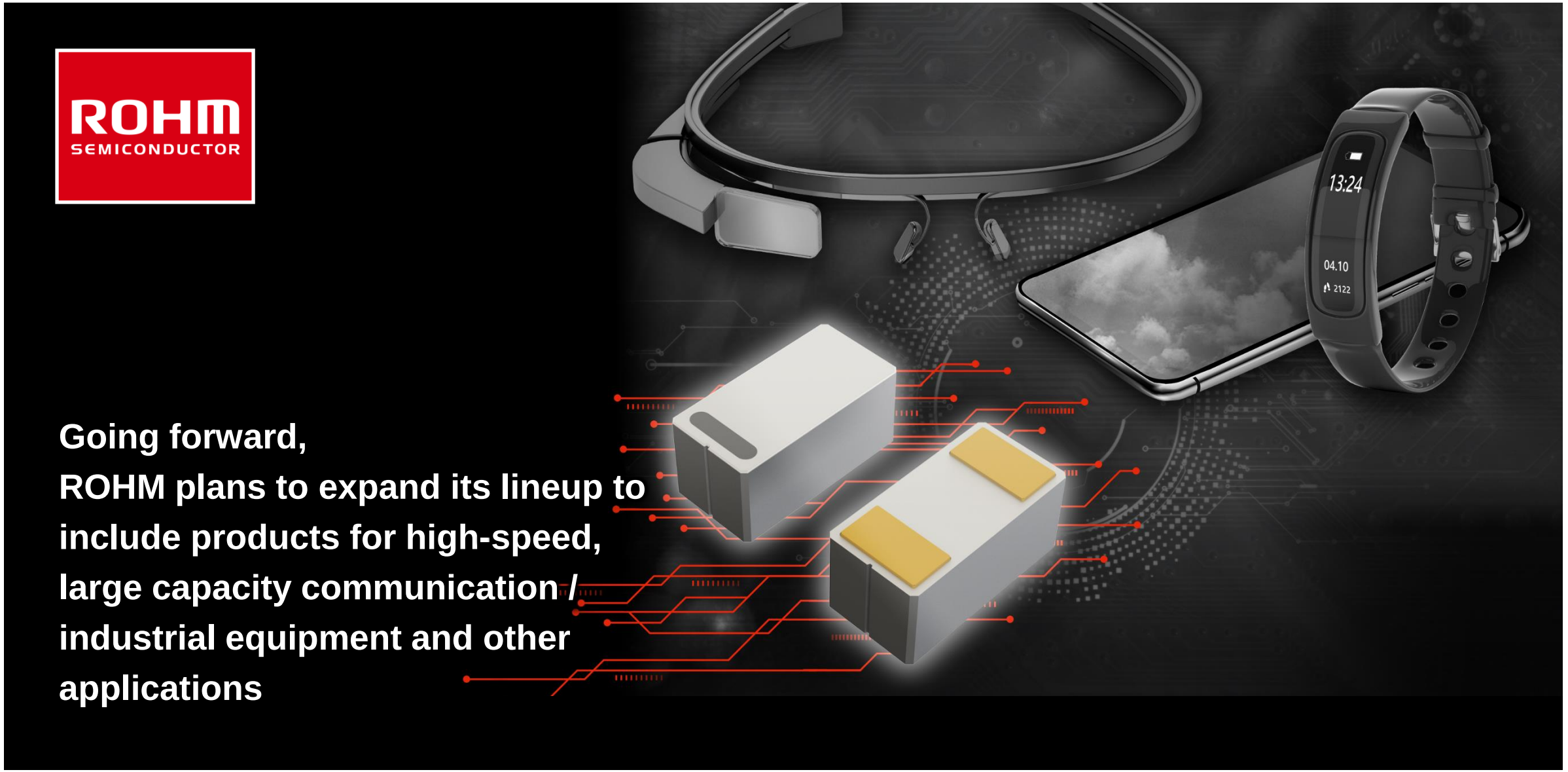
- High-speed communication applications
- Power amps for base stations
- Smart cards
- RFID tags



- Industrial equipment
- Automotive (i.e. EV onboard chargers, DC-DC converters, sensors)
- LiDAR



Conclusion



Going forward,
ROHM plans to expand its lineup to include products for high-speed, large capacity communication / industrial equipment and other applications

Electronics for the Future

ROHM Co.,Ltd.

Notes

- The content specified herein is for the purpose of introducing ROHM's products (hereinafter "Products").
- If you wish to use any such Product, please be sure to refer to the specifications, which can be obtained from ROHM upon request.
- Great care was taken in ensuring the accuracy of the information specified in this document. However, should you incur any damage arising from any inaccuracy or misprint of such information, ROHM shall bear no responsibility for such damage.
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