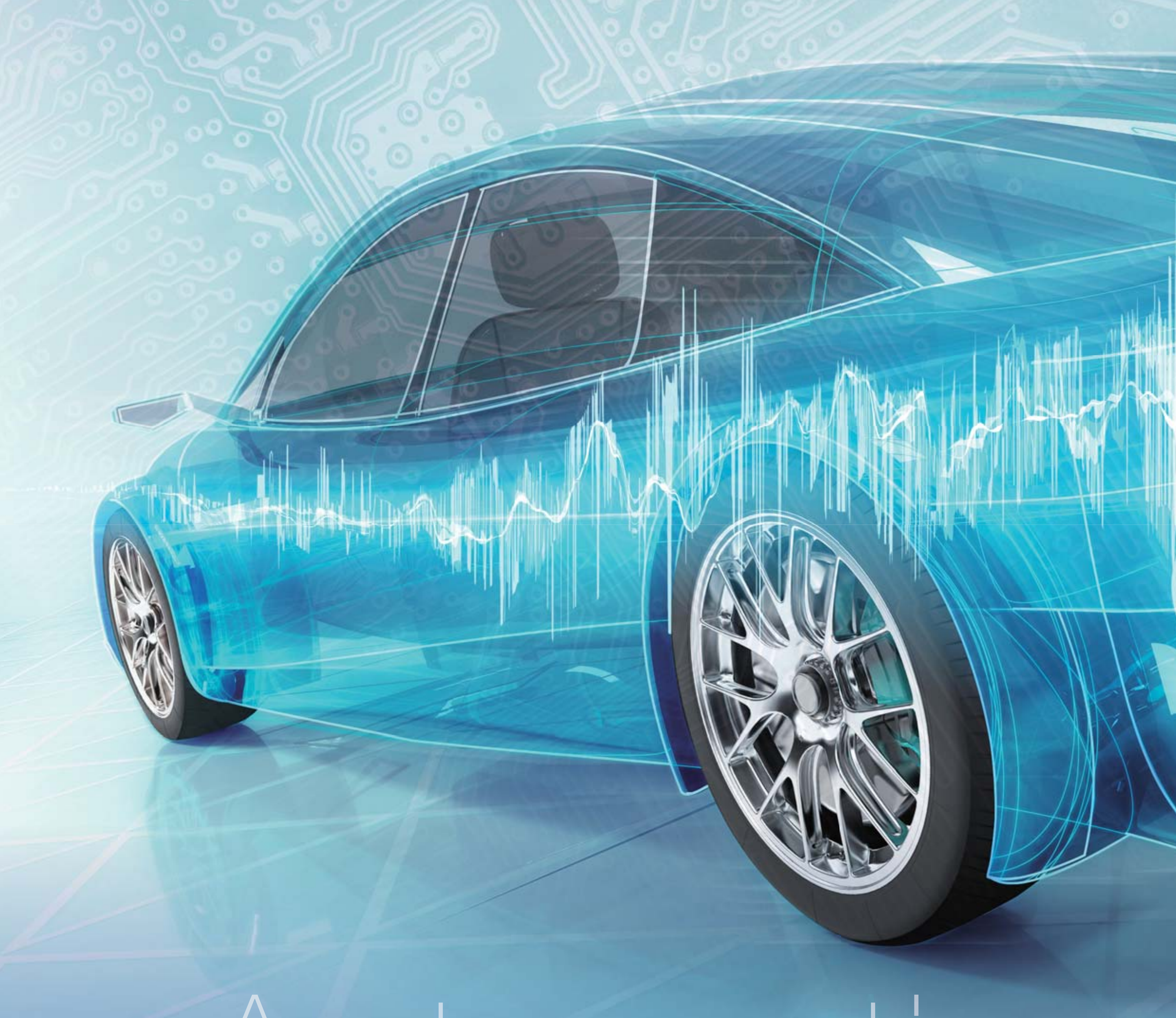
# Automotive Regulator Selection Guide

Ver.3.2

ROHM SEMICONDUCTOR

Creating the future of Automobiles



Automotive

ROHM Co.,Ltd.

# Towards a new era of mobility undergoing significant transformation

In recent years the mobility sector has reached a period of major change with the increasing proliferation of EVs and autonomous driving systems, driving the demand for automotive-grade semiconductors.
ROHM has consistently provided a stable supply of high quality products and solutions by leveraging an integrated development system and industry-leading technologies cultivated since the company was established in 1958.
Even now, ROHM continues to develop products that minimize environmental impact in the mobility sector by taking advantage of proprietary groundbreaking technologies such as Nano Pulse Control™ and Quick Buck Booster™ to decrease size while boosting efficiency.
In addition, to meet the increasing requirements for functional safety, ROHM acquired certification under the international functional safety standard ISO26262 for the development process. For this new era of mobility, ROHM will develop products that improve system safety and meet customer needs through a broad lineup of automotive-grade products and solutions ranging from chip resistors to SiC.


Note: "Nano Pulse Control™"is a trademark or a registered trademark of ROHM Co., Ltd.
Note: "Quick Buck Booster™"is a trademark or a registered trademark of ROHM Co., Ltd.

Automotive Regulator Selection Guide

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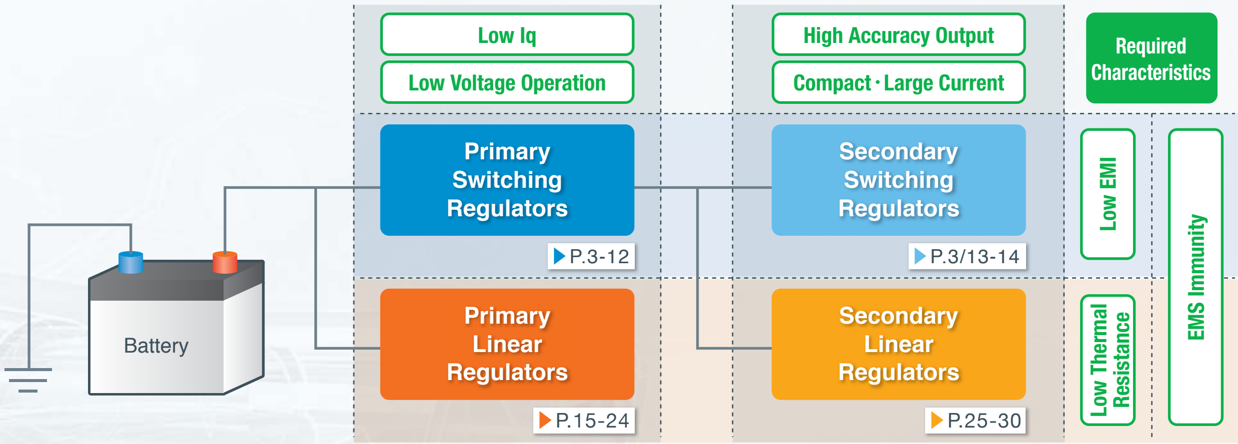
# Types and Features of Automotive Power Supply ICs




| | Switching Regulators(DC/DC) | Linear Regulators(LDO) |
|---|---|---|
| Features | **Enables not just buck but boost and buck-boost operation as well**<br>(Depends on the product)<br>Many external parts ⇒ Higher total costs<br>Good conversion efficiency<br>⇒ Less heat generation | **Easier configuration than DC/DC**<br>Few external parts ⇒ Lower total costs<br>Poor conversion efficiency<br>⇒ More heat generation |
| Voltage Generation Method | PWM(width)/PFM(frequency)<br>⇒ High noise | Resistance divider ⇒ Low noise |
| Applications | **Ideal for energy saving(high efficiency)<br>From low to high power** | **Meets low noise, low cost requirements<br>For low power applications** |

## Technologies that Maximize the Performance of Switching Regulators

**Effective noise countermeasures**

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**Effective heat dissipation countermeasures**

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## Technologies Required for Power Supply ICs

**Low Iq**

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**Low Voltage Operation**

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## Linear Regulators


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# Automotive Switching Regulator Lineup

**AEC-Q100 qualified**

Series Name: Primary (48V) · Series Name: Primary (12V/24V) · Series Name: Secondary · ◇ Synchronous rectification · Maximum rating

Nano: Nano Pulse Control™ · SSCG: Spread spectrum function · LLM: Light load mode · Buck-Boost: Buck-boost operation

Input Rail Voltage(V): 2.5, 2.7, 3.0, 3.5, 3.6, 3.7, 3.8, 3.9, 4.0, 4.5, 5.0, 5.5, 5.6, 5.7, 5.8, 5.9, 6.0, 7.0, 8.0

| Output Current(A) | | Features | Product | Maximum rating |
|---|---|---|---|---|
| Ext. | | Buck-Boost, External Synchronization | BD9035AEFV-C($V_{OUT}$: Variable, $f_{SW}$: 100k to 600kHz) | |
| Ext. | | 2ch, External Synchronization | ◆BD9015KV-M/◆BD9016KV-M($V_{OUT}$: Variable, $f_{SW}$: 250k to 550kHz) | |
| 4.0 | | External Synchronization | BD90640EFJ-C/BD90640HFP-C($V_{OUT}$: Variable, $f_{SW}$: 50k to 600kHz) | |
| 4.0 | | LLM, External Synchronization | ◆BD9S400MUF-C($V_{OUT}$: Variable, $f_{SW}$: 2.2MHz) | 125℃ 2MHz |
| 3.0 | | LLM, External Synchronization | ◆BD9S300MUF-C($V_{OUT}$: Variable, $f_{SW}$: 2.2MHz) | 125℃ 2MHz |
| 2.5 | | External Synchronization | BD90620EFJ-C/BD90620HFP-C($V_{OUT}$: Variable, $f_{SW}$: 50k to 600kHz) | |
| 2.0 | | Nano, SSCG, LLM | ◆BD8P250MUF-C($V_{OUT}$: 5V, $f_{SW}$: 2.2MHz) | |
| 2.0 | | Nano, SSCG, LLM, External Synchronization | ◆BD9P233MUF-C($V_{OUT}$: 3.3V, $f_{SW}$: 200k to 2.2MHz) | |
| 2.0 | New | Nano, SSCG, LLM, External Synchronization | ◆BD9P2x5EFV-C/BD9P2x5MUF-C($V_{OUT}$: 3.3V/5V/Variable, $f_{SW}$: 2.2MHz) | |
| 2.0 | New | | ◆BD9S201NUX-C($V_{OUT}$: Variable, $f_{SW}$: 2.2MHz) | 125℃ 2MHz |
| 2.0 | | LLM, External Synchronization | ◆BD9S200MUF-C($V_{OUT}$: Variable, $f_{SW}$: 2.2MHz) | 125℃ 2MHz |
| 2.0 | | LLM | ◆BD99010EFV-M/BD99011EFV-M($V_{OUT}$: 3.3V/5V, $f_{SW}$: 200k to 500kHz) | |
| 1.25 | | External Synchronization | BD90610EFJ-C($V_{OUT}$: Variable, $f_{SW}$: 50k to 600kHz) | |
| 1.0 | New | Nano, SSCG, LLM, External Synchronization | ◆BD9P1x5EFV-C/BD9P1x5MUF-C($V_{OUT}$: 3.3V/5V/Variable, $f_{SW}$: 2.2MHz) | |
| 1.0 | New | | ◆BD9S110NUX-C($V_{OUT}$: 1.2V, $f_{SW}$: 2.2MHz) | 125℃ 2MHz |
| 1.0 | New | | ◆BD9S111NUX-C($V_{OUT}$: 1.8V, $f_{SW}$: 2.2MHz) | 125℃ 2MHz |
| 1.0 | | | ◆BD9S100NUX-C($V_{OUT}$: Variable, $f_{SW}$: 2.2MHz) | 125℃ 2MHz |
| 0.8 | | Nano, SSCG, LLM, Buck-Boost | ◆BD8P250MUF-C+BD90302NUF-C *Buck-Boost($V_{OUT}$: 5V, $f_{SW}$: 2.2MHz) | |
| 0.6 | New | | ◆BD9S012NUX-C($V_{OUT}$: 1.1V, $f_{SW}$: 2.2MHz) | 125℃ 2MHz |
| 0.6 | | | ◆BD9S000NUX-C($V_{OUT}$: Variable, $f_{SW}$: 2.2MHz) | 125℃ 2MHz |

125˚C: 125˚C compatibility 2MHz: fsw ≧ 2MHz switching supported 2ch: 2ch output

External Synchronization External synchronization function


Note: Nano Pulse Control™ is a trademark or registered trademark of ROHM Co., Ltd.

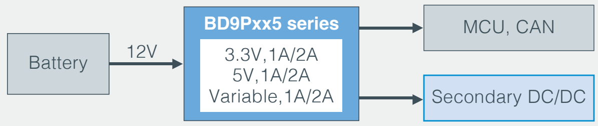
# Primary Switching Regulators

## BD9Pxx5EFV-C/BD9Pxx5MUF-C series

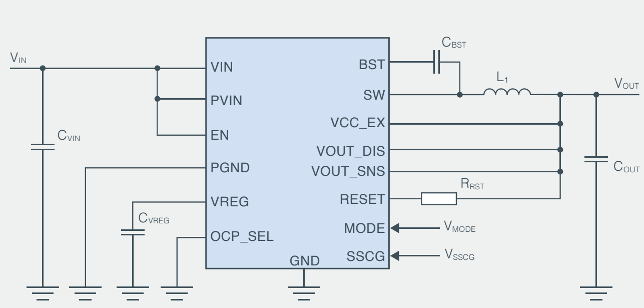
Low Iq | High Speed Response Solution

### Low Quiescent Current + High Speed Response Solution

The BD9Pxx5EFV/ MUF-C are low quiescent current buck DC/ DC converters that integrate ROHM's proprietary Nano Pulse Control™ technology. This enables stable operation even at high step-down ratios. In addition to heavy loads, LLM (Light Load Mode) achieves high efficiency and low current consumption even during light loads. What's more, a minimum operating voltage of 3.5V ensures exceedingly stable output even during cold cranking.




### BD9Pxx5EFV-C/ BD9Pxx5MUF-C Application Circuit



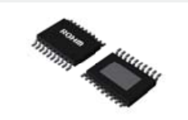

### Overview: BD9Pxx5EFV/MUF-C series

#### Fast response with strong cranking

- Input voltage: 3.5V to 40V ●Output voltage: 0.8V to 8.5V
- Switching frequency: 2.2MHz ±10%
- Operating temp. range: –40°C to +125°C
- Built-in Nano Pulse Control™
- AEC-Q100 qualified ●Minimum ON time: 50ns (Max)
- Synchronous rectification buck DC/DC converters with built-in power MOSFET
- Soft start function
- Current mode control ●Reset function
- Quiescent current: 10uA (Typ) (12V input/5V output)
- Light load mode (LLM) ●Forced PWM mode
- Built-in phase compensation
- Selectable spread spectrum function (OCP)
- Input under voltage lock out (UVLO)
- Thermal shut down (TSD)
- Over voltage protection (OVP) ●Short circuit prevention (SCP)

VQFN20FV4040

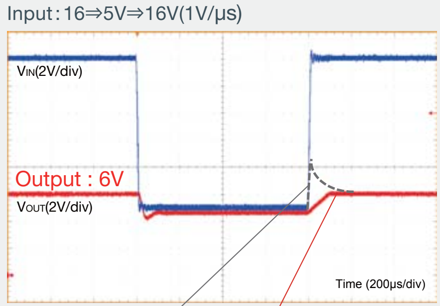
Wettable Flank



HTSSOP-B20

### Strong against power supply voltage fluctuations

Input: 16⇒5V⇒16V(1V/μs)



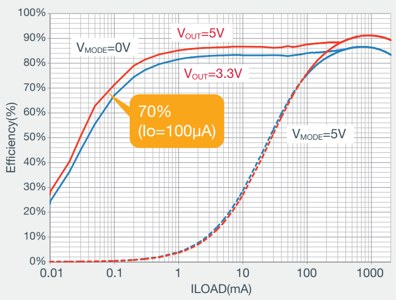

**Competitor Product**

Large output overshoot

**BD9Pxx5**

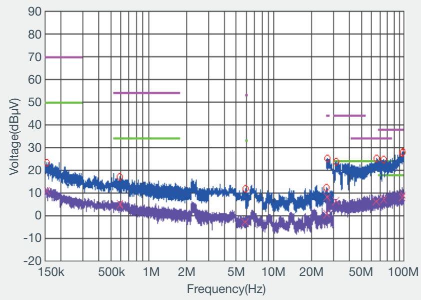
Small output fluctuation with no overshoot capacitor required

### Significantly increases efficiency in the light load region




**Achieves considerably higher efficiency in the light load region (Io=100μA)**

### Spread spectrum function ensures low noise characteristics




**Spread spectrum function ensures low noise characteristics**

| Part No. | Number of Outputs(ch) | Output FET High Side (Typ) | Output FET Low Side (Typ) | Rated Voltage(V) | Output Current(A)(Max) | Input Voltage (V) Initial Startup | Input Voltage (V) Min | Input Voltage (V) Max | Output Voltage (V) (Typ) | Reference(Output) Voltage Accuracy(%) | Switching Frequency Frequency Range (kHz) | Switching Frequency Precision(%) | Control Method | Circuit Current (mA) (Typ) | Power Good | External Synchronization | Variable Soft Start | Synchronous Rectification | Light Load Efficiency | Overcurrent Protection | Thermal Protection | Overvoltage Protection | Spread Spectrum | Operating Temperature (°C) | Package |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New BD9P205MUF-C | 1 | Nch (140mΩ) | Nch (90mΩ) | 42 | 2.0 | 4.0 | 3.5 | 40 | Adj (0.8 to 8.5) | ±1.75 | 2,200 | ±10 | Current | 0.01 | ✓ | ✓ | — | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | –40 to +125 | VQFN20FV4040 |
| New BD9P205EFV-C | 1 | Nch (150mΩ) | Nch (100mΩ) | | | | | | | | | | | | | | | | | | | | | | HTSSOP-B20 |
| New BD9P235MUF-C | 1 | Nch (140mΩ) | Nch (90mΩ) | 42 | 2.0 | 4.0 | 3.5 | 40 | 3.3 | ±1.75 | 2,200 | ±10 | Current | 0.01 | ✓ | ✓ | — | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | –40 to +125 | VQFN20FV4040 |
| New BD9P235EFV-C | 1 | Nch (150mΩ) | Nch (100mΩ) | | | | | | | | | | | | | | | | | | | | | | HTSSOP-B20 |
| New BD9P255MUF-C | 1 | Nch (140mΩ) | Nch (90mΩ) | 42 | 2.0 | 4.0 | 3.5 | 40 | 5.0 | ±1.75 | 2,200 | ±10 | Current | 0.01 | ✓ | ✓ | — | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | –40 to +125 | VQFN20FV4040 |
| New BD9P255EFV-C | 1 | Nch (150mΩ) | Nch (100mΩ) | | | | | | | | | | | | | | | | | | | | | | HTSSOP-B20 |
| New BD9P105MUF-C | 1 | Nch (210mΩ) | Nch (140mΩ) | 42 | 1.0 | 4.0 | 3.5 | 40 | Adj (0.8 to 8.5) | ±1.75 | 2,200 | ±10 | Current | 0.01 | ✓ | ✓ | — | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | –40 to +125 | VQFN20FV4040 |
| New BD9P105EFV-C | 1 | Nch (220mΩ) | Nch (150mΩ) | | | | | | | | | | | | | | | | | | | | | | HTSSOP-B20 |
| New BD9P135MUF-C | 1 | Nch (210mΩ) | Nch (140mΩ) | 42 | 1.0 | 4.0 | 3.5 | 40 | 3.3 | ±1.75 | 2,200 | ±10 | Current | 0.01 | ✓ | ✓ | — | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | –40 to +125 | VQFN20FV4040 |
| New BD9P135EFV-C | 1 | Nch (220mΩ) | Nch (150mΩ) | | | | | | | | | | | | | | | | | | | | | | HTSSOP-B20 |
| New BD9P155MUF-C | 1 | Nch (210mΩ) | Nch (140mΩ) | 42 | 1.0 | 4.0 | 3.5 | 40 | 5.0 | ±1.75 | 2,200 | ±10 | Current | 0.01 | ✓ | ✓ | — | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | –40 to +125 | VQFN20FV4040 |
| New BD9P155EFV-C | 1 | Nch (220mΩ) | Nch (150mΩ) | | | | | | | | | | | | | | | | | | | | | | HTSSOP-B20 |

Note: Nano Pulse Control™ is a trademark or a resistered trademark of ROHM CO., Ltd.

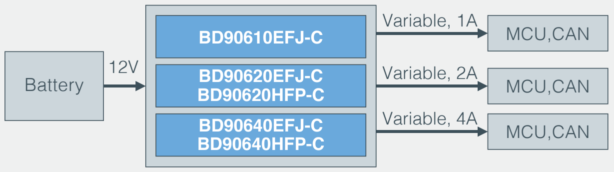
# Primary Switching Regulators

## BD906x0EFJ-C/BD906x0HFP-C series

Low Voltage Operation

### Low Voltage Operation Solution

The BD906x0EFJ-C/BD906x0HFP-C are switching regulators with built-in high voltage power MOSFET that allows the operating frequency to be arbitrarily set via external resistors.
Features include a wide input voltage(3.5V to 36V) broad operating temperature range(–40˚C to +125˚C), and the ability to synchronize with an external clock using the external synchronization input pin.
In the case of stop-start vehicles, normal operation is required even during severe voltage drops from conventional cranking voltage, so a Pch type capable of 100% ON duty is adopted even for our buck switching regulators.




### Overview: BD906x0EFJ-C/BD906x0HFP-C series

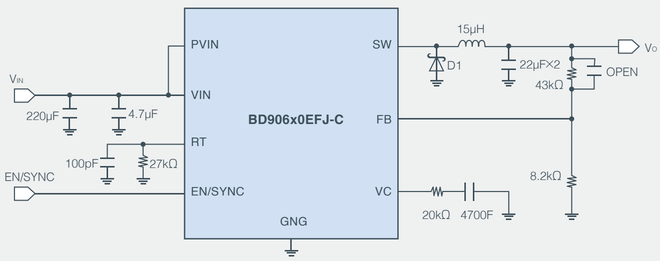
#### Wide input voltage range

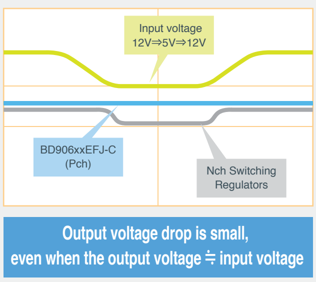
- Input voltage: 3.5V to 36V(42V rated)
  (However, initial startup 3.9V or more)
- Built-in Pch FET: achieves 100% ON duty
- Shutdown circuit current: 0μA(Typ)
- Reference voltage: 0.8V±2%(Ta: –40˚C to +125˚C)
  0.8V±1%(Ta: 25˚C)
- Switch output current:
  1.25A Max(BD90610EFJ-C)
  2.5A Max(BD90620EFJ-C/BD90620HFP-C)
  4.0A Max(BD90640EFJ-C/BD90610HFP-C)
- Switching frequency: 50kHz to 600kHz
- Internal switch FET: Pch 160mΩ(Typ)
- Built-in soft start function prevents inrush current at power ON(varies with switching frequency)
- Enable pin from CMOS logic input to battery voltage input
- Current mode control
- Multiple protection functions
  OCP, SCP, UVLO, TSD

HTSOPJ-8
(BD906x0EFJ-C)

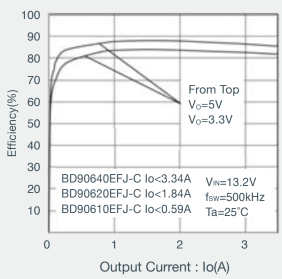

HRP7
(BD906x0HFP-C)

### BD906x0EFJ-C/BD906x0HFP-C series Application Circuit Diagram




BD906x0EFJ-C
Output voltage waveforms
during input voltage fluctuations




BD906x0EFJ-C
Efficiency vs Load Current
$V_{IN}$=13.2V

### Flexible Design

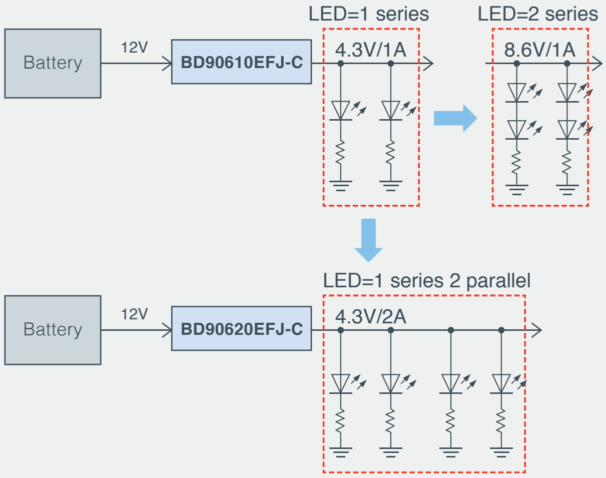
#### ●Flexible voltage/phase compensation design

The BD906x0EFJ-C/BD906xHFP-C series allow the switching frequency and output voltage to be adjusted via external resistors, ensuring support for a wide range of applications. For example, when used as an LED power supply the output voltage can be adjusted when changing from 1 LED to 2 LEDs in series. In addition, the phase compensation circuit can be externally configured to support stability-oriented or response-focused designs.

#### ●Supports sudden requirement(load)changes

Even if the load current increases due to a requirement changes, the optimum product can be selected from among ROHM's pin-compatible 1.25A/2.5A/4A lineup, which is offered in 2 package types to support various thermal countermeasures.

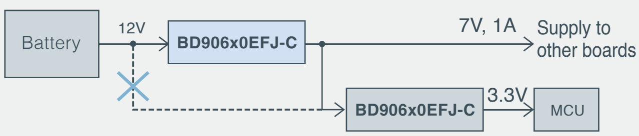
#### 〈LED Power Supply Example〉




#### ●Wide input/output voltage range

The wide input/output voltage range is ideal for primary/secondary middle voltage applications. For example, instead of supplying power supply to 2 systems directly from the battery, it is possible to generate an intermediate voltage appropriate for the MCU that both reduces switching loss while improving total application efficiency.

#### 〈Dual Power Supply System Example〉




### Heat source dispersion

The main sources of heat in a DC/DC converter are the high side and low side switches. The BD906x0EFJ and BD906x0HFP-C are diode rectification types that utilize an external Schottky barrier diodes as the low side switch for heat dispersion. Suppressing the rise in IC junction temperature makes it possible to flexibly respond to applications exposed to harsh ambient conditions such as engine rooms.

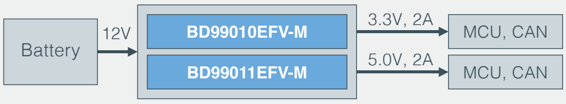
# Primary Switching Regulators

## BD9901xEFV-M series

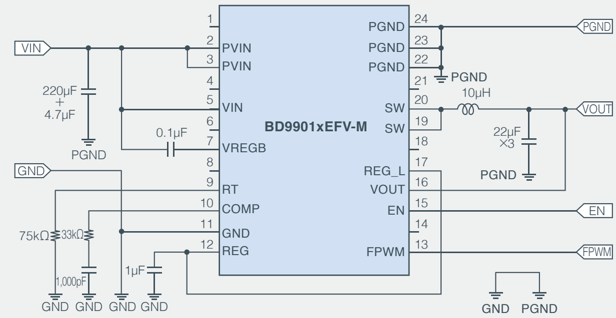
Low Iq

### Low Quiescent Current Solution

The BD99010EFV-M and BD99011EFV-M are low Iq buck DC/DC converters with built-in 3.3V and 5V power MOSFETs, respectively. In addition to achieving high efficiency while maintaining regulated output voltage during heavy loads, LLM(Light Load Mode) ensures high efficiency and low current consumption even during light loads. The minimum operating voltage of 3.6V maintains output even during cold cranking. Also, current mode control enables fast response with easy phase compensation. The BD99010EFV-M and BD99011EFV-M are offered in the compact HTSSOP-B24 package and require few external components, contributing to smaller PCB designs.




### BD9901xEFV-M series Application Circuit Diagram




### Overview: BD9901xEFV-M series

HTSSOP-B24

#### Achieves low Iq

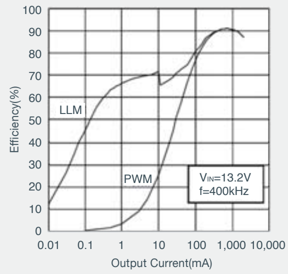
- No-load quiescent current: 22µA(Typ)

#### Achieves high efficiency

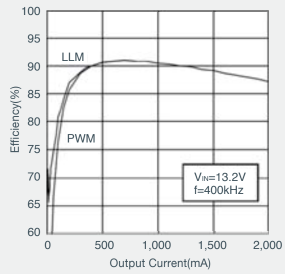
- Adopts the synchronous rectification method; no external Schottky diode needed
- ROHM's original Light Load Mode(LLM)

#### Supports cold cranking 3.6V operation(Max)

- Input voltage: 3.6V to 35V(42V rated)(However, initial startup requires 3.9V or more)
- Output voltage: 3.3V±2%(BD99010EFV-M) 5.0V±2%(BD99011EFV-M)
- Switch output current: 2A(Max)
- Switching frequency: 200kHz to 500kHz
- Internal switch FET: Pch 170mΩ(Typ), Nch 130mΩ(Typ)
- Built-in soft start function prevents inrush current at power ON
- Enable pin from CMOS logic input to battery voltage input
- Forced PWM mode function
- Current mode control
- Multiple protection functions: OCP, SCP, $V_{OUT}$ overvoltage, Under voltage lock out(UVLO), TSD




BD99011EFV-M
Efficiency vs Load Current
$V_{IN}$=13.2V, $V_{OUT}$=5.0V(Log scale)




BD99011EFV-M
Efficiency vs Load Current
$V_{IN}$=13.2V, $V_{OUT}$=5.0V(Linear scale)

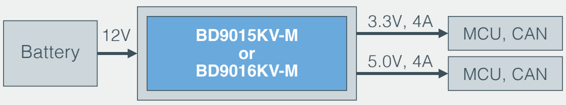
# Primary Switching Controller

## BD9015KV-M/BD9016KV-M

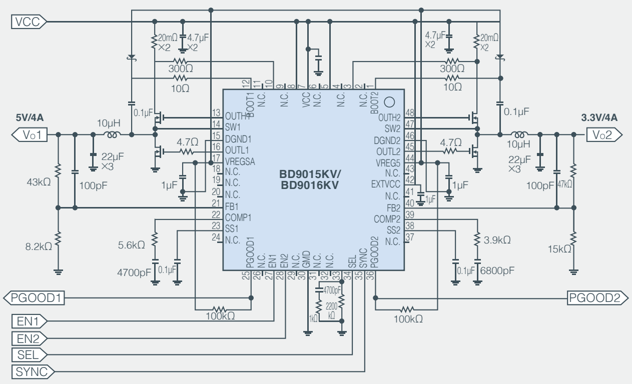
Large Current

### Large Current Solution

The BD9015KV-M and BD9016KV-M are dual-input synchronous rectification switching controllers that can be used over a wide input range. Synchronous rectification achieves high efficiency that contributes to lower power consumption in a variety of electronic devices. Each output has an EN pin, soft start function, power good function, and can control rise/fall independently. In addition, a PLL circuit is built in that can sync with an external 250kHz to 600kHz clock.




### BD9015KV-M/BD9016KV-M Application Circuit Diagram

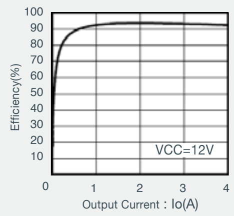



### Overview: BD9015KV-M/BD9016KV-M

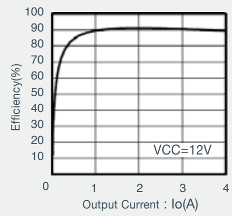
VQFP48C

#### Supports 2ch Large Current Applications

- Input voltage: 3.9V to 30V(35V rated)
- Enables direct drive of Nch MOSFETs
- Synchronous rectification ensures high efficiency
- Shutdown circuit current: 0µA(Typ)
- Reference voltage: 0.8V±1.5%(Ta: –40˚C to +105˚C) 0.8V±1%(Ta: 25˚C)
- Switching frequency: 250kHz to 550kHz
- Built-in PLL circuit supports synchronization with an external 250kH to 600kHz clock
- Current mode control
- Pre-bias function
- Reduces the input/output voltage difference by dividing the frequency by 1/5 during Max duty operation
- Multiple protection functions: OCP, SCP, Under voltage lock out(UVLO), TSD
- Low/over voltage detection circuit included at each output
  Overvoltage detection: Low-side FET OFF(BD9015KV-M)
  Low-side FET ON(BD9016KV-M)




BD9015KV-M
Efficiency vs Load Current
5V output




BD9015KV-M
Efficiency vs Load Current
3.3V output

**Achieves a peak efficiency of 91% at 3.3V and 93% at 5V output**

New Products

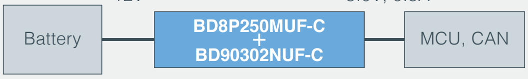
# Buck-Boost Primary Switching Regulators

## BD8P250MUF-C + BD90302NUF-C

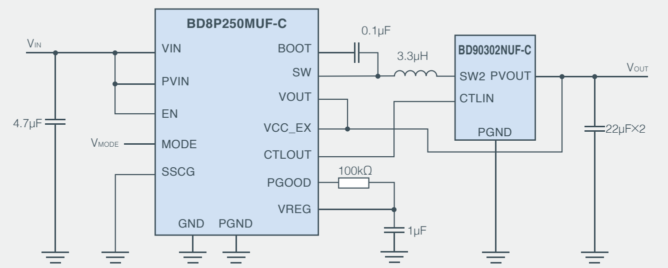
Low Iq | Low Voltage Operation

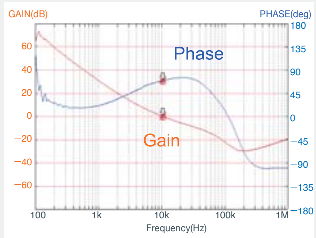
### Buck-Boost Solution

The BD8P250MUF-C is a 5V fixed output synchronous rectification buck DC/DC converter with boost control function. In the event output voltage drop is permitted when the input voltage decreases (i.e. during cold cranking), it is used as a buck DC/DC converter, and in cases where the output voltage needs to be maintained it can function as a buck-boost DC/DC converter by connecting to a dedicated boost FET.
In addition, Quick Buck Booster™ technology provides high-speed response during buck-boost operation, allowing the capacitance of the output capacitor to be reduced.

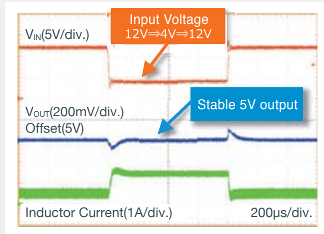



### BD8P250MUF-C+BD90302NUF-C Application Circuit Diagram




BD8P250MUF-C+BD90302NUF-C
Frequency Characteristics
($V_{IN}$=4 V, $I_{OUT}$=0.4 A)




BD8P250MUF-C+BD90302NUF-C
Line transient response
($V_{IN}$=12V to 4V, $I_{OUT}$=0.4A)

### Overview: BD8P250MUF-C

**Achieves high efficiency at light loads**

- No-load quiescent current: 8µA(Typ)

**Buck-boost operation supports cold cranking 2.7V Max**

- Input voltage: 2.7V to 36V(42V rated)
  (Requires 7.5V or more during startup if a dedicated boost FET is used)
- Output voltage: 5.0V±2%
- Output current during buck-boost operation: 0.8A(Max)
- Switching frequency: 2.2MHz(Typ)
- Quick Buck Booster™

VQFN24FV4040
Wettable Flank

### Quick Buck Booster™ Technology

**Achieves stable frequency characteristics using the same output capacitance as buck mode**
**Ensures stable output even during severe line transient response**

Note: "Quick Buck Booster™" is a trademark or a registered trademark of ROHM Co., Ltd.

### Overview: BD90302NUF-C

**Achieves high efficiency at light loads**

- Built-In Pch/Nch Power MOSFET(with driver)
- Pch/Nch power MOSFET control via the CTLIN pin
- PVOUT pin voltage: 3.0V to 5.5V
- SW 2pin current: 2A(Max)
- Pch power MOSFET ON-resistance: 55mΩ(Typ)
- Nch Power MOSFET ON-resistance: 65mΩ(Typ)
- Shutdown circuit current: 0µA(Typ)

VSON10FV3030
Wettable Flank

# Buck-Boost Primary Switching Controller

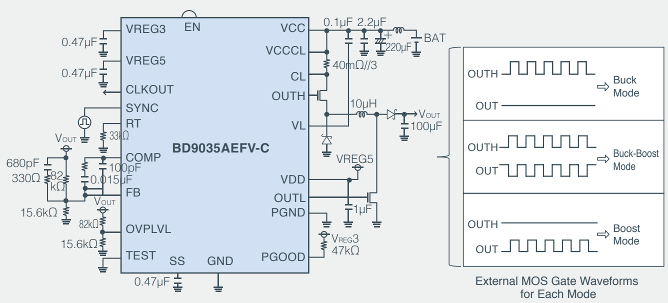
## BD9035AEFV-C

Low Voltage Operation

### Automatic buck-boost control solution that enables low voltage drive

The BD9035AEFV-C is a high voltage buck-boost controller featuring a wide input range($V_{IN}$=3.8 to 30V) that can provide buck-boost output using a single inductor. In addition, adopting an automatic buck-boost control method makes it possible to achieve a higher efficiency compared with conventional REGSPIC type switching regulators. A switching frequency accuracy of ±7% is ensured over the entire operating temperature range (Ta=−40°C to +125°C).

### BD9035AEFV-C Application Circuit Diagram




External MOS Gate Waveforms for Each Mode

### Overview: BD9035AEFV-C

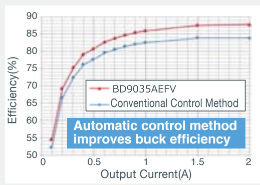
**Achieves buck-boost output using a single inductor**
**Automatic boost/buck-boost/buck switching control ensures high efficiency**

- Buck-boost 3-mode automatic switching control method

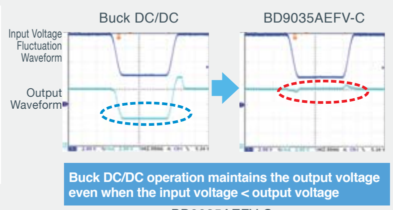
**High oscillation frequency accuracy and external synchronization function with built-in PLL facilitates noise countermeasures**

- Switching frequency accuracy : ±7%
- Wide external synchronization frequency range via PLL: 100kHz to 600kHz
- Input voltage: 3.8V to 30V(40V rated)
- Oscillation frequency: 100kHz to 600kHz
- Two-stage overcurrent protection circuit achieved with one resistor
- Built-in output under voltage/over voltage protection and Power Good pins

HTSSOP-B24




BD9035AEFV-C
Efficiency vs Load Current
$V_{IN}$=12V, $V_{OUT}$=6V, f=350kHz




BD9035AEFV-C
Input Voltage vs Output Voltage
$V_{IN}$=10V, $V_{OUT}$=8V, f=350kHz

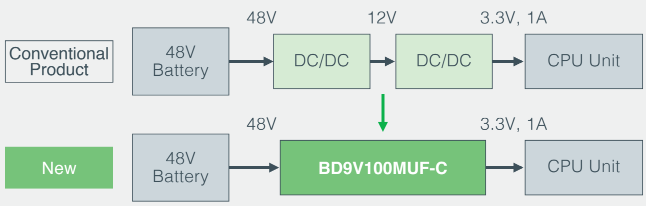
# Primary Switching Regulator

## BD9V100MUF-C

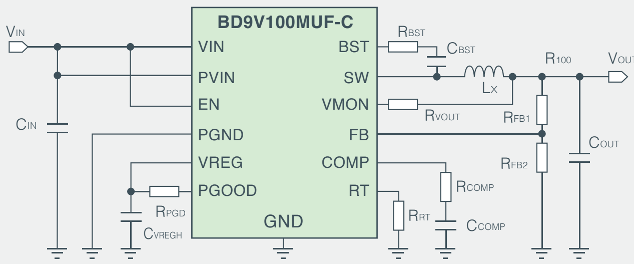
### 60V Input High Step-down Ratio Switching Regulator

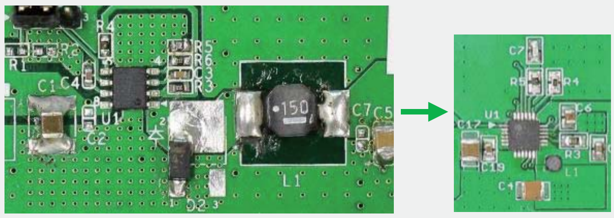
**Power supply solution for 48V hybrid systems**

The BD9V100MUF-C utilizes ROHM's ultra-fast pulse control technology Nano Pulse Control™ to achieve a high step-down ratio of up to 24:1 at 2MHz. For example, 2V output is possible from a 48V power supply at 2MHz. This makes it possible to reduce the number of power ICs required for step-down from high voltage to low voltage from two or more with conventional solutions to just one, contributing to set miniaturization and simpler system design.




### BD9V100MUF-C Application Circuit Diagram



Existing PCB
47mm×25mm=1,175mm²

BD9V100MUF-C PCB
18mm×20mm=360mm²

Increasing the switching frequency to 2MHz reduces the size of external components(inductor), decreasing mounting area. Further space savings can be achieved by switching from a 2-stage buck configuration to single stage conversion.
Also, the 2MHz switching frequency avoids the AM radio band(MW).

### Overview: BD9V100MUF-C

**VQFN24FV4040**

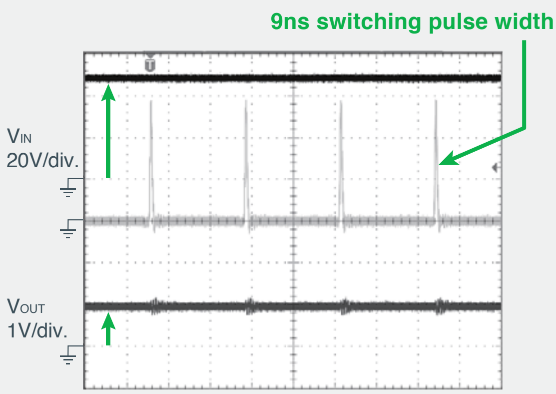
Wettable Flank

- High step-down ratio enables direct conversion from high voltage to low voltage
- Min switching ON time: 9ns(Typ), 20ns Max
- Input voltage: 16V to 60V(70V rated)
- Output voltage: 0.8V to 5.5V
- Reference voltage: 0.8V±2.0%
- Output current: 1.0A
- High-speed transient characteristics through current mode control
- Synchronous rectification eliminates the need for external diodes
- Soft start function prevents inrush current at power ON
- Power good output
- Multiple protection circuits:
  Overcurrent protection(OCP),Short-circuit protection(SCP), Thermal shutdown(TSD), Under voltage lock out(UVLO), Over voltage protection(OVP), Over voltage lock out(OVLO)

| Part No. | Number of Outputs(ch) | Output FET | | Rated Voltage(V) | Output Current(A)(Max) | Input Voltage (V) | | | Output Voltage (V) (Typ) | Reference(Output) Voltage Accuracy(%) | Switching Frequency | | Control Method | Circuit Current (mA) (Typ) | Functions | | | | | | | | | Operating Temperature (°C) | Package |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | High Side (Typ) | Low Side (Typ) | | | At Startup | Min | Max | | | Frequency Range (kHz) | Precision(%) | | | Power Good | External Synchronization | Variable Soft Start | Synchronous Rectification | Light Load Efficiency | Overcurrent Protection | Thermal Protection | Overvoltage Protection | Spread Spectrum | | |
| **BD9V100MUF-C** | 1 | Nch (600mΩ) | Nch (400mΩ) | 70 | 1.0 | 16 | 16 | 60 | Adj (0.8 to 5.5) | ±2.0 | 1,900 to 2,300 | ±10 | Current | 2.5 | ✓ | – | – | ✓ | – | ✓ | ✓ | ✓ | – | –40 to +125 | VQFN24FV4040 |

### Ultra-High-Speed Pulse Control Technology Nano Pulse Control™

Buck switching DC/DC converters generate an output voltage by controlling the switching pulse width. This pulse width is thicker when the step-down ratio of the input/output voltage is low and thinner when this ratio is high. As a result, when stepping down from a 60V power supply to 2.5V, the switching pulse width becomes extremely thin since the buck ratio is high (24:1). For example, when the switching frequency is 2MHz the switching cycle is 500ns, so with a step-down ratio of 24:1 the pulse width becomes ultra-narrow at 20.8ns. ROHM's Nano Pulse Control™ technology achieves a pulse width of just 9ns.
Current mode control detects the current flowing through the inductor, but when the pulse width narrows accurate current detection is prevented due to ringing caused by the parasitic inductance within the device, resulting in unstable circuit operation. ROHM's original Nano Pulse Control™ technology eliminates the effects of ringing by feeding back the inductor current to the IC, making it possible to stabilize the output voltage even with narrow pulse width using current mode control.



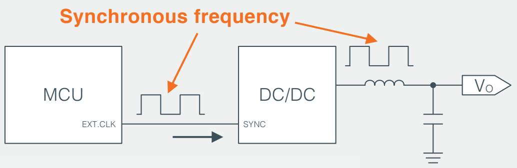

Nano Pulse Control™ Example
$V_{IN}$=48V, $V_{OUT}$=1V, $f_{SW}$=2.2MHz

Note: Nano Pulse Control™ is a trademark or registered trademark of ROHM Co., Ltd.

# Pickup Technologies that Maximize the Features of Switching Regulators

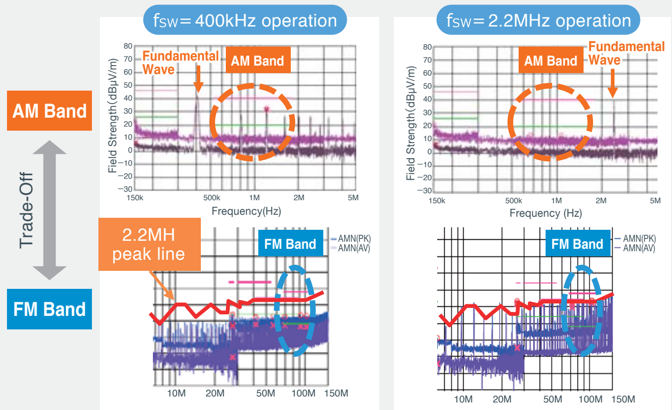
## External Synchronization Function

- A function that enables synchronous switching with an external clock
- Shifts the second- and third-order harmonics that affect the AM radio band
- Includes functions primarily used for vehicle multimedia systems



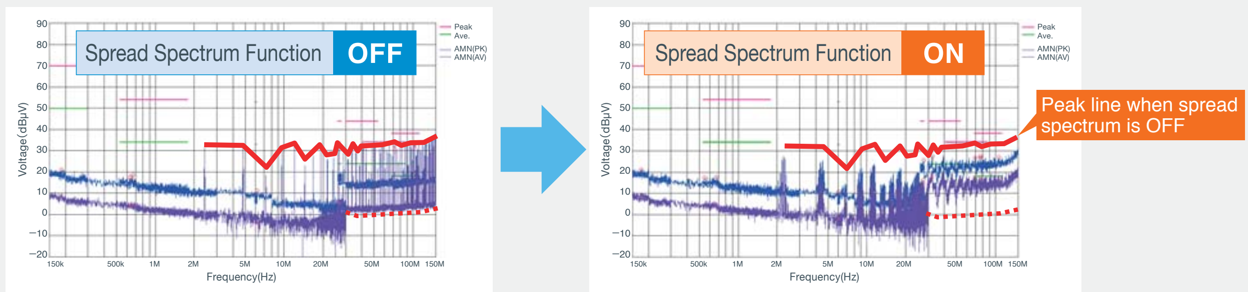

## Increasing Switching Frequency

- Higher frequency trade-off between AM and FM radio band noise
- High switching frequency above 2MHz does not generate a spectrum in the AM band
- Increasing the switching frequency above 2MHz increases the noise level in the FM radio band



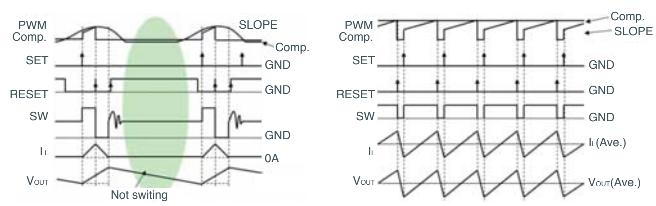

## Spread Spectrum

- Avoids spectrum concentration by spreading the frequency over broadband
- Although the peak and average both have a reduction effect, the lower limit of the high frequency band(red dotted line) becomes higher



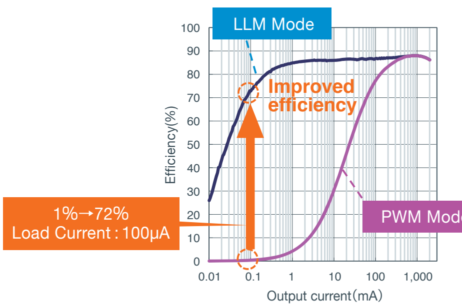

## LLM(Light Load Mode) Control

In LLM, PWM control is performed by comparing the output voltage with the internal reference voltage. When the output voltage is lower than the internal reference voltage a number of switching pulses are output in order to raise the output voltage, then when the output voltage becomes higher than the reference voltage the switching output is turned OFF, spreading out the switching pulses. Although the cycle of spread-out switching pulses will vary depending on output load, the control circuit block consumes low current in standby mode until the output voltage drops below the reference voltage and switching resumes. When the cycle of spread-out switching pulses becomes short, the IC exits LLM and returns to normal continuous mode. The switching pulse spread-out load current will vary depending on the inductance, input voltage, etc.

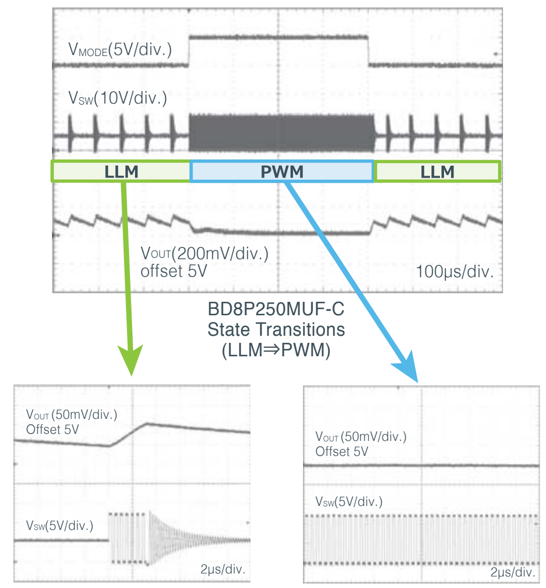



LLM Switching Timing Chart

PWM Switching Timing Chart




BD8P250MUF-C
Efficiency vs Load Current
$V_{IN}$=12V, $V_{OUT}$=5.0V(Log scale)




Switching and $V_{OUT}$ Waveforms with LLM Control (At Light Load)

Switching and $V_{OUT}$ Waveforms with PWM (At Heavy Load)

LLM control at light loads differs from normal PWM control, so the output ripple voltage will slightly increase. Also during LLM control, transient response will be delayed at large loads.

# Primary Switching Regulator Product Specifications Table AEC-Q100 qualified

## Buck Solutions

| Part No. | Number of Outputs (ch) | Output FET High Side (Typ) | Output FET Low Side (Typ) | Rated Voltage (V) | Output Current (A) (Max) | Input Voltage (V) Initial Startup | Input Voltage (V) Min | Input Voltage (V) Max | Output Voltage (V) (Typ) | Reference (Output ) Voltage Accuracy (%) | Switching Frequency Frequency Range (kHz) | Switching Frequency Precision (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New BD9P205MUF-C | 1 | Nch(140mΩ) | Nch(90mΩ) | 42 | 2.0 | 4.0 | 3.5 | 40 | Adj(0.8 to 8.5) | ±1.75 | 2,200 | ±10 |
| New BD9P205EFV-C | 1 | Nch(150mΩ) | Nch(100mΩ) | | | | | | | | | |
| New BD9P235MUF-C | 1 | Nch(140mΩ) | Nch(90mΩ) | 42 | 2.0 | 4.0 | 3.5 | 40 | 3.3 | ±1.75 | 2,200 | ±10 |
| New BD9P235EFV-C | 1 | Nch(150mΩ) | Nch(100mΩ) | | | | | | | | | |
| New BD9P255MUF-C | 1 | Nch(140mΩ) | Nch(90mΩ) | 42 | 2.0 | 4.0 | 3.5 | 40 | 5.0 | ±1.75 | 2,200 | ±10 |
| New BD9P255EFV-C | 1 | Nch(150mΩ) | Nch(100mΩ) | | | | | | | | | |
| New BD9P105MUF-C | 1 | Nch(210mΩ) | Nch(140mΩ) | 42 | 1.0 | 4.0 | 3.5 | 40 | Adj(0.8 to 8.5) | ±1.75 | 2,200 | ±10 |
| New BD9P105EFV-C | 1 | Nch(220mΩ) | Nch(150mΩ) | | | | | | | | | |
| New BD9P135MUF-C | 1 | Nch(210mΩ) | Nch(140mΩ) | 42 | 1.0 | 4.0 | 3.5 | 40 | 3.3 | ±1.75 | 2,200 | ±10 |
| New BD9P135EFV-C | 1 | Nch(220mΩ) | Nch(150mΩ) | | | | | | | | | |
| New BD9P155MUF-C | 1 | Nch(210mΩ) | Nch(140mΩ) | 42 | 1.0 | 4.0 | 3.5 | 40 | 5.0 | ±1.75 | 2,200 | ±10 |
| New BD9P155EFV-C | 1 | Nch(220mΩ) | Nch(150mΩ) | | | | | | | | | |
| BD9V100MUF-C | 1 | Nch(600mΩ) | Nch(400mΩ) | 70 | 1.0 | 16 | 16 | 60 | Adj(0.8 to 5.5) | ±2.0 | 1,900 to 2,300 | ±10 |
| BD8P250MUF-C | 1 | Nch(110mΩ) | Nch(110mΩ) | 42 | 2.0 | 4.8 | 3.5 | 36 | 5.0 | ±2.0 | 2.200 | ±10 |
| BD9P233MUF-C | 1 | Pch(190mΩ) | Nch(120mΩ) | 42 | 2.0 | 3.6 | 3.0 | 36 | 3.3 | ±2.0 | 200 to 2,400 | ±9 |
| BD99010EFV-M | 1 | Pch(170mΩ) | Nch(130mΩ) | 42 | 2.0 | 3.9 | 3.6 | 35 | 3.3 | ±2.0 | 200 to 500 | ±20 |
| BD99011EFV-M | 1 | Pch(170mΩ) | Nch(130mΩ) | 42 | 2.0 | 3.9 | 3.6 | 35 | 5.0 | ±2.0 | 200 to 500 | ±20 |
| BD9015KV-M | 2 | Ext. Nch | Ext. Nch | 35 | — | 4.5 | 3.9 | 30 | Adj(0.8 to 10) | ±1.5 | 250 to 550 | ±10 |
| BD9016KV-M | 2 | Ext. Nch | Ext. Nch | 35 | — | 4.5 | 3.9 | 30 | Adj(0.8 to 10) | ±1.5 | 250 to 550 | ±10 |
| BD90610EFJ-C | 1 | Pch(160mΩ) | — | 42 | 1.25 | 3.9 | 3.5 | 36 | Adj(0.8 to $V_{IN}$) | ±2.0 | 50 to 600 | ±10 |
| BD90620EFJ-C | 1 | Pch(160mΩ) | — | 42 | 2.5 | 3.9 | 3.5 | 36 | Adj(0.8 to $V_{IN}$) | ±2.0 | 50 to 600 | ±10 |
| BD90620HFP-C | 1 | Pch(160mΩ) | — | 42 | 2.5 | 3.9 | 3.5 | 36 | Adj(0.8 to $V_{IN}$) | ±2.0 | 50 to 600 | ±10 |
| BD90640EFJ-C | 1 | Pch(160mΩ) | — | 42 | 4.0 | 3.9 | 3.5 | 36 | Adj(0.8 to $V_{IN}$) | ±2.0 | 50 to 600 | ±10 |
| BD90640HFP-C | 1 | Pch(160mΩ) | — | 42 | 4.0 | 3.9 | 3.5 | 36 | Adj(0.8 to $V_{IN}$) | ±2.0 | 50 to 600 | ±10 |

## Buck-Boost Solutions

| Part No. | Number of Outputs (ch) | Output FET High Side (Typ) | Output FET Low Side (Typ) | Rated Voltage (V) | Output Current (A) (Max) | Input Voltage (V) Initial Startup | Input Voltage (V) Min | Input Voltage (V) Max | Output Voltage (V) (Typ) | Reference (Output ) Voltage Accuracy (%) | Switching Frequency Frequency Range (kHz) | Switching Frequency Precision (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BD8P250MUF-C + BD90302NUF-C | 1 | Nch(110mΩ) | Nch(110mΩ) | 42 | 0.8 | 7.5 | 2.7 | 36 | 5.0 | ±2.0 | 2,200 | ±10 |
| | | Pch(55mΩ) | Nch(65mΩ) | 7 | | | | | | | | |
| BD9035AEFV-C | 1 | Ext. Pch | Ext. Nch | 40 | — | 4.5 | 3.8 | 30 | Adj | ±1.5 | 100 to 600 | ±7 |

| Control Method | Circuit Current (mA) (Typ) | Functions | | | | | | | | | Operating Temperature (˚C) | Package |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Power Good | External Synchronization | Adjustable Soft Start | Synchronous Rectification | Light Load Efficiency | Overcurrent Protection | Thermal Protection | Overvoltage Protection | Spread Spectrum | | |
| Current | 0.01 | ✓ | ✓ | — | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | −40 to +125 | VQFN20FV4040<br>HTSSOP-B20 |
| Current | 0.01 | ✓ | ✓ | — | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | −40 to +125 | VQFN20FV4040<br>HTSSOP-B20 |
| Current | 0.01 | ✓ | ✓ | — | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | −40 to +125 | VQFN20FV4040<br>HTSSOP-B20 |
| Current | 0.01 | ✓ | ✓ | — | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | −40 to +125 | VQFN20FV4040<br>HTSSOP-B20 |
| Current | 0.01 | ✓ | ✓ | — | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | −40 to +125 | VQFN20FV4040<br>HTSSOP-B20 |
| Current | 0.01 | ✓ | ✓ | — | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | −40 to +125 | VQFN20FV4040<br>HTSSOP-B20 |
| Current | 2.5 | ✓ | — | — | ✓ | — | ✓ | ✓ | ✓ | — | −40 to +125 | VQFN24FV4040 |
| Current | 0.008 | ✓ | — | — | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | −40 to +125 | VQFN24FV4040 |
| Current | 0.026 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | −40 to +125 | VQFN32FAV050 |
| Current | 0.022 | — | — | — | ✓ | ✓ | ✓ | ✓ | ✓ | — | −40 to +105 | HTSSOP-B24 |
| Current | 0.022 | — | — | — | ✓ | ✓ | ✓ | ✓ | ✓ | — | −40 to +105 | HTSSOP-B24 |
| Current | 4 | ✓ | ✓ | ✓ | ✓ | — | ✓ | ✓ | ✓ * | — | −40 to +105 | VQFP48C |
| Current | 4 | ✓ | ✓ | ✓ | ✓ | — | ✓ | ✓ | ✓ * | — | −40 to +105 | VQFP48C |
| Current | 2.2 | — | ✓ | ✓ | — | — | ✓ | ✓ | — | — | −40 to +125 | HTSOP-J8 |
| Current | 2.2 | — | ✓ | ✓ | — | — | ✓ | ✓ | — | — | −40 to +125 | HTSOP-J8 |
| Current | 2.2 | — | ✓ | ✓ | — | — | ✓ | ✓ | — | — | −40 to +125 | HRP7 |
| Current | 2.2 | — | ✓ | ✓ | — | — | ✓ | ✓ | — | — | −40 to +125 | HTSOP-J8 |
| Current | 2.2 | — | ✓ | ✓ | — | — | ✓ | ✓ | — | — | −40 to +125 | HRP7 |

*BD9015KV-M: Low Side FET OFF during overvoltage detection, BD9016KV-M: Low Side ON during overvoltage detection

| Control Method | Circuit Current (mA) (Typ) | Functions | | | | | | | | | Operating Temperature (˚C) | Package |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Power Good | External Synchronization | Adjustable Soft Start | Synchronous Rectification | Light Load Efficiency | Overcurrent Protection | Thermal Protection | Overvoltage Protection | Spread Spectrum | | |
| Current | 0.008 | ✓ | — | — | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | −40 to +125 | VQFN24FV4040 |
| | 0.065 | | | | | | | | | | | VSON10FV3030 |
| Voltage | 7 | ✓ | ✓ | ✓ | — | — | ✓ | ✓ | ✓ | — | −40 to +125 | HTSSOP-B24 |

# Secondary Switching Regulators

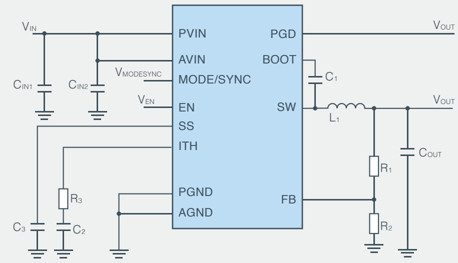
## BD9Sx00MUF-C series

**Compact・Large Current**

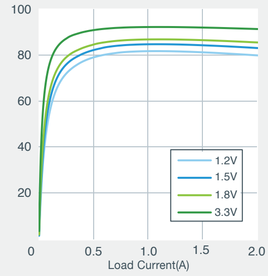
### Space-Saving High Efficiency Solutions

The BD9Sx00MUF-C series are synchronous rectification buck DC/DC converters with integrated low ON resistance power MOSFET. These are offered in a compact 3.0×3.0mm package. The high 2.2MHz switching frequency (self-oscillation) supports smaller inductors while the built-in external synchronization function allows the switching frequency to be synchronized with an external pulse.
In addition, LLM control ensures superior efficiency at light loads, making it possible to reduce application power consumption during standby.
Also, fast transient response via current mode control allows users to easily set phase compensation.

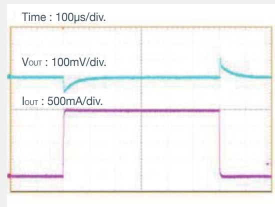

### BD9Sx00MUF-C series Application Circuit Diagram




Inputting an external pulse signal to the MODE/SYNC pin makes it possible to synchronize the switching frequency with an external pulse signal. When a pulse signal 1.8MHz or greater is applied, external sync operation begins after 7 falling edges of the pulse signal. Please set the duty between 25% and 75%. Also, when using the external synchronization function, connect a 10pF capacitor in parallel with phase compensation components(R3 and C2) connected to the ITH pin as a countermeasure against interference to the ITH pin which serves as the output of the GM error amp.




BD9S200MUF-C Efficiency vs Load Current ($V_{IN}$=5V)




BD9S200MUF-C Load Response ($V_{IN}$=5V, $V_{OUT}$=1.2V, $I_{OUT}$=0A⇔2A)

### Overview: BD9Sx00MUF-C series

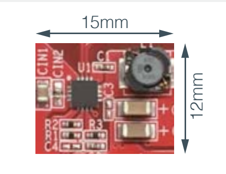
#### Wide input voltage range

- Adopts the synchronous rectification method

#### Facilitates noise countermeasures

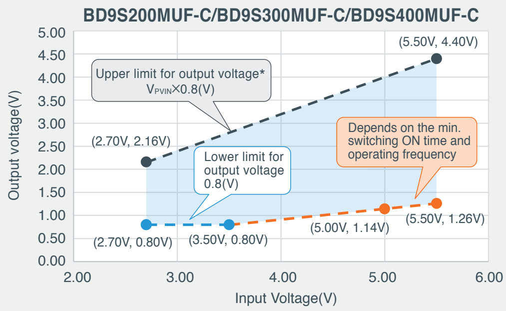
- Switching frequency: 2.2MHz ±10%
  (During external sync)1.8MHz to 2.4MHz
- Input voltage: 2.7V to 5.5V(7V rated)
- Output voltage: 0.8V to $V_{IN}$×0.8
- Reference voltage: 0.8V±1.5%
- Built-in Power MOSFETs: High-Side(35mΩ/Nch), Low-side(35mΩ/Nch)
- LLM(Light load mode)/Forced PWM mode select pin
- Current mode control
- Multiple protection functions : OCP, SCP, Under voltage lock out(UVLO), $V_{OUT}$ overvoltage, TSD

VQFN16FV3030
3.0mm×3.0mm
Wettable Flank




BD9S200MUF-C PCB

#### Output Settable Voltage Range




*Set the input/output voltage taking into account voltage fluctuations during load response

# Secondary Switching Regulator Product Specifications Table

| | Part No. | Number of Outputs (ch) | Output FET | | Rated Voltage (V) | Output Current (A) (Max) | Input Voltage (V) | | Output Voltage (V) (Typ) | Reference (Output ) Voltage Accuracy (%) | Switching Frequency | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | High Side (Typ) | High Side (Typ) | | | Min | Max | | | Frequency Range (MHz) | Precision (%) |
| | BD9S400MUF-C | 1 | Nch(35mΩ) | Nch(35mΩ) | 7 | 4.0 | 2.7 | 5.5 | Adj(0.8 to $V_{IN}$×0.8) | ±1.5 | 2.2 | ±10 |
| | BD9S300MUF-C | 1 | Nch(35mΩ) | Nch(35mΩ) | 7 | 3.0 | 2.7 | 5.5 | Adj(0.8 to $V_{IN}$×0.8) | ±1.5 | 2.2 | ±10 |
| | BD9S200MUF-C | 1 | Nch(35mΩ) | Nch(35mΩ) | 7 | 2.0 | 2.7 | 5.5 | Adj(0.8 to $V_{IN}$×0.8) | ±1.5 | 2.2 | ±10 |
| New | BD9S201NUX-C | 1 | Pch(150mΩ) | Nch(95mΩ) | 7 | 2.0 | 2.7 | 5.5 | Adj(0.8 to $V_{IN}$) | ±1.5 | 2.2 | ±10 |
| | BD9S100NUX-C | 1 | Pch(270mΩ) | Nch(180mΩ) | 7 | 1.0 | 2.7 | 5.5 | Adj(0.8 to $V_{IN}$) | ±1.5 | 2.2 | ±10 |
| | BD9S000NUX-C | 1 | Pch(270mΩ) | Nch(180mΩ) | 7 | 0.6 | 2.7 | 5.5 | Adj(0.8 to $V_{IN}$) | ±1.5 | 2.2 | ±10 |
| New | BD9S110NUX-C | 1 | Pch(270mΩ) | Nch(180mΩ) | 7 | 1.0 | 2.7 | 5.5 | 1.2 | ±1.5 | 2.2 | ±10 |
| New | BD9S111NUX-C | 1 | Pch(270mΩ) | Nch(180mΩ) | 7 | 1.0 | 2.7 | 5.5 | 1.8 | ±1.5 | 2.2 | ±10 |
| New | BD9S012NUX-C | 1 | Pch(270mΩ) | Nch(180mΩ) | 7 | 0.6 | 2.7 | 5.5 | 1.1 | ±1.5 | 2.2 | ±10 |
| New | BD9SD11NUX | 1 | Pch(270mΩ) | Nch(180mΩ) | 7 | 0.6 | 2.7 | 5.5 | 1.15 | ±1.5 | 2.2 | ±10 |

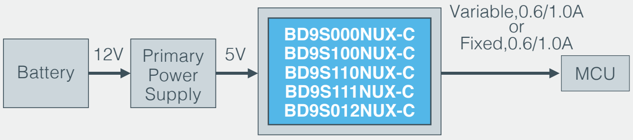
# Secondary Switching Regulators

## BD9SxxxNUX-C series

**Compact**

### Space-Saving High Efficiency Solutions

The BD9SxxxNUX-C series are synchronous rectification buck DC/DC converters integrates a low ON resistance power MOSFET. These are offered in a compact 2.0×2.0mm package. The high 2.2MHz switching frequency (self-oscillation) supports smaller inductors.
In addition, the built-in phase compensation circuit makes it possible to configure applications using few external parts.
And current mode control ensures fast transient response.
Also, fixed output models in the BD9Sx1xNUX-C lineup utilize a built-in feedback resistor to not only reduce the number of external parts, but achieve high output voltage accuracy by suppressing variations in component characteristics while improving resistance against aged-based deterioration.

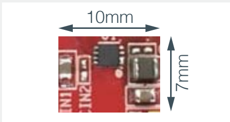



### Overview: BD9Sx00NUX-C(Variable Output Type) BD9Sx1xNUX-C(Fixed Output Type) BD9S201NUX(Variable Output Type)

#### Achieves high efficiency

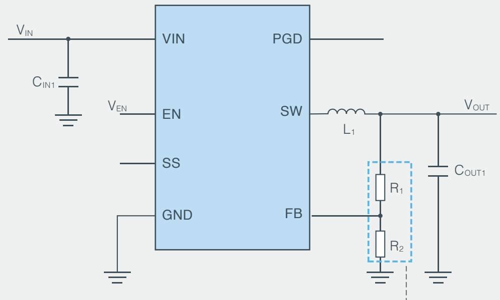
- Adopts the synchronous rectification method
- Switching Frequency: 2.2MHz±10%
- Input voltage: 2.7V to 5.5V(7V rated)
- Output voltage: 0.8V to $V_{IN}$(Variable Type) or 1.1V, 1.2V, 1.8V(Fixed Type)
- Reference voltage: 0.8V±1.5%
- Built-in Power MOSFETs: High-Side(270mΩ/Pch), Low-side(180mΩ/Nch)
  (BD9S201NUX)High-Side(150mΩ/Pch), Low-Side(95mΩ/Nch)
- Output Discharge function ●Current mode control
- Multiple protection circuits: OCP, SCP, Under voltage lock out(UVLO), $V_{OUT}$ Overvoltage, Thermal protection

VSON008X2020
2.0mm×2.0mm

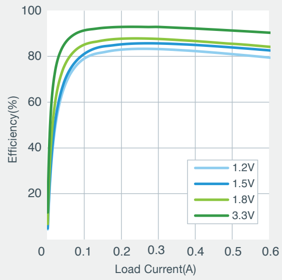



BD9S000NUX-C PCB

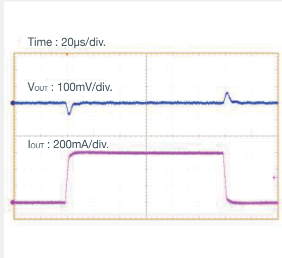
### BD9SxxxNUX-C series Application Circuit Diagram




BD9S11NUX-C series has a built-in IC.

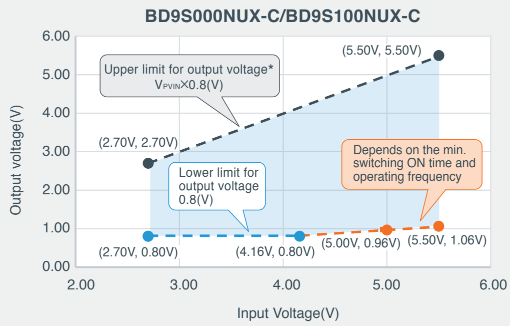



BD9S000NUX-C Efficiency vs Load Current ($V_{IN}$=5V)




BD9S110NUX-C Load Response ($V_{IN}$=5V, $V_{OUT}$=1.2V, $I_{OUT}$=0A⇔0.6A)

#### ■Output Settable Voltage Range

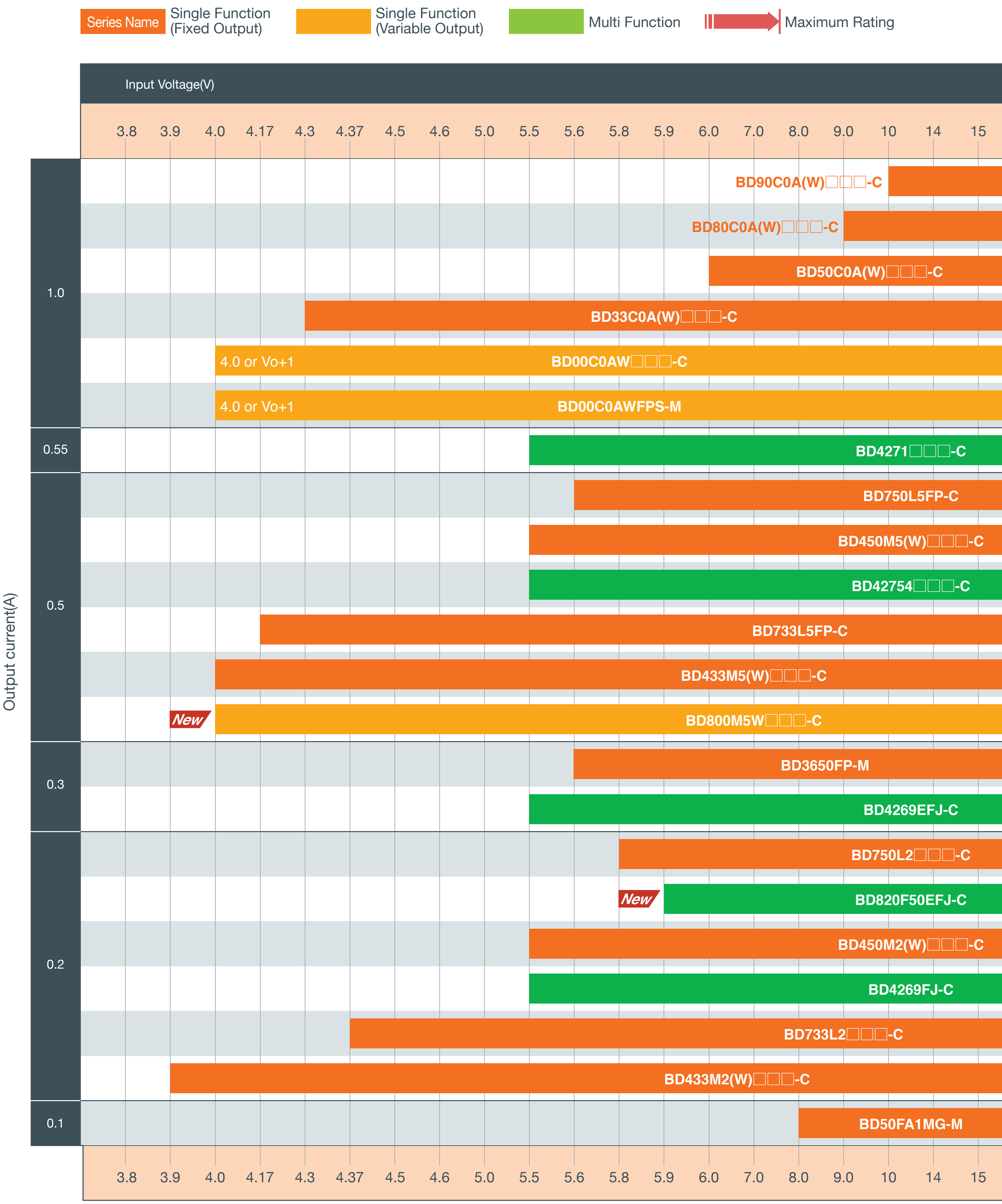


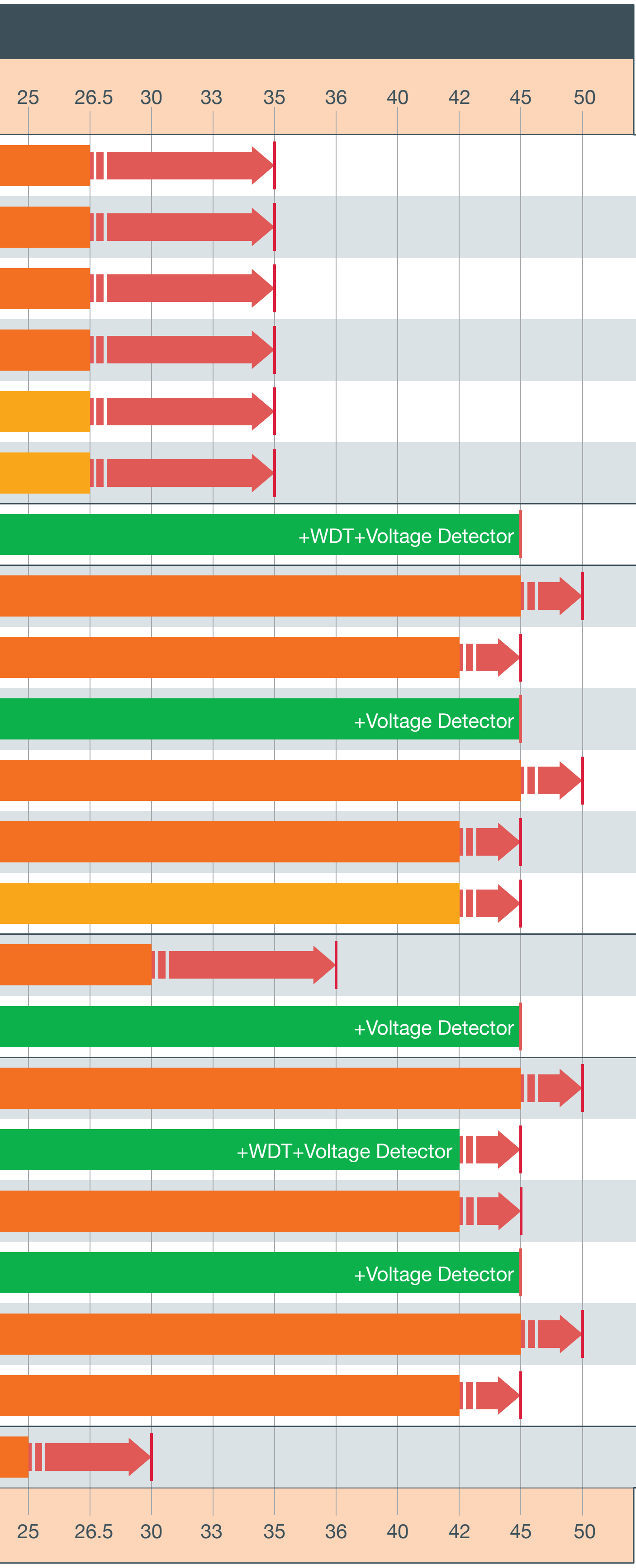

*Set the input/output voltage taking into account voltage fluctuations during load response

## AEC-Q100 qualified

| Control Method | Circuit Current (mA) (Typ) | Power Good | Light Load Efficiency | External Synchronization | Adjustable Soft Start | Synchronous Rectification | Overcurrent Protection | Thermal Protection | Overvoltage Protection | Output Discharge | Operating Temperature (℃) | Package |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Functions | | | | | | | | | | |
| Current | 0.65 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | — | –40 to +125 | VQFN16FV3030 |
| Current | 0.65 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | — | –40 to +125 | VQFN16FV3030 |
| Current | 0.65 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | — | –40 to +125 | VQFN16FV3030 |
| Current | 0.40 | ✓ | — | — | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | –40 to +125 | VSON008X2020 |
| Current | 0.35 | ✓ | — | — | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | –40 to +125 | VSON008X2020 |
| Current | 0.35 | ✓ | — | — | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | –40 to +125 | VSON008X2020 |
| Current | 0.40 | ✓ | — | — | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | –40 to +125 | VSON008X2020 |
| Current | 0.40 | ✓ | — | — | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | –40 to +125 | VSON008X2020 |
| Current | 0.40 | ✓ | — | — | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | –40 to +125 | VSON008X2020 |
| Current | 0.40 | ✓ | — | — | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | –40 to +125 | VQFN008X2020 |

# Automotive Primary Linear Regulator Lineup AEC-Q100 qualified






| Output Voltage (V) | Circuit Current (μA) | Shutdown Switch | Support 125°C | Package | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | SSOP5 | SOP8 | SOT223 | HTSOP-J8 | TO252 | HRP5/7 | TO263 |
| 9.0 | 500 | ✓ | ✓ | — | — | — | — | ✓ | ✓ | ✓ |
| 8.0 | 500 | ✓ | ✓ | — | — | — | — | ✓ | ✓ | ✓ |
| 5.0 | 500 | ✓ | ✓ | — | — | — | — | ✓ | ✓ | ✓ |
| 3.3 | 500 | ✓ | ✓ | — | — | — | — | ✓ | ✓ | ✓ |
| Variable | 500 | ✓ | ✓ | — | — | — | — | ✓ | ✓ | ✓ |
| Variable | 500 | ✓ | — | — | — | — | — | ✓ | — | — |
| 5.0 | 75 | ✓ | ✓ | — | — | — | — | — | ✓ | ✓ |
| 5.0 | 6 | — | ✓ | — | — | — | — | ✓ | — | — |
| 5.0 | 38 | ✓ | ✓ | — | — | — | — | ✓ | — | ✓ |
| 5.0 | 75 | — | ✓ | — | — | — | — | ✓ | — | ✓ |
| 3.3 | 6 | — | ✓ | — | — | — | — | ✓ | — | — |
| 3.3 | 38 | ✓ | ✓ | — | — | — | — | ✓ | — | — |
| Variable | 20 | ✓ | ✓ | — | — | — | — | — | ✓ | ✓ |
| 5.0 | 500 | — | ✓ | — | — | — | — | ✓ | — | — |
| 5.0 | 70 | — | ✓ | — | — | — | ✓ | — | — | — |
| 5.0 | 6 | — | ✓ | — | — | ✓ | ✓ | ✓ | — | — |
| 5.0 | 6 | — | ✓ | — | — | — | ✓ | — | — | — |
| 5.0 | 40 | ✓ | ✓ | — | — | ✓ | ✓ | — | — | — |
| 5.0 | 70 | — | ✓ | — | ✓ | — | — | — | — | — |
| 3.3 | 6 | — | ✓ | — | — | ✓ | ✓ | ✓ | — | — |
| 3.3 | 40 | ✓ | ✓ | — | — | ✓ | ✓ | — | — | — |
| 5.0 | 300 | — | — | ✓ | — | — | — | — | — | — |

Note1: Please set the minimum value of the input/output voltage taking into account the input/output voltage difference based on load current.
Note2: Series with a(W) in the part number indicate products with/without a shutdown switch.
Note3: In the above table, the □□□ in the series name are reserved for the package type.
[Example] Series : BD733L2□□□-C, Package : HTSOP-J8 → Part No : BD733L2EFJ-C

# Automotive Primary Linear Regulator Family Diagram

**AEC-Q100 qualified**

| Input | Functions | Output Voltage | Features | Output Voltage (V) | Output Current (A) | Maximum Rating (V) | Series Name | SSOP5 | SOP8 | SOT223 | HTSOP-J8 | TO252 | HRP5/7 | TO263 | Support 125°C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Primary | Single Function | Fixed (3.3V 5.0V Others) | Ultra Low Iq (6.0μA(Typ)) | 3.3 | 0.2 | 50 | BD733L2□□□-C | — | — | ✓ | ✓ | ✓ | — | — | ✓ |
| | | | | 3.3 | 0.5 | 50 | BD733L5□□□-C | — | — | — | — | ✓ | — | — | ✓ |
| | | | | 5.0 | 0.2 | 50 | BD750L2□□□-C | — | — | ✓ | ✓ | ✓ | — | — | ✓ |
| | | | | 5.0 | 0.5 | 50 | BD750L5□□□-C | — | — | — | — | ✓ | — | — | ✓ |
| | | | Low Iq (30μA or more) | 3.3 | 0.2 | 45 | BD433M2(W) □□□-C | — | — | ✓ | ✓ | — | — | — | ✓ |
| | | | | 3.3 | 0.5 | 45 | BD433M5(W) □□□-C | — | — | — | — | ✓ | — | ✓ | ✓ |
| | | | | 5.0 | 0.2 | 45 | BD450M2(W) □□□-C | — | — | ✓ | ✓ | — | — | — | ✓ |
| | | | | 5.0 | 0.5 | 45 | BD450M5(W) □□□-C | — | — | — | — | ✓ | — | ✓ | ✓ |
| | | | Medium Withstand Voltage/ 1.0A Output | 3.3 | 1.0 | 35 | BD33C0A(W) □□□-C | — | — | — | — | ✓ | ✓ | ✓ | ✓ |
| | | | | 5.0 | 1.0 | 35 | BD50C0A(W) □□□-C | — | — | — | — | ✓ | ✓ | ✓ | ✓ |
| | | | | 8.0 | 1.0 | 35 | BD80C0A(W) □□□-C | — | — | — | — | ✓ | ✓ | ✓ | ✓ |
| | | | | 9.0 | 1.0 | 35 | BD90C0A(W) □□□-C | — | — | — | — | ✓ | ✓ | ✓ | ✓ |
| | | | Medium Withstand Voltage/ Standard | 5.0 | 0.3 | 36 | BD3650FP-M | — | — | — | — | ✓ | — | — | ✓ |
| | | | Medium Withstand Voltage/ Compact Package | 5.0 | 0.1 | 30 | BD50FA1MG-M | ✓ | — | — | — | — | — | — | — |
| | | Variable | Low Iq | Variable | 0.5 | 45 | New BD800M5□□□-C | — | — | — | — | — | ✓ | ✓ | ✓ |
| | | | Medium Withstand Voltage/ 1.0A Output | Variable | 1.0 | 35 | BD00C0AW□□□-C | — | — | — | — | ✓ | ✓ | ✓ | ✓ |
| | | | | Variable | 1.0 | 35 | BD00C0AWFPS-M | — | — | — | — | ✓ | — | — | — |
| | Multi Function | Fixed (5.0V) | Ultra Low Iq with Watchdog Timer and Voltage Detector | 5.0 | 0.2 | 45 | New BD820F50EFJ-C | — | — | — | ✓ | — | — | — | ✓ |
| | | | with Watchdog Timer and Voltage Detector | 5.0 | 0.55 | 45 | BD4271□□□-C | — | — | — | — | — | ✓ | ✓ | ✓ |
| | | | with Voltage Detector | 5.0 | 0.2 | 45 | BD4269FJ-C | — | ✓ | — | — | — | — | — | ✓ |
| | | | | 5.0 | 0.3 | 45 | BD4269EFJ-C | — | — | — | ✓ | — | — | — | ✓ |
| | | | | 5.0 | 0.5 | 45 | BD42754□□□-C | — | — | — | — | ✓ | — | ✓ | ✓ |
| | | | Voltage Tracker | — | 0.05 | 45 | BD42500G-C | ✓ | — | — | — | — | — | — | ✓ |
| | | | | — | 0.07 | 45 | BD42540FJ-C | — | ✓ | — | — | — | — | — | ✓ |
| | | | | — | 0.25 | 45 | BD42530□□□-C | — | — | — | ✓ | ✓ | — | ✓ | ✓ |

Secondary

▶P.25 to 30

## ROHM Primary Linear Regulator Features

**Low Iq** ▶P.19 to 20

**Compatible Lineup** ▶P.17

**Thermal Design Support** ▶P.35

| Package | External Appearance | Package Name | Product Code | Size (mm) | $\theta_{JA}$ |
|---|---|---|---|---|---|
| **SSOP5** |  | SSOP5 | G | 2.9×2.8 | 185.4˚C/W |
| **SOP8** |  | SOP-J8 | FJ | 4.9×6.0 | 76.9˚C/W |
| **SOT223** |  | SOT223-4 | FP3 | 6.53×7.00 | 70.5˚C/W |
| **HTSOP-J8** |  | HTSOP-J8 | EFJ | 4.9×6.0 | 33.3˚C/W |
| **TO252** |  | TO252-3 | FP | 6.5×9.5 | 20.8˚C/W |
| | | TO252-5 | | | |
| | | Low profile TO252S-3 | FPS | | 24.3˚C/W |
| | | Low profile TO252S-5 | | | |
| | | TO252-J5 | FPJ | 6.6×10.1 | 23.6˚C/W |
| **HRP5/ HRP7** |  | HFP5 | HFP | 9.395×10.54 | 22.0˚C/W |
| | | HFP7 | | | |
| **TO263** |  | TO263-3 | FP2 | 10.16×15.10 | 20.3˚C/W |
| | | TO263-5 | | | |
| | | TO263-7 | | | |

Smaller ↑ Package Size*

Heat Dissipation Performance ↓ High

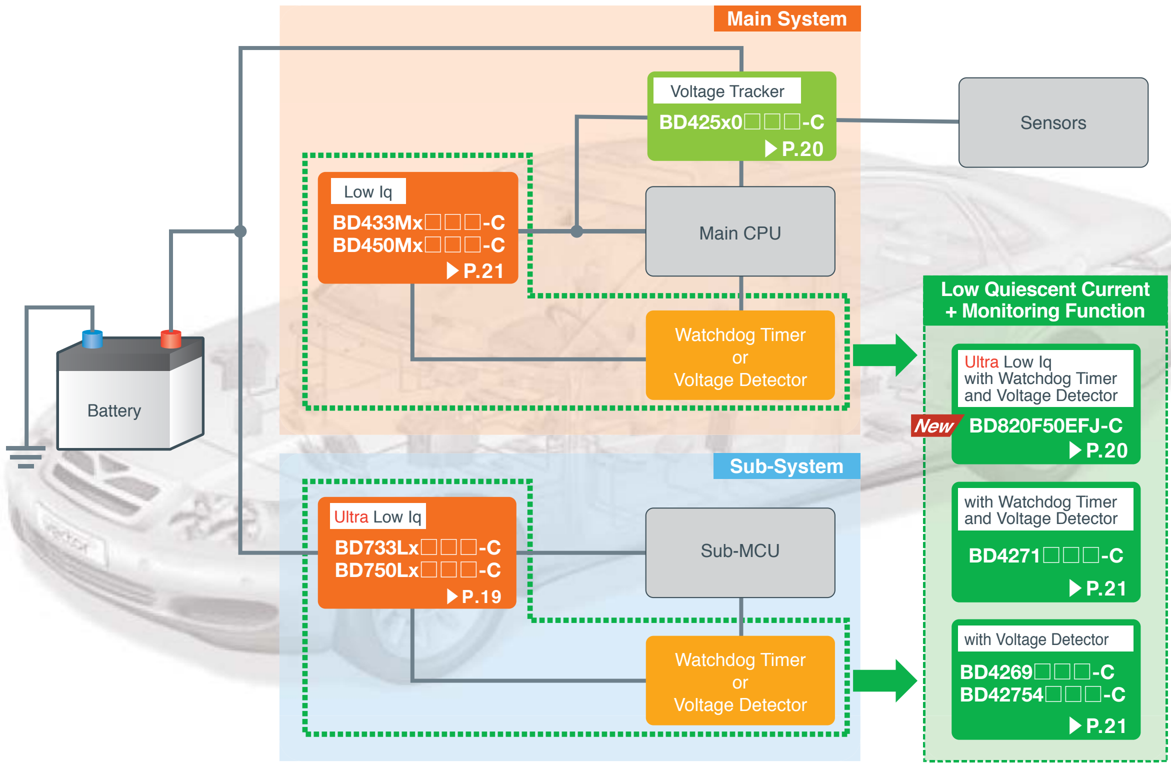
*with some exceptions

Note1: The □□□ in the series name are reserved for the package type.
[Example] Series: BD733L2□□□-C, Package: HTSOP-J8 → Part No: BD733L2EFJ-C

Note2: $\theta_{JA}$ are typical values measured using a 4-layer substrate(ROHM standard/JEDEC compliant). For details on the measurement conditions and/or thermal resistance values, please refer to the datasheet for the respective products. Also, please note that the characteristics may vary depending on the board used. When estimating the junction temperature in greater detail, it is necessary to verify using the actual equipment.

# Automotive Primary Linear Regulator Configuration Example

**AEC-Q100 qualified**



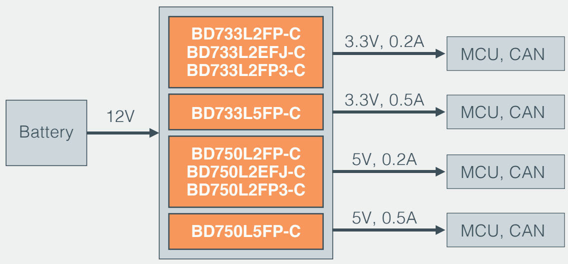

# Primary Linear Regulators

## BD7xxLx□□□-C series

**Ultra Low Iq**

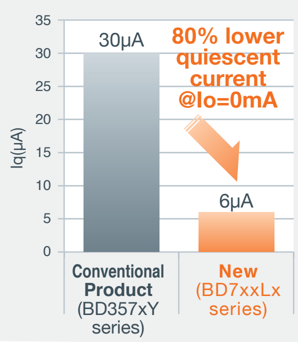
### Space-Saving High Efficiency Solutions

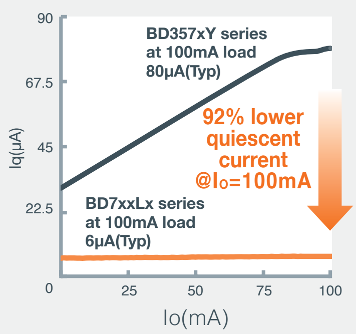
The BD7xxxLx□□□-C series of low Iq(6μA Typ) regulators features 50V withstand voltage, an output voltage accuracy of ±2%, and 200/500mA output current, making them ideal for battery-driven systems requiring lower current consumption. In addition, a ceramic capacitor can be used as the output phase compensation capacitor. Also, these ICs have an overcurrent protection function that prevents IC breakdown(i.e. due to output shorts) and a thermal shutdown circuit that prevents thermal damage caused by overload conditions.




### BD7xxLx□□□-C series Application Circuit Diagram


### BD7xxLx□□□-C series Low Iq Comparison




### Overview: BD7xxLx□□□-C

- Ultra-low Iq: 6μA(Typ)
- Output transistor: Pch DMOS(low saturation type)
- $V_{CC}$ Max: 50V
- Output current: 200mA(Max)/500mA(Max)
- Output voltage: 3.3V±2%/5.0V±2%
- Compatible with low ESR ceramic capacitors for output phase compensation
- Built-in output current limit circuit prevents IC breakdown due to output shorts, etc.
- Thermal shutdown circuit included to prevent thermal damage caused by overload conditions


**TO252-3**
BD733L2FP-C
BD733L5FP-C
BD750L2FP-C
BD750L5FP-C

**HTSOPJ-8**
BD733L2EFJ-C
BD750L2EFJ-C

**SOT223-4**
BD733L2FP3-C
BD750L2FP3-C

# New Products — Primary Linear Regulator with Monitoring Function

## BD820F50EFJ-C

**Ultra Low Iq** **Monitoring Function**

### Ultra-Low Quiescent Current + Monitoring Function Solution

The BD820F50EFJ-C is a high voltage 45V regulator that integrates a watchdog timer(WDT) and reset(RESET) for monitoring the output. An output current capacity of just 200mA along with minimal quiescent current contribute to reducing system current consumption. In addition, when the regulator output falls below 4.2V(Typ), a reset signal is sent. Both the reset recovery delay and WDT monitoring times can be adjusting using an external capacitor.

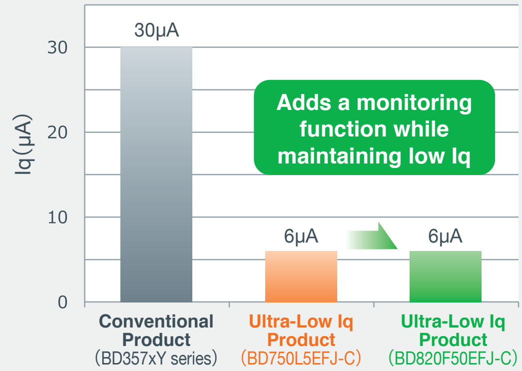

### BD820F50EFJ-C Application Circuit Diagram


### Overview: BD820F50EFJ-C

- Ultra-low Iq: **6μA(Typ)**
- Output transistor: Pch DMOS(low saturation type)
- $V_{CC}$ Max: 45V ● Output current: 200mA(Max)
- Output voltage: 5.0V±2%
- Low saturation voltage PMOS output transistor
- Built-in output low voltage detection reset circuit
- Reset delay and WDT monitoring times adjustable via external capacitor
- Compatible with low ESR ceramic capacitors for output phase compensation
- Internal output current limiting circuit prevents IC breakdown due to output shorts, etc.
- Thermal shutdown circuit included to prevent thermal damage caused by overload conditions

HTSOPJ-8

### Ultra-Low Quiescent Current + Monitoring Function



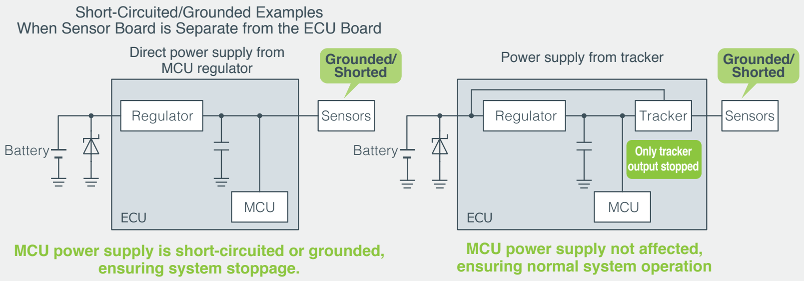

# Voltage Trackers

## BD425x0□□□-C series

**Low Iq**

### What is a Voltage Tracker?

For sensor-equipped applications, the sensors and other components(i.e. MCU, power supply circuit) can be configured on separate boards. In these cases, if power to the sensors is supplied directly from the regulator used for the MCU, in the event the sensor board is short-circuited or grounded the same will also occur to the MCU power supply, possibly resulting in system stoppage. Conversely, if power is supplied to the sensors from a tracker, if the sensor board is short-circuited or grounded only the tracker output will be affected, preventing the MCU power supply from being affected and ensuring normal system operation.

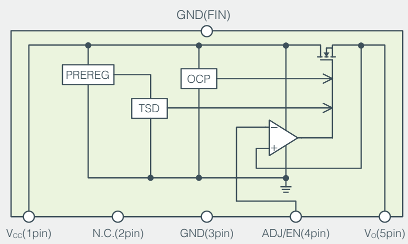



### Overview: BD425x0□□□-C

- Low Iq : 40μA(Typ) ● Tracking voltage accuracy : ±10 to 15mV
- Compatible with ceramic capacitors

SSOP5 SOP-J8 HTSOP-J8 TO252-J5 TO263-5

### BD42530FP2-C Application Circuit Diagram




| Part No. | Input Voltage (V) | Output Current (A) (Max) | Offset Voltage (mV) | Circuit Current (μA) (Typ) | Operating Temperature (℃) | Package |
|---|---|---|---|---|---|---|
| **BD42500G-C** | 5.3 to 42 | 0.05 | ±15(Tj=−40 to +150℃, $V_{CC}$=6 to 40V, Io=1 to 50mA) | 40 | −40 to +150@Tj | SSOP5 |
| **BD42540FJ-C** | 5.4 to 42 | 0.07 | ±10(Tj=−40 to +150℃, $V_{CC}$=5.5 to 26V, Io=0.1 to 60mA) | 40 | −40 to +150@Tj | SOP-J8 |
| **BD42530EFJ-C** | 5.6 to 42 | 0.25 | ±10(Tj=−40 to +150℃, $V_{CC}$=6 to 32V, Io=0.1 to 250mA) | 40 | −40 to +150@Tj | HTSOP-J8 |
| **BD42530FPJ-C** | | | | | −40 to +150@Tj | TO252-J5 |
| **BD42530FP2-C** | | | | | −40 to +150@Tj | TO263-5 |

*5V setting

# Primary Linear Regulator Product Specifications Table

| Part No. | Rated Voltage (V) | Input Voltage (V) | | Output Voltage (V) (Typ) | Output Voltage Accuracy (%) | Output Current (A) (Max) |
|---|---|---|---|---|---|---|
| | | Min | Max | | | |
| BD733L2FP-C | 50 | 4.37(Io=0.2A) | 45 | 3.3 | ±2 | 0.2 |
| BD733L2EFJ-C | | | | | | |
| BD733L2FP3-C | | | | | | |
| BD733L5FP-C | 50 | 4.17(Io=0.2A) | 45 | 3.3 | ±2 | 0.5 |
| BD750L2FP-C | 50 | 5.8(Io=0.2A) | 45 | 5.0 | ±2 | 0.2 |
| BD750L2EFJ-C | | | | | | |
| BD750L2FP3-C | | | | | | |
| BD750L5FP-C | 50 | 5.6(Io=0.2A) | 45 | 5.0 | ±2 | 0.5 |
| BD433M2EFJ-C | 45 | 4.3(Io=0.2A)/ 3.9(Io=0.1A) | 42 | 3.3 | ±2 | 0.2 |
| BD433M2FP3-C | | | | | | |
| BD433M2WEFJ-C | | | | | | |
| BD433M2WFP3-C | | | | | | |
| BD433M5FP-C | 45 | 4.6(Io=0.5A)/ 4.0(Io=0.25A) | 42 | 3.3 | ±2 | 0.5 |
| BD433M5FP2-C | | | | | | |
| BD433M5WFP2-C | | | | | | |
| BD433M5WFPJ-C | | | | | | |
| BD450M2EFJ-C | 45 | 5.8(Io=0.2A)/ 5.5(Io=0.1A) | 42 | 5.0 | ±2 | 0.2 |
| BD450M2FP3-C | | | | | | |
| BD450M2WEFJ-C | | | | | | |
| BD450M2WFP3-C | | | | | | |
| BD450M5FP-C | 45 | 5.9(Io=0.5A)/ 5.5(Io=0.25A) | 42 | 5.0 | ±2 | 0.5 |
| BD450M5FP2-C | | | | | | |
| BD450M5WFP2-C | | | | | | |
| BD450M5WFPJ-C | | | | | | |
| *New* BD800M5WHFP-C | 45 | $V_{OUT}$+0.9 (Io=0.5A) (3.3V or more) | 42 | Adj (1.2 to 16.0) | ±2 | 0.5 |
| *New* BD800M5WFP2-C | | | | | | |
| *New* BD820F50EFJ-C | 45 | 5.9(Io=0.2A) | 42 | 5.0 | ±2 | 0.2 |
| BD42754FPJ-C | 45 | 5.5(Io=0.3A)/ 5.9(Io=0.5A) | 45 | 5.0 | ±2 | 0.50 |
| BD42754FP2-C | | | | | | |
| BD4269FJ-C | 45 | 5.5(Io=0.1A)/ 6.0(Io=0.2A) | 45 | 5.0 | ±2 | 0.20 |
| BD4269EFJ-C | | | | | | 0.30 |
| BD4271HFP-C | 45 | 5.5(Io=0.3A)/ 6.0(Io=0.55A) | 45 | 5.0 | ±2 | 0.55 |
| BD4271FP2-C | | | | | | |

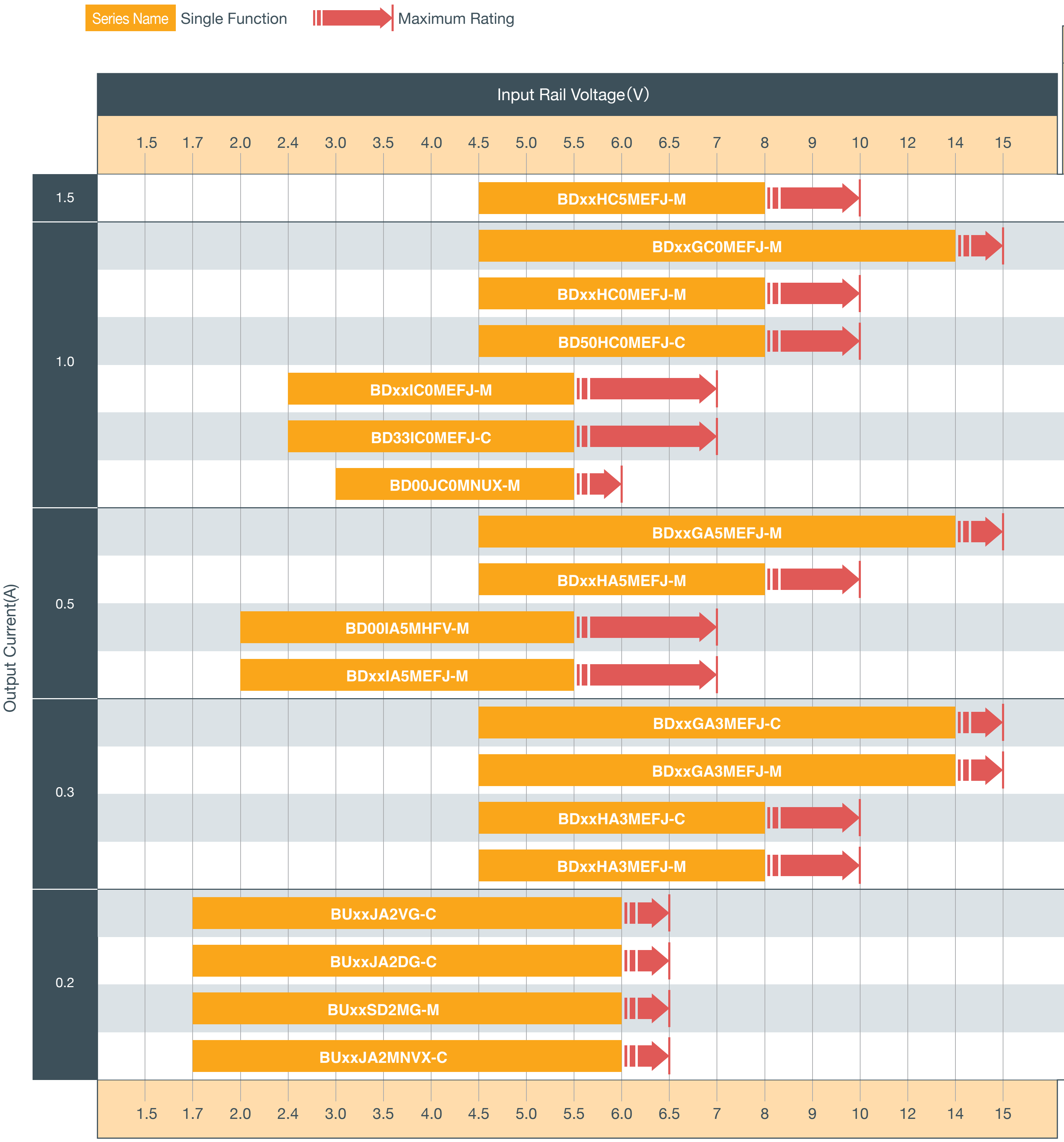
| Dropout Voltage (V) (Typ) | Circuit Current (μA) (Typ) | Functions | | | | | | Operating Temperature (℃) | Package |
|---|---|---|---|---|---|---|---|---|---|
| | | Shutdown Switch | Detection Variable Reset | Detection Fixed Reset | Detection Accuracy (%) | WDT (Monitoring Time Fixed) | WDT (Adjustable Monitoring Time) | | |
| 0.60(Io=0.2A) | 6 | – | – | – | – | – | – | −40 to +125(Ta) | TO252-3 |
| | | | | | | | | | HTSOP-J8 |
| | | | | | | | | | SOT223-4 |
| 0.40(Io=0.2A) | 6 | – | – | – | – | – | – | −40 to +125(Ta) | TO252-3 |
| 0.40(Io=0.2A) | 6 | – | – | – | – | – | – | −40 to +125(Ta) | TO252-3 |
| | | | | | | | | | HTSOP-J8 |
| | | | | | | | | | SOT223-4 |
| 0.25(Io=0.2A) | 6 | – | – | – | – | – | – | −40 to +125(Ta) | TO252-3 |
| 0.20(Io=0.1A) | 40 | – | – | – | – | – | – | −40 to +150(Tj) | HTSOP-J8 |
| | | – | – | – | – | – | – | | SOT223-4 |
| | | ✓ | – | – | – | – | – | | HTSOP-J8 |
| | | ✓ | – | – | – | – | – | | SOT223-4 |
| 0.25(Io=0.3A) | 38 | – | – | – | – | – | – | −40 to +150(Tj) | TO252-3 |
| | | – | – | – | – | – | – | | TO263-3 |
| | | ✓ | – | – | – | – | – | | TO263-5 |
| | | ✓ | – | – | – | – | – | | TO252-J5 |
| 0.16(Io=0.1A) | 40 | – | – | – | – | – | – | −40 to +150(Tj) | HTSOP-J8 |
| | | – | – | – | – | – | – | | SOT223-4 |
| | | ✓ | – | – | – | – | – | | HTSOP-J8 |
| | | ✓ | – | – | – | – | – | | SOT223-4 |
| 0.20(Io=0.3A) | 38 | – | – | – | – | – | – | −40 to +150(Tj) | TO252-3 |
| | | – | – | – | – | – | – | | TO263-3 |
| | | ✓ | – | – | – | – | – | | TO263-5 |
| | | ✓ | – | – | – | – | – | | TO252-J5 |
| 0.20(Io=0.3A) | 20 | ✓ | – | – | – | – | – | −40 to +150(Tj) | HRP5 |
| | | ✓ | – | – | – | – | – | | TO263 |
| 0.40(Io=0.2A) | 6 | – | – | 4.20 | ±2.6 | – | ✓ | −40 to +150(Tj) | HTSOP-J8 |
| 0.25(Io=0.3A) | 75 | – | – | 4.62 | ±2.8<br>−2.6 | – | – | −40 to +150(Tj) | TO252-J5 |
| | | | | | | | | | TO263-5 |
| 0.25(Io=0.1A) | 70 | – | ✓ | 4.62 | ±2.6 | – | – | −40 to +150(Tj) | SOP-J8 |
| | | | | | | | | | HTSOP-J8 |
| 0.20(Io=0.3A) | 75 | ✓ | – | 4.65 | ±2.6 | ✓ | ✓ | −40 to +150(Tj) | HRP7 |
| | | | | | | | | | TO263-7 |

# Primary Linear Regulator Product Specifications Table

| Part No. | Rated Voltage (V) | Input Voltage (V) | | Output Voltage (V) (Typ) | Output Voltage Accuracy (%) | Output Current (A) (Max) |
|---|---|---|---|---|---|---|
| | | Min | Max | | | |
| **BD33C0AFP-C** | 35 | 4.3 | 26.5 | 3.3 | ±3 | 1 |
| **BD33C0AHFP-C** | | | | | | |
| **BD33C0AFP2-C** | | | | | | |
| **BD33C0AWFP-C** | | | | | | |
| **BD33C0AWHFP-C** | | | | | | |
| **BD33C0AWFP2-C** | | | | | | |
| **BD50C0AFP-C** | 35 | 6 | 26.5 | 5 | ±3 | 1 |
| **BD50C0AHFP-C** | | | | | | |
| **BD50C0AFP2-C** | | | | | | |
| **BD50C0AWFP-C** | | | | | | |
| **BD50C0AWHFP-C** | | | | | | |
| **BD50C0AWFP2-C** | | | | | | |
| **BD80C0AFP-C** | 35 | 9 | 26.5 | 8 | ±3 | 1 |
| **BD80C0AFPS-C** | | | | | | |
| **BD80C0AHFP-C** | | | | | | |
| **BD80C0AFP2-C** | | | | | | |
| **BD80C0AWFP-C** | | | | | | |
| **BD80C0AWHFP-C** | | | | | | |
| **BD80C0AWFP2-C** | | | | | | |
| **BD80C0AWEFJ-C** | | | | | | |
| **BD90C0AFP-C** | 35 | 10 | 26.5 | 9 | ±3 | 1 |
| **BD90C0AHFP-C** | | | | | | |
| **BD90C0AFP2-C** | | | | | | |
| **BD90C0AWFP-C** | | | | | | |
| **BD90C0AWHFP-C** | | | | | | |
| **BD90C0AWFP2-C** | | | | | | |
| **BD00C0AWFP-C** | 35 | 4.0 or $V_O$+1.0 | 26.5 | Adj (1.0 to 15.0) | ±3 | 1 |
| **BD00C0AWHFP-C** | | | | | | |
| **BD00C0AWFP2-C** | | | | | | |
| **BD00C0AWFPS-M** | 35 | 4.0 or $V_O$+1.0 | 26.5 | Adj (1.0 to 15.0) | ±3 | 1 |
| **BD3650FP-M** | 36 | 5.6 | 30 | 5.0 | ±2 | 0.3 |
| **BD50FA1MG-M** | 30 | 8.0 | 25 | 5.0 | ±2 | 0.1 |

| Dropout Voltage (V) (Typ) | Circuit Current (μA) (Typ) | Functions | | | | | | Operating Temperature (℃) | Package |
|---|---|---|---|---|---|---|---|---|---|
| | | Shutdown Switch | Detection Variable Reset | Detection Fixed Reset | Detection Accuracy (%) | WDT | WDT (Adjustable Monitoring Time) | | |
| — | 500 | — | — | — | — | — | — | −40 to +125(Ta) | TO252-3 |
| | | — | — | — | — | — | — | | HRP5 |
| | | — | — | — | — | — | — | | TO263-3 |
| | | ✓ | — | — | — | — | — | | TO252-5 |
| | | ✓ | — | — | — | — | — | | HRP5 |
| | | ✓ | — | — | — | — | — | | TO263-5 |
| 0.30(Io=0.5A) | 500 | — | — | — | — | — | — | −40 to +125(Ta) | TO252-3 |
| | | — | — | — | — | — | — | | HRP5 |
| | | — | — | — | — | — | — | | TO263-3 |
| | | ✓ | — | — | — | — | — | | TO252-5 |
| | | ✓ | — | — | — | — | — | | HRP5 |
| | | ✓ | — | — | — | — | — | | TO263-5 |
| 0.30(Io=0.5A) | 500 | — | — | — | — | — | — | −40 to +125(Ta) | TO252-3 |
| | | — | — | — | — | — | — | | TO252S-3 |
| | | — | — | — | — | — | — | | HRP5 |
| | | — | — | — | — | — | — | | TO263-3 |
| | | ✓ | — | — | — | — | — | | TO252-5 |
| | | ✓ | — | — | — | — | — | | HRP5 |
| | | ✓ | — | — | — | — | — | | TO263-5 |
| | | ✓ | — | — | — | — | — | | HTSOP-J8 |
| 0.30(Io=0.5A) | 500 | — | — | — | — | — | — | −40 to +125(Ta) | TO252-3 |
| | | — | — | — | — | — | — | | HRP5 |
| | | — | — | — | — | — | — | | TO263-3 |
| | | ✓ | — | — | — | — | — | | TO252-5 |
| | | ✓ | — | — | — | — | — | | HRP5 |
| | | ✓ | — | — | — | — | — | | TO263-5 |
| 0.30(Io=0.5A) $V_O \geq 5.0$ | 500 | ✓ | — | — | — | — | — | −40 to +125(Ta) | TO252-5 |
| | | ✓ | — | — | — | — | — | | HRP5 |
| | | ✓ | — | — | — | — | — | | TO263-5 |
| 0.30(Io=0.5A) Vo≥5.0 | 500 | ✓ | — | — | — | — | — | −40 to +105(Ta) | TO252S-5 |
| 0.20(Io=0.2A) | 500 | — | — | — | — | — | — | −40 to +125(Ta) | TO252-3 |
| 3.00(Io=0.1A) | 300 | ✓ | — | — | — | — | — | −40 to +105(Ta) | SSOP5 |

# Automotive Secondary Linear Regulator Lineup AEC-Q100 qualified



| Variable Type | Output Voltage(V) 1.0 | 1.1 | 1.2 | 1.25 | 1.5 | 1.8 | 2.5 | 2.8 | 2.85 | 2.9 | 3.0 | 3.3 | 3.4 | 5.0 | >5.0 | Shutdown Switch | Discharge Function | Support 125℃ | Input Capacitor (µF) | Output Capacitor (µF) | Package |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ✓ | — | — | — | — | ✓ | ✓ | ✓ | — | — | — | ✓ | ✓ | — | ✓ | ✓ | ✓ | — | — | 1.0 | 1.0 | HTSOP-J8 |
| ✓ | — | — | — | — | ✓ | ✓ | ✓ | — | — | — | ✓ | ✓ | — | ✓ | ✓ | ✓ | — | — | 1.0 | 1.0 | HTSOP-J8 |
| ✓ | — | — | — | — | ✓ | ✓ | ✓ | — | — | — | ✓ | ✓ | — | ✓ | ✓ | ✓ | — | — | 1.0 | 1.0 | HTSOP-J8 |
| — | — | — | — | — | — | — | — | — | — | — | — | — | — | ✓ | — | ✓ | — | ✓ | 1.0 | 1.0 | HTSOP-J8 |
| ✓ | ✓ | — | ✓ | — | ✓ | ✓ | ✓ | — | — | — | ✓ | ✓ | — | — | — | ✓ | — | — | 1.0 | 1.0 | HTSOP-J8 |
| — | — | — | — | — | — | — | — | — | — | — | — | ✓ | — | — | — | ✓ | — | ✓ | 1.0 | 1.0 | HTSOP-J8 |
| ✓ | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | ✓ | — | — | 1.0 | 22 | VSON010X3030 |
| ✓ | — | — | — | — | ✓ | ✓ | ✓ | — | — | — | ✓ | ✓ | — | ✓ | ✓ | ✓ | — | — | 1.0 | 1.0 | HTSOP-J8 |
| ✓ | — | — | — | — | ✓ | ✓ | ✓ | — | — | — | ✓ | ✓ | — | ✓ | ✓ | ✓ | — | — | 1.0 | 1.0 | HTSOP-J8 |
| ✓ | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | ✓ | — | — | 1.0 | 1.0 | HVSOF6 |
| ✓ | ✓ | — | ✓ | — | ✓ | ✓ | ✓ | — | — | — | ✓ | ✓ | — | — | — | ✓ | — | — | 1.0 | 1.0 | HTSOP-J8 |
| ✓ | — | — | — | — | — | — | — | — | — | — | — | ✓ | — | ✓ | — | ✓ | — | ✓ | 1.0 | 1.0 | HTSOP-J8 |
| ✓ | — | — | — | — | ✓ | ✓ | ✓ | — | — | — | ✓ | ✓ | — | ✓ | ✓ | ✓ | — | — | 1.0 | 1.0 | HTSOP-J8 |
| ✓ | — | — | — | — | ✓ | ✓ | ✓ | — | — | — | ✓ | ✓ | — | ✓ | ✓ | ✓ | — | ✓ | 1.0 | 1.0 | HTSOP-J8 |
| ✓ | — | — | — | — | ✓ | ✓ | ✓ | — | — | — | ✓ | ✓ | — | ✓ | ✓ | ✓ | — | — | 1.0 | 1.0 | HTSOP-J8 |
| — | ✓ | — | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | — | ✓ | ✓ | — | — | — | ✓ | — | ✓ | 1.0 | 1.0 | SSOP5 |
| — | ✓ | — | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | — | ✓ | ✓ | — | — | — | ✓ | ✓ | ✓ | 1.0 | 1.0 | SSOP5 |
| — | — | — | ✓ | — | ✓ | ✓ | ✓ | ✓ | — | — | ✓ | ✓ | — | — | — | ✓ | — | — | 1.0 | 1.0 | SSOP5 |
| — | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | — | — | ✓ | ✓ | ✓ | 0.47 | 0.47 | SSON004R1010 |

Note: In the above table, the xx in the series name indicates the output voltage. → 00: Variable Output Voltage, XX: Fixed Output Voltage
e.g.1) 33 → 3.3V Output, e.g.2) 10 → 1.0V Output

# Automotive Secondary Linear Regulator Family Diagram **AEC-Q100 qualified**

Input | Package | Operating Temperature

**Secondary** — Standard

**HTSOPJ-8**
4.9mm×6.0mm
$\theta_{JA}$: 33.3℃/W

| Operating Temperature | Maximum Rating (V) | Output Current (A) | Series Name | Variable Type | 1.0 | 1.1 | 1.2 | 1.25 | 1.5 | 1.8 | 2.5 | 2.8 | 2.85 | 2.9 | 3.0 | 3.3 | 3.4 | 5.0 | >5.0 | Discharge Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 125℃ | 15 | 0.3 | **BDxxGA3MEFJ-C** | ✓ | — | — | — | — | — | — | — | — | — | — | — | ✓ | — | ✓ | — | — |
| 125℃ | 10 | 0.3 | **BDxxHA3MEFJ-C** | ✓ | — | — | — | — | ✓ | ✓ | ✓ | — | — | — | ✓ | ✓ | — | ✓ | ✓ | — |
| 125℃ | 10 | 1.0 | **BD50HC0MEFJ-C** | — | — | — | — | — | — | — | — | — | — | — | — | — | — | ✓ | — | — |
| 125℃ | 7 | 1.0 | **BD33IC0MEFJ-C** | — | — | — | — | — | — | — | — | — | — | — | — | ✓ | — | — | — | — |
| 105℃ | 15 | 0.3 | **BDxxGA3MEFJ-M** | ✓ | — | — | — | — | ✓ | ✓ | ✓ | — | — | — | ✓ | ✓ | — | ✓ | ✓ | — |
| 105℃ | 15 | 0.5 | **BDxxGA5MEFJ-M** | ✓ | — | — | — | — | ✓ | ✓ | ✓ | — | — | — | ✓ | ✓ | — | ✓ | ✓ | — |
| 105℃ | 15 | 1.0 | **BDxxGC0MEFJ-M** | ✓ | — | — | — | — | ✓ | ✓ | ✓ | — | — | — | ✓ | ✓ | — | ✓ | ✓ | — |
| 105℃ | 10 | 0.3 | **BDxxHA3MEFJ-M** | ✓ | — | — | — | — | ✓ | ✓ | ✓ | — | — | — | ✓ | ✓ | — | ✓ | ✓ | — |
| 105℃ | 10 | 0.5 | **BDxxHA5MEFJ-M** | ✓ | — | — | — | — | ✓ | ✓ | ✓ | — | — | — | ✓ | ✓ | — | ✓ | ✓ | — |
| 105℃ | 10 | 1.0 | **BDxxHC0MEFJ-M** | ✓ | — | — | — | — | ✓ | ✓ | ✓ | — | — | — | ✓ | ✓ | — | ✓ | ✓ | — |
| 105℃ | 10 | 1.5 | **BDxxHC5MEFJ-M** | ✓ | — | — | — | — | ✓ | ✓ | ✓ | — | — | — | ✓ | ✓ | — | ✓ | ✓ | — |
| 105℃ | 7 | 0.5 | **BDxxIA5MEFJ-M** | ✓ | ✓ | — | ✓ | — | ✓ | ✓ | ✓ | — | — | — | ✓ | ✓ | — | — | — | — |
| 105℃ | 7 | 1.0 | **BDxxIC0MEFJ-M** | ✓ | ✓ | — | ✓ | — | ✓ | ✓ | ✓ | — | — | — | ✓ | ✓ | — | — | — | — |

▶**Pin-to-Pin replaceable voltage/current lineup**

Compact/ Gull Wing

**SSOP5**
2.9mm×2.8mm
$\theta_{JA}$: 185.4℃/W

| Operating Temperature | Maximum Rating (V) | Output Current (A) | Series Name | Variable Type | 1.0 | 1.1 | 1.2 | 1.25 | 1.5 | 1.8 | 2.5 | 2.8 | 2.85 | 2.9 | 3.0 | 3.3 | 3.4 | 5.0 | >5.0 | Discharge Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 125℃ | 6.5 | 0.2 | **BUxxJA2VG-C** | — | ✓ | — | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | — | ✓ | ✓ | — | — | — | — |
| 125℃ | 6.5 | 0.2 | **BUxxJA2DG-C** | — | — | — | — | — | — | ✓ | — | ✓ | — | — | — | — | — | — | — | ✓ |
| 105℃ | 6.5 | 0.2 | **BUxxSD2MG-M** | — | — | — | ✓ | — | ✓ | ✓ | ✓ | ✓ | — | — | ✓ | ✓ | — | — | — | — |

▶**Gull wing structure ensures superior bonding reliability with the substrate**

Compact/ High Heat Dissipation

**VSON010X3030**
3.0mm×3.0mm
$\theta_{JA}$: 69.4℃/W

| Operating Temperature | Maximum Rating (V) | Output Current (A) | Series Name | Variable Type | 1.0 | 1.1 | 1.2 | 1.25 | 1.5 | 1.8 | 2.5 | 2.8 | 2.85 | 2.9 | 3.0 | 3.3 | 3.4 | 5.0 | >5.0 | Discharge Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 105℃ | 6.0 | 1.0 | **BD00JC0MNUX-M** | ✓ | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |

▶**NMOS topology and exposed heat sink enables 1.0A output in a compact package**

Compact/ High Heat Dissipation

**HVSOF6**
1.6mm×3.0mm
$\theta_{JA}$: 65.2℃/W

| Operating Temperature | Maximum Rating (V) | Output Current (A) | Series Name | Variable Type | 1.0 | 1.1 | 1.2 | 1.25 | 1.5 | 1.8 | 2.5 | 2.8 | 2.85 | 2.9 | 3.0 | 3.3 | 3.4 | 5.0 | >5.0 | Discharge Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 105℃ | 7.0 | 0.5 | **BD00IA5MHFV-M** | ✓ | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |

Ultra-Compact

**SSON004R1010**
1.0mm×1.0mm
$\theta_{JA}$: 97.1℃/W

| Operating Temperature | Maximum Rating (V) | Output Current (A) | Series Name | Variable Type | 1.0 | 1.1 | 1.2 | 1.25 | 1.5 | 1.8 | 2.5 | 2.8 | 2.85 | 2.9 | 3.0 | 3.3 | 3.4 | 5.0 | >5.0 | Discharge Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 125℃ | 6.5 | 0.2 | **BUxxJA2MNVX-C** | — | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | — | — | ✓ |

▶**Smallest automotive-grade package on the market**

**Primary**

▶P.15 to 24

Note1: In the above table, the xx in the series name indicates the output voltage. → 00: Variable Output Voltage, XX: Fixed Output Voltage
e.g.1)33 → 3.3V Output, e.g.2)10 → 1.0V Output

Note2: $\theta_{JA}$ are typical values measured using a 4-layer substrate(ROHM standard/JEDEC compliant). For details on the measurement conditions and/or thermal resistance values, please refer to the datasheet for the respective products. Also, please note that the characteristics may vary depending on the board used. When estimating the junction temperature in greater detail, it is necessary to verify using the actual equipment.

# Secondary Linear Regulators

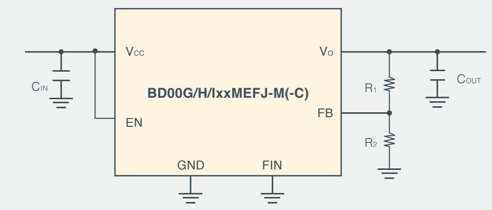
## BDxxG/H/IxxMEFJ-M(C) series

Compact・Large Current

### BDxxG/H/IxxMEFJ-M(C) series Application Circuit Diagram

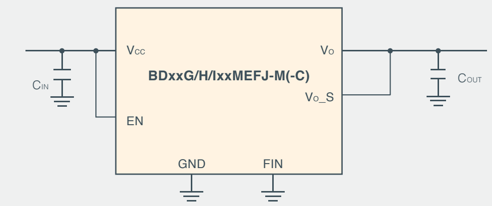
**BDxxG/H/IxxMEFJ-M(C)**

Maximum Rating G: 15V H: 10V I: 7V




$C_{IN}$,$C_{OUT}$: Ceramic Capacitoe

Variable Output Type Application Circuit Diagram




$C_{IN}$,$C_{OUT}$: Ceramic Capacitoe

Fixed Output Type Application Circuit Diagram

### Overview: BDxxG/H/IxxMEFJ-M(C)

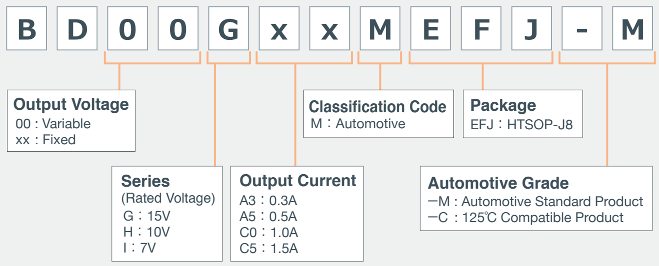
- Shutdown circuit current: 0μA(Typ)
- Output voltage accuracy: –M=±3%(Ta: –40℃ to +105℃)
  –C=±2%(Ta: –40℃ to +125℃)
- Standby function
- Compatible with low ESR ceramic capacitors for output phase compensation(1.0μF Min)
- Built-in output current limit circuit prevents IC breakdown due to output shorts, etc.
- Thermal shutdown circuit included to prevent thermal damage caused by overload conditions

HTSOPJ-8

4.9mm×6.0mm

Both the BDxxIC0MEFJ-C and BDxxIC0MEFJ feature an output voltage accuracy of ±3%

### Part Number Configuration




# Secondary Linear Regulator

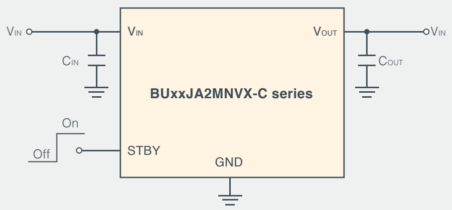
## BUxxJA2MNVX-C series

Ultra-Compact

### BUxxJA2MNVX-C series Application Circuit Diagram

**BUxxJA2MNVX-C series**

Absolute Maximum Ratings 6.5V




Application Circuit Diagram

### Overview: BUxxJA2MNVX-C series

- Input voltage range: 1.7V to 6.0V(6.5V rated)
- Low Iq: 35μA(Typ)
- Output current: 200mA(Max)
- Output voltage accuracy: ±2%(Ta: –40℃ to +125℃)
- High PSRR(Ripple Rejection): 70dB(Typ)@1kHz
- Standby function
- Supports low ESR ceramic capacitors for output phase compensation(0.22μF Min)
- Built-in overcurrent protection circuit prevents IC breakdown due to output shorts, etc.
- Thermal shutdown circuit included to prevent thermal damage caused by overload conditions

SSON004R1010

1.0mm×1.0mm

# Secondary Linear Regulator Product Specifications Table

| Part No. | Rated Voltage (V) | Input Voltage (V) | | Output Voltage (V) (Typ) | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Min | Max | Variable Type | 1.0 | 1.1 | 1.2 | 1.25 | 1.5 | 1.8 | 2.5 | 2.8 | 2.85 | 2.9 | 3.0 | 3.3 | 3.4 | 5.0 | 6.0 | 7.0 |
| **BDxxGC0MEFJ-M** | 15 | 4.5 | 14 | ✓ | — | — | — | — | ✓ | ✓ | ✓ | — | — | — | ✓ | ✓ | — | ✓ | ✓ | ✓ |
| **BDxxGA5MEFJ-M** | 15 | 4.5 | 14 | ✓ | — | — | — | — | ✓ | ✓ | ✓ | — | — | — | ✓ | ✓ | — | ✓ | ✓ | ✓ |
| **BDxxGA3MEFJ-M** | 15 | 4.5 | 14 | ✓ | — | — | — | — | ✓ | ✓ | ✓ | — | — | — | ✓ | ✓ | — | ✓ | ✓ | ✓ |
| **BDxxGA3MEFJ-C** | 15 | 4.5 | 14 | ✓ | — | — | — | — | — | — | — | — | — | — | — | ✓ | — | — | — | — |
| **BDxxHC5MEFJ-M** | 10 | 4.5 | 8 | ✓ | — | — | — | — | ✓ | ✓ | ✓ | — | — | — | ✓ | ✓ | — | ✓ | ✓ | ✓ |
| **BDxxHC0MEFJ-M** | 10 | 4.5 | 8 | ✓ | — | — | — | — | ✓ | ✓ | ✓ | — | — | — | ✓ | ✓ | — | ✓ | ✓ | ✓ |
| **BD50HC0MEFJ-C** | 10 | 4.5 | 8 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | ✓ | — | — |
| **BDxxHA5MEFJ-M** | 10 | 4.5 | 8 | ✓ | — | — | — | — | ✓ | ✓ | ✓ | — | — | — | ✓ | ✓ | — | ✓ | ✓ | ✓ |
| **BDxxHA3MEFJ-M** | 10 | 4.5 | 8 | ✓ | — | — | — | — | ✓ | ✓ | ✓ | — | — | — | ✓ | ✓ | — | ✓ | ✓ | ✓ |
| **BDxxHA3MEFJ-C** | 10 | 4.5 | 8 | ✓ | — | — | — | — | ✓ | ✓ | ✓ | — | — | — | ✓ | ✓ | — | ✓ | ✓ | ✓ |
| **BDxxIC0MEFJ-M** | 7 | 2.4 | 5.5 | ✓ | ✓ | — | ✓ | — | ✓ | ✓ | ✓ | — | — | — | ✓ | ✓ | — | — | — | — |
| **BD33IC0MEFJ-C** | 7 | 2.4 | 5.5 | — | — | — | — | — | — | — | — | — | — | — | — | ✓ | — | — | — | — |
| **BD00IA5MHFV-M** | 7 | 2.4 | 5.5 | ✓ | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| **BDxxIA5MEFJ-M** | 7 | 2.4 | 5.5 | ✓ | ✓ | — | ✓ | — | ✓ | ✓ | ✓ | — | — | — | ✓ | ✓ | — | — | — | — |
| **BUxxSD2MG-M** | 6.5 | 1.7 | 6 | — | — | — | ✓ | — | — | — | — | — | — | — | — | — | — | — | — | — |
| | | | | — | — | — | — | — | ✓ | — | — | — | — | — | — | — | — | — | — | — |
| | | | | — | — | — | — | — | — | ✓ | — | — | — | — | — | — | — | — | — | — |
| | | | | — | — | — | — | — | — | — | ✓ | — | — | — | — | — | — | — | — | — |
| | | | | — | — | — | — | — | — | — | — | ✓ | — | — | ✓ | ✓ | — | — | — | — |
| **BUxxJA2MNVX-C** | 6.5 | 1.7 | 6 | — | ✓ | ✓ | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| | | | | — | — | — | ✓ | ✓ | — | — | — | — | — | — | — | — | — | — | — | — |
| | | | | — | — | — | — | — | ✓ | — | — | — | — | — | — | — | — | — | — | — |
| | | | | — | — | — | — | — | — | ✓ | — | — | — | — | — | — | — | — | — | — |
| | | | | — | — | — | — | — | — | — | ✓ | — | — | — | — | — | — | — | — | — |
| | | | | — | — | — | — | — | — | — | — | ✓ | ✓ | — | — | — | — | — | — | — |
| | | | | — | — | — | — | — | — | — | — | — | — | ✓ | ✓ | — | — | — | — | — |
| | | | | — | — | — | — | — | — | — | — | — | — | — | — | ✓ | ✓ | — | — | — |
| **BUxxJA2VG-C** | 6.5 | 1.7 | 6 | — | ✓ | — | ✓ | ✓ | ✓ | — | — | — | — | — | — | — | — | — | — | — |
| | | | | — | — | — | — | — | — | ✓ | — | — | — | — | — | — | — | — | — | — |
| | | | | — | — | — | — | — | — | — | ✓ | — | — | — | — | — | — | — | — | — |
| | | | | — | — | — | — | — | — | — | — | ✓ | ✓ | — | ✓ | ✓ | — | — | — | — |
| **BUxxJA2DG-C** | 6.5 | 1.7 | 6 | — | ✓ | — | ✓ | ✓ | ✓ | — | — | — | — | — | — | — | — | — | — | — |
| | | | | — | — | — | — | — | — | ✓ | — | — | — | — | — | — | — | — | — | — |
| | | | | — | — | — | — | — | — | — | ✓ | — | — | — | — | — | — | — | — | — |
| | | | | — | — | — | — | — | — | — | — | ✓ | ✓ | — | ✓ | ✓ | — | — | — | — |
| **BD00JC0MNUX-M** | 6 | 0.95 | 4.5 | ✓ | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |

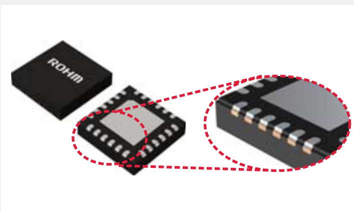
| | | | | | | | | Functions | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8.0 | 9.0 | 10 | 12 | Output Voltage Accuracy (%) | Output Current (A) (Max) | Dropout Voltage (V) (Typ) | Circuit Current (μA) (Typ) | Shutdown Switch | Discharge Function | Support 125℃ | Operating Temperature (℃) | Package |
| ✓ | ✓ | ✓ | ✓ | ±3 | 1.0 | 0.60(Io=1.00A) | 600 | ✓ | — | — | −40 to +105(Ta) | HTSOP-J8 |
| ✓ | ✓ | ✓ | ✓ | ±3 | 0.5 | 0.60(Io=0.50A) | 600 | ✓ | — | — | −40 to +105(Ta) | HTSOP-J8 |
| ✓ | ✓ | ✓ | ✓ | ±3 | 0.3 | 0.60(Io=0.30A) | 600 | ✓ | — | — | −40 to +105(Ta) | HTSOP-J8 |
| — | — | — | — | ±2 | 0.3 | 0.60(Io=0.30A) | 600 | ✓ | — | ✓ | −40 to +125(Ta) | HTSOP-J8 |
| — | — | — | — | ±3 | 1.5 | 0.60(Io=1.50A) | 600 | ✓ | — | — | −40 to +105(Ta) | HTSOP-J8 |
| — | — | — | — | ±3 | 1.0 | 0.60(Io=1.00A) | 600 | ✓ | — | — | −40 to +105(Ta) | HTSOP-J8 |
| — | — | — | — | ±3 | 1.0 | 0.60(Io=1.00A) | 600 | ✓ | — | ✓ | −40 to +125(Ta) | HTSOP-J8 |
| — | — | — | — | ±3 | 0.5 | 0.60(Io=0.50A) | 600 | ✓ | — | — | −40 to +105(Ta) | HTSOP-J8 |
| — | — | — | — | ±3 | 0.3 | 0.60(Io=0.30A) | 600 | ✓ | — | — | −40 to +105(Ta) | HTSOP-J8 |
| — | — | — | — | ±2 | 0.3 | 0.60(Io=0.30A) | 600 | ✓ | — | ✓ | −40 to +125(Ta) | HTSOP-J8 |
| — | — | — | — | ±3 | 1.0 | 0.40(Io=1.00A) | 250 | ✓ | — | — | −40 to +105(Ta) | HTSOP-J8 |
| — | — | — | — | ±3 | 1.0 | 0.40(Io=1.00A) | 400 | ✓ | — | ✓ | −40 to +125(Ta) | HTSOP-J8 |
| — | — | — | — | ±3 | 0.5 | 0.40(Io=0.50A) | 250 | ✓ | — | — | −40 to +105(Ta) | HVSOF6 |
| — | — | — | — | ±3 | 0.5 | 0.40(Io=0.50A) | 250 | ✓ | — | — | −40 to +105(Ta) | HTSOP-J8 |
| — | — | — | — | ±2 | 0.2 | 0.40(Io=0.10A) | 33 | ✓ | — | — | −40 to +105(Ta) | SSOP5 |
| — | — | — | — | | | 0.28(Io=0.10A) | | | | | | |
| — | — | — | — | | | 0.15(Io=0.10A) | | | | | | |
| — | — | — | — | | | 0.10(Io=0.10A) | | | | | | |
| — | — | — | — | | | 0.085(Io=0.10A) | | | | | | |
| — | — | — | — | ±36mV (Io=0.01mA) | 0.2 | 0.80(Io=0.20A) | 35 | ✓ | ✓ | ✓ | −40 to +125(Ta) | SSON004R1010 |
| — | — | — | — | | | 0.60(Io=0.20A) | | | | | | |
| — | — | — | — | | | 0.44(Io=0.20A) | | | | | | |
| — | — | — | — | ±2mV (Io=0.01mA) | | 0.38(Io=0.20A) | | | | | | |
| — | — | — | — | | | 0.28(Io=0.20A) | | | | | | |
| — | — | — | — | | | 0.26(Io=0.20A) | | | | | | |
| — | — | — | — | | | 0.24(Io=0.20A) | | | | | | |
| — | — | — | — | | | 0.22(Io=0.20A) | | | | | | |
| — | — | — | — | ±2mV | 0.2 | — | 33 | ✓ | — | ✓ | −40 to +125(Ta) | SSOP5 |
| — | — | — | — | | | 0.16(Io=0.10A) | | | | | | |
| — | — | — | — | | | 0.10(Io=0.10A) | | | | | | |
| — | — | — | — | | | 0.085(Io=0.10A) | | | | | | |
| — | — | — | — | ±2 | 0.2 | — | 33 | ✓ | ✓ | ✓ | −40 to +125(Ta) | SSOP5 |
| — | — | — | — | | | 0.16(Io=0.10A) | | | | | | |
| — | — | — | — | | | 0.10(Io=0.10A) | | | | | | |
| — | — | — | — | | | 0.085(Io=0.10A) | | | | | | |
| — | — | — | — | ±1 | 1.0 | 0.20(Io=1.0A) | 700 | ✓ | — | — | −40 to +105(Ta) | VSON010X3030 |

# Automotive Switching Regulator Package List

| Package Name | External Appearance | Package Code | Size(mm)<br>W(Typ)×D(Typ)×H(Max) |
|---|---|---|---|
| **VSON008X2020** |  | NUX | 2.00 × 2.00 × 0.60 |
| **VSON10FV3030** |  | NUF | 3.00 × 3.00 × 1.00 |
| **VQFN16FV3030** |  | MUF | 3.00 × 3.00 × 1.00 |
| **VQFN20FV4040** |  | MUF | 4.00 × 4.00 × 1.00 |
| **VQFN24FV4040** |  | MUF | 4.00 × 4.00 × 1.00 |
| **VQFN32FAV050** |  | MUF | 5.00 × 5.00 × 1.00 |
| **HTSOP-J8** |  | EFJ | 4.90 × 6.00 × 1.00 |
| **SOP8** |  | F | 5.00 × 6.20 × 1.71 |
| **HTSSOP-B20** |  | EFV | 6.50 × 6.40 × 1.00 |
| **HTSSOP-B24** |  | EFV | 7.80 × 7.60 × 1.00 |
| **VQFP48C** |  | KV | 9.00 × 9.00 × 1.60 |
| **HRP7** |  | HFP | 9.395 × 10.540 × 2.005 |

**Wettable Flank**

Packages without leads such as the standard QFN and SON packages make it difficult to visually determine whether the electrodes are properly soldered to the printed circuit board. (Although copper is exposed at the end surface of the electrode, it is difficult to maintain solder wettability at the terminal end due to the oxidation of copper.)
Wettable flank packages are packages in which recesses are made at the terminal ends by adding a process during assembly that adds tin plating to improve visibility during appearance inspection.



# Automotive Linear Regulator Package List

| Package Name | External Appearance | Package Code | Size(mm)<br>W(Typ)×D(Typ)×H(Max) |
|---|---|---|---|
| **SSON004R1010** |  | NVX | 1.00 × 1.00 × 0.60 |
| **HVSOF6** |  | HFV | 1.60 × 3.00 × 0.75 |
| **VSON010X3030** |  | NUX | 3.00 × 3.00 × 0.60 |
| **SSOP5** |  | G | 2.90 × 2.80 × 1.25 |
| **SOP-J8** |  | FJ | 4.90 × 6.00 × 1.65 |
| **HTSOP-J8** |  | EFJ | 4.90 × 6.00 × 1.00 |
| **SOT223-4** |  | FP3 | 6.53 × 7.00 × 1.80 |
| **TO252-3** |  | FP | 6.50 × 9.50 × 2.30 |
| **TO252-5** |  | FP | 6.50 × 9.50 × 2.30 |
| **TO252-J5** |  | FPJ | 6.60 × 10.10 × 2.30 |
| **TO252S-5** |  | FPS | 6.60 × 9.50 × 1.20 |
| **HRP5** |  | HFP | 9.395 × 10.54 × 1.905 |
| **HRP7** |  | HFP | 9.395 × 10.54 × 1.905 |
| **TO263-3** |  | FP2 | 10.16 × 15.10 × 4.57 |
| **TO263-5** |  | FP2 | 10.16 × 15.10 × 4.57 |
| **TO263-7** |  | FP2 | 10.16 × 15.10 × 4.57 |

# Tech Tips Noise Characteristics and Immunity

## What are noise characteristics?

### EMC
⇒ **Electromagnetic Compatibility**

Refers to the ability to maintain performance even if disturbed by other equipment without interfering with external systems. It is called electromagnetic compatibility due to the need to ensure normal device operation without mutual electromagnetic interference, classified as EMI and EMS , below.

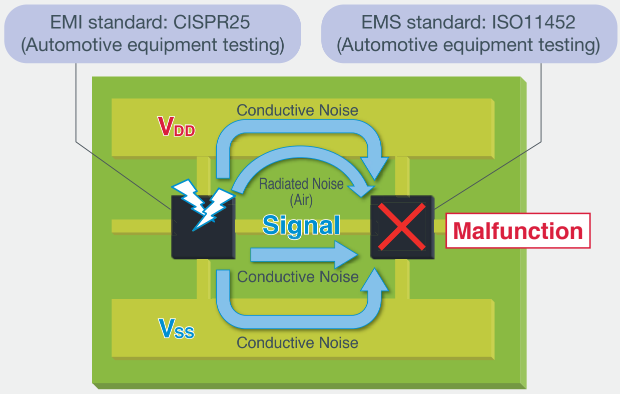
### EMI
⇒ **Electromagnetic Interference(Emission)**

EMI refers to noise generated by the target IC that can interfere with the operation of surrounding ICs and systems. Since EMI may cause peripheral IC and/or systems to malfunction, delicate circuit design is necessary to prevent this phenomenon from occurring.

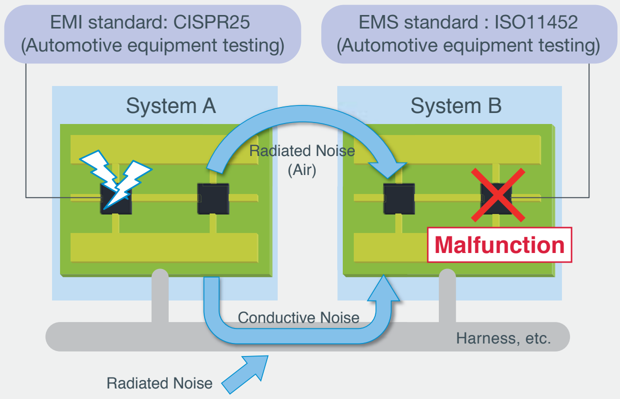
### EMS
⇒ **Electromagnetic Susceptibility(Immunity)**

EMS is the tendency(ability/tolerance) for equipment to malfunction in the presence of external noise. If sufficient tolerance cannot be secured, the circuit may malfunction or fail to operate, so a robust circuit design is necessary.

## EMC Issues on the Same Board




## EMC Issues from Outside the Board




## Possible issues with improper PCB layout

**Possible issues when the PCB layout for the power supply IC is improper include the following.**

⇒ **Low EMC and PI performance**

⇒ **Degradation of basic performance such as output voltage accuracy**

⇒ **Unstable operation (oscillation, switching waveform breakdown)**

## PCB Design Checklist

**For proper PCB layout**

PCB layout is just as important as circuit design when designing a DC/DC converter. A proper layout can help avoid various power supply issues. Figures 1 to 3 illustrate the current paths of a buck DC/DC converter.
Figure 1, Loop 1 shows the current flowing through the converter when the high side switch is ON and low side switch is OFF, while Figure 2, Loop 2 depicts the current flow when the high side switch is OFF and low side switch is ON. The thick line in Figure 3 shows the difference between Loop 1 and Loop 2. The current in the thick line section changes dramatically each time the high side and low side switches turn OFF and ON. Because the changes in the system are steep, high-frequency content appear.
Therefore, by decreasing the area of the thick line section comprised of the input capacitor and IC as small as possible, noise can be reduced.

Please refer to the application notes on the , switching regulator series titled, 'Buck Converter PCB Layout Technique' for notes on other PCB layouts.

**https://www.rohm.com/search/application-notes**

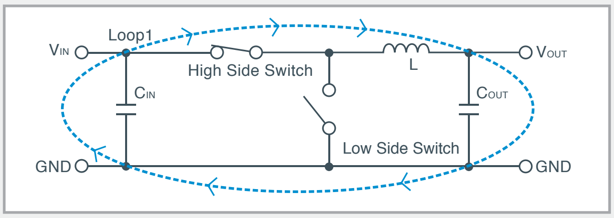



**Figure 1 : Current Path When the High Side Switch is ON and Low Side Switch is OFF**

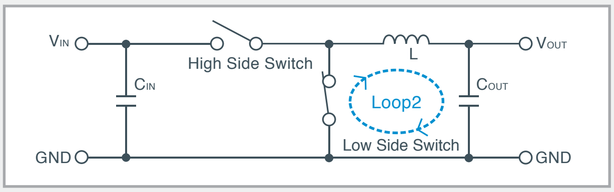



**Figure 2 : Current Path When the High Side Switch is OFF and Low Side Switch is ON**

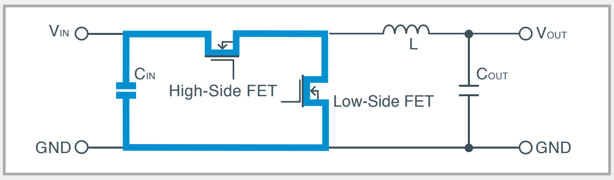



**Figure 3 : Current Difference + Important Points on Layout**

# Tech Tips Heat Resistance and Thermal Characteristics

## Definitions ·Applications ·Formulas

■ These definitions conform to JEDEC standard JESD51

| Symbol | Definition | Applications | Formula |
|---|---|---|---|
| $\theta_{JA}$ | The thermal resistance between the junction temperature Tj and ambient temperature Ta when the package is mounted on a PCB | Comparing the heat dissipation performance among packages of different shapes | $\theta_{JA} = (Tj - Ta) \div P$ |
| $\Psi_{JT}$ | The thermal characteristics parameter between the junction temperature Tj and the temperature of the center of the upper surface of the package $T_T$. | Estimating junction temperature | $\Psi_{JT} = (Tj - T_T) \div P$ |
| $\theta_{JC\text{-}TOP}$ | The thermal resistance between the junction temperature Tj and temperature of the top surface of the package $T_{C\text{-}TOP}$. The heat dissipation path is only on the top surface; the others are adiabatic. | Used for simulations using the 2-resistance model | $\theta_{JC\text{-}TOP} = (Tj - T_{C\text{-}TOP}) \div P$ |
| $\theta_{JC\text{-}BOT}$ | The thermal resistance between the junction temperature Tj and the temperature of the bottom surface of the package $T_{C\text{-}BOT}$. The heat dissipation path is only on the bottom surface; the others are adiabatic. | Used to estimate the junction temperature, since when the heat dissipation metal at the bottom of the package is exposed, most of the heat flows only through the package bottom. | $\theta_{JC\text{-}BOT} = (Tj - T_{C\text{-}BOT}) \div P$ |

Note 1: $\theta_{JA}/\Psi_{JT}$ is the value when mounted on a JEDEC board. Note 2: Conventionally, the value provided as $\theta_{JC}$ is $\Psi_{JT}$ in this definition.

## Illustrations for Each Definition

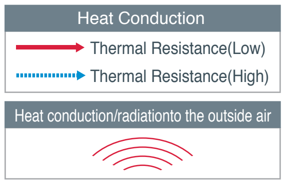
JEDEC(JESD51) reference

■ $\theta_{JA}$: Thermal resistance between the junction and the ambient environment

*Heat dissipation through multiple thermal paths

■ $\Psi_{JT}$: Thermal characteristics between the junction and the center of the top surface of the package

*Heat conduction(with heat dissipation) other than at the top surface of the package



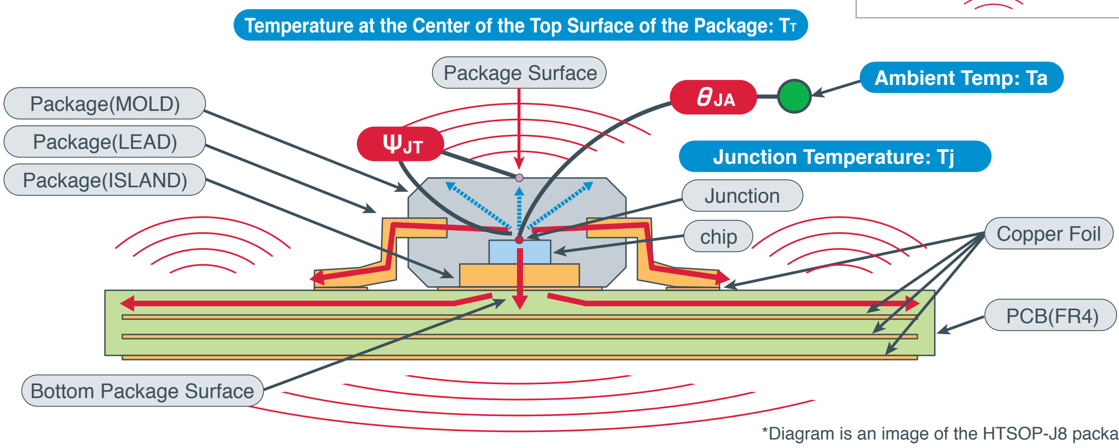
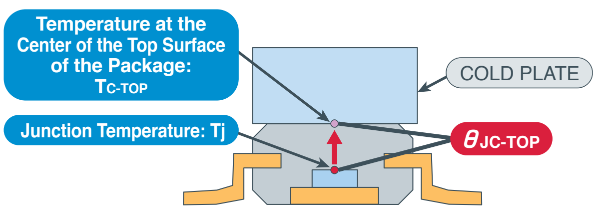




*Diagram is an image of the HTSOP-J8 package

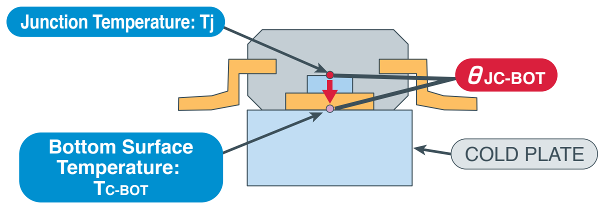
■ $\theta_{JC\text{-}TOP}$: Thermal resistance between the junction and the top surface of the package

*Heat is dissipated only at the top surface of the package; the others are adiabatic.




■ $\theta_{JC\text{-}BOT}$: Thermal resistance between the junction and the bottom surface of the package

*Heat is dissipated only at the bottom surface of the package; the others are adiabatic.



# Support System for EMC/Thermal Treatment

## EMC Countermeasure

### Market Background

- The increasing number of ECUs and continuing miniaturization (higher frequency) is increasing the number of cases where the internal noise interference worsens.
  - ⇒ **Increased risk of malfunction due to noise**
  - ⇒ **Greater risk of generating noise which can cause malfunctions to surrounding equipment**
- Also, upon further investigation the following can be expected.
  - ⇒ **With the continuing proliferation of ADAS and automated driving, it has become imperative to prevent malfunctions and control failures due to external noise.**
  - ⇒ **Eliminating metal body (shield) and reducing body weight to minimize environmental load**

**EMC countermeasure technology is becoming more important**

### ROHM EMC Countermeasure Support System

- **Established an anechoic chamber** (at the Shin-Yokohama Technology Center)
- **Recommendations on application countermeasures designed to** clear the CISPR 25 Class 5 requirements

anechoic chamber

### Automotive EMC Test Standard

- EMI/EMC standards that can be tested at ROHM

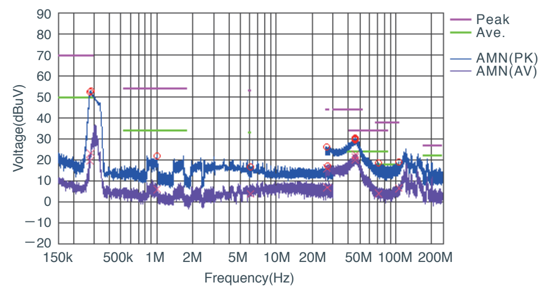
**Automotive Immunity Test**

| Test Method | Standard | Frequency | Max |
|---|---|---|---|
| BCI Immunity | ISO11452-4 | 100kHz to 2.1GHz | 200mA *≦400MHz: 300mA |
| Transient Immunity | ISO7637-2/3/5 | Pulse 1/2a/2b/3a/3b/4/5a/5b | |
| Radiated Immunity | ISO11452-2 | 80MHz to 3GHz | 200V/m |
| | Radar pulse | 1.2 to 1.4GHz | 300V/m |
| | | 3.1 to 4.2GHz | |
| Near field Antenna Immunity | Custom SPEC | 800MHz to 2.4GHz | up to 15W |
| TEM CELL Immunity | ISO11452-3 | 1MHz to 400MHz | 200W |

**Automotive Emission Test**

| Test Method | Standard | Frequency |
|---|---|---|
| Radiated Emission | CISPR25 | 150kHz to 1GHz |
| Conducted Emission | CISPR25 | 150kHz to 108MHz |

**Measurement Example**




Standard: CISPR25 Target: BD18351EFV-M
Load: White LEDs/8 lamps connected in series $I_{OUT}$: 300mA

## Thermal Countermeasure

### Market Background

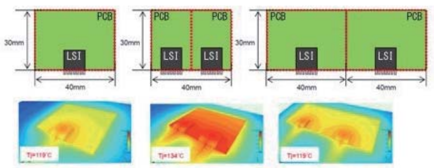
- The number of cases where the thermal environment for parts is worsening has increased due to mechanical integration and mounting in engine compartments
  - ⇒ **Increases the risk of a reduction in the quality and life of electronic components**

**Heat dissipation design technology is becoming more important**

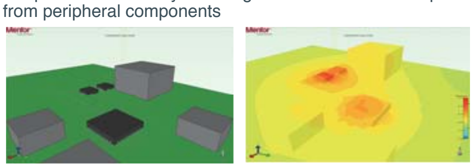
### Thermal Simulation Support Case Study

- Recommendations on PCB design possible using simulations

Ex. 1: Analysis of temperature rise based on substrate size and component layout




Ex. 2: Temperature rise analysis taking into account heat reception from peripheral components



*FloTHERM used (Mentor Graphics)

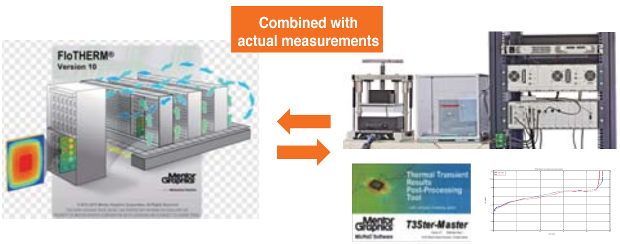
### Thermal Resistance Measurement Environment Example

- We are constructing an environment that conforms with JEDEC


### Initiatives to Improve Accuracy

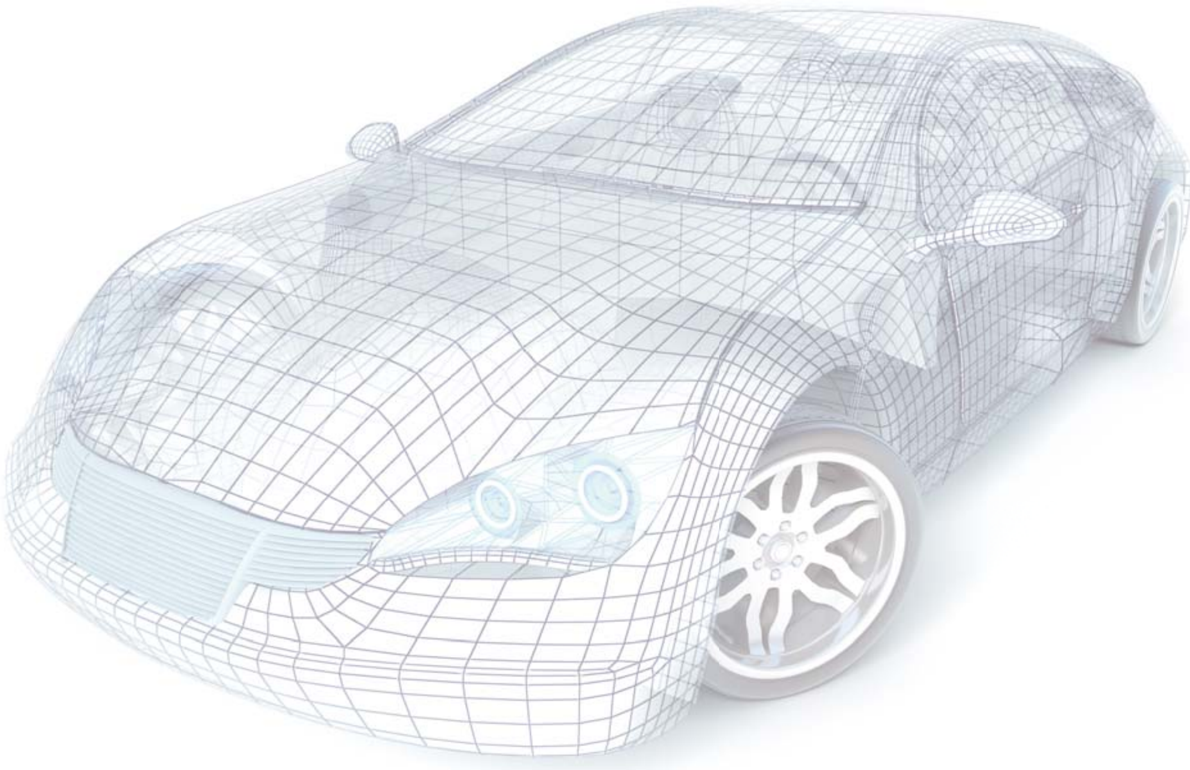
- Model supply and analysis enabled using high accuracy models

| CFD Tool | Thermal Resistance Measurement Equipment |
|---|---|
| FloTHERM | T3Ster |



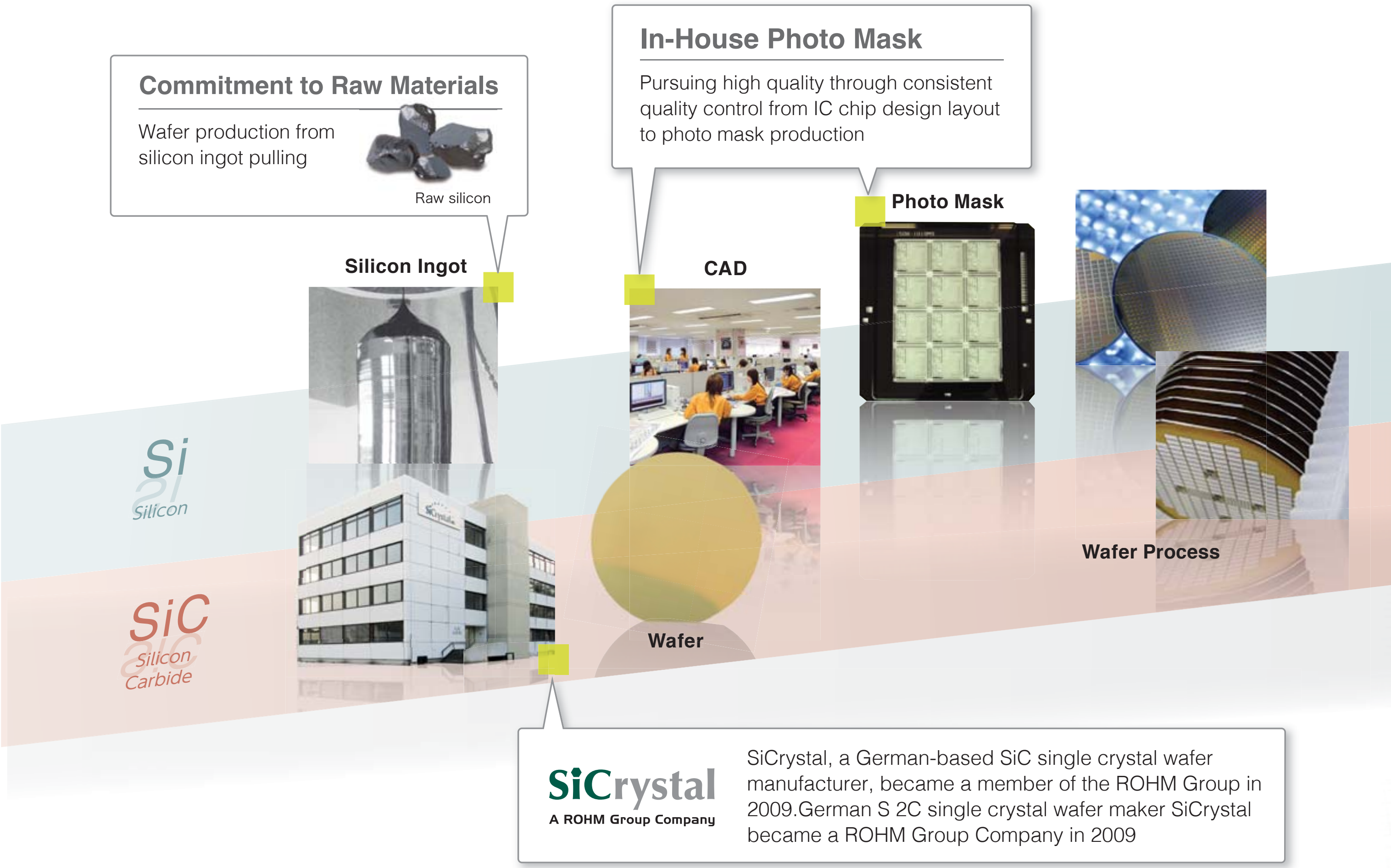
## ROHM Manufacturing

Throughout its history cars have continued to evolve in response to the growing awareness for safety, comfort, and the environment, in step towards continued electrification.
In the course of this progress, autonomous driving and smart cities will soon be realized with the advent of next-generation vehicles.
ROHM contributes to the evolution and advancement of the automotive sector and next-generation cars by taking a quality-first approach to manufacturing and ensuring long-term, stable supply of products.



# Achieving High Quality and Stable Supply Through a Vertically Integrated Production System

ROHM's vertically integrated production system is the result of its commitment to 'Quality First'.
The ROHM Group carries out manufacturing, sales and service - from design and development to wafer fabrication - in-house and continually works on initiatives to improve quality in all processes.




## High Quality

### Achieving high quality in every process

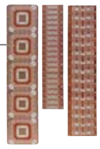
ROHM continually pursues 'Quality First' as a corporate objective. Through our vertically integrated production system the Group implements production, sales, and service - including design, development, and wafer fabrication - and are working on initiatives to improve quality in all processes. At the same time, excellent traceability is achieved through a system that ensures worry-free use of our products by customers.

## Stable Supply

### Utilizing the Group's collective power to fulfill supply responsibilities

The ROHM Group is tasked with supplying products that meet market demands. By managing the manufacturing process in-house using our vertically integrated production system, we are able to create a system that is less susceptible to external factors compared with general fabless and foundry manufacturers. We have established a BCM(Business Continuity Management) system that involves securing appropriate inventory and carrying out multi-site production, and endeavor to ensure a stable supply to customers.

### In-house dies and lead frames



To ensure quality, all dies for lead frame punching, lead frames, and even molds are produced in-house.

### Cutting-edge packages

Broad package lineup(i.e. CSP, BGA, COF, COC, stacked package) supports the latest assembly technologies.

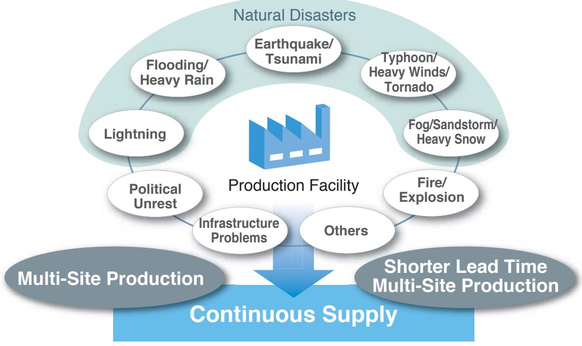

## In-House Production System

All production equipment were developed completely in-house, making it possible to flexibly and precisely meet customer needs.

All production systems developed in-house

## BCM System

ROHM continues to strengthen its BCM system by performing diagnosis based on risk verification at all production sites.



# Approach for Automotive-Grade Products

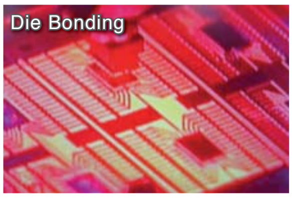
ROHM establishes 'Quality First' as a corporate objective, pursues innovative, high quality manufacturing, and provides greater peace of mind through guaranteed delivery times. ROHM implements a variety of initiatives to ensure high reliability.

## Initiative Example

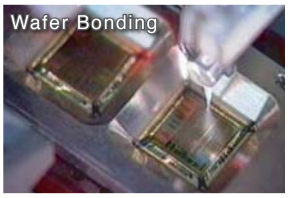
### Real-time quality checks

From silicon ingot pulling and wafer fabrication to testing, final assembly, and shipment, ROHM adopted a screening method to check the workmanship at each process.

**ROHM original real-time quality checks** Real Time Work & Check




Check the workmanship at the same time as performing die bonding

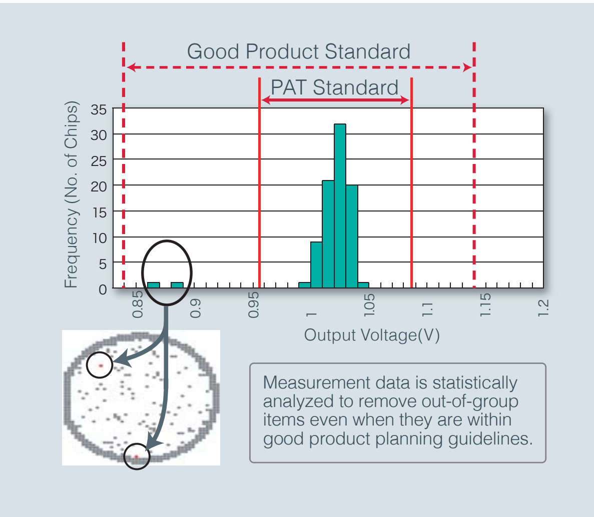



Check the quality at the same time as performing die bonding

### Introducing the PAT System(Conforming to AEC Guidelines)

The PAT system statistically analyzes measurement data and removes out-of-group items even when they are within good product standards. With this method even when a product is determined to be non-defective and within the standard at the time of shipment, if it is out-of-group within the lot distribution it is removed as having the potential of being defective. This allows ROHM to act out of an abundance of caution to prevent the shipment of defective products.

**PAT System** PAT: Part Average Testing (Parts Averaging Test)




### Dedicated automotive product line

Automotive products are manufactured on dedicated lines by certified operators who have passed special tests. Utilizing dedicated Machine and Man results in a higher grade manufacturing environment.

### Line division and 4M differentiation

The basic elements of ROHM's approach to quality 4M···Man Machine Material Method

All automotive-grade products are manufactured on HR(High Reliability) lines separate from general products.


Certified operator


HR line classification for automotive applications


Certification armband

## Initiative Overview(IC Case)

**Model Design**

Robust design with multiple protection circuits/improved damage resistance/easier testability/characteristics limit evaluation

**Model Test Design**

High/normal/low temperature measurement of all chips, HV stress testing, PAT system introduction

**Model Qualification Testing**

Based on JEITA. JEDEC,AEC-Q100/AEC-Q101/AEC-Q200 compliance
- Long-term reliability testing
- Life prediction based on WLR data
- Electrostatic breakdown test

**Wafer Process Management**

SPC management/Real-time monitoring/Defect inspection of all chips

**Assembly Process Management**

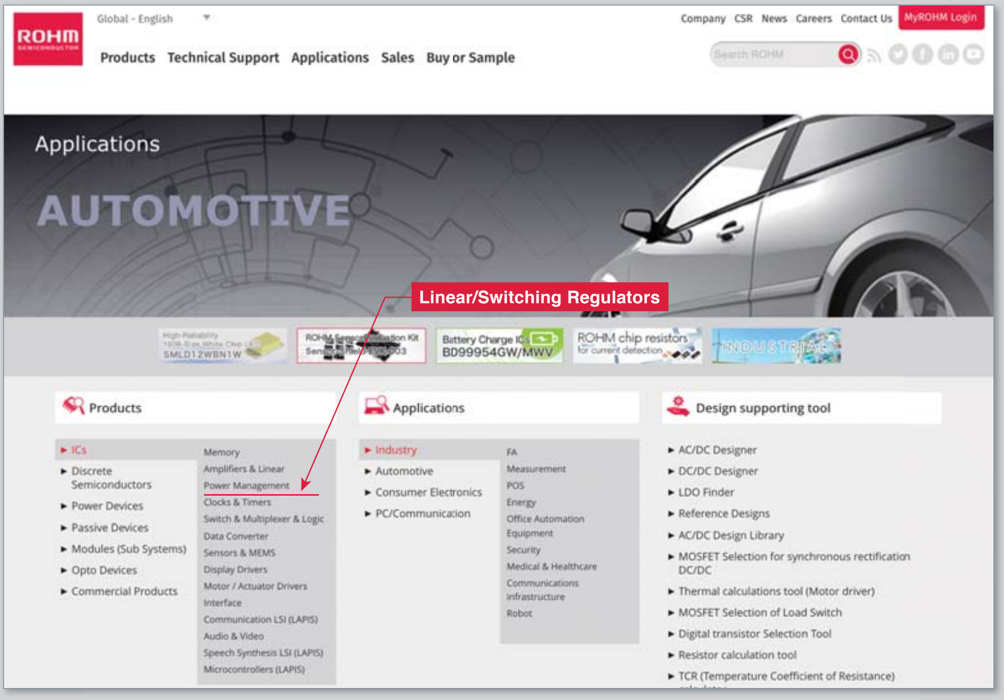
Real-time Work & Check at main processing point (s)/Quality guarantee (i.e. internal X-ray inspection, reflow screening)/4M establishment

**Traceability, keep samples, in-process defect analysis, etc.**

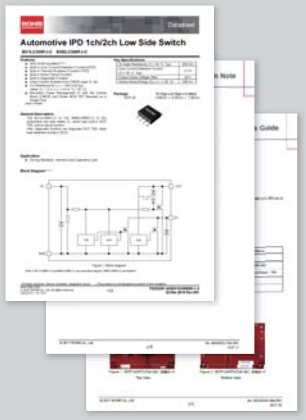
Important Security Applications
All keep samples from all lots are stored for 10 years/In-process defective product analysis(all lots), etc.

# Guide to ROHM's Website https://www.rohm.com

## Please visit ROHM's website for product lineups for each category




Datasheets, application notes, reference designs, Spice models, and other materials are available.




ROHM's website provides technical information useful for designers, focused on basic knowledge on products and seminar information.

Tech Web
https://micro.rohm.com/en/techweb

DEVICE PLUS
https://www.deviceplus.com

Electronics Basics
https://www.rohm.com/electronics-basics

## Home Page Design Support Content List

| Item | Overview | |
|---|---|---|
| Selection Guide (This Catalog) | A guidebook that simplifies IC selection.<br>Product pickups and sample solutions are provided. | |
| Datasheet | Contains the most important information provided to customers on ROHM products.<br>Functional characteristics, conditions, and applicable ranges built into the products are listed, along with the scope of warranty.<br>Also provided is application information, including the required external parts, in order to ensure stable operation and maximize performance. | |
| Application Note Example | Switching Type | Capacitor Calculation for Buck Converter ICs<br>Considerations for Multilayer Ceramic Capacitor Used for Buck Converters<br>Inductor Calculation for Buck Converter ICs<br>Considerations for Power Inductors Used for Buck Converters<br>Quick Reference Table for Setting the Output Voltage of Buck Converter ICs<br>PCB Layout Method for Buck Converters<br>Snubber Circuit for Buck Converter ICs<br>Buck Converter Efficiency<br>Calculating Power Loss(Synchronous Rectification Type) |
| | Linear Type | Reverse Voltage Protection for Linear Regulators<br>Output Voltage Setting Resistance Table for Linear Regulator ICs<br>Linear Regulator Power Supply ON/OFF Characteristics<br>Simple Stability Experiments for Linear Regulators<br>Thermal Resistance Data of Automotive Linear Regulators |
| | General | Phase Margin Measurement Method Using a Frequency Characteristics Analyzer(FRA)<br>Regarding Thermal Resistance<br>About Thermal Resistance and Thermal Characteristics of IC Packages |
| SPICE Models | SPICE models are offered that can be used in PSpice simulations.<br>However, since the files are encrypted for security purposes, they are executable only with PSpice | |
| Basic Information | Package Information | Implementation specifications, resistance to whiskers |
| | Package Information Environmental Data | REACH Substances of Very High Concern(SVHC) non-use certificate, UL94 flame retardant class<br>ELV, RoHS Directive certificates of compliance |
| | Reliability Information | Report on reliability test results |
| | Individual Product Data | List of production facilities |
| | Export-Related Information | Regarding the Export Trade Control Order and US Export Regulations |
| Support Page | Provides new product information, evaluation boards, and videos | |
| Technology Information Site<br>Tech Web | Acquire basic knowledge on power supply ICs<br>Archive site on the latest topics on power supply ICs ideal for engineers - TECH INFO | |

# ROHM Group Locations (Japan)

## • Sales Offices

| | | |
|---|---|---|
| Kyoto | Nagoya | Sendai |
| Tokyo | Matsumoto | Takasaki |
| Yokohama | Nishi-Tokyo | Utsunomiya |

## • Manufacturing Facilities

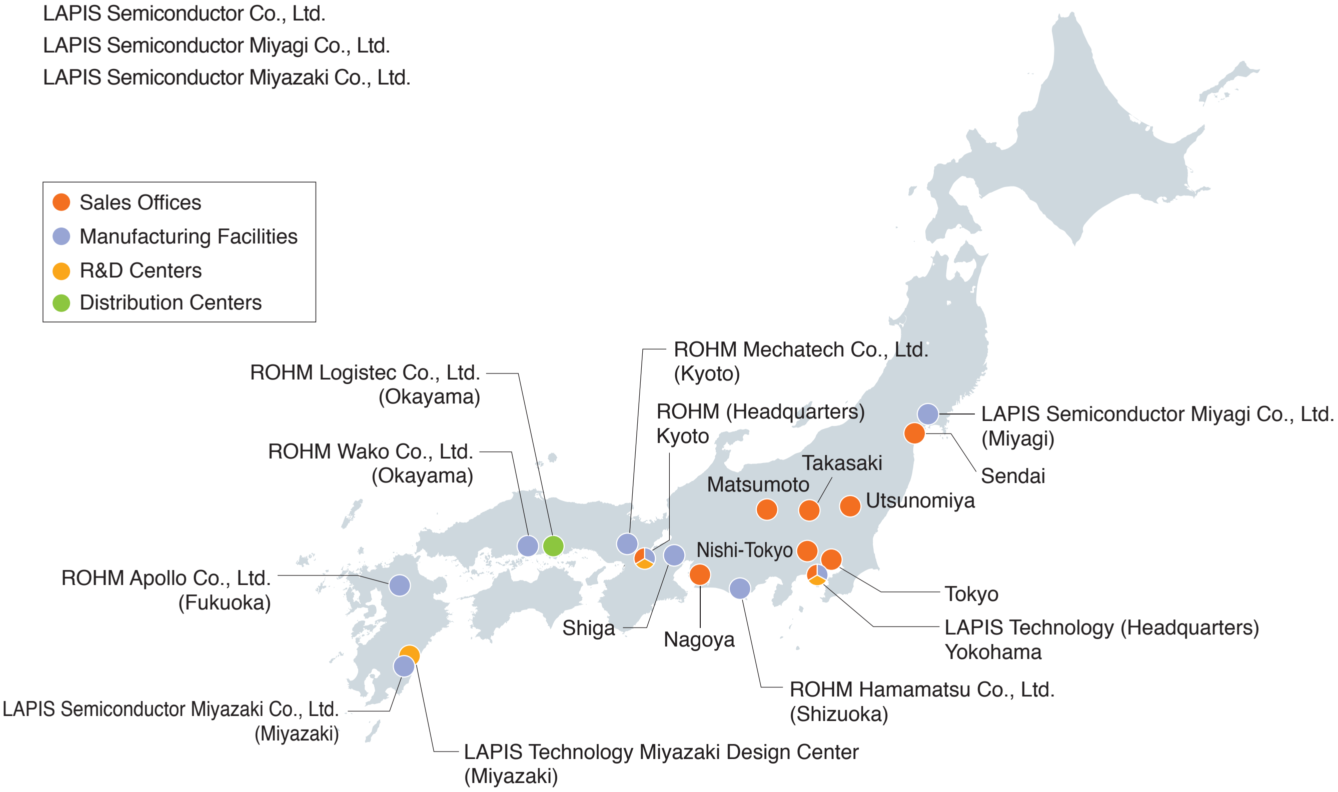
ROHM Co., Ltd.
Shiga Plant
ROHM Hamamatsu Co., Ltd.
ROHM Wako Co., Ltd.
ROHM Apollo Co., Ltd.
ROHM Mechatech Co., Ltd.
LAPIS Semiconductor Co., Ltd.
LAPIS Semiconductor Miyagi Co., Ltd.
LAPIS Semiconductor Miyazaki Co., Ltd.

## • R&D Centers

Kyoto Technology Center (Head Office)
Kyoto Technology Center (Kyoto Ekimae)
Yokohama Technology Center
LAPIS Technology Co., Ltd.(Shin-Yokohama)
LAPIS Technology Miyazaki Design Center

## • Distribution Centers

ROHM Logistec Co., Ltd.




# ROHM Group Locations (Global)

## Sales Offices

| | |
|---|---|
| ASIA | ROHM Semiconductor Korea Corporation |
| | ROHM Semiconductor (Beijing) Co., Ltd. |
| | ROHM Semiconductor (Shanghai) Co., Ltd. |
| | ROHM Semiconductor (Shenzhen) Co., Ltd. |
| | ROHM Semiconductor Hong Kong Co., Ltd. |
| | ROHM Semiconductor Taiwan Co., Ltd. |
| | ROHM Semiconductor Singapore Pte. Ltd. |
| | ROHM Semiconductor Philippines Corporation |
| | ROHM Semiconductor (Thailand) Co., Ltd. |
| | ROHM Semiconductor Malaysia Sdn. Bhd. |
| | ROHM Semiconductor India Pvt. Ltd. |
| AMERICA | ROHM Semiconductor U.S.A., LLC |
| EUROPE | ROHM Semiconductor GmbH |

## R&D Centers

| | |
|---|---|
| ASIA | Korea Technical Center |
| | Beijing Technical Center |
| | Shanghai Technical Center |
| | Shenzhen Technical Center |
| | Taiwan Technical Center |
| | India Technical Center/India Design Center |
| AMERICA | Americas Technical Center (Santa Clara) |
| EUROPE | Europe Technical Center |
| | Finland Software Development Center |

## Manufacturing Facilities

| | |
|---|---|
| ASIA | ROHM Korea Corporation |
| | ROHM Electronics Philippines, Inc. |
| | ROHM Integrated Systems (Thailand) Co., Ltd. |
| | ROHM Semiconductor (China) Co., Ltd. |
| | ROHM Electronics Dalian Co., Ltd. |
| | ROHM-Wako Electronics (Malaysia) Sdn. Bhd. |
| | ROHM Mechatech Philippines, Inc. |
| | ROHM Mechatech (Thailand) Co., Ltd. |
| AMERICA | Kionix, Inc. |
| EUROPE | SiCrystal GmbH |

## QA Centers

| | |
|---|---|
| ASIA | Korea QA Center |
| | Shanghai QA Center |
| | Shenzhen QA Center |
| | Taiwan QA Center |
| | Thailand QA Center |
| AMERICA | Americas QA Center |
| EUROPE | Europe QA Center |

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2) The information contained herein is subject to change without notice. Before you use our Products, please contact our sales representative (as listed below) and verify the latest specifications.
3) Although ROHM is continuously working to improve product reliability and quality, semiconductors can break down and malfunction due to various factors. Therefore, in order to prevent personal injury or fire arising from failure, please take safety measures such as complying with the derating characteristics, implementing redundant and fire prevention designs, and utilizing backups and fail-safe procedures. ROHM shall have no responsibility for any damages arising out of the use of our Products beyond the rating specified by ROHM.
4) Examples of application circuits, circuit constants and any other information contained herein are provided only to illustrate the standard usage and operations of the Products.The peripheral conditions must be taken into account when designing circuits for mass production.
5) The technical information specified herein is intended only to show the typical functions of and examples of application circuits for the Products. ROHM does not grant you, explicitly or implicitly, any license to use or exercise intellectual property or other rights held by ROHM or any other parties. ROHM shall have no responsibility whatsoever for any dispute arising out of the use of such technical information.
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7) The Products specified in this document are not designed to be radiation tolerant.
8) For use of our Products in applications requiring a high degree of reliability (as exemplified below), please contact and consult with a ROHM representative: transportation equipment (i.e. cars, ships, trains), primary communication equipment, traffic lights, fire/crime prevention, safety equipment, medical systems, servers, solar cells, and power transmission systems.
9) Do not use our Products in applications requiring extremely high reliability, such as aerospace equipment, nuclear power control systems, and submarine repeaters.
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Contact us for further information about the products.

| | | | | | | | |
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| **Atlanta** | +1-770-754-5972 | **France** | +33 (0) 1 40 60 87 30 | **Shenzhen** | +86-755-8307-3008 | **Yokohama** | +81-45-476-2121 |
| **Boston** | +1-781-565-1138 | **United Kingdom** | +44-1-908-272400 | **Hong Kong** | +852-2740-6262 | | |
| **Chicago** | +1-847-368-1006 | **Finland** | +358-400-726 124 | **Taiwan** | +886-2-2500-6956 | | |
| **Detroit** | +1-248-348-9920 | **Spain** | +34-9375-24320 | **Singapore** | +65-6436-5100 | | |
| **San Diego** | +1-858-625-3600 | **Hungary** | +36-1-950-5859 | **Philippines** | +63-2-8807-6872 | | |
| **Mexico** | +52-33-3123-2001 | **Italy** | +39-039-5783432 | **Thailand** | +66-2-254-4890 | | |
| **Germany** | +49-2154-921-0 | **Seoul** | +82-2-8182-700 | **Malaysia** | +60-3-7931-8155 | | |
| **Stuttgart** | +49-711-7272370 | **Beijing** | +86-10-8525-2483 | **India** | +91-80-4125-0811 | | |

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