Automotive Regulator Selection Guide

Ver.3.0

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.

Automotive Regulator Selection Guide

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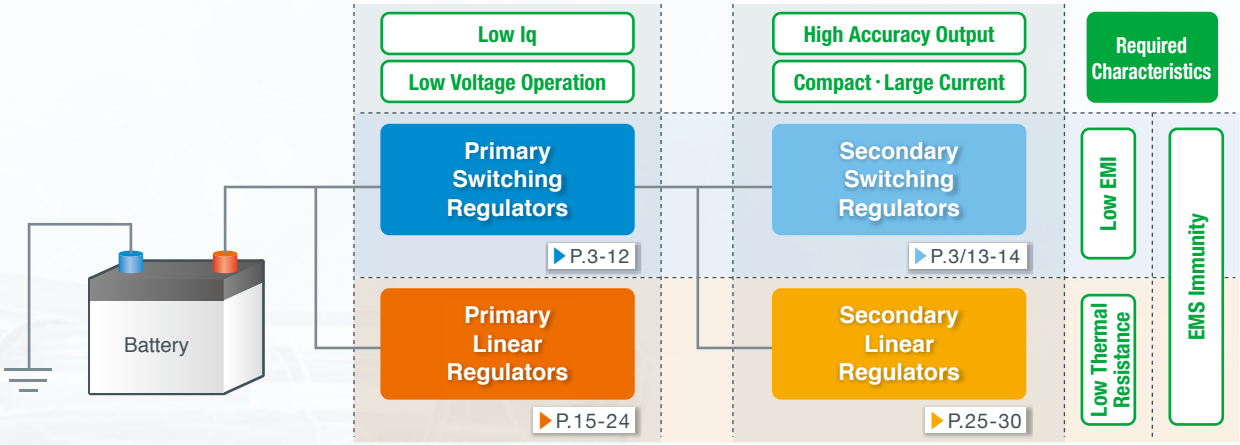
Types and Features of Automotive Power Supply ICs



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

Technologies that Maximize the Performance of Switching Regulators

Effective noise countermeasures — Noise Characteristics and Immunity P.33/35

Effective heat dissipation countermeasures — Heat Resistance and Thermal Characteristics P.34-35

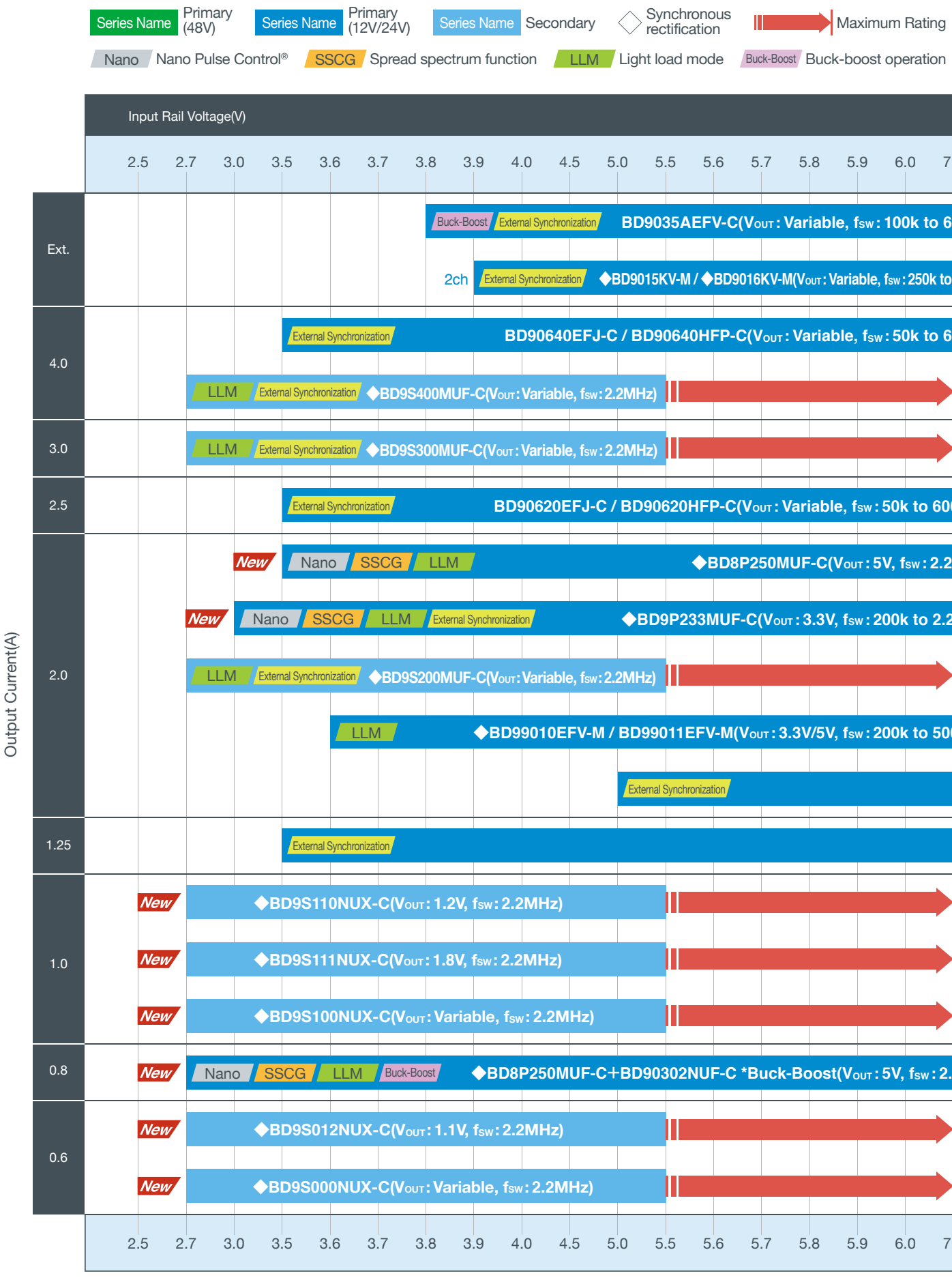
Technologies Required for Power Supply ICs

Low Iq — P.6/7/9/19/20

Low Voltage Operation — P.6/8/9

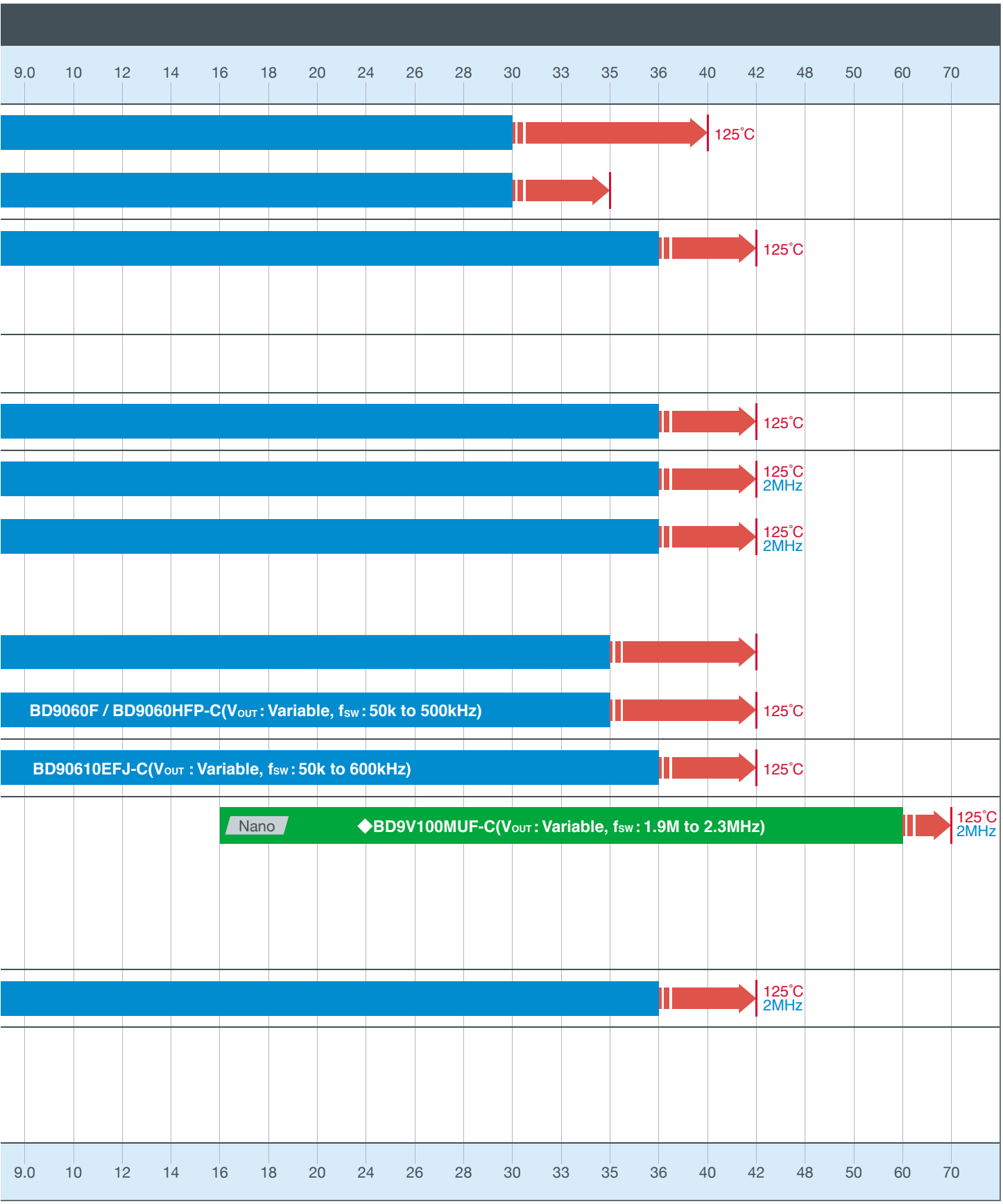
Compact・Large Current — P.13/28

Automotive Switching Regulator Lineup AEC-Q100 qualified



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

External Synchronization External synchronization function



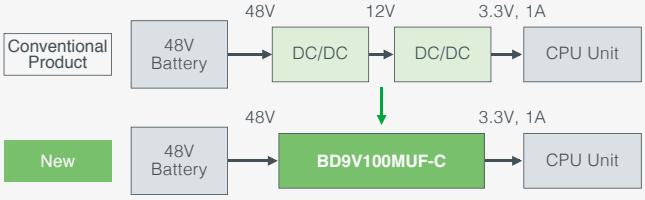
Primary Switching Regulator

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.



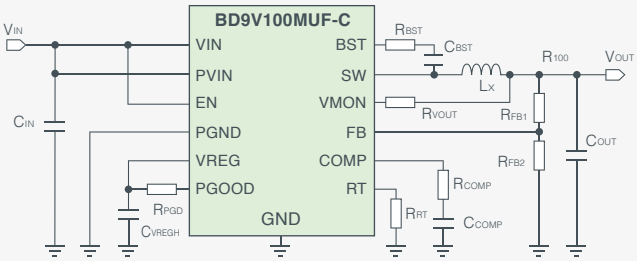
Overview : BD9V100MUF-C

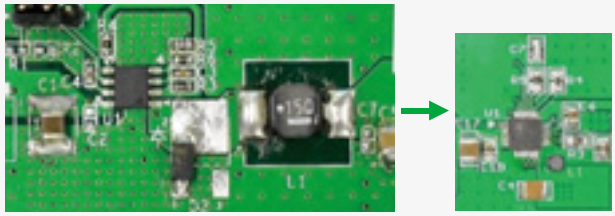
- High step-down ratio enables direct conversion from high voltage to low voltage
- Min. switching ON time : 9ns(Typ.), 20ns Max.
- Input voltage : 16V to 60V(70V rated)
- Output voltage : 0.8V to 5.5V
- Reference voltage : 0.8V±2.0%
- Output current : 1.0A
- High-speed transient characteristics through 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)

VQFN24FV4040

Wettable Flank

BD9V100MUF-C Application Circuit Diagram





Existing PCB
47mm×25mm=1,175mm²

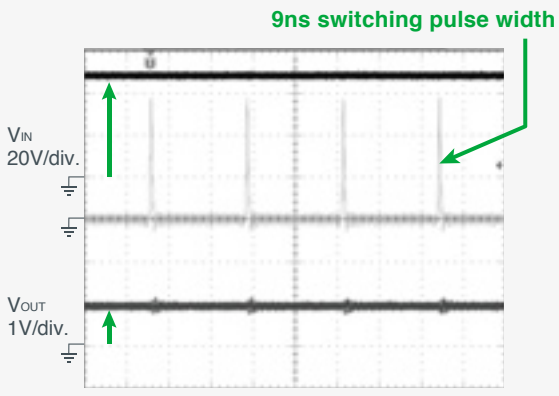
BD9V100MUF-C PCB
18mm×20mm=360mm²

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).

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	16	16	60	Variable (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

New Products

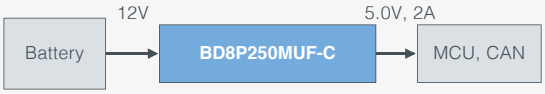
Primary Switching Regulator

BD8P250MUF-C

Low Iq | Low Voltage Operation

Low Quiescent Current 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, LLM(Light Load Mode) ensures high efficiency equivalent to heavy loads during light loads(8μA).



Overview : BD8P250MUF-C

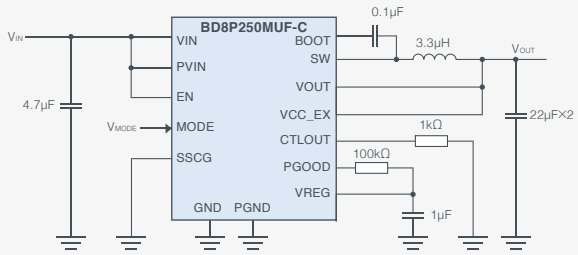
Achieves high efficiency at light loads

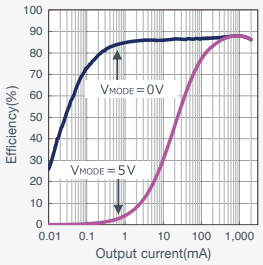
- No-load quiescent current : 8μA(Typ.)
- Input voltage : 3.5V to 36V(42V rated)
  (Requires 4.8V or more during startup if a dedicated boost FET is not used)
- Output voltage : 5.0V±2%
- Output current during buck operation: 2.0A(Max.)
- Switching frequency : 2.2MHz(Typ.)
- Shutdown circuit current : 3.5μA(Typ.)
- Nano Pulse Control®
- LLM(Light Load Mode)
- Spread spectrum function
- Power Good function
- Soft Start
- Current mode control
- Built-in phase compensation
- Multiple protection functions(overcurrent protection, under voltage lock out, thermal shutdown, output overvoltage protection, short-circuit protection)

VQFN24FV4040

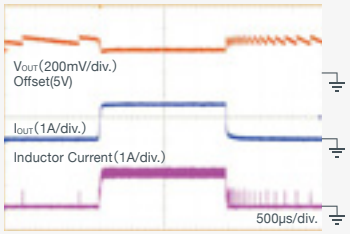
Wettable Flank

BD8P250MUF-C Application Circuit Diagram





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



BD8P250MUF-C
Load transient response
(V_{IN}=12V, V_{MODE}=0V, I_{OUT} = 0A to 1.5A)

- High efficiency at light loads (72%@100μA load current)
- Minimizes output voltage variations even with load transient from no-load conditions

New Products

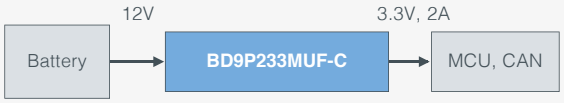
Primary Switching Regulator

BD9P233MUF-C

Low Iq | Low Voltage Operation

Low Quiescent Current and Low Voltage Solutions

The BD9P233MUF-C is a low Iq buck DC/DC converter featuring 3.3V output. This synchronous rectification buck DC/DC converter utilizes Light Load Mode(LLM) to ensure low power consumption and high efficiency at both light and heavy loads. A Pch FET adopted at the high side makes it possible to achieve a 100% ON duty cycle and low drop out operation even during battery cranking. In addition, the switching frequency is adjustable over a wide range via external resistor, allowing for flexible designs.



Overview : BD9P233MUF-C

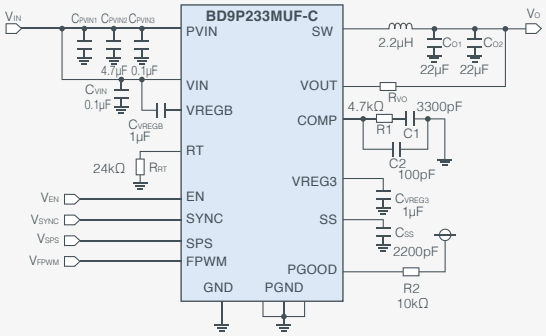
Supports 100% ON duty cycle!

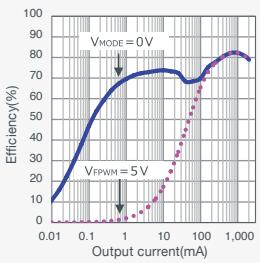
- No-load quiescent current : 26μA(Typ.)
- Input voltage : 3.0V to 36V(42V rated)
  (3.6V or more required during initial startup)
- Output voltage : 3.3V±2%
- Output current : 2.0A(Max.)
- Switching frequency : 200kHz to 2.4MHz(Adjustable)
- Shutdown circuit current : 10μA(Typ.)
- Nano Pulse Control®
- Low drop-out operation : 100% ON Duty Cycle
- LLM(Light Load Mode)
- Spread Spectrum function
- Adjustable switching frequency
- External synchronization
- Power Good function
- Soft Start
- Current mode control
- Multiple protection functions(overcurrent protection, under voltage lock out, thermal shutdown, output overvoltage protection, short-circuit protection)

VQFN32FAV050

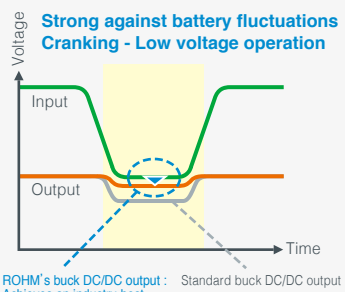
Wettable Flank

BD9P233MUF-C Application Circuit Diagram





BD9P233MUF-C
Efficiency vs Load Current
V_{IN}=12V , V_{OUT}=3.3V(Log scale)



- Small output voltage drop at Pch FET 100% duty
- High efficiency at light loads

Primary Switching Regulators

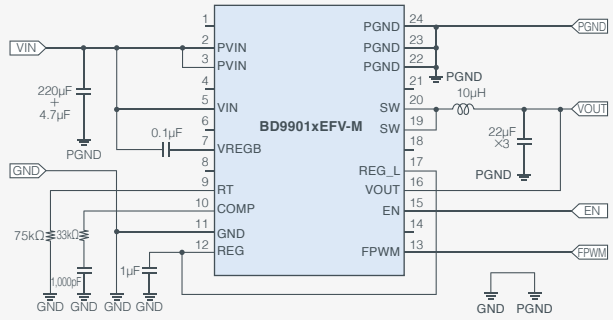
BD9901xEFV-M series

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

Achieves low Iq

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

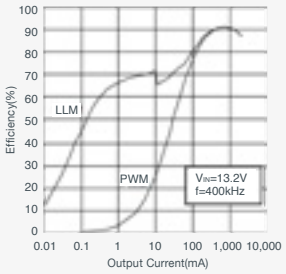
Achieves high efficiency

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

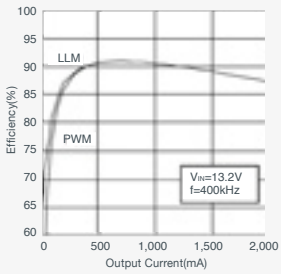
HTSSOP-B24

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)

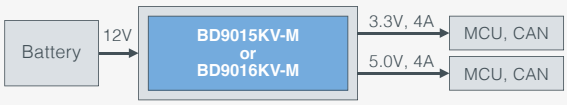
Primary Switching Controller

BD9015KV-M/BD9016KV-M

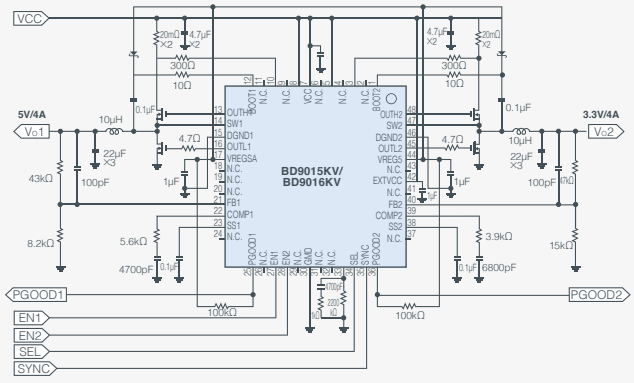
Large Current

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

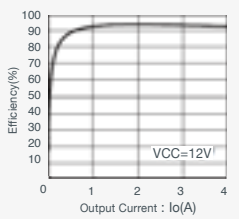


Overview : BD9015KV-M/BD9016KV-M

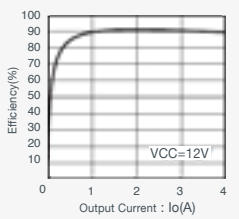
Supports 2ch Large Current Applications

- 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℃ to +105℃) 0.8V±1%(Ta : 25℃)
- 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)

VQFP48C



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

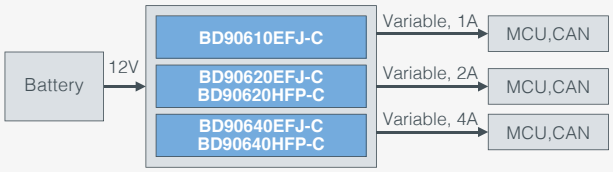
Primary Switching Regulators

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℃ to +125℃), 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

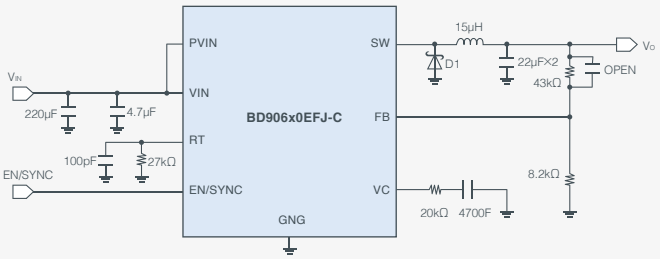
Wide input voltage range

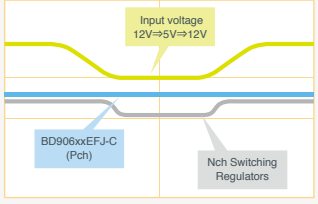
- Input voltage : 3.5V to 36V(42V rated)
  (However, initial startup 3.9V or more)
- Built-in Pch FET : achieves 100% ON duty
- Shutdown circuit current: 0μA(Typ.)
- Reference voltage : 0.8V±2%(Ta : −40℃ to +125℃)
  0.8V±1%(Ta : 25℃)
- Switch output current :
  1.25A Max.(BD90610EFJ-C)
  2.5A Max.(BD90620EFJ-C/BD90620HFP-C)
  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)

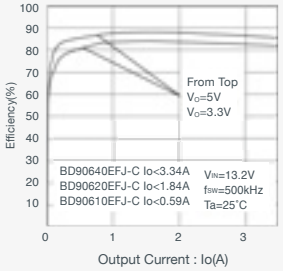
BD906x0EFJ-C/BD906x0HFP-C series Application Circuit Diagram





Output voltage drop is small, even when the output voltage ≒ input voltage

BD906x0EFJ-C
Output voltage waveforms
during input voltage fluctuations



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

Flexible Design

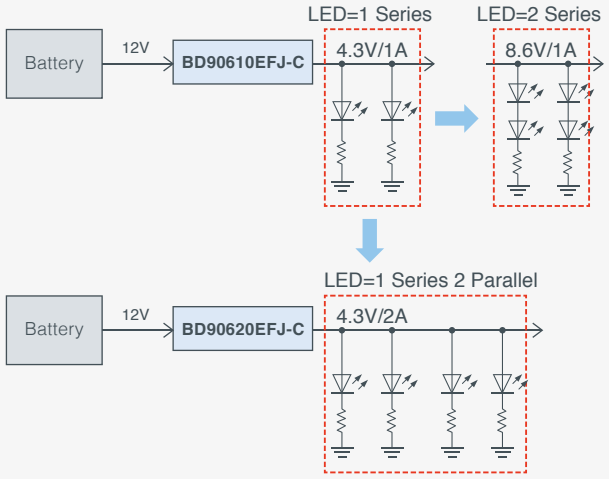
Flexible voltage/phase compensation design

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.

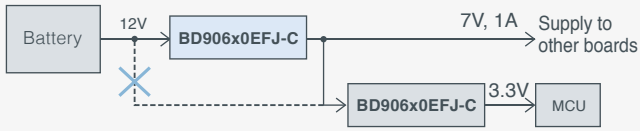
〈LED Power Supply Example〉



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-C 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.

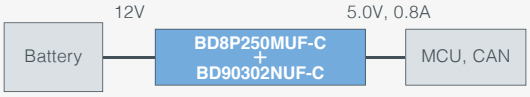
New Products Buck-Boost Primary Switching Regulators

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.



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

Overview : BD90302NUF-C

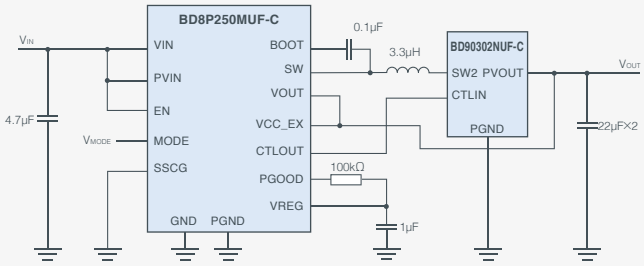
Achieves high efficiency at light loads

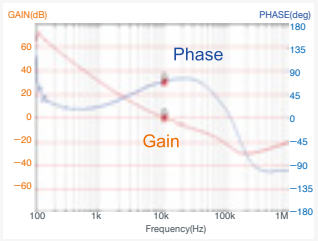
- Built-In Pch/Nch Power MOSFET(with driver)
- Pch/Nch power MOSFET control via the CTLIN pin
- PVOUT pin voltage : 3.0V to 5.5V
- SW 2pin current : 2A(Max.)
- Pch power MOSFET ON-resistance : 55mΩ(Typ.)
- Nch Power MOSFET ON-resistance : 65mΩ(Typ.)
- Shutdown circuit current: 0μA(Typ.)

VSON10FV3030

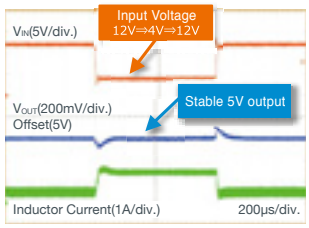
Wettable Flank

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)

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

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).

Overview : BD9035AEFV-C

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

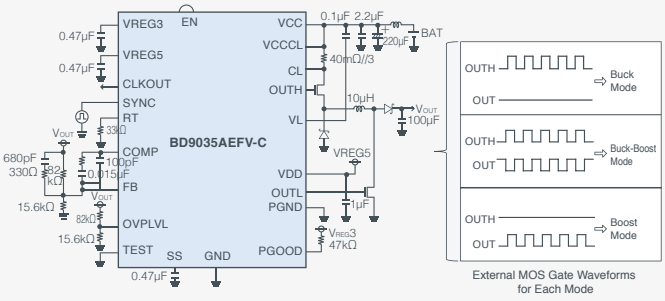
- Buck-boost 3-mode automatic switching control method

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

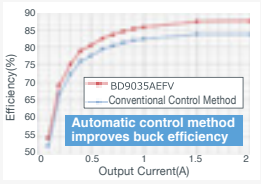
- Switching frequency accuracy : ±7%
- Wide external synchronization frequency range via PLL : 100kHz to 600kHz
- Input voltage : 3.8V to 30V(40V rated)
- Oscillation frequency : 100kHz to 600kHz
- Two-stage overcurrent protection circuit achieved with one resistor
- Built-in output under voltage/over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

HTSSOP-B24

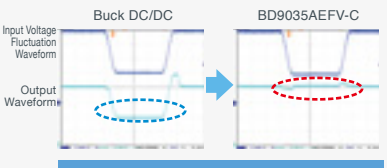
BD9035AEFV-C Application Circuit Diagram



External MOS Gate Waveforms for Each Mode



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



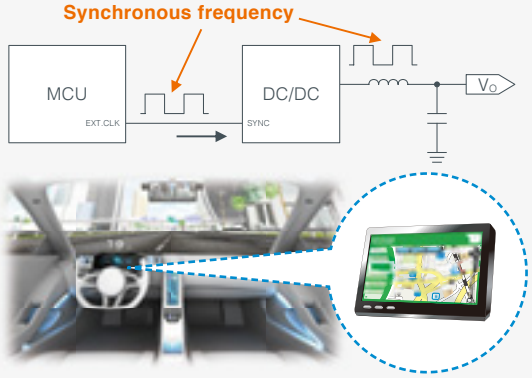
Buck DC/DC operation maintains the output voltage even when the input voltage < output voltage

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

Pickup Technologies that Maximize the Features of Switching Regulators

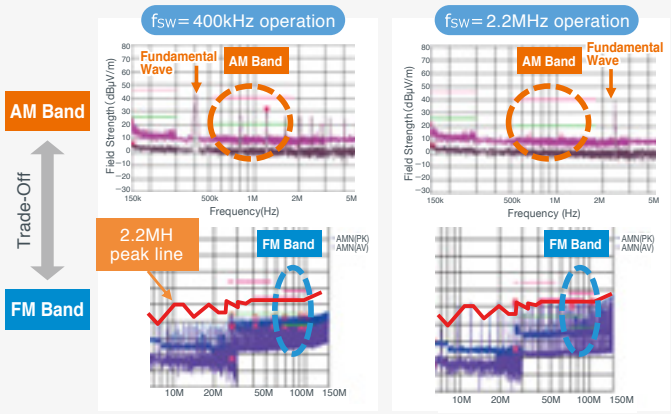
External Synchronization Function

- 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



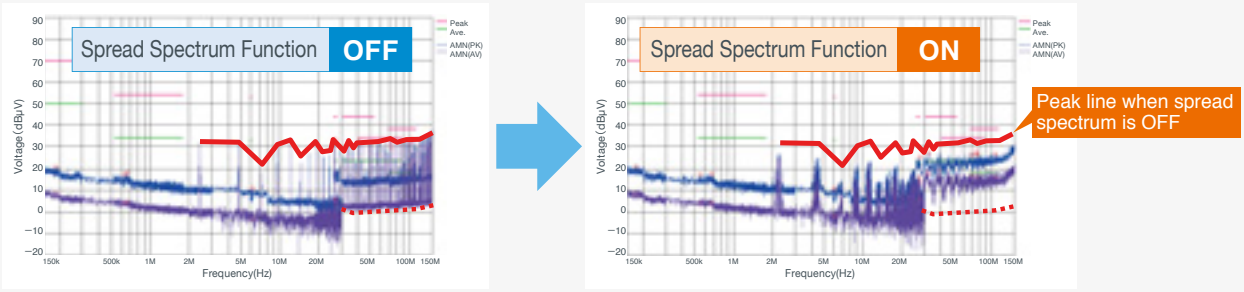
Increasing Switching Frequency

- 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



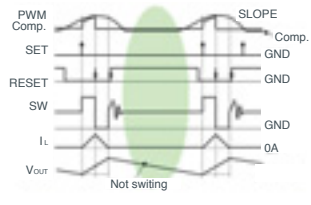
Spread Spectrum

- 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

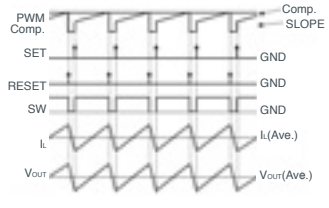


LLM(Light Load Mode) Control

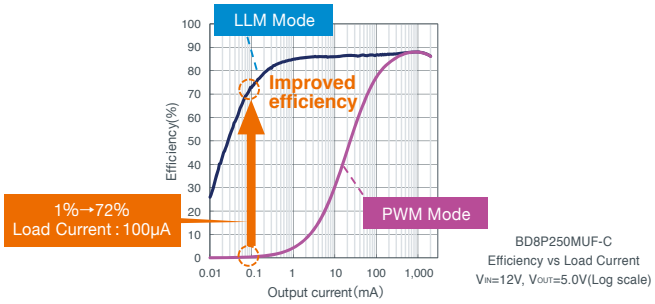
In LLM, PWM control is performed by comparing the output voltage with the internal reference voltage. When the output voltage is lower than the internal reference voltage a number of switching pulses are output in order to raise the output voltage, then when the output voltage becomes higher than the 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.

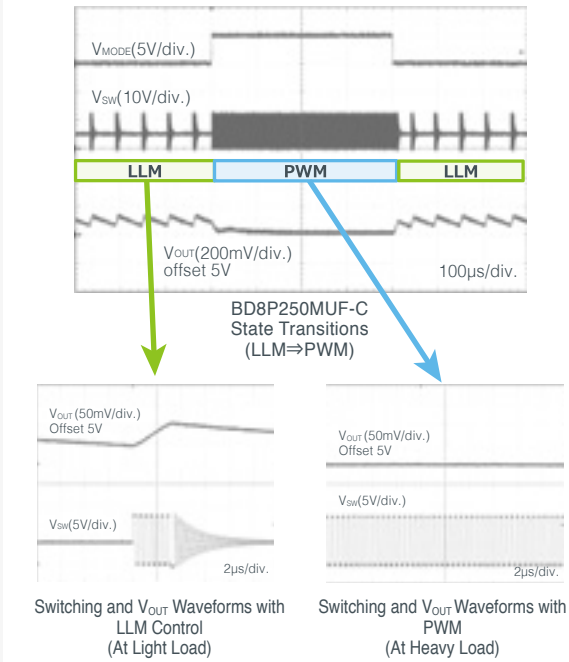


LLM Switching Timing Chart



PWM Switching Timing Chart





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		Rated Voltage (V)	Output Current (A) (Max.)	Input Voltage (V)			Output Voltage (V) (Typ.)	Reference (Output) Voltage Accuracy (%)	Switching Frequency	
		High Side (Typ.)	Low Side (Typ.)			At Startup	Min.	Max.			Frequency Range (kHz)	Precision (%)
New BD9V100MUF-C	1	Nch(600mΩ)	Nch(400mΩ)	70	1.0	16	16	60	Variable(0.8 to 5.5)	±2.0	1,900 to 2,300	±10
New BD8P250MUF-C	1	Nch(110mΩ)	Nch(110mΩ)	42	2.0	4.8	3.5	36	5.0	±2.0	2,200	±10
New 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	Variable(0.8 to 10)	±1.5	250 to 550	±10
BD9016KV-M	2	Ext. Nch	Ext. Nch	35	—	4.5	3.9	30	Variable(0.8 to 10)	±1.5	250 to 550	±10
BD90610EFJ-C	1	Pch(160mΩ)	—	42	1.25	3.9	3.5	36	Variable(0.8 to V_{IN})	±2.0	50 to 600	±10
BD90620EFJ-C	1	Pch(160mΩ)	—	42	2.5	3.9	3.5	36	Variable(0.8 to V_{IN})	±2.0	50 to 600	±10
BD90620HFP-C	1	Pch(160mΩ)	—	42	2.5	3.9	3.5	36	Variable(0.8 to V_{IN})	±2.0	50 to 600	±10
BD90640EFJ-C	1	Pch(160mΩ)	—	42	4.0	3.9	3.5	36	Variable(0.8 to V_{IN})	±2.0	50 to 600	±10
BD90640HFP-C	1	Pch(160mΩ)	—	42	4.0	3.9	3.5	36	Variable(0.8 to V_{IN})	±2.0	50 to 600	±10
BD9060F-C	1	Pch(300mΩ)	—	42	2.0	5.0	5.0	35	Variable(0.8 to V_{IN})	±2.0	50 to 550	±5
BD9060HFP-C	1	Pch(300mΩ)	—	42	2.0	5.0	5.0	35	Variable(0.8 to V_{IN})	±2.0	50 to 550	±5

Buck-Boost Solutions

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.)	Low Side (Typ.)			At Startup	Min.	Max.			Frequency Range (kHz)	Precision (%)
New BD8P250MUF-C	1	Nch(110mΩ)	Nch(110mΩ)	42	0.8	7.5	2.7	36	5.0	±2.0	2,200	±10
+												
New BD90302NUF-C		Pch(55mΩ)	Nch(65mΩ)	7								
BD9035AEFV-C	1	Ext. Pch	Ext. Nch	40	—	4.5	3.8	30	Variable	±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	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
Voltage	4.5	—	✓	—	—	—	✓	✓	—	—	−40 to +125	SOP8
Voltage	4.5	—	✓	—	—	—	✓	✓	—	—	−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

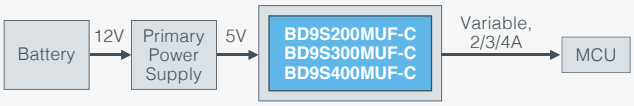
Secondary Switching Regulators

BD9Sx00MUF-C series

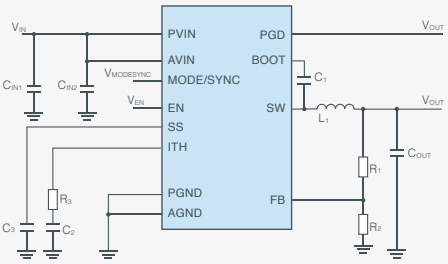
Compact・Large Current

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.

Overview : BD9Sx00MUF-C series

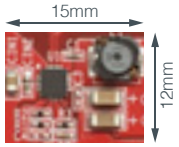
Achieves high efficiency

- Adopts the synchronous rectification method

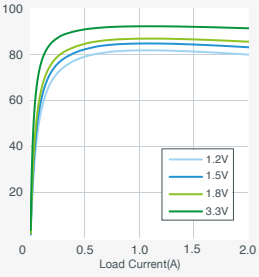
Facilitates noise countermeasures

- 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

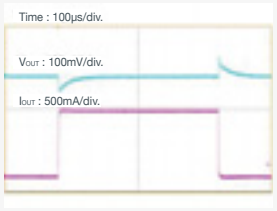
VQFN16FV3030
3.0mm×3.0mm
Wettable Flank



BD9S200MUF-C PCB



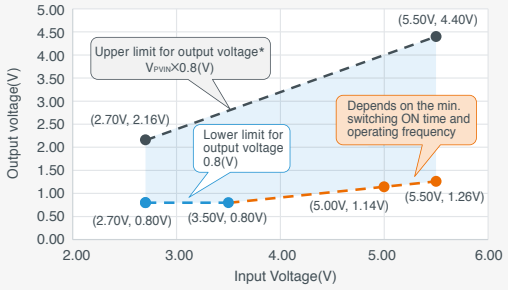
BD9S200MUF-C Efficiency vs Load Current (V_{IN}=5V)



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

■Output Settable Voltage Range

BD9S200MUF-C/BD9S300MUF-C/BD9S400MUF-C



*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 (kHz)	Precision (%)
BD9S400MUF-C	1	Nch(35mΩ)	Nch(35mΩ)	7	4.0	2.7	5.5	Variable(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	Variable(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	Variable(0.8 to V_{IN}×0.8)	±1.5	2.2	±10
New **BD9S100NUX-C**	1	Pch(270mΩ)	Nch(180mΩ)	7	1.0	2.7	5.5	Variable(0.8 to V_{IN})	±1.5	2.2	±10
New **BD9S000NUX-C**	1	Pch(270mΩ)	Nch(180mΩ)	7	0.6	2.7	5.5	Variable(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 Products

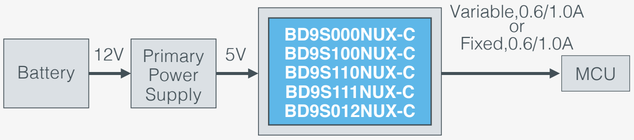
Secondary Switching Regulators

BD9SxxxNUX-C series

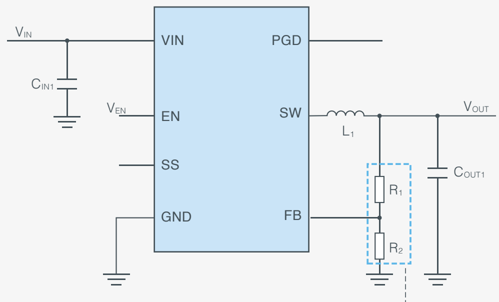
Compact

Space-Saving High Efficiency Solutions

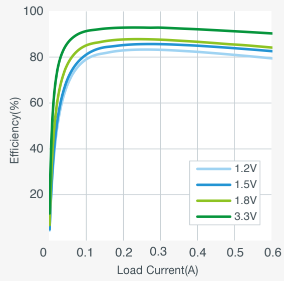
The BD9SxxxNUX-C series are synchronous rectification buck DC/DC converters integrates a low ON resistance power MOSFET. These are offered in a compact 2.0×2.0mm package. The high 2.2MHz switching frequency (self-oscillation) supports smaller inductors.
In addition, the built-in phase compensation circuit 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 utilizes 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.



BD9SxxxNUX-C series Application Circuit Diagram



BD9Sx1xNUX-C series has a built-in IC.



BD9S000NUX-C Efficiency vs Load Current (VIN=5V)

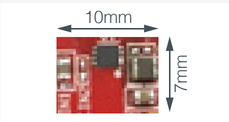
BD9Sx1xNUX-C Load Response (V_{IN}=5V, V_{OUT}=1.2V, I_{OUT}=0A⇔0.6A)

Overview : BD9Sx00NUX-C(Variable Output type) BD9Sx1xNUX-C(Fixed 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)
- Output Discharge function
- Current mode control
- Multiple protection circuits : OCP, SCP, Under Voltage Lock Out(UVLO), V_{OUT}overvoltage, Thermal Protection

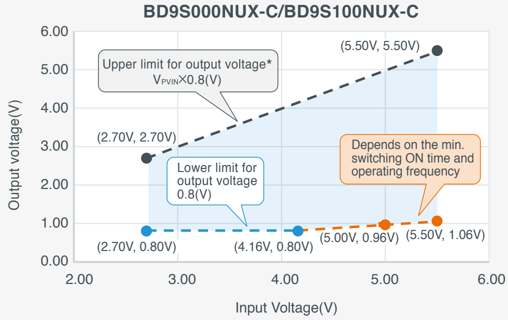
VSON008X2020
2.0mm×2.0mm



BD9S000NUX-C PCB

Output Settable Voltage Range

BD9S000NUX-C/BD9S100NUX-C

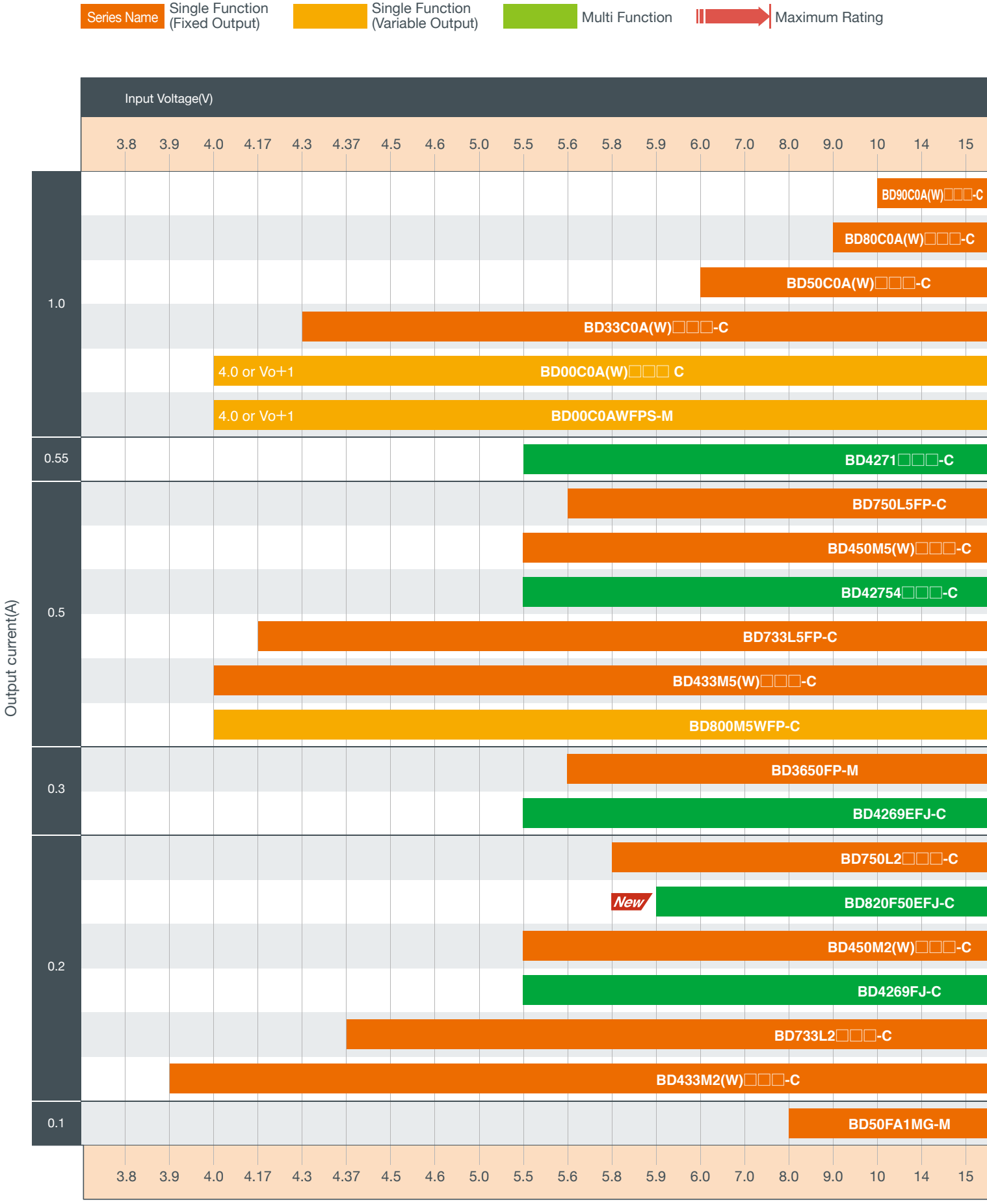


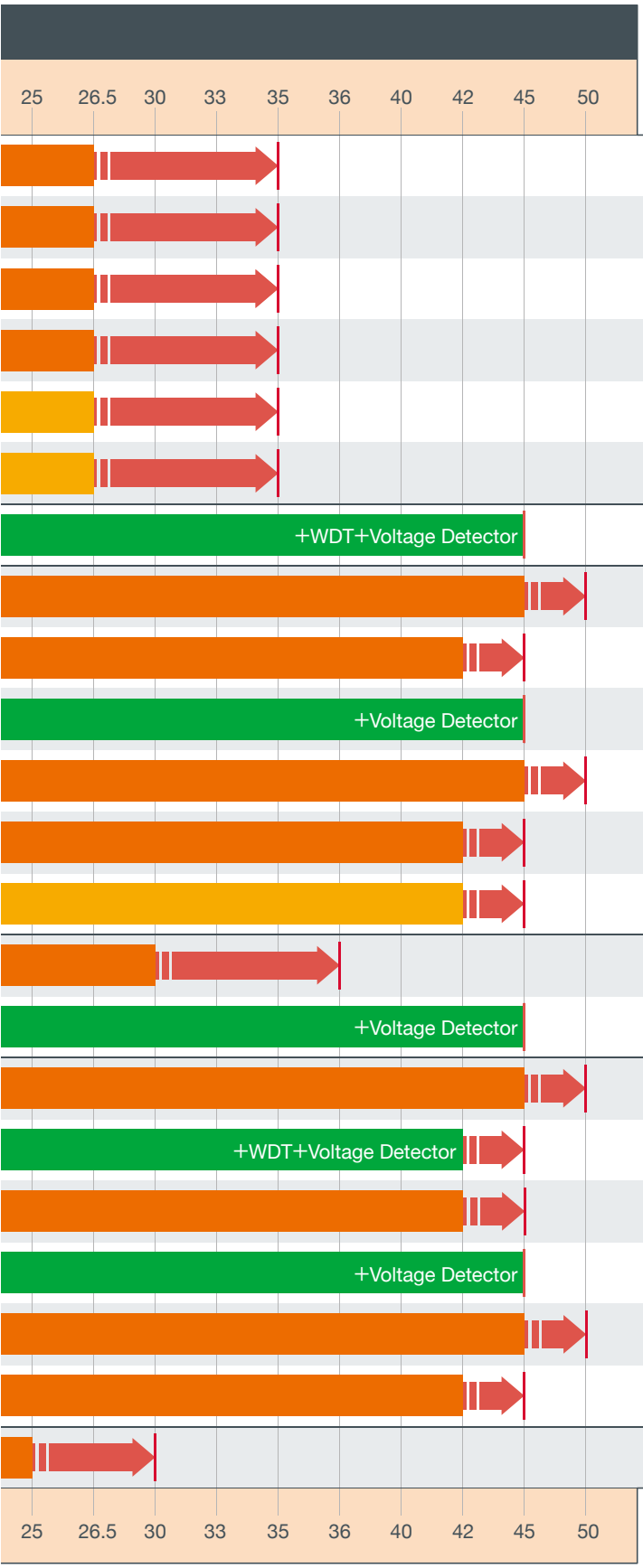
*Set the input/output voltage taking into account voltage fluctuations during load response

AEC-Q100 qualified

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

Automotive Primary Linear Regulator Lineup AEC-Q100 qualified

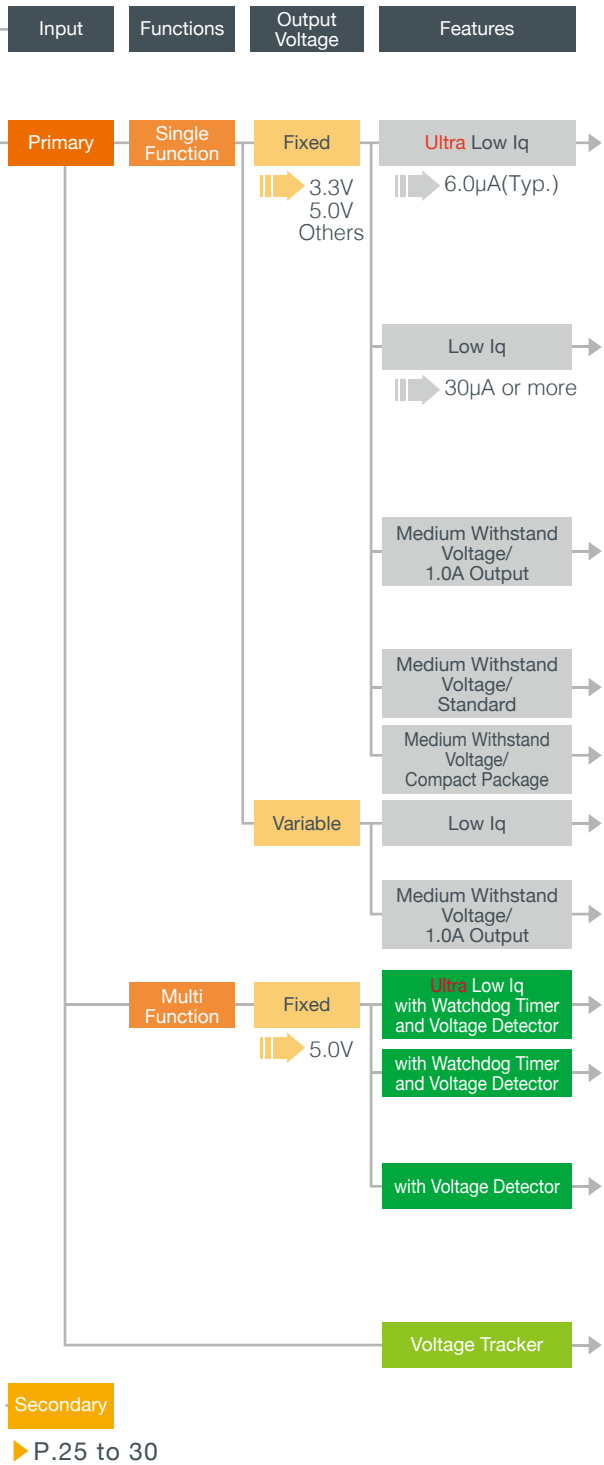




Output voltage (V)	Circuit Current (μA)	Shutdown Switch	Support 125°C	Package						
				SSOP5	SOP8	SOT223	HTSOP-J8	TO252	HRP5/7	TO263
9.0	500	✓	✓	—	—	—	—	✓	✓	✓
8.0	500	✓	✓	—	—	—	—	✓	✓	✓
5.0	500	✓	✓	—	—	—	—	✓	✓	✓
3.3	500	✓	✓	—	—	—	—	✓	✓	✓
Variable	500	✓	✓	—	—	—	—	✓	✓	✓
Variable	500	✓	—	—	—	—	—	✓	—	—
5.0	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	—	—	✓	—	—	—	—	—	—

*Please set the minimum value of the input/output voltage taking into account the input/output voltage difference based on load current.
*Series with a(W) in the part number indicate products with/without a shutdown switch.
*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



Output Voltage (V)	Output Current (A)	Maximum Rating (V)	Series Name	Package							Support 125°C
				SSOP5	SOP8	SOT223	HTSOP-J8	TO252	HRP5/7	TO263	
3.3	0.2	50	BD733L2□□□-C	—	—	✓	✓	✓	—	—	✓
	0.5		BD733L5□□□-C	—	—	—	—	✓	—	—	✓
5.0	0.2		BD750L2□□□-C	—	—	✓	✓	✓	—	—	✓
	0.5		BD750L5□□□-C	—	—	—	—	✓	—	—	✓
3.3	0.2	45	BD433M2(W) □□□-C	—	—	✓	✓	✓	✓	✓	✓
	0.5		BD433M5(W) □□□-C	—	—	—	—	✓	✓	✓	✓
5.0	0.2		BD450M2(W) □□□-C	—	—	✓	✓	✓	✓	✓	✓
	0.5		BD450M5(W) □□□-C	—	—	—	—	✓	✓	✓	✓
3.3	1.0	35	BD33C0A(W) □□□-C	—	—	—	—	✓	✓	✓	✓
5.0			BD50C0A(W) □□□-C	—	—	—	—	✓	✓	✓	✓
8.0			BD80C0A(W) □□□-C	—	—	—	—	✓	✓	✓	✓
9.0			BD90C0A(W) □□□-C	—	—	—	—	✓	✓	✓	✓
5.0	0.3	36	BD3650FP-M	—	—	—	—	✓	—	—	✓
5.0	0.1	30	BD50FA1MG-M	✓	—	—	—	—	—	—	—
Variable	0.5	45	BD800M5WFP-C	—	—	—	—	✓	—	—	✓
Variable	1.0	35	BD00C0AW□□□-C	—	—	—	—	✓	✓	✓	✓
			BD00C0AWFPS-M	—	—	—	—	✓	—	—	—
5.0	0.2	45	New BD820F50EFJ-C	—	—	—	✓	—	—	—	✓
5.0	0.55	45	BD4271□□□-C	—	—	—	—	—	✓	✓	✓
5.0	0.2	45	BD4269FJ-C	—	✓	—	—	—	—	—	✓
	0.3		BD4269EFJ-C	—	—	—	✓	—	—	—	✓
	0.5		BD42754□□□-C	—	—	—	—	✓	—	✓	✓
—	0.05	45	BD42500G-C	✓	—	—	—	—	—	—	✓
	0.07		BD42540FJ-C	—	✓	—	—	—	—	—	✓
	0.25		BD42530□□□-C	—	—	—	✓	✓	—	✓	✓

▶P.25 to 30

■ ROHM Primary Linear Regulator Features

Low Iq
▶P.19 to 20

Compatible Lineup
▶P17

Thermal Design Support
▶P.24

Package	External Appearance	Package Name	Product Code	Size (mm)	Θja
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

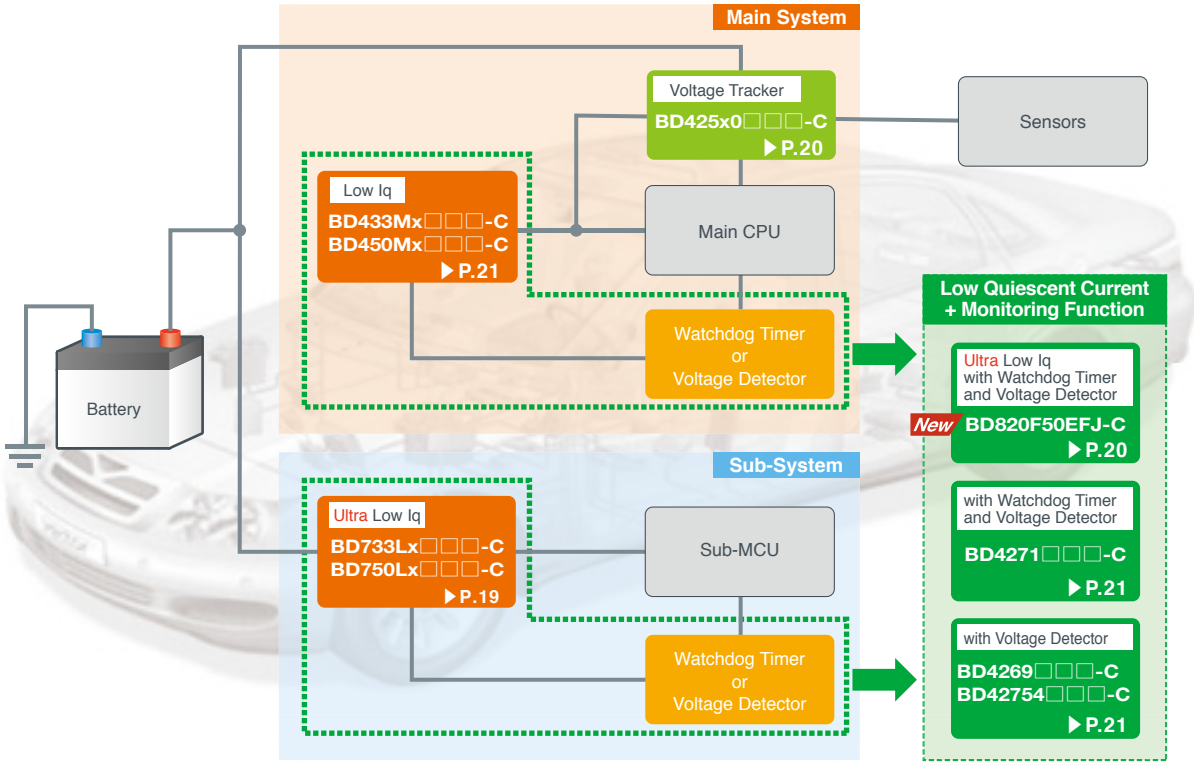
*with some exceptions

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

*Θja 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



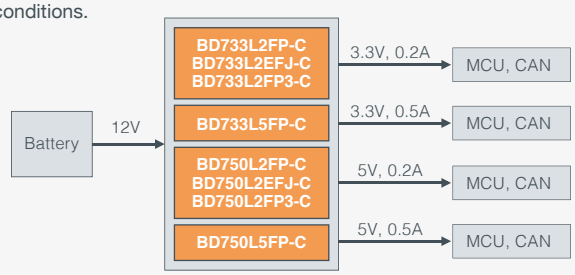
Primary Linear Regulators

BD7xxLx□□□-C series

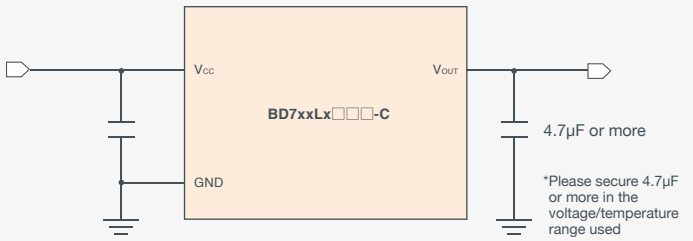
Ultra Low Iq

Space-Saving High Efficiency Solutions

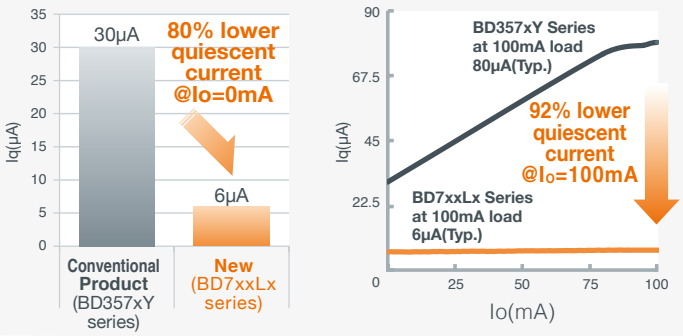
The BD7xxxLx□□□-C series of low Iq(6μA Typ.) regulators features 50V withstand voltage, an output voltage accuracy of ±2%, and 200/500mA output current, making them ideal for battery-driven systems requiring lower current consumption. In addition, a ceramic capacitor can be used as the output phase compensation 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

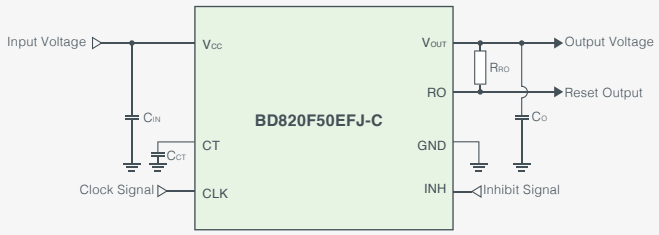
The BD820F50EFJ-C is a high voltage 45V regulator that integrates a watchdog timer(WDT) and reset(RESET) for monitoring the output. An output current capacity of just 200mA along with minimal quiescent current contribute to reducing system current consumption. In addition, when the regulator output falls 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.

Overview : BD820F50EFJ-C

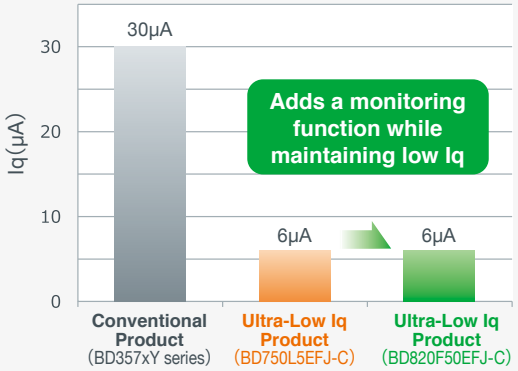
- Ultra-low Iq : **6μA(Typ.)**
- Output transistor : Pch DMOS(low saturation type)
- Vcc Max. : 45V ● Output current : 200mA(Max.)
- Output voltage : 5.0V±2%
- Low saturation voltage PMOS output transistor
- Built-in output low voltage detection reset circuit
- Reset delay and WDT monitoring times adjustable 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

BD820F50EFJ-C Application Circuit Diagram



Ultra-Low Quiescent Current + Monitoring Function



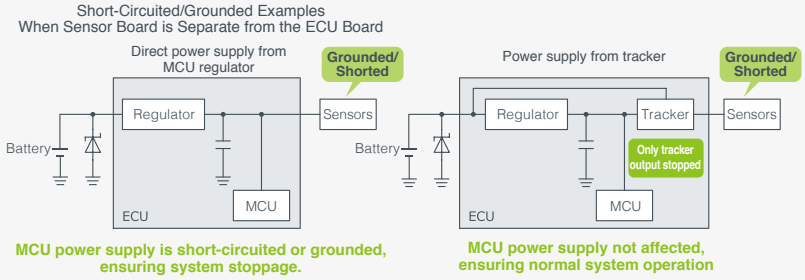
Voltage Trackers

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.

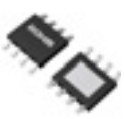


Overview : BD425x0□□□-C

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

SSOP5

SOP-J8

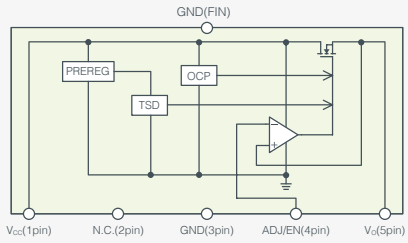


HTSOP-J8

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℃, Vcc=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℃, Vcc=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℃, Vcc=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

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	45	3.3	±2	0.2
BD733L2EFJ-C						
BD733L2FP3-C						
BD733L5FP-C	50	4.17@0.2A	45	3.3	±2	0.5
BD750L2FP-C	50	5.8	45	5.0	±2	0.2
BD750L2EFJ-C						
BD750L2FP3-C						
BD750L5FP-C	50	5.6@0.2A	45	5.0	±2	0.5
BD433M2EFJ-C	45	4.3@0.2A/ 3.9@0.1A	42	3.3	±2	0.2
BD433M2FP3-C						
BD433M2WEFJ-C						
BD433M2WFP3-C						
BD433M5FP-C	45	4.6@0.5A/ 4.0@0.25A	42	3.3	±2	0.5
BD433M5FP2-C						
BD433M5WFP2-C						
BD433M5WFPJ-C						
BD450M2EFJ-C	45	5.8@0.2A/ 5.5@0.1A	42	5.0	±2	0.2
BD450M2FP3-C						
BD450M2WEFJ-C						
BD450M2WFP3-C						
BD450M5FP-C	45	5.9@0.5A/ 5.5@0.25A	42	5.0	±2	0.5
BD450M5FP2-C						
BD450M5WFP2-C						
BD450M5WFPJ-C						
New **BD800M5WFP-C**	45	V_{OUT}+0.9 @0.5A (3.3V or more)	42	Variable (1.2 to 16.0)	±2	0.5
New **BD820F50EFJ-C**	45	5.9@0.2A	42	5.0	±2	0.2
BD42754FPJ-C	45	5.5@0.3A/ 5.9@0.5A	45	5.0	±2	0.50
BD42754FP2-C						
BD4269FJ-C	45	5.5@0.1A/ 6.0@0.2A	45	5.0	±2	0.20
BD4269EFJ-C						0.30
BD4271HFP-C	45	5.5@0.3A/ 6.0@0.55A	45	5.0	±2	0.55
BD4271FP2-C						

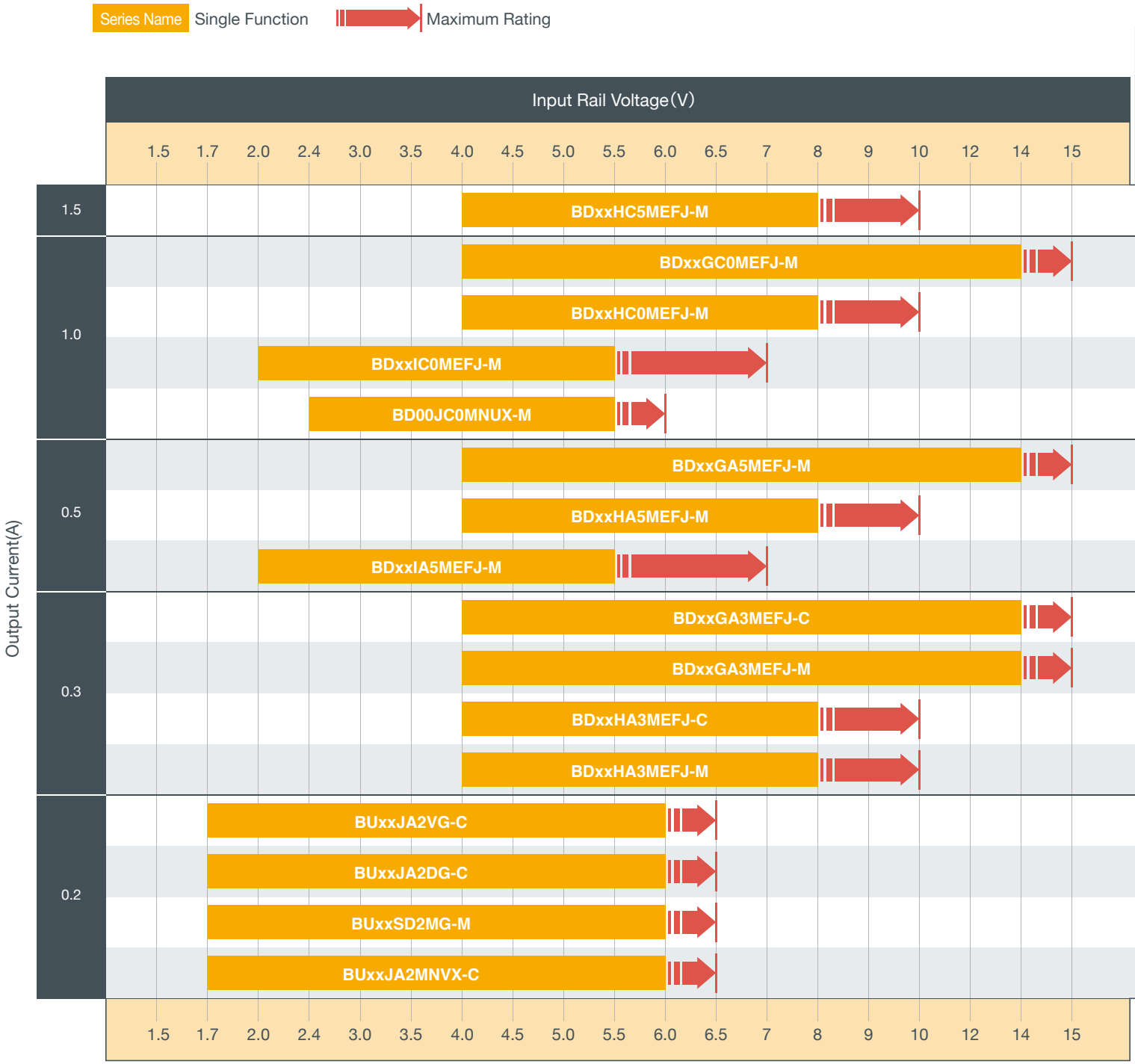
Dropout Voltage (V) (Typ.)	Circuit Current (μA) (Typ.)	Functions						Operating Temperature (℃)	Package
		Shutdown Switch	Detection Variable Reset	Detection Fixed Reset	Detection Accuracy (%)	WDT (Monitoring Time Fixed)	WDT (Adjustable Monitoring Time)		
0.60@0.2A	6	—	—	—	—	—	—	−40 to +125@Ta	TO252-3
									HTSOP-J8
									SOT223-4
0.40@0.2A	6	—	—	—	—	—	—	−40 to +125@Ta	TO252-3
0.40@0.2A	6	—	—	—	—	—	—	−40 to +125@Ta	TO252-3
									HTSOP-J8
									SOT223-4
0.25@0.2A	6	—	—	—	—	—	—	−40 to +125@Ta	TO252-3
0.20@0.1A	40	—	—	—	—	—	—	−40 to +150@Tj	HTSOP-J8
		—	—	—	—	—	—		SOT223-4
		✓	—	—	—	—	—		HTSOP-J8
		✓	—	—	—	—	—		SOT223-4
0.25@0.3A	38	—	—	—	—	—	—	−40 to +150@Tj	TO252-3
		—	—	—	—	—	—		TO263-3
		✓	—	—	—	—	—		TO263-5
		✓	—	—	—	—	—		TO252-J5
0.16@0.1A	40	—	—	—	—	—	—	−40 to +150@Tj	HTSOP-J8
		—	—	—	—	—	—		SOT223-4
		✓	—	—	—	—	—		HTSOP-J8
		✓	—	—	—	—	—		SOT223-4
0.20@0.3A	38	—	—	—	—	—	—	−40 to +150@Tj	TO252-3
		—	—	—	—	—	—		TO263-3
		✓	—	—	—	—	—		TO263-5
		✓	—	—	—	—	—		TO252-J5
0.20@0.3A	20	✓	—	—	—	—	—	−40 to +150@Tj	TO252-5
0.40@0.2A	6	—	—	4.20	±2.6	—	✓	−40 to +150@Tj	HTSOP-J8
0.25@0.3A	75	—	—	4.62	+2.8 −2.6	—	—	−40 to +150@Tj	TO252-J5
									TO263-5
0.25@0.1A	70	—	✓	4.62	±2.6	—	—	−40 to +150@Tj	SOP-J8
									HTSOP-J8
0.20@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	Variable (1.0 to 15.0)	±3	1
BD00C0AWHFP-C						
BD00C0AWFP2-C						
BD00C0AWFPS-M	35	4.0 or V_O+1.0	26.5	Variable (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@0.5A	500	—	—	—	—	—	—	−40 to +125@Ta	TO252-3
		—	—	—	—	—	—		HRP5
		—	—	—	—	—	—		TO263-3
		✓	—	—	—	—	—		TO252-5
		✓	—	—	—	—	—		HRP5
		✓	—	—	—	—	—		TO263-5
0.30@0.5A	500	—	—	—	—	—	—	−40 to +125@Ta	TO252-3
		—	—	—	—	—	—		TO252S-3
		—	—	—	—	—	—		HRP5
		—	—	—	—	—	—		TO263-3
		✓	—	—	—	—	—		TO252-5
		✓	—	—	—	—	—		HRP5
		✓	—	—	—	—	—		TO263-5
		✓	—	—	—	—	—		HTSOP-J8
0.30@0.5A	500	—	—	—	—	—	—	−40 to +125@Ta	TO252-3
		—	—	—	—	—	—		HRP5
		—	—	—	—	—	—		TO263-3
		✓	—	—	—	—	—		TO252-5
		✓	—	—	—	—	—		HRP5
		✓	—	—	—	—	—		TO263-5
0.30@0.5A V_O≥5.0	500	✓	—	—	—	—	—	−40 to +125@Ta	TO252-5
		✓	—	—	—	—	—		HRP5
		✓	—	—	—	—	—		TO263-5
0.30@0.5A Vo≥5.0	500	✓	—	—	—	—	—	−40 to +105@Ta	TO252S-5
0.20@0.2A	500	—	—	—	—	—	—	−40 to +125@Ta	TO252-3
3.00@0.1A	300	✓	—	—	—	—	—	−40 to +105@Ta	SSOP5

Automotive Secondary Linear Regulator Lineup AEC-Q100 qualified



Output voltage(V)																Shutdown Switch	Discharge Function	Support 125℃	Input Capacitor (μF)	Output Capacitor (μF)	Package
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						
✓	—	—	—	—	✓	✓	✓	—	—	—	✓	✓	—	✓	✓	✓	—	—	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	VSON010X3030
✓	—	—	—	—	✓	✓	✓	—	—	—	✓	✓	—	✓	✓	✓	—	—	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	1.0	HTSOP-J8
—	✓	—	✓	✓	✓	✓	✓	✓	✓	—	✓	✓	—	—	—	✓	—	✓	1.0	1.0	SSOP5
—	✓	—	✓	✓	✓	✓	✓	✓	✓	—	✓	✓	—	—	—	✓	✓	✓	1.0	1.0	SSOP5
—	—	—	✓	—	✓	✓	✓	✓	—	—	✓	✓	—	—	—	✓	—	—	1.0	1.0	SSOP5
—	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	—	—	✓	✓	✓	0.47	0.47	SSON004R1010

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

Automotive Secondary Linear Regulator Family Diagram AEC-Q100 qualified

Input → Secondary

Package → Standard

Operating Temperature → 125℃

HTSOPJ-8
4.9mm×6.0mm
θja : 33.3℃/W

Maximum Rating (V)	Output Current (A)	Series Name	Output voltage(V) 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
15	0.3	**BDxxGA3MEFJ-C**	✓	—	—	—	—	—	—	—	—	—	—	—	✓	—	✓	—	—
10	0.3	**BDxxHA3MEFJ-C**	✓	—	—	—	—	✓	✓	✓	—	—	—	✓	✓	—	✓	✓	—

Operating Temperature → 105℃

Maximum Rating (V)	Output Current (A)	Series Name	Output voltage(V) 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
15	0.3	**BDxxGA3MEFJ-M**	✓	—	—	—	—	✓	✓	✓	—	—	—	✓	✓	—	✓	✓	—
	0.5	**BDxxGA5MEFJ-M**	✓	—	—	—	—	✓	✓	✓	—	—	—	✓	✓	—	✓	✓	—
	1.0	**BDxxGC0MEFJ-M**	✓	—	—	—	—	✓	✓	✓	—	—	—	✓	✓	—	✓	✓	—
10	0.3	**BDxxHA3MEFJ-M**	✓	—	—	—	—	✓	✓	✓	—	—	—	✓	✓	—	✓	✓	—
	0.5	**BDxxHA5MEFJ-M**	✓	—	—	—	—	✓	✓	✓	—	—	—	✓	✓	—	✓	✓	—
	1.0	**BDxxHC0MEFJ-M**	✓	—	—	—	—	✓	✓	✓	—	—	—	✓	✓	—	✓	✓	—
	1.5	**BDxxHC5MEFJ-M**	✓	—	—	—	—	✓	✓	✓	—	—	—	✓	✓	—	✓	✓	—
7	0.5	**BDxxIA5MEFJ-M**	✓	✓	—	✓	—	✓	✓	✓	—	—	—	✓	✓	—	—	—	—
	1.0	**BDxxIC0MEFJ-M**	✓	✓	—	✓	—	✓	✓	✓	—	—	—	✓	✓	—	—	—	—

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

Package → Compact/ Gull Wing

Operating Temperature → 125℃

SSOP5
2.9mm×2.8mm
θja : 185.4℃/W

Maximum Rating (V)	Output Current (A)	Series Name	Output voltage(V) 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
6.5	0.2	**BUxxJA2VG-C**	—	✓	—	✓	✓	✓	✓	✓	✓	✓	—	✓	✓	—	—	—	—
	0.2	**BUxxJA2DG-C**	—	—	—	—	—	—	✓	—	✓	—	—	—	—	—	—	—	—	✓

Operating Temperature → 105℃

Maximum Rating (V)	Output Current (A)	Series Name	Output voltage(V) 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
6.5	0.2	**BUxxSD2MG-M**	—	—	—	✓	—	✓	✓	✓	✓	—	—	✓	✓	—	—	—	—

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

Package → Compact/ High Heat Dissipation

Operating Temperature → 105℃

VSON010X3030
3.0mm×3.0mm
θja : 69.4℃/W

Maximum Rating (V)	Output Current (A)	Series Name	Output voltage(V) 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
6.0	0.2	**BD00JC0MNUX-M**	✓	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

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

Package → Ultra-Compact

Operating Temperature → 125℃

SSON004R1010
1.0mm×1.0mm
θja : 97.1℃/W

Maximum Rating (V)	Output Current (A)	Series Name	Output voltage(V) 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
6.5	0.2	**BUxxJA2MNVX-C**	—	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	—	—	✓

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

Input → Primary

▶P.15 to 26

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

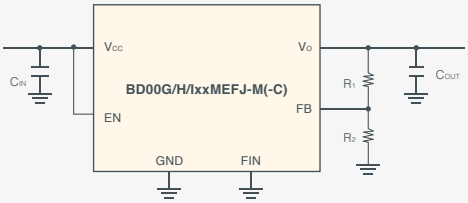
BDxxG/H/IxxMEFJ-M(C) series

Compact・Large Current

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

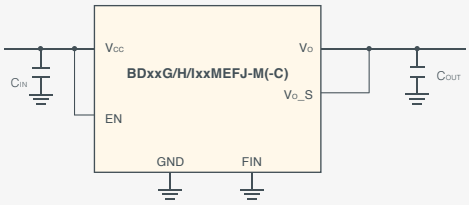
BDxxG/H/IxxMEFJ-M(C)

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



CIN,COUT : Ceramic Capacitoe

Variable Output Type Application Circuit Diagram

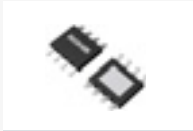


CIN,COUT : Ceramic Capacitoe

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
BDxxG/H/
IxxMEFJ-M(-C)

Part Number Configuration

B	D	0	0	G	x	x	M	E	F	J	-	M

Output voltage
00 : Variable
xx : Fixed

Series
(Rated Voltage)
G : 15V
H : 10V
I : 7V

Output Current
A3 : 0.3A
A5 : 0.5A
C0 : 1.0A
C5 : 1.5A

Classification Code
M : Automotive

Package
EFJ : HTSOP-J8

Automotive Grade
−M : Automotive Standard Product
−C : 125℃ Compatible Product

Secondary Linear Regulator

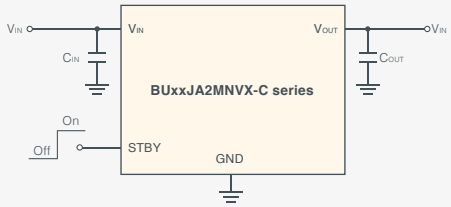
BUxxJA2MNVX-C series

Ultra-Compact

BUxxJA2MNVX-C series Application Circuit Diagram

BUxxJA2MNVX-C series

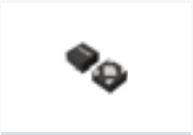
Absolute Maximum Ratings 6.5V



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
BUxxJA2MNVX-C

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	✓	—	—	—	—	✓	✓	✓	—	—	—	✓	✓	—	✓	✓	✓
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	✓	✓	—	✓	—	✓	✓	✓	—	—	—	✓	✓	—	—	—	—
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	✓	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

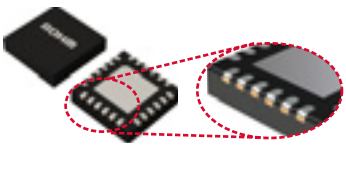
8.0	9.0	10	12	Output Voltage Accuracy (%)	Output Current (A) (Max.)	Dropout Voltage (V) (Typ.)	Circuit Current (μA) (Typ.)	Functions			Operating Temperature (℃)	Package
								Shutdown Switch	Discharge Function	Support 125℃		
✓	✓	✓	✓	±3	1	0.60@1.00A	600	✓	—	—	−40 to +105@Ta	HTSOP-J8
✓	✓	✓	✓	±3	0.5	0.60@0.50A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

Automotive Switching Regulator Package List

Package Name	External Appearance	Package Code	Size(mm) 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
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-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) W(Typ.)×D(Typ.)×H(Max.)
SSON004R1010		NVX	1.00 × 1.00 × 0.60
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.

Possible issues with improper PCB layout

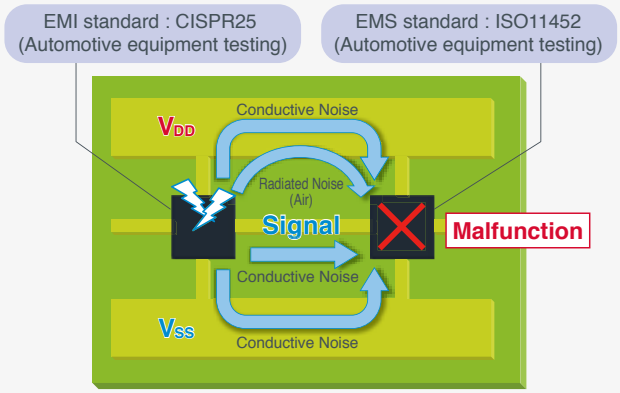
Possible issues when the PCB layout for the power supply IC is improper include the following.

⇒ **Low EMC and PI performance**

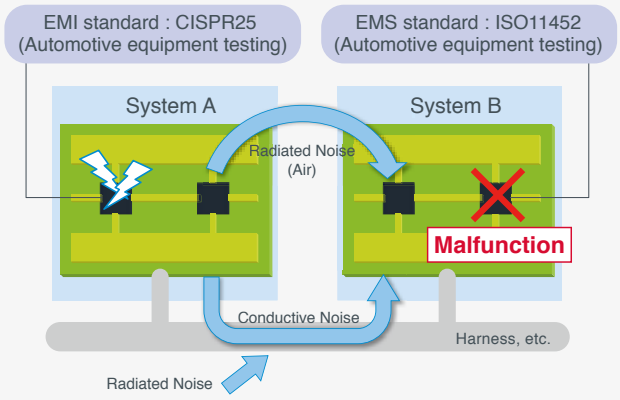
⇒ **Degradation of basic performance such as output voltage accuracy**

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

EMC Issues on the Same Board



EMC Issues from Outside the Board



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.co.jp/search/application-notes

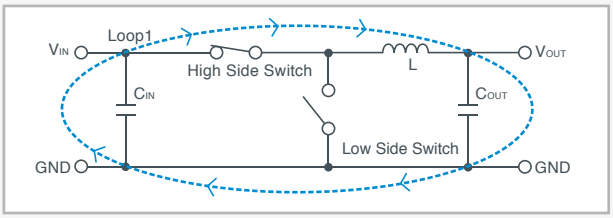


Figure 1 : Current Path When the High Side Switch is ON and Low Side Switch is OFF

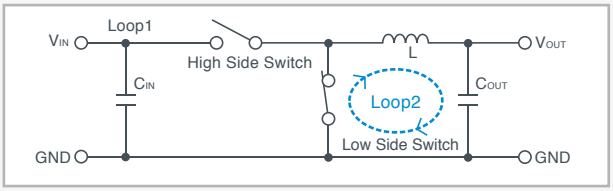


Figure 2 : Current Path When the High Side Switch is OFF and Low Side Switch is ON

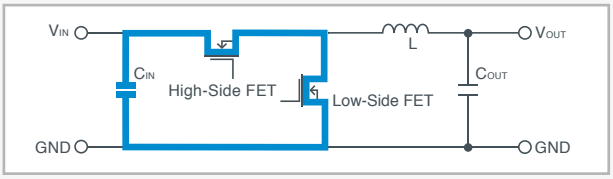


Figure 3 : Current Difference + Important Points on Layout

Tech Tips Heat Resistance and Thermal Characteristics

Definitions •Applications •Formulas

■ These definitions conform to JEDEC standard JESD51

Symbol	Definition	Applications	Formula
θ_{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	$\theta_{JA} = (Tj–Ta) \div P$
Ψ_{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 θ_{JC} is Ψ_{JT} in this definition.

Illustrations for Each Definition

JEDEC(JESD51) reference

■ θ_{JA} : Thermal resistance between the junction and the ambient environment

*Heat dissipation through multiple thermal paths

■ Ψ_{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

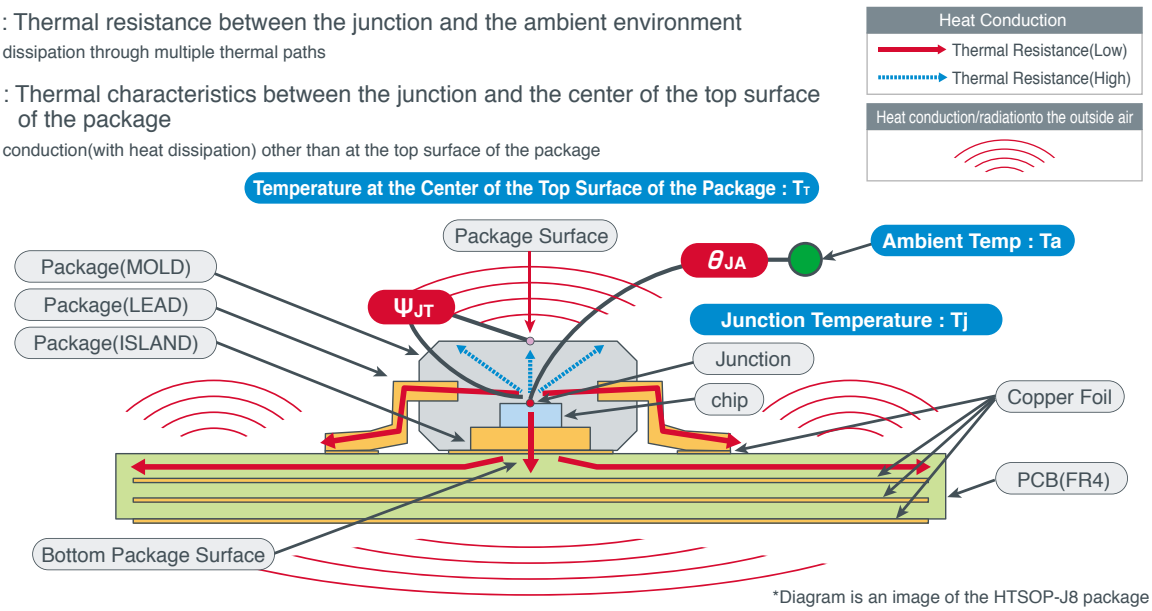
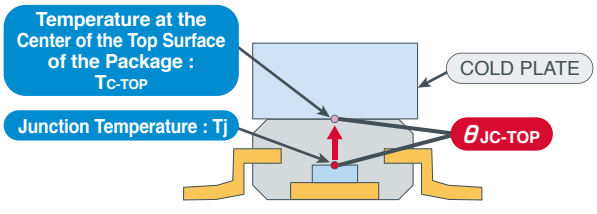


*Diagram is an image of the HTSOP-J8 package

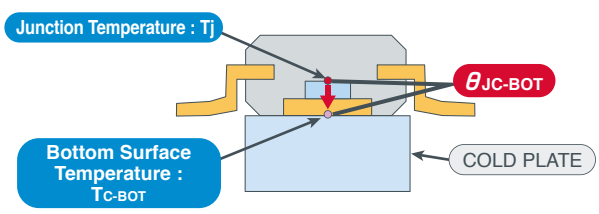
■ $\theta_{JC\text{-}TOP}$: Thermal resistance between the junction and the top surface of the package

*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

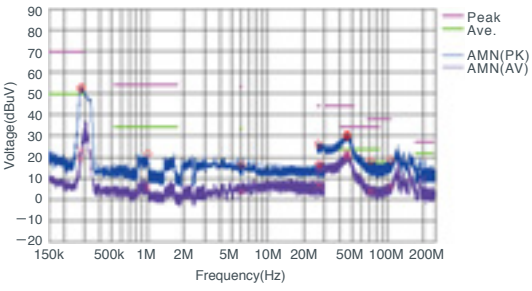
Automotive Immunity Test

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

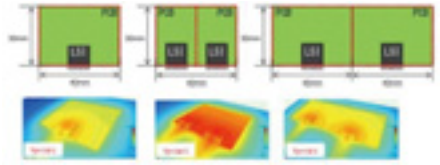
⇒ **Increases the risk of a reduction in the quality and life of electronic components**

Heat dissipation design technology is becoming more important

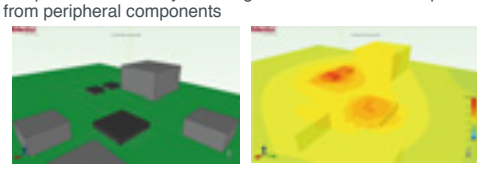
Thermal Simulation Support Case Study

■ 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)

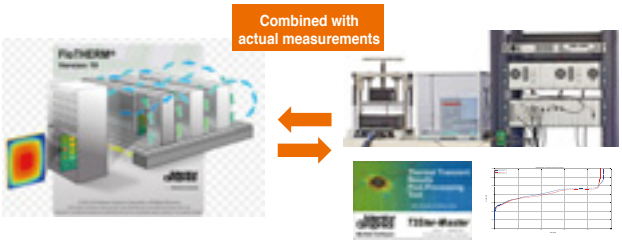
Thermal Resistance Measurement Environment Example

■ We are constructing an environment that conforms with JEDEC

Initiatives to Improve Accuracy

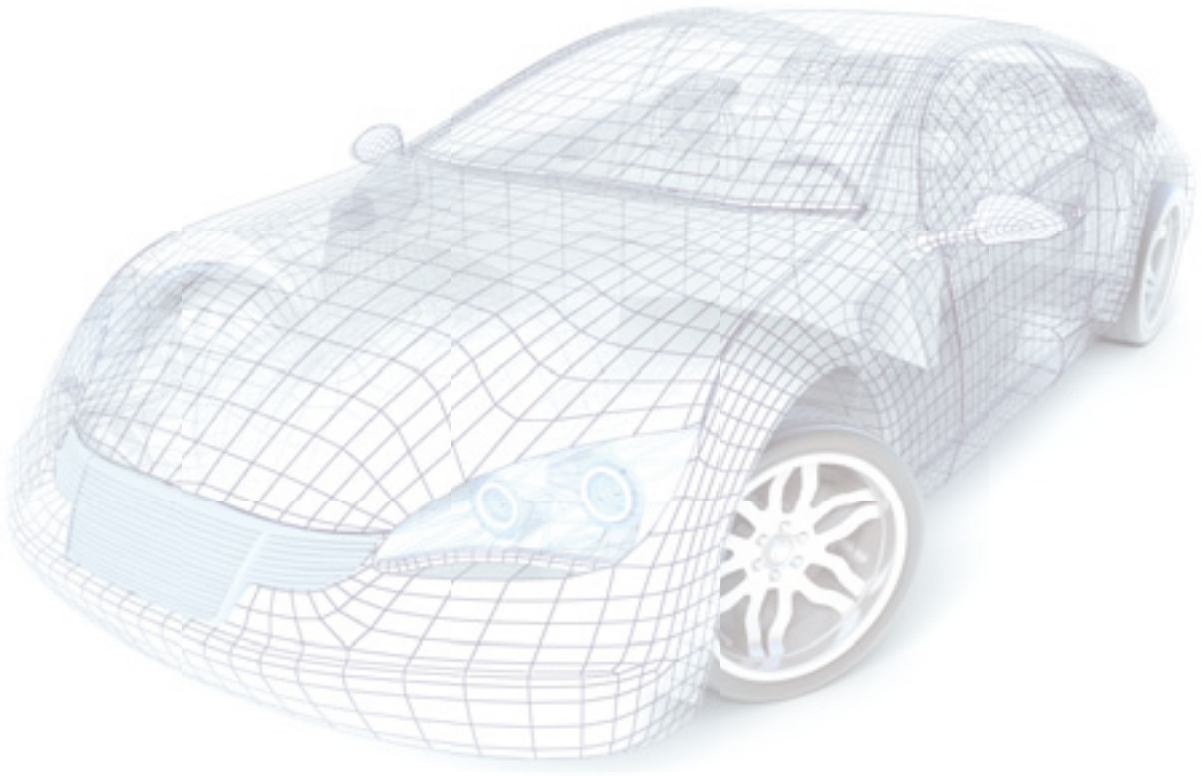
■ Model supply and analysis enabled using high accuracy models

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.

Commitment to Raw Materials

Wafer production from silicon ingot pulling

Raw silicon

In-House Photo Mask

Pursuing high quality through consistent quality control from IC chip design layout to photo mask production

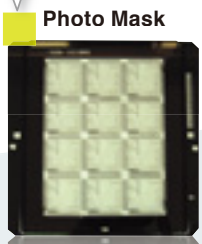
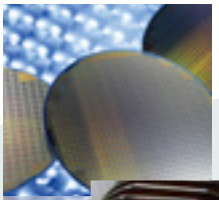
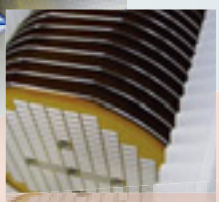


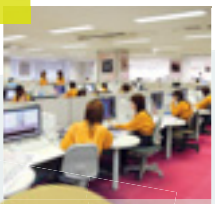
Photo Mask



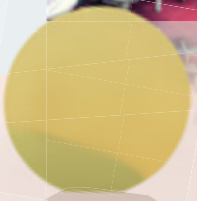


Wafer Process

Silicon Ingot



CAD



Wafer

Si Silicon

SiC Silicon Carbide

SiCrystal A ROHM Group Company

SiCrystal, a German-based SiC single crystal wafer manufacturer, became a member of the ROHM Group in 2009.German S 2C single crystal wafer maker SiCrystal became a ROHM Group Company in 2009

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

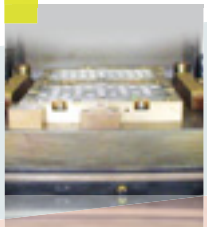
The ROHM Group is tasked with supplying products that meet market demands. By managing the manufacturing process in-house using our vertically integrated production system, we are able to create a system that is less susceptible to external factors compared with general fabless and foundry manufacturers. 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

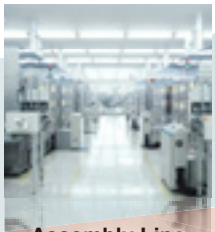
To ensure quality, all dies for lead frame punching, lead frames, and even molds are produced in-house.

Cutting-edge packages

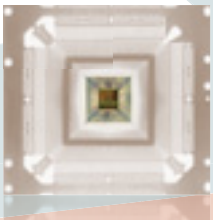
Broad package lineup(i.e. CSP, BGA, COF, COC, stacked package) supports the latest assembly technologies.



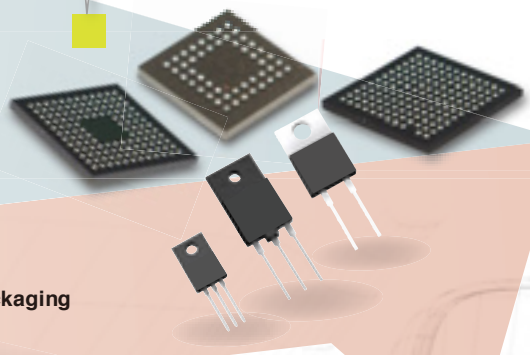
Frame & Dies



Assembly Line



Packaging



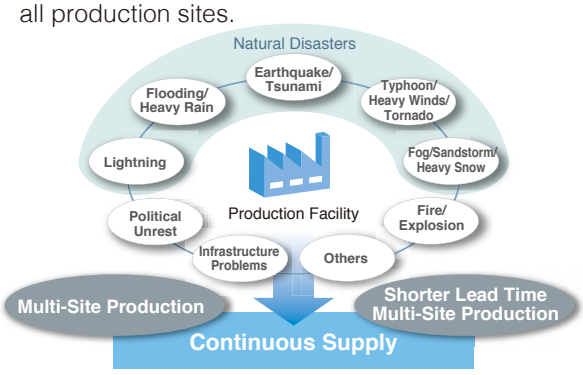
In-House Production System

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

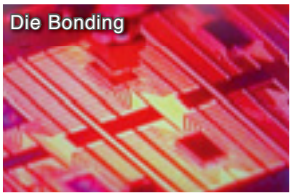
ROHM establishes 'Quality First' as a corporate objective, pursues innovative,
high quality manufacturing, and provides greater peace of mind through guaranteed delivery times.
ROHM implements a variety of initiatives to ensure high reliability.

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



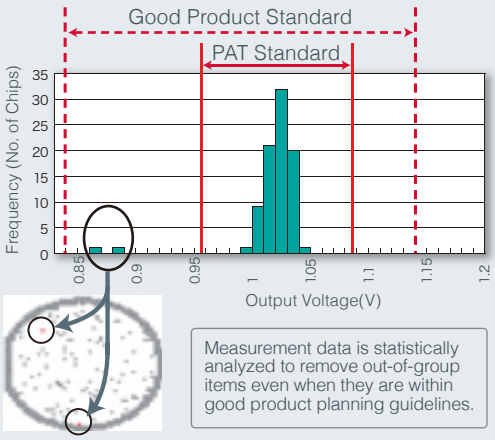
Check the workmanship at the same time as performing die bonding

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)



Measurement data is statistically analyzed to remove out-of-group items even when they are within good product planning guidelines.

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.

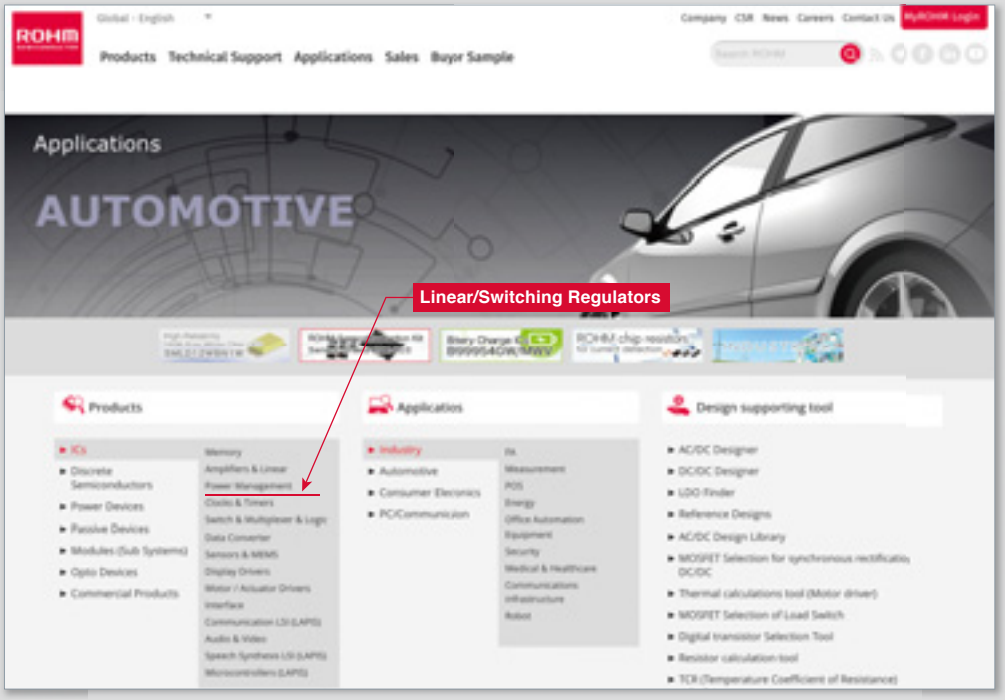
Certification armband

Initiative Overview(IC Case)

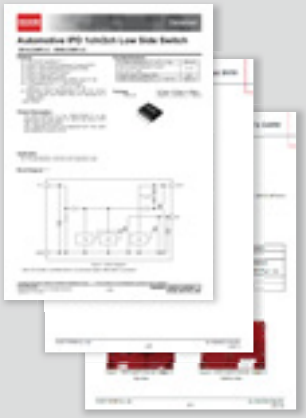
Model Design	Model Test Design	Model Qualification Testing
Robust design with multiple protection circuits/improved damage resistance/easier testability/characteristics limit evaluation	High/normal/low temperature measurement of all chips, HV stress testing, PAT system introduction	Based on JEITA. JEDEC,AEC-Q100/AEC-Q101/AEC-Q200 compliance · Long-term reliability testing · Life prediction based on WLR data · Electrostatic breakdown test
Wafer Process Management	**Assembly Process Management**	**Traceability, keep samples, in-process defect analysis, etc.**
SPC management/Real-time monitoring/Defect inspection of all chips	Real-time Work & Check at main processing point (s)/Quality guarantee (i.e. internal X-ray inspection, reflow screening)/4M establishment	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	DEVICE PLUS	Electronics Basics
https://micro.rohm.com/en/techweb	https://www.deviceplus.com	https://www.rohm.com/electronics-basics

Home Page Design Support Content List

Item	Overview	
Selection Guide (This Catalog)	A guidebook that simplifies IC selection. Product pickups and sample solutions are provided.	
Datasheet	Contains the most important information provided to customers on ROHM products. Functional characteristics, conditions, and applicable ranges built into the products are listed, along with the scope of warranty. 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 Considerations for Multilayer Ceramic Capacitor Used for Buck Converters Inductor Calculation for Buck Converter ICs Considerations for Power Inductors Used for Buck Converters Quick Reference Table for Setting the Output Voltage of Buck Converter ICs PCB Layout Method for Buck Converters Snubber Circuit for Buck Converter ICs Buck Converter Efficiency Calculating Power Loss(Synchronous Rectification Type)
	Linear Type	Reverse Voltage Protection for Linear Regulators Output Voltage Setting Resistance Table for Linear Regulator ICs Linear Regulator Power Supply ON/OFF Characteristics Simple Stability Experiments for Linear Regulators Thermal Resistance Data of Automotive Linear Regulators
	General	Phase Margin Measurement Method Using a Frequency Characteristics Analyzer(FRA) Regarding Thermal Resistance About Thermal Resistance and Thermal Characteristics of IC Packages
SPICE Models	SPICE models are offered that can be used in PSpice simulations. 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 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 Tech Web	Acquire basic knowledge on power supply ICs Archive site on the latest topics on power supply ICs ideal for engineers - TECH INFO	

ROHM Group Locations (Japan)

Sales Offices

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

R&D Centers

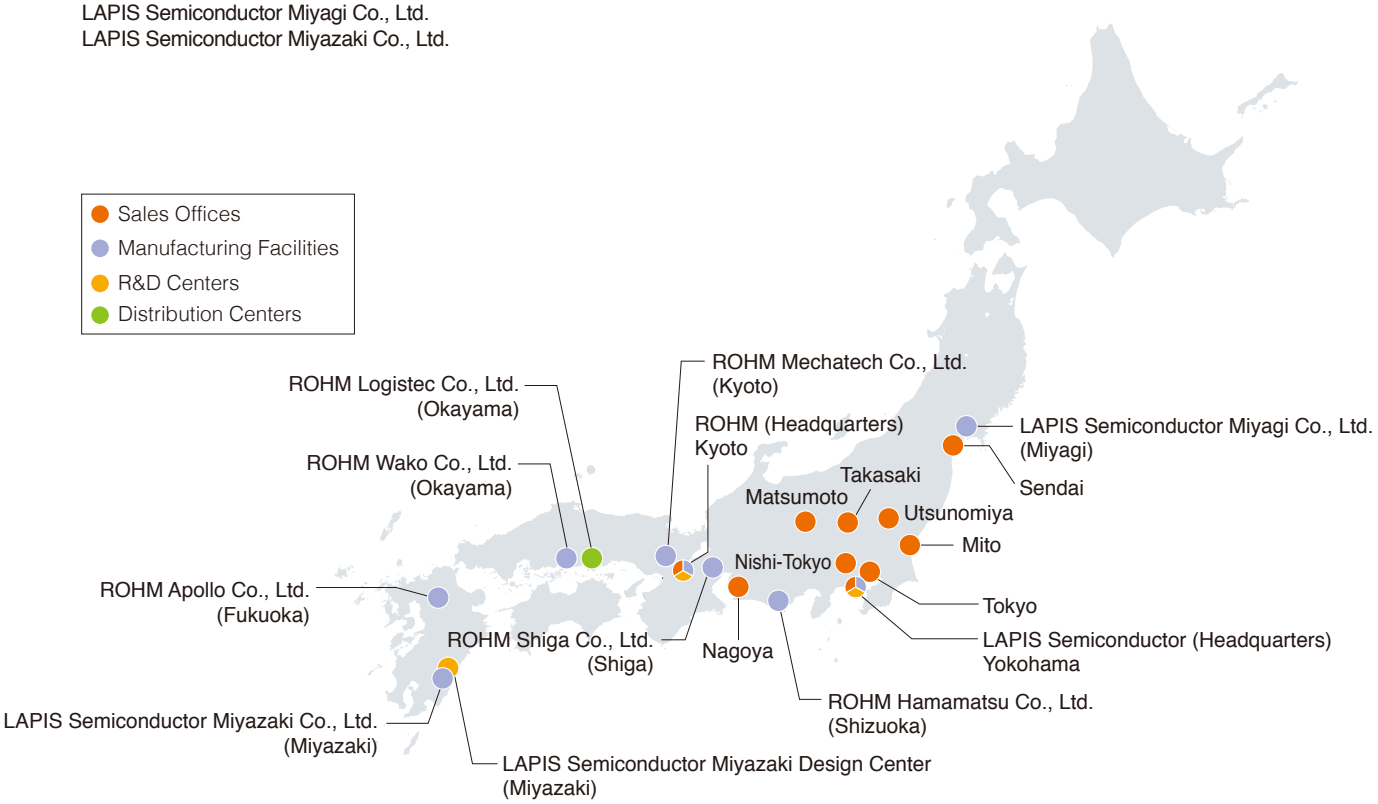
Kyoto Technology Center (Head Office)
Kyoto Technology Center (Kyoto Ekimae)
Yokohama Technology Center
LAPIS Semiconductor Co., Ltd.(Shin-Yokohama)
LAPIS Semiconductor Miyazaki Design Center

Manufacturing Facilities

ROHM Co., Ltd.
ROHM Shiga Co., Ltd.
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.

Distribution Centers

ROHM Logistec Co., Ltd.



ROHM Group Locations (Global)

Sales Offices

ASIA	ROHM Semiconductor Korea Corporation
	ROHM Semiconductor Trading (Dalian) Co., Ltd.
	ROHM Semiconductor Trading (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
	ROHM Semiconductor do Brasil Ltda.
EUROPE	ROHM Semiconductor GmbH

R&D Centers

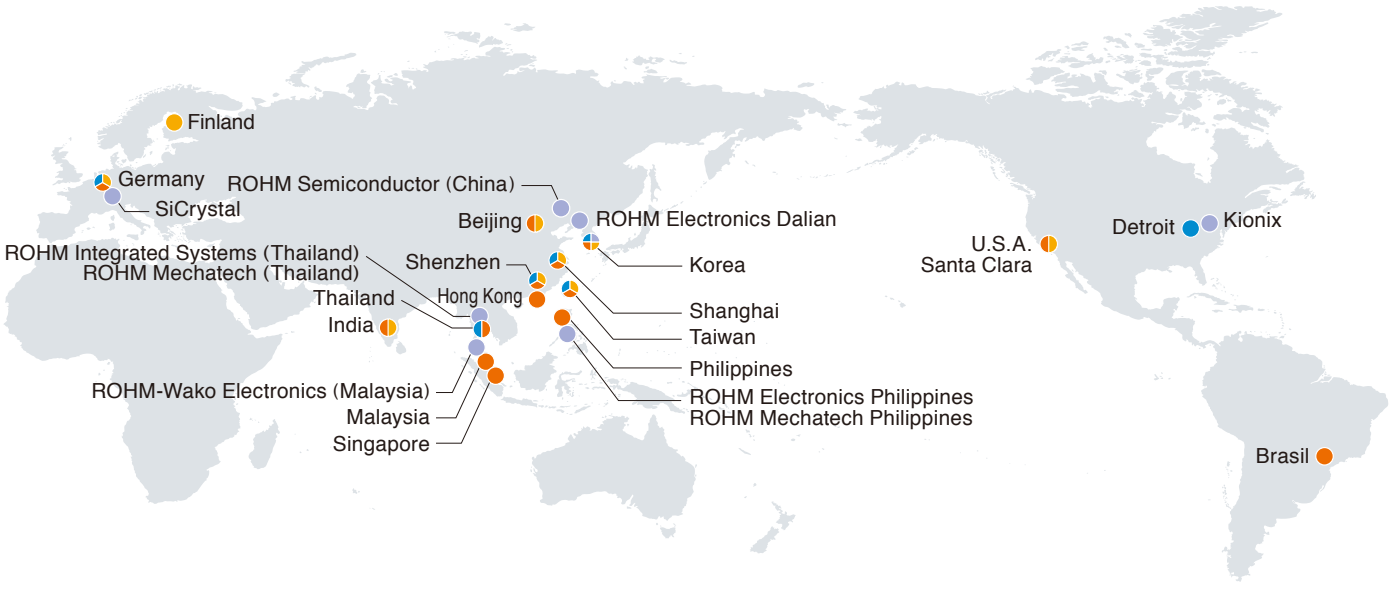
ASIA	Korea Design Center
	Beijing Design Center
	Shanghai Design Center
	Shenzhen Design Center
	Taiwan Design Center
	India Design Center
AMERICA	America Design Center (Santa Clara)
EUROPE	Europe Design Center
	Finland Software Development Center
	ROHM POWERVATION Ltd.

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	America 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.
6) The Products are intended for use in general electronic equipment (i.e. AV/OA devices, communication, consumer systems, gaming/entertainment sets) as well as the applications indicated in this document.
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.
10) ROHM shall have no responsibility for any damages or injury arising from non-compliance with the recommended usage conditions and specifications contained herein.
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ROHM Sales Offices

Contact us for further information about the products.

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Atlanta	+1-770-754-5972	**Nuremberg**	+49-911-810452-26	**Shanghai**	+86-21-6072-8612	**Kyoto**	+81-75-365-1077
Boston	+1-781-565-1138	**France**	+33 (0) 1 40 60 87 30	**Shenzhen**	+86-755-8307-3008	**Yokohama**	+81-45-476-2121
Chicago	+1-847-368-1006	**United Kingdom**	+44-1-908-272400	**Hong Kong**	+852-2740-6262		
Detroit	+1-248-348-9920	**Finland**	+358-400-726 124	**Taiwan**	+886-2-2500-6956		
San Diego	+1-858-625-3600	**Spain**	+34-9375-24320	**Singapore**	+65-6436-5100		
Mexico	+52-33-3123-2001	**Hungary**	+36-1-950-5859	**Philippines**	+63-2-807-6872		
Brazil	+55-11-3539-6320	**Italy**	+39-039-5783432	**Thailand**	+66-2-254-4890		
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