行動/可穿戴裝置電源系統趨勢
Power System Trend for Mobile / Wearable Device

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(1) Power System Trend for Mobile and Wearable Devices

(2) Mobile/Wearable power study
- Power Consumption: Nano Energy ®
  - Normally-Off

(3) Power Charge / Harvest
- Wireless Power Charger
- Energy Harvesting: EnOcean ®

(4) Rohm Activities
- Mobile & Wearable application
Wearable Market Highlights

Significant Changes

Overall
- Become popular in various sectors such as entertainment, fitness, and healthcare.
- Trend as attachability, good design, long battery life and multiple functions.
- Demand to components ① small ② low power consuming ③ sensing solution.

Three themes for AR/VR

1. Miniaturization of parts
2. Reduction of power consumption
3. Vital Sensing

Mobility
Immersion
Control/UI
Technology Trend in Wearable Market

Development Trend of Wearable Device use Battery

- Challenges of Battery
  - Safety Improvement
  - Down-sizing
  - Long life

Li-ion Battery → New Type of Battery

Low power consumption power IC is required

Key Point

Low power consumption of power supply IC
Demand for Battery products drastically increasing ⇒Boost/Buck/Buck boost DC/DC with Low power consumption are needed
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Nano Energy® ~Concept~

New DC/DC Converter Featuring the Industry’s Lowest Current Consumption

Nano series

Ultra Low Power Consumption Technology deliver 10-year operation on a single coin battery

IoT industry keywords

Specific Technology
- Nano Energy®

Optimized Process
- Internal Element
  - Synchronous rectification
  - Light Load Mode

DCDC converter Consumption current trend

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Low Power Consumption

Challenges

- Leak Current
- Noise Sensitivity
- Response Speed

Trade Off against Low Power Consumption

Key Technology

Stable Control Technology against trade-off
Nano Energy® ~Application Example~

* Effect of WW Smallest Consumption Current
* Longer Battery Life, Driver for Small Power Generation Equipment

Wearable Devices • IoT Devices

Energy Harvest Equipment

Longer Battery Life and Operating Time

Support Small Power Generation
To Achieve Ultra Low Consumption Current

Switching Regulator Block Diagram

- Protection block, etc.
- Reference Voltage
- Control Monitor
- Control Logic

Light Load
Reference Voltage + Control/Monitor

Key Technology

- Power Consumption Reduction at Light Load situation
- Minimize Fluctuations at All Load Situation
- Response Time against Load Variation
Performance of Nano Energy® Switching Regulator

**Efficiency**

90% efficiency at Iout 10μA → Loss reduction at stand-by mode

**Load regulation**

- Stable regulation from Iout 1μA to 500mA
- Seamless change from light load to heavy load
Nano Energy® Expansion

Based on different consumption current and response speed needs.

- Development of different type of products.

Contribution for longer battery operation such as lasting 10 years.
Key Function For Portable

We can meet your requirement by our latest boost/Buck/Buck-boost converter

- **Boost**
  - BU33UVNUX
    - Input: 0.9～5.5V
    - Output: 3.3V
    - Package: VSON10X3030
    - Iq: 7μA

- **Buck**
  - BD70522GUL
    - Input: 2.5～5.5V
    - Output: Selectable
    - Package: VCSP50L1C
    - Iq: 180nA

- **Buck-Boost**
  - BD83070QWL
    - Input: 1.8～5.5V
    - Output: 3.3V
    - Package: UCSP50L1C
    - Iq: 3μA

Target Application

Remote controller etc...
Smart Watch etc..
Wireless headphone etc.
Normally-Off Computing for Constant Monitoring (Battery)

Need Miniaturization & Weight Reduction

Standard “CR2032” coin battery
Capacity: 220mAh
Size: 20.0mm diameter x 3.2mm height

Smaller coin battery to forget your wearing
Capacity =10mAh

2 wks continuous usage
10mAh for 14 days x 24hrs/day ≈ 30μA

⇒ People can forget you are wearing.

Image of Constant Monitoring

Smartphone or Reader/Writer

Patch
Battery
Antenna for NFC
NFC tag IC

NFC

Command Program

Logging data
Normally-Off Computing Activities of NEDO
(New Energy and Industrial Technology Development Organization)

Rohm co-works with University of Kobe in healthcare application.

Wearable Biosensor Module Power Consumption Comparison

- Conventional Technology:
  - 10mAH: 200μA
  - 20mAH: 38μA

- 2014/E Technology:
  - @10mAH: 38μA
  - @20mAH: 20μA

- 2016/B Technology:
  - Approx. 20μA

- Non-volatile memory reduces power consumption
  - Reduced power consumption through amp optimized for heart beat extraction, AD converter, and proprietary algorithm
  - Novel modular design achieves the world’s lowest average current consumption (38μA)

- New logic

Android with data retrieving application
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## Wireless Charging – Method Comparison

There are three (3) kinds of methods
Magnetic Field Coupling is most realistic and mainstream

<table>
<thead>
<tr>
<th>Method</th>
<th>Distance</th>
<th>Antenna Size</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnetic Field Coupling</td>
<td>Short ~ Middle Range</td>
<td>Small ~ Middle</td>
<td></td>
</tr>
<tr>
<td>Electric Field Coupling</td>
<td>Short Range</td>
<td>Large</td>
<td></td>
</tr>
<tr>
<td>Radio Wave</td>
<td>Long Range</td>
<td>Large</td>
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Source: TDK, Apple, Murata's HP and from [https://k-tai.watch.impress.co.jp/docs/event/ces2016/738258.html](https://k-tai.watch.impress.co.jp/docs/event/ces2016/738258.html)
Wireless Power System Technologies

Transmitter (Tx)
- HB/FB inverter
- Communication De-modulator
- Power control
- ADC
- Protections

Receiver (Rx)
- Sync. Rectifier
- ADC
- Communication control
- Power control
- Protections

Qi 13.56MHz (NFC)
Energy Harvesting - EnOcean ®

- Patented energy-harvesting wireless sensor and communication technology.
- Communication protocol is ISO/IEC 14534-3-10.

No power needed  No wire needed  No maintenance needed

In Asia, Rohm is the first party to become the promotor of EnOcean alliance since October 2012.

EnOcean products are installed into more than 400,000 buildings mainly in Europe and America.
EnOcean Communication in Low Power

Energy Harvesting + Low power RF

Energy Harvesting $\rightarrow$ Battery-less

Sensor

Ultra-Low power Wireless (EnOcean)

Module

1/10 Transmitting power than IEEE802.15.4

Electromagnetic Power Generation

Low Power under 200μJ (μW·s)

PTM210J (Switch Module)

Transmit “Switch On/OFF info.”

STM431J (Temp. sensor module)

Temp. sensor Humidity sensor

Transmit “Temp and Humidity”

STM429J (Magnet contact sensor module)

Transmit “Magnet contact info.”

Charge to the internal CAPA.

Magnetic contact sensor

Charge to the internal CAPA.
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Rohm Position

- 23000+ employee at 44 sites globally

- Focusing on Analog Solution, Power Solution, Sensor Solution, Mobile Solution

- IoT, Industrial and Automotive segment

Quality is our top priority at all times.

Our objective is to contribute to the advancement and progress of our culture through a consistent supply, under all circumstances, of high quality products in large volumes to the global market.
ROHM’s solution for IoT module

Fusion of sensing, circuit, & communication expands the possibility for IoT.

**Module**
- Integrated “RF design” “Sensor Algorithm”
- Packaging to small size Module

**Sensing + Algorithm**
- **Motion**
  - ACC, Gyro, Pressure, Geomagnetic,
- **Environment**
  - Color, Pulse wave, Temp, Ambient Light, UV, IR, Hall
- **Input device**
  - Capacitive, Touch, Presence

**ASIC**
- Analog Front End
- Signal processing
- I/F
- High Eff. Power
- DC/DC
- LDO Voltage Monitor

**MCU**
- Low Power
- Low voltage
- Sensor HUB

Based on Original Low Power Fab process

**Package**
- Non-Lead
- SOP
- SON/QFN
- CSP
- LGA
- Clear package
- Ceramic Package

**Communication**
- Low Power RF
- Sub-GHz
- Bluetooth
- Wi-Fi
- Wi-SUN
- EnOcean
- HD-PLC

**Element Technology**
- MEMS
- Geomagnetic
- Photo
- PZT

**LSI AFE Technology**
- High Accuracy
- Low Noise
- Low Power
- Digital Correction (Temp, Light Filter)

**Sensor Medal**
- Low power
- Low voltage operation
- Algorithm included (Accelerometer etc.)
- Driver support

**Earthquake Sensor**
- Molding
- Hollow sealing
- CAN sealing
- Ceramic board
- High-density mounting
- Optically transparent resin sealing

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We combine analog technology and control technology to provide high-performance power control.

- ACDC Converter ICs
- Digital Controllers (Rohm Power Version)
- DCDC Converter ICs
- Wireless Power
- Linear Regulators
- USB Power Delivery
- Power Management Switch

etc... Contributing to power management with various items

Market Performance

- Automotive
- Industry
- Infrastructure
- Office appliance
- Mobile / IT
- Home appliance
- Consumer

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World Smallest Electric Components

ROHM’s discrete contributes downsizing of applications

03015mm size Chip resistor

<table>
<thead>
<tr>
<th>Series</th>
<th>MCR004 (0.4mm × 0.2mm)</th>
<th>SMR003 (0.3mm × 0.15mm)</th>
</tr>
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<tbody>
<tr>
<td>Rated power</td>
<td>0.031 (1/32)W</td>
<td>0.02 (1/50)W</td>
</tr>
<tr>
<td>Resistance Value</td>
<td>10Ω ~ 3MΩ (E24/E96)</td>
<td>10Ω ~ 1MΩ (E24/E96)</td>
</tr>
<tr>
<td>Tolerance</td>
<td>F(±1%)</td>
<td>F(±1%)</td>
</tr>
<tr>
<td></td>
<td>J(±5%)</td>
<td>J(±5%)</td>
</tr>
<tr>
<td>Limiting element voltage</td>
<td>15V</td>
<td>10V</td>
</tr>
<tr>
<td>Operating Temp</td>
<td>-55°C ~ 125°C</td>
<td>-55°C ~ 125°C</td>
</tr>
<tr>
<td>TCR</td>
<td>±300ppm/°C(10 ≤ R &lt; 100Ω)</td>
<td>±200ppm/°C</td>
</tr>
<tr>
<td></td>
<td>±250ppm/°C(100 ≤ R ≤ 1M)</td>
<td></td>
</tr>
</tbody>
</table>

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**Nano Pulse Control® ~ Concept & Application~**

**Example: automotive application**

**Existing EV System**
- 250VHEV Motor
- 250V Battery
- DC/DC Converter
- 12V
- ECU

**48V Mild Hybrid EV**
- 48VHEV Motor
- 48V Battery
- 48V Power

**Input**
- Existing
- 12V Power
- 3.3V
- 3.3V
- ECU

**Output**
- Higher
- 48V Power
- 3.3V
- 48V

**Input**
- high

**Better Efficiency / One-Chip**

**Bigger Step-down Ratio, Smaller On Duty**

**e.g.) POE device**
48V POE (power over Ethernet) devices such as IP Phone and wireless access point.

**e.g.) Industrial/Automotive**
48V motor system application for FA (Factory Automation), industrial robot, EV motor, etc. Merit of down-sizing motor/battery

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