Creating the future of Automobiles

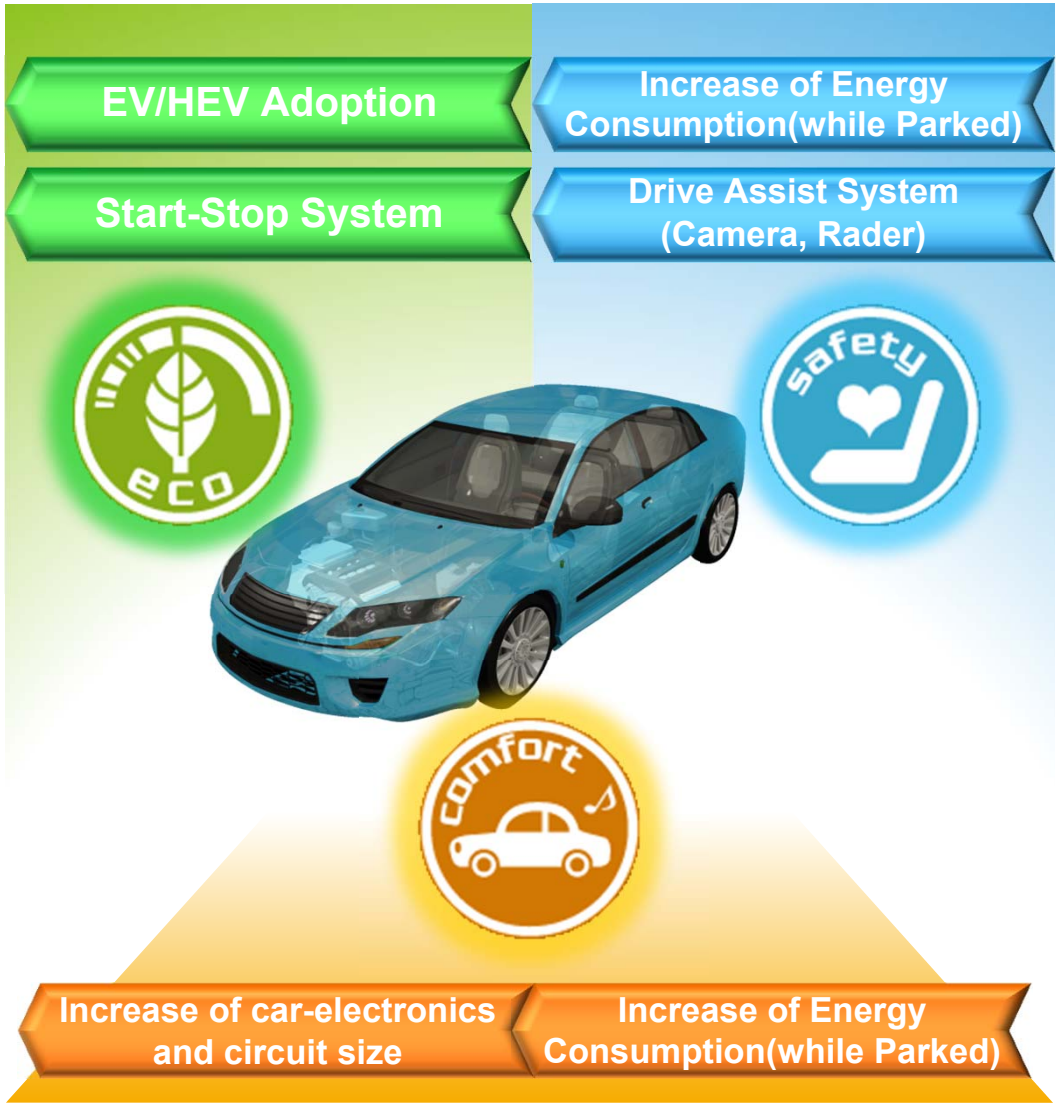
Automotive Regulator Selection Guide

Rev. 1.3

www.rohm.com

ROHM SEMICONDUCTOR

Power Supply Requirements the Drive Automotive Evolution



ROHM Power Supply IC Advantages

Low Quiescent Current ➤ P5,6,15

Low Voltage Operation ➤ P7,12

Compact · Large Current ➤ P9,10,21

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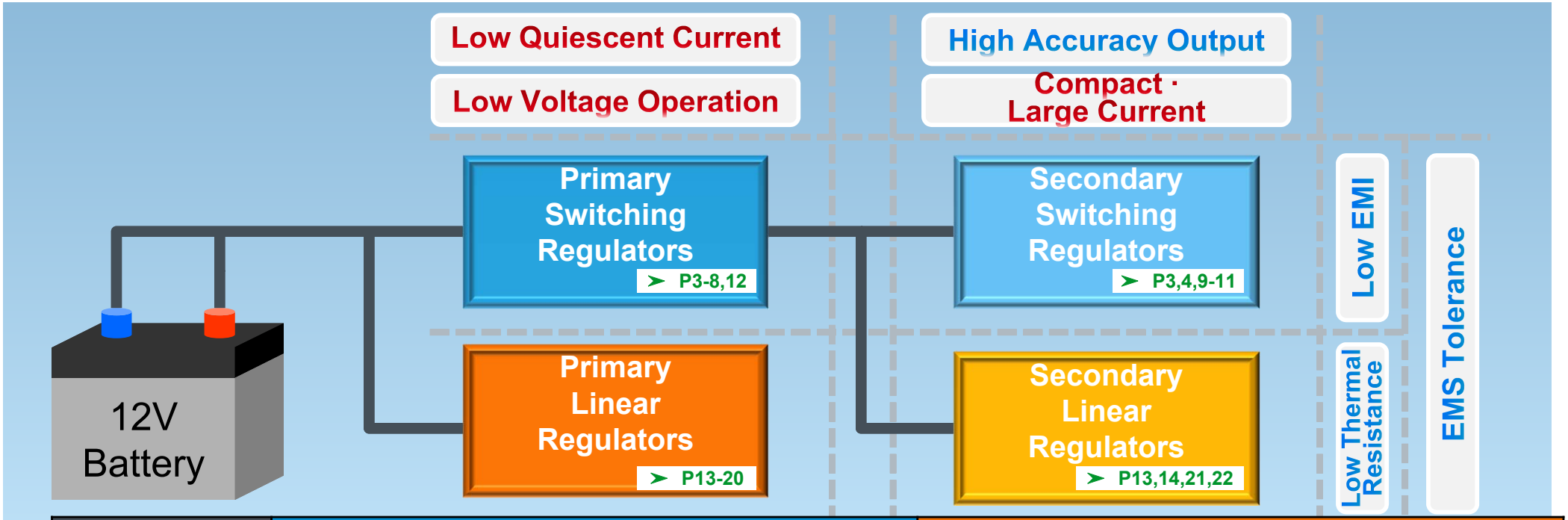


	Switching Regulator (DC/DC)	Linear Regulator (LDO)
Features	Buck / Boost / Buck-Boost (Depends on model) Many external parts ⇒ **Higher total cost** High conversion efficiency ⇒ **Low heat generation**	Simple circuit configuration Less external parts ⇒ **Lower total cost** (vs DC/DC) Low conversion efficiency ⇒ **High heat generation**
Voltage Generation	PWM (width) / PFM (frequency) ⇒ **Significant noise**	Resistor divider ⇒ **Low noise**
Applications	Contributes to greater energy savings, suitable for both low and high power systems	Low noise, low-cost solution Ideal for low power devices

ROHM Power Supply IC Advantages

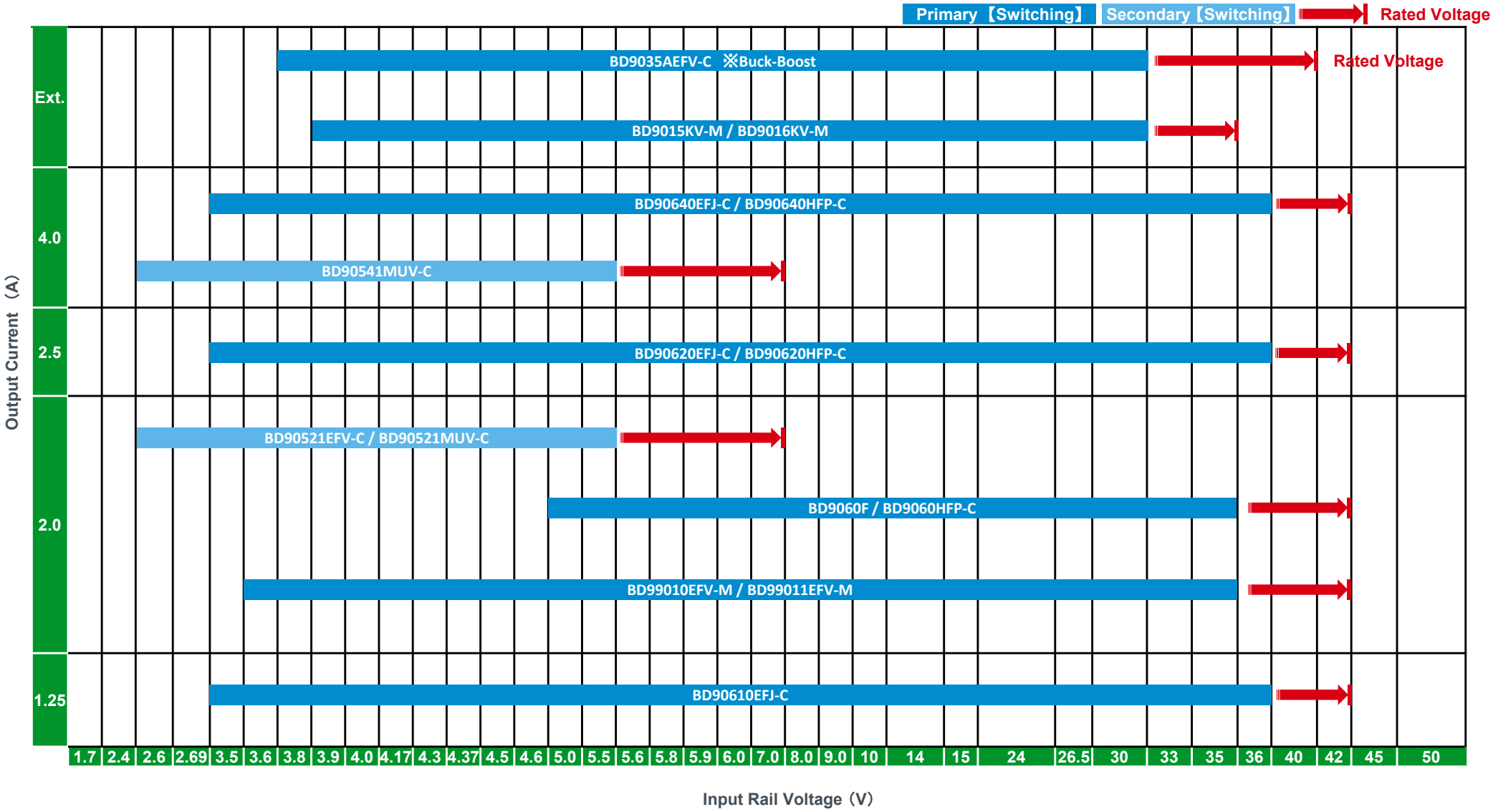
Effective Anti-Noise Technology

Noise Characteristics · Tolerance ➤ P25-27

Superior Heat Dissipation Technology

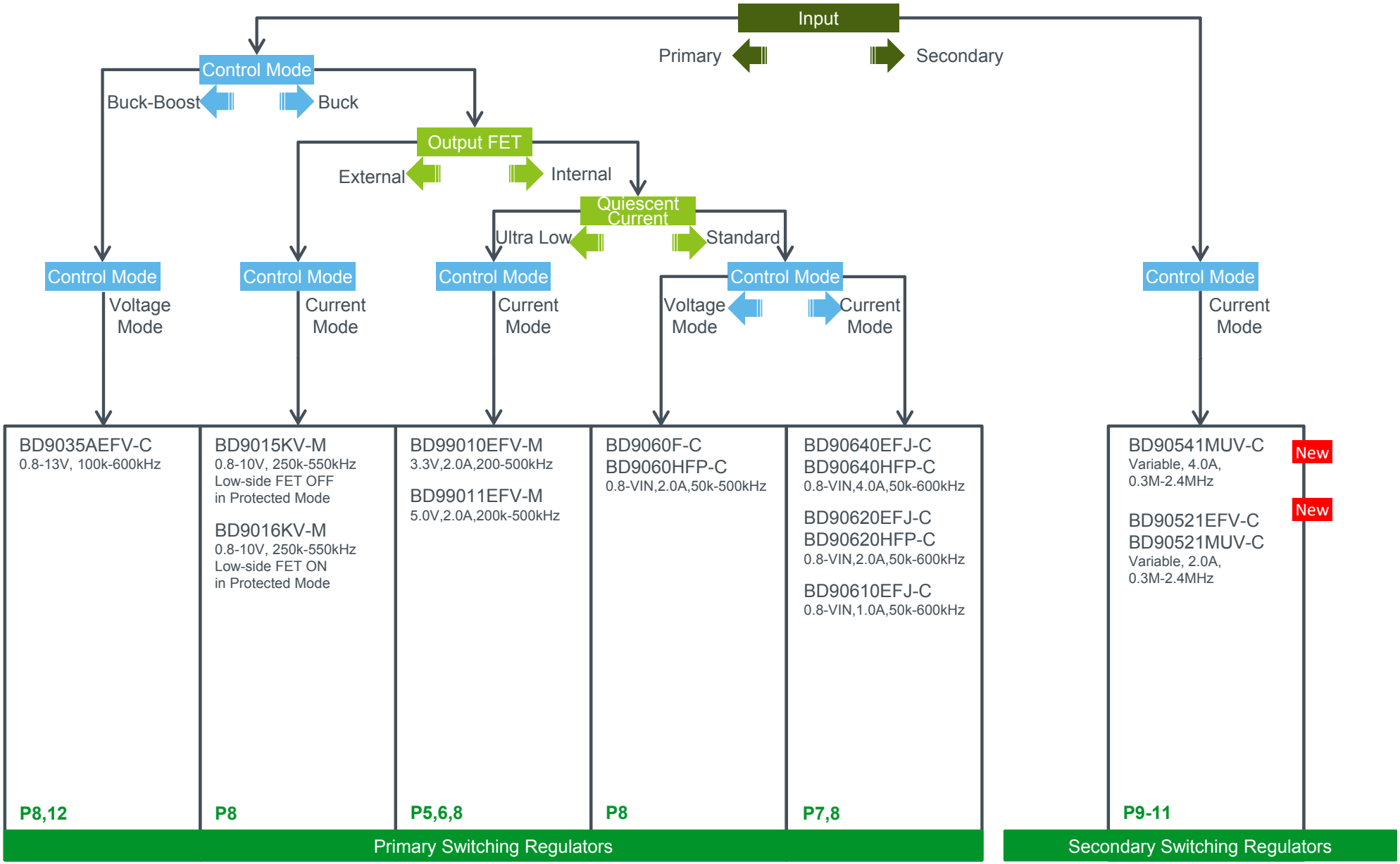
Thermal Resistance · Characteristics ➤ P23,24

Automotive Step-Down Switching Regulator Lineup



Automotive Step-Down Switching Regulator Product Family

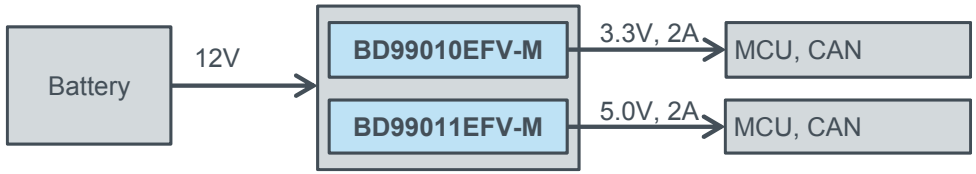
AEC-Q100 Qualified



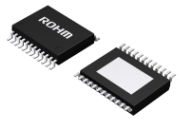
Low Quiescent Current

Low Quiescent Current Solutions

The BD99010EFV-M and BD99011EFV-M are low Iq step-down DC/DC converters that integrate a power MOSFET and provide 3.3V and 5V output, respectively.
SLLM™ (Simple Light Load Mode) is included, ensuring low current consumption and high efficiency at light loads as well as high efficiency during heavy loads while providing regulated output voltage. In addition, the ICs are compliant with automotive standards and support a maximum voltage of 42V.
A minimum input voltage of 3.6V maintains output when cold cranking, and current mode control delivers fast transient response and easy phase compensation. Both models are available in a HTSSOP-B24 package, making them ideal for applications requiring few external components and a small PCB footprint.



Product Overview: BD9901xEFV-M



HTSSOP-B24

Low Quiescent Current

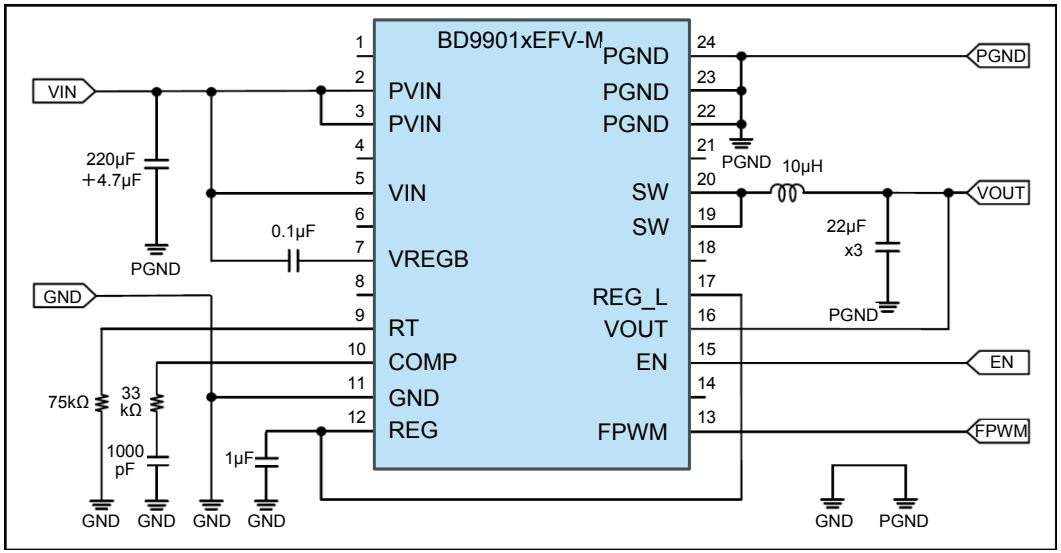
- Low quiescent current: 22μA (Typ.)

High Efficiency

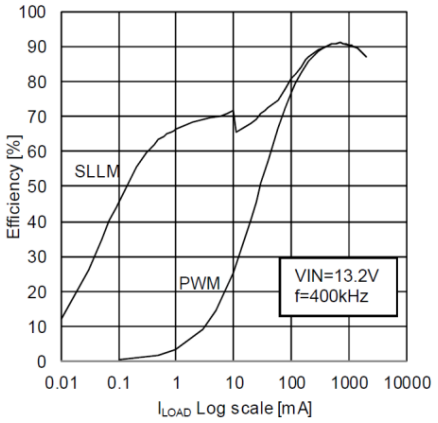
- Synchronous rectification (No external Schottky diode required)
- Simple Light Load Mode (SLLM™)

Supports Cold Cranking Operation (3.6V Operation)

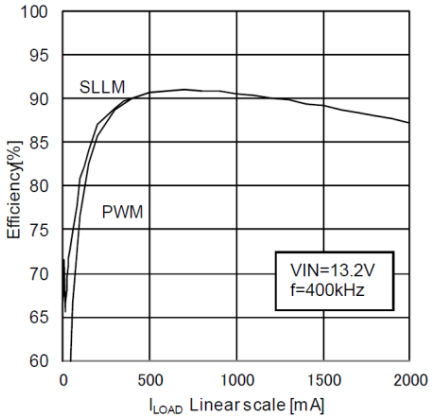
- Input voltage range: 3.6V to 35V (42V rating)
  (Initial startup over 3.9V)
- Output voltage: 3.3V±2% (BD99010EFV-M)
  5.0V±2% (BD99011EFV-M)
- Switching output current: 2A (Max.)
- Switching frequency: 200k to 500kHz
- Integrated switching FET: Pch 170mΩ (Typ.), Nch 130mΩ (Typ.)
- Soft Start built in
- Enable pin compatible with CMOS logic and battery voltages
- Forced PMW Mode function
- Current Mode control with external compensation circuit
- Over Current/Short Circuit protection, VOUT Over Voltage protection, Under Voltage Lock Out, and thermal protection circuits



BD9901xEFV Application Circuit



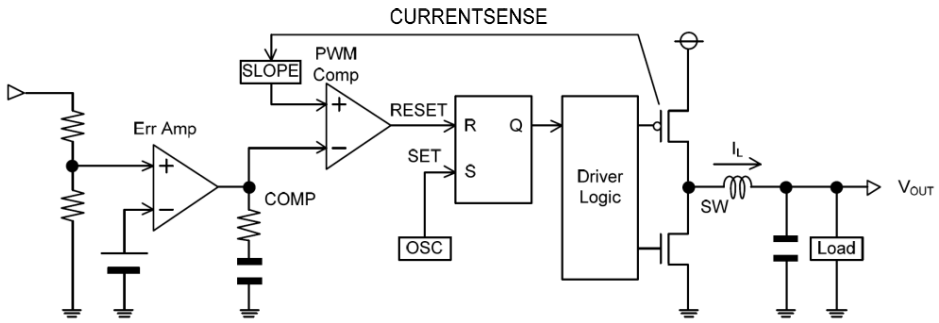
BD99011EFV-M Efficiency vs Load Current
VIN=13.2V , VOUT=5.0V (Log scale)



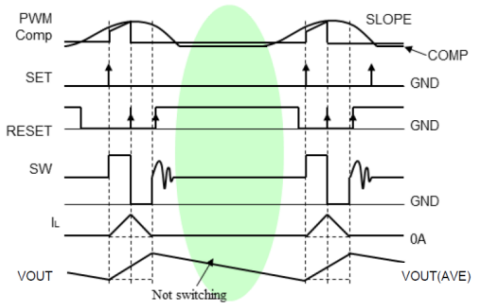
BD99011EFV-M Efficiency vs Load Current
VIN=13.2V , VOUT=5.0V (Linear scale)

SLLM™ (Simple Light Load Mode) Control

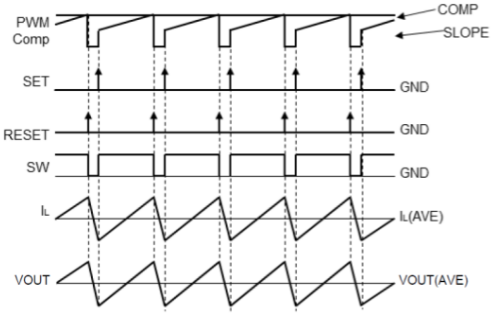
During lighter loads operation automatically switches to Simple Light Load Mode (SLLM™), which utilizes PWM control and compares the output voltage to an internal reference voltage. When the output voltage drops below the reference voltage switching pulses are output to increase the voltage above the reference level, after which the SW output turns off and the controller goes into a very low current consumption standby mode until the output voltage dips below the reference voltage again.
When the time between switching pulse skips becomes short the devices exit SLLM™ mode and resume normal continuous switching operation. The load level of the switching pulse skip can be adjusted by the input voltage and inductor value.



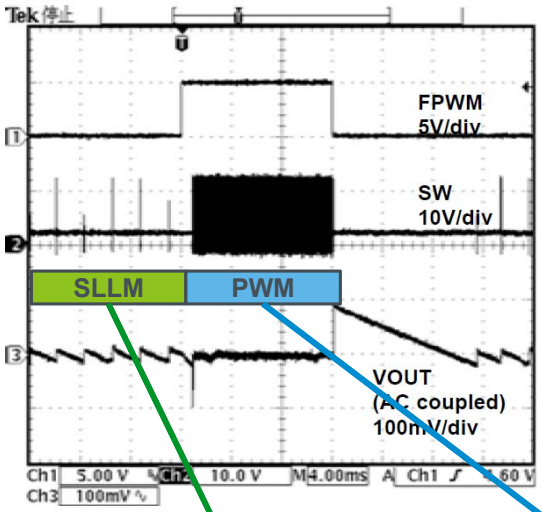
Current Mode PWM Control Diagram



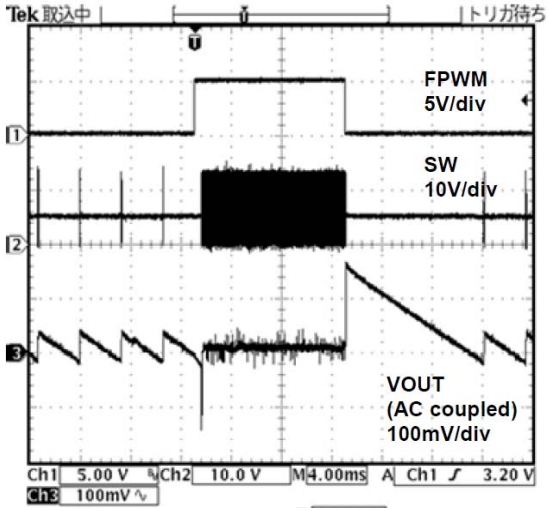
SLLM Switching Timing Chart



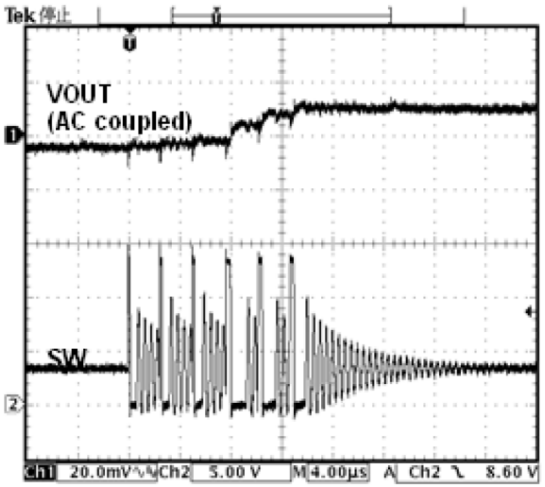
PWM Switching Timing Chart



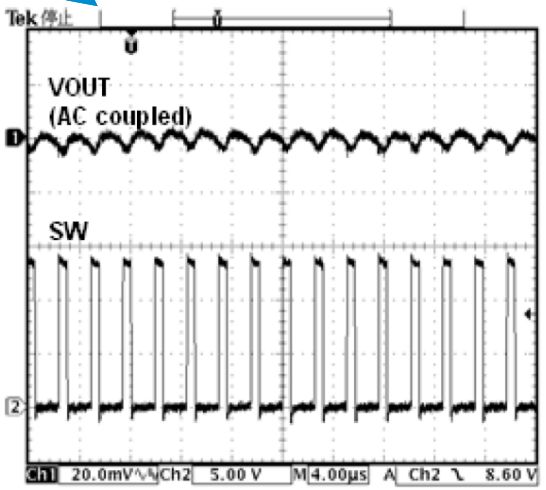
BD99010EFV-M Mode Transition
(SLLM to PWM)



BD99011EFV-M Mode Transition
(SLLM to PWM)



SW and VOUT Waveforms at SLLM
(Light load)

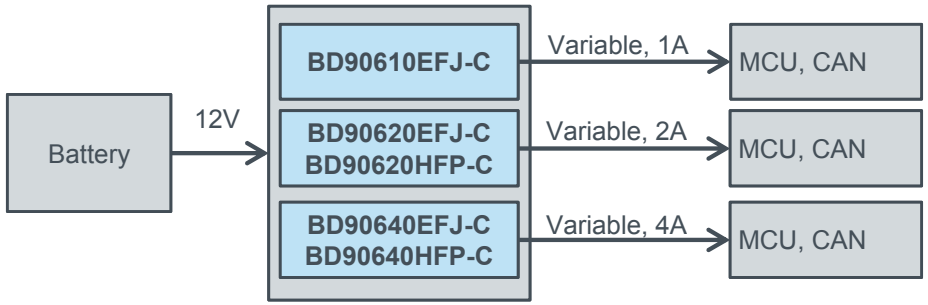


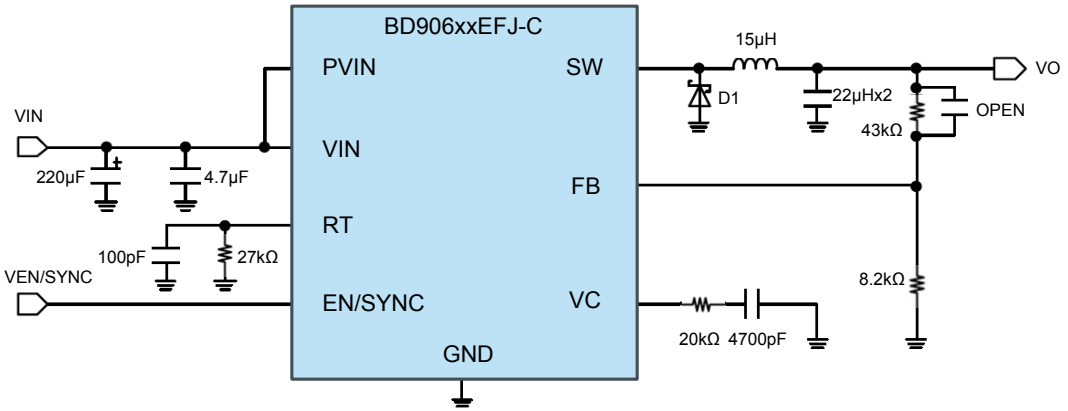
SW and VOUT Waveforms at PWM
(Heavy load)

SLLM™ control at light loads differs from regular PWM, resulting in higher output ripple voltage. Also, during SLLM™ the transient response for heavy loads is slower.

Low Voltage Operation Solutions

The BD906xxEFJ-C series of step-down switching regulators integrate a high voltage power MOSFET and make it possible to easily set the operating frequency via external resistor. Features include wide input voltage (3.5V to 36V) and operating temperature (-40˚C to +125˚C) ranges, along with an external synchronization input pin that enables synchronous operation via external clock.
In addition, the internal Pch MOSFET can operate at 100% ON duty to ensure stable operation even during severe battery drops during conventional cranking or idling stop operation.





BD906xxEFJ-C Application Circuit

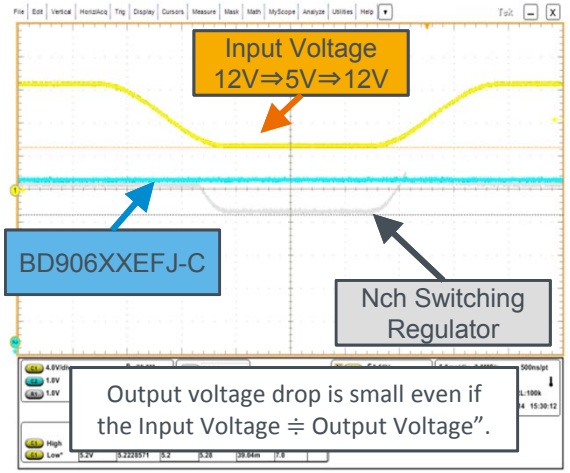
Product Overview: BD906xxEFJ-C/HFP-C

HTSOPJ-8
BD906xxEFJ-C

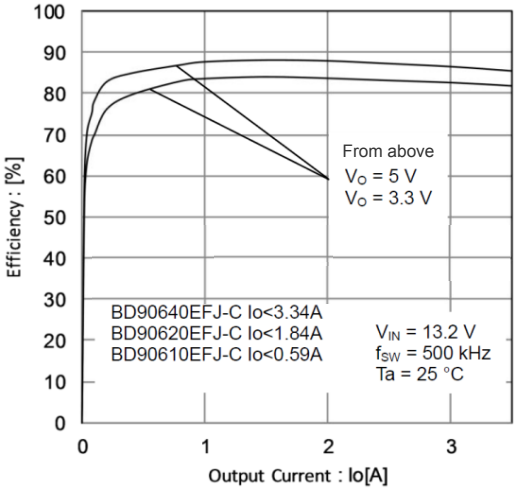
Wide Input Voltage Range

- Input voltage range: 3.5V to 36V (42V rating) (Initial startup over 3.9V)
- Built-in Pch FET enables 100% duty
- Circuit current at shutdown: 0µA (Typ.)
- Reference voltage: 0.8V±2% (Ta: -40˚C to +125˚C) 0.8V±1% (Ta: 25˚C)
- Switch output current: 1.25A Max. (BD90610EFJ-C) 2.5A Max. (BD90620EFJ-C/HFP-C) 4A Max. (BD90640EFJ-C/HFP-C)
- Switching frequency: 50k to 600kHz
- Internal switching FET: Pch 160mΩ (Typ.)
- Soft Start function
- Enable pin compatible with CMOS logic and battery voltages
- Current mode control with external compensation circuit
- Over Current/Short Circuit protection, Under Voltage Lock Out, and Thermal Shutdown circuits

HRP7
BD906xxHFP-C



BD906xxEFJ-C Output Waveform in Input Voltage Change



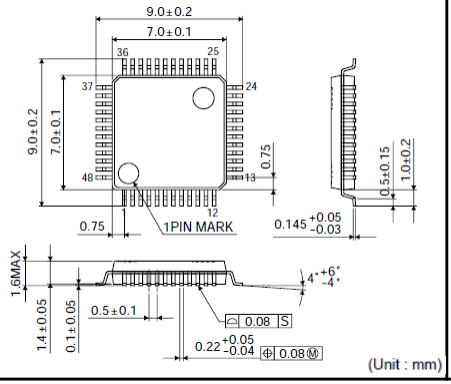
BD906xxEFJ-C Efficiency vs Load Current VIN=13.2V

Primary Switching Regulator Selection Guide

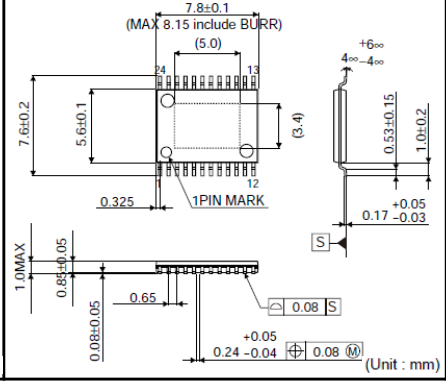
Part No.	Number of Channels	Output FET		Rated Voltage (V)	Output Current (A) Max.	Input Voltage Range (V)			Output Voltage (V) Typ.	Reference (Output) Voltage Accuracy (%)	Switching Frequency		Control Mode	Operating Circuit Current (mA) Typ.	Functions								Operating Temperature Range (°C)	Package
		High Side (Typ.)	Low Side (Typ.)			Start	Min.	Max.			Range (kHz)	Accuracy (%)			Power Good	External Synchronization	Variable Soft Start	Synchronous Rectification	Simple Light Load Mode	Over Current Protection	Thermal Shutdown	Overvoltage Protection		
BD9015KV-M	2	Ext. Nch	Ext. Nch	35	-	4.5	3.9	30	Variable (0.8-10)	±1.5	250 ~ 550	±10	Current	4	✓	✓	✓	✓	-	SR	SR	✓	-40 ~ 105	VQFP48C
BD9016KV-M	2	Ext. Nch	Ext. Nch	35	-	4.5	3.9	30	Variable (0.8-10)	±1.5	250 ~ 550	±10	Current	4	✓	✓	✓	✓	-	SR	SR	✓	-40 ~ 105	VQFP48C
BD99010EFV-M	1	Pch (170mΩ)	Nch (130mΩ)	42	2.0	3.9	3.6	35	3.3	(±2.0)	200 ~ 500	±20	Current	0.02	-	-	-	✓	✓	SR	SR	✓	-40 ~ 105	HTSSOP-B24
BD99011EFV-M	1	Pch (170mΩ)	Nch (130mΩ)	42	2.0	3.9	3.6	35	5.0	(±2.0)	200 ~ 500	±20	Current	0.02	-	-	-	✓	✓	SR	SR	✓	-40 ~ 105	HTSSOP-B24
BD9060F-C	1	Pch (300mΩ)	-	42	2.0	5.0	5.0	35	Variable (0.8-VIN)	±2.0	50 ~ 550	±5	Voltage	4.5	-	✓	-	-	-	SR	SR	-	-40 ~ 125	SOP8
BD9060HFP-C	1	Pch (300mΩ)	-	42	2.0	5.0	5.0	35	Variable (0.8-VIN)	±2.0	50 ~ 550	±5	Voltage	4.5	-	✓	-	-	-	SR	SR	-	-40 ~ 125	HRP7
BD90640HFP-C	1	Pch (160mΩ)	-	42	4.0	3.9	3.5	36	Variable (0.8-VIN)	±2.0	50 ~ 600	±10	Current	2.2	-	✓	✓	-	-	SR	SR	-	-40 ~ 125	HRP7
BD90640EFJ-C	1	Pch (160mΩ)	-	42	4.0	3.9	3.5	36	Variable (0.8-VIN)	±2.0	50 ~ 600	±10	Current	2.2	-	✓	✓	-	-	SR	SR	-	-40 ~ 125	HTSOP-J8
BD90620HFP-C	1	Pch (160mΩ)	-	42	2.5	3.9	3.5	36	Variable (0.8-VIN)	±2.0	50 ~ 600	±10	Current	2.2	-	✓	✓	-	-	SR	SR	-	-40 ~ 125	HRP7
BD90620EFJ-C	1	Pch (160mΩ)	-	42	2.5	3.9	3.5	36	Variable (0.8-VIN)	±2.0	50 ~ 600	±10	Current	2.2	-	✓	✓	-	-	SR	SR	-	-40 ~ 125	HTSOP-J8
BD90610EFJ-C	1	Pch (160mΩ)	-	42	1.25	3.9	3.5	36	Variable (0.8-VIN)	±2.0	50 ~ 600	±10	Current	2.2	-	✓	✓	-	-	SR	SR	-	-40 ~ 125	HTSOP-J8

※ SR : Self Recovery , L : Latch

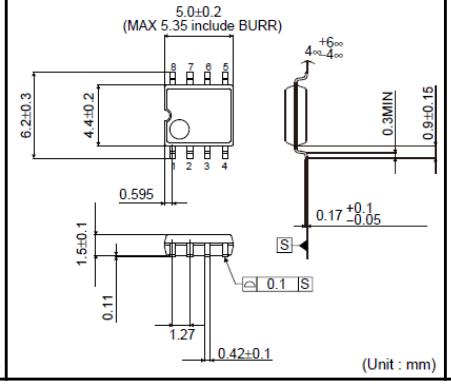
VQFP48C



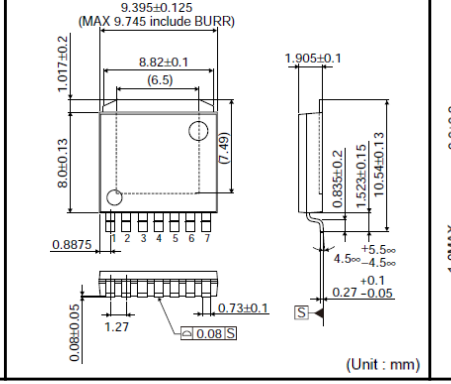
HTSSOP-B24



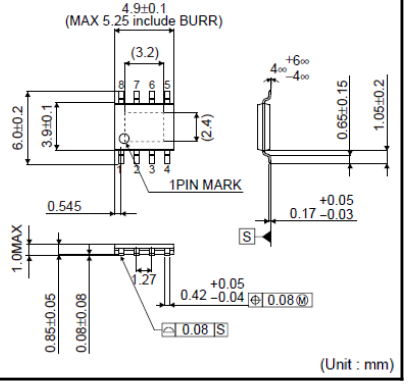
SOP8



HRP7



HTSOP-J8



Compact
Large Current

Space-Saving High Efficiency Solutions

The BD905x1 series is synchronous step-down converter which operates in current mode. It can operate with maximum frequency of 2.4 MHz, and can downsize external parts such as inductor. Oscillation frequency can be adjusted by external resistors and can also be synchronized with an external clock. Furthermore, this switching regulator adopted the small size VQFN20S4040 package, contributes to reduced the mounting area.

Product Overview: BD905x1FEV / MUV-C

- Synchronous rectification type
- Switching frequency: 0.3M to 2.4MHz ±15%
  Synchronous operation via external clock is possible.
- Input voltage range: 2.6V to 5.5V (7V Rating)
- Integrated SW FET: Pch 90mΩ (Typ.), Nch 60mΩ (Typ.)
- Current mode control
- Over Current/Short Circuit protection, VOUT Over Voltage protection, Under Voltage Lock Out, and thermal protection circuits

HTSSOP-B20

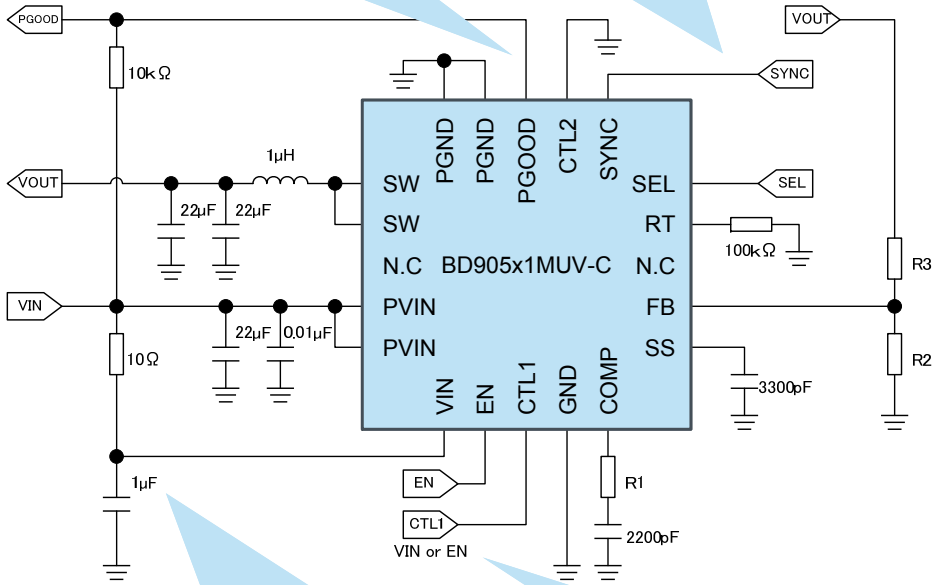
VQFN20SV4040

Output Current	Output (Reference) Voltage	
	0.8V±1.5%	
2A	BD90521EFV-C	BD90521MUV-C
4A	—	BD90541MUV-C

BD905x1FEV-C / MUV-C Lineup

PGOOD pin is an open-drain pin, it should be connected GND when not in use.

SYNC pin and SEL pin are being pull-down internally, these pins should be connected when not in use.



VIN pin is used as the power supply of the internal control circuit, in order to prevent malfunction due to transient change of VIN, input filter is required at this pin. If the value of RIN is large, the internal circuit current and this resistor will cause the voltage drop, please use RIN=10Ω and CIN2=1uF for the input filter.

CTL1 pin and CTL2 pin are test pins. Please connect CTL1 pin to VIN or EN,and connect CTL2 pin to GND.

BD90521MUV-C Application Circuit

BD90521MUV-C（Vo=1.2V）
Application Sample Circuit 1

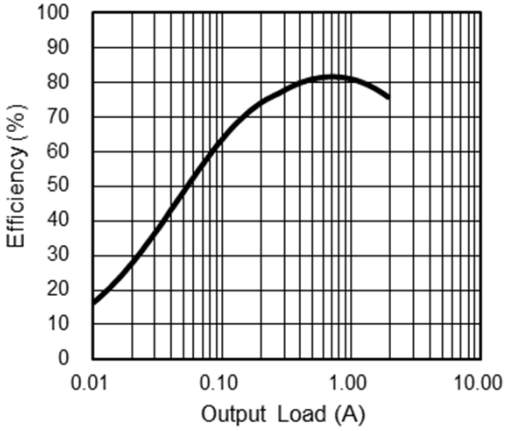
Symbol	Parameter
R1	10kΩ
R2	30kΩ
R3	30kΩ

BD90521MUV-C（Vo=3.3V）
Application Sample Circuit 2

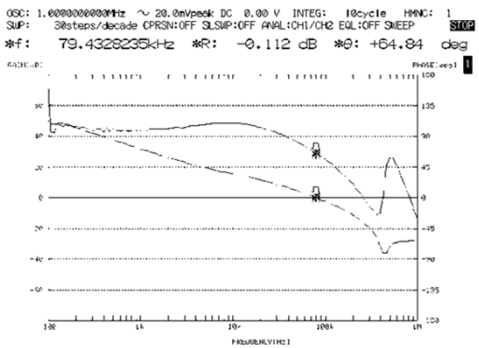
Symbol	Parameter
R1	20kΩ
R2	10kΩ
R3	45kΩ

BD90521MUV-C Application Sample Circuit 1（VO=1.2V）

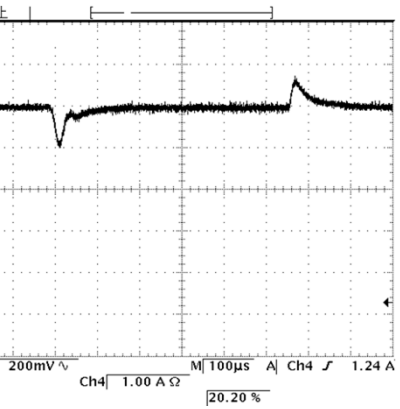
Parameter	Symbol	Conditions
Input Power Supply Voltage	VIN	5V
Output Voltage / Current	Vo / Io	1.2V / 2A
Switching Frequency	fsw	2.0MHz
Soft Start Time	Tss	1ms
Operating Temperature Range	Ta	-40 ～ +105°C



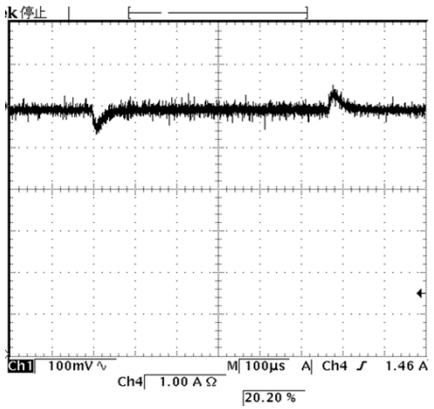
Efficiency vs Load current



Frequency characteristic , Io = 2A



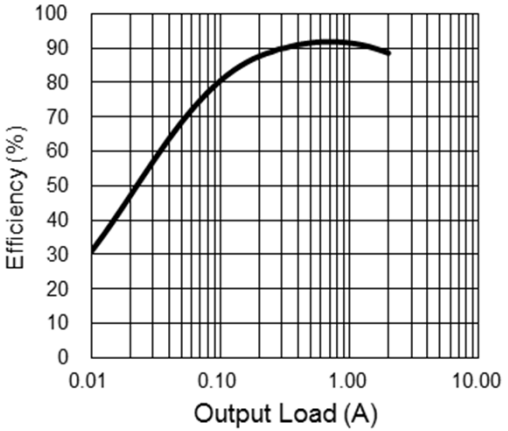
Load Response , Io = 0A ⇔ 2A



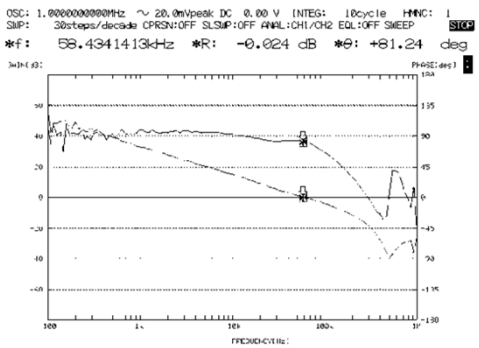
Load Response , Io = 1A ⇔ 2A

BD90521MUV-C Application Sample Circuit 2（VO=3.3V）

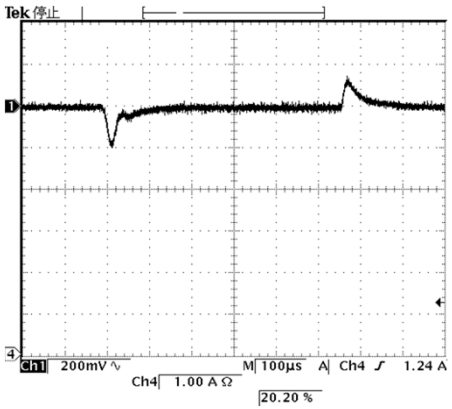
Parameter	Symbol	Conditions
Input Power Supply Voltage	VIN	5V
Output Voltage / Current	Vo / Io	3.3V / 2A
Switching Frequency	fsw	2.0MHz
Soft Start Time	Tss	1ms
Operating Temperature Range	Ta	-40 ～ +105°C



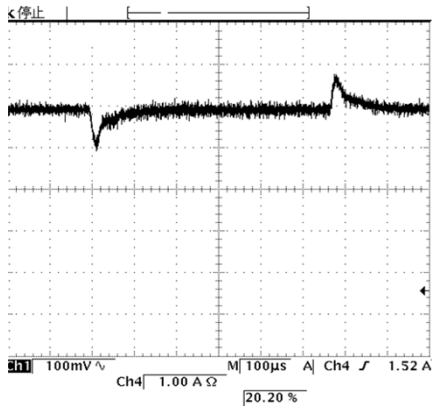
Efficiency vs Load current



Frequency characteristic , Io = 2A



Load Response , Io = 0A ⇔ 2A

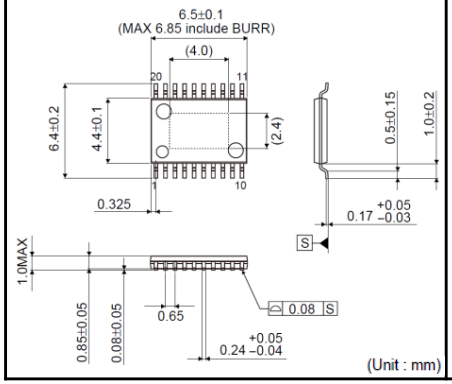
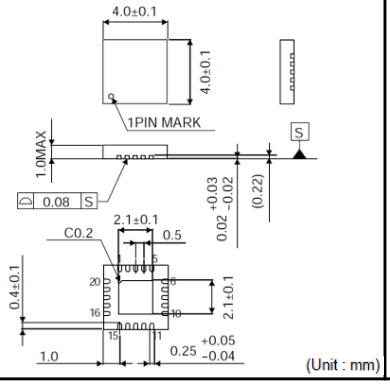


Load Response , Io = 1A ⇔ 2A

Secondary Switching Regulator Selection Guide

Part No.	Number of CH	Output FET		Rated Voltage (V)	Output Current (A) Max.	Input Voltage Range (V)		Output Voltage (V) Typ.	Reference (Output) Voltage Accuracy (%)	Switching Frequency		Control Mode	Operating Circuit Current (mA) Typ.	Functions								Operating Temperature Range (°C)	Package
		High Side (Typ.)	Low Side (Typ.)			Min.	Max.			Range (MHz)	Accuracy (%)			Power Good	External Synchronization	Variable Soft Start	Synchronous Rectification	Simple Light Mode	Over Current Protection	Thermal Shutdown	Overvoltage Protection		
New BD90541MUV-C	1	Pch (90mΩ)	Nch (60mΩ)	7	4.0	2.6	5.5	Variable (0.6-5.0)	±1.5	0.3～2.4	±15	Current	0.7	✓	✓	✓	✓	✓	SR	SR	✓	-40 ～ 125	VQFN20SV4040
New BD90521EFV-C	1	Pch (90mΩ)	Nch (60mΩ)	7	2.0	2.6	5.5	Variable (0.6-5.0)	±1.5	0.3～2.4	±15	Current	0.7	✓	✓	✓	✓	✓	SR	SR	✓	-40 ～ 125	HTSSOP-B20
New BD90521MUV-C	1	Pch (90mΩ)	Nch (60mΩ)	7	2.0	2.6	5.5	Variable (0.6-5.0)	±1.5	0.3～2.4	±15	Current	0.7	✓	✓	✓	✓	✓	SR	SR	✓	-40 ～ 125	VQFN20SV4040

※ SR : Self Recovery

HTSSOP-B20	VQFN20SV4040			
				
				

Buck-Boost Switching Regulator Controller （BD9035AEFV-C)

Low Voltage Operation

Buck-Boost Automatic Switching Control Solution for Low Voltage Drive

The BD9035 buck-boost switching controller features high withstand voltage, a wide input range (VIN=3.8 to 30V), and is capable of generating buck-boost output using only one inductor. Boost-buck automatic switching control improves efficiency over conventional REGSPIC switching regulators. In addition, high switching frequency accuracy (±7%) is achieved throughout the entire operating temperature range (Ta=-40˚C to +125˚C).

Product Overview: BD9035AEFV-C

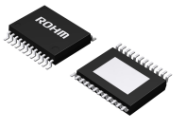
Buck-boost output possible with only one inductor

Automatic Boost/Boost-Buck/Buck switching improves efficiency

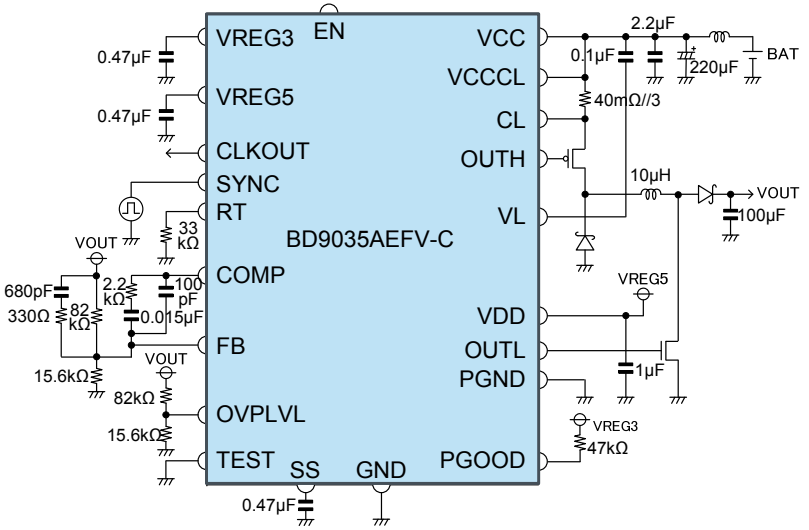
- 3-mode automatic switching control

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

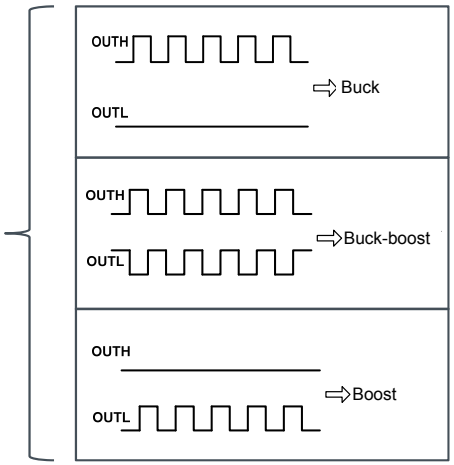
- High switching frequency accuracy: ±7% (-40˚C to +125˚C)
- PLL enables a wide external synchronous frequency range: 100k to 600kHz
- Input voltage range: 3.8V to 30V (40V rating)
- Oscillation frequency range: 100k to 600kHz
- Two-stage overcurrent protection through one external resistor
- Output undervoltage/overvoltage protection and Power Good



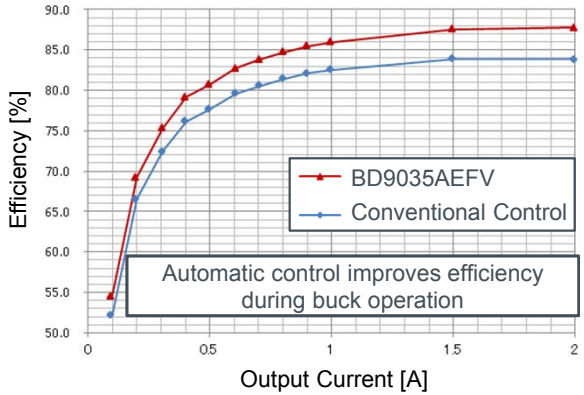
HTSSOP-B24



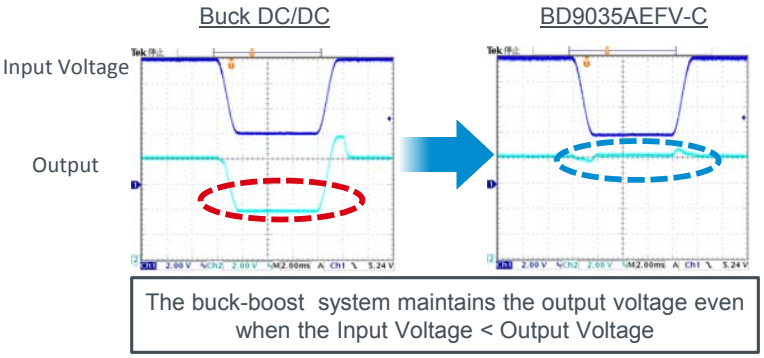
BD9035AEFV-C Application Circuit



External MOS Gate Waveforms for Each Mode



BD9035AEFV-C Efficiency vs Load Current
VIN=12V , VOUT=6V , f=350kHz

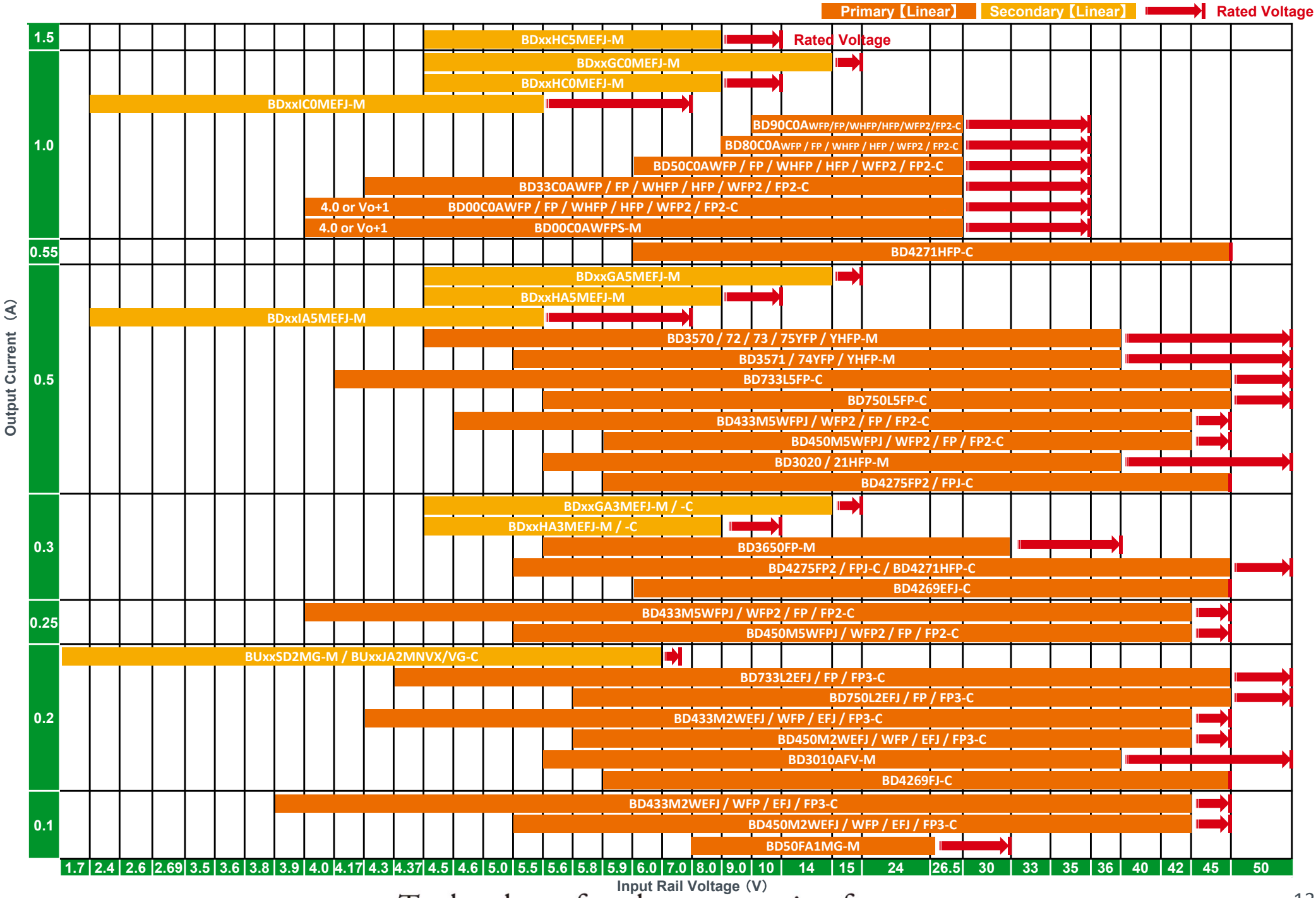


BD9035AEFV-C Input vs Output Voltage
VIN=10V , VOUT=8V , f=350kHz

Part No.	Number of Channels	Output Control Method		Maximum Input Voltage (V)	Output Current (A) Max.	Input Voltage Range (V)			Output Voltage (V) Typ.	Reference (Output) Voltage Accuracy (%)	Switching Frequency		Control Mode	Operating Circuit Current (mA) Typ.	Functions									Operating Temperature Range (˚C)	Package
		Pch Controller	Nch Controller			Start	Min.	Max.			Range (kHz)	Accuracy (%)			Power Good	External Synchronization	Variable Soft Start	Synchronous Rectification	Simple Light Load Mode	Over Current Protection	Thermal Shutdown	Overvoltage Protection		
BD9035AEFV-C	1	Push-Pull	Push-Pull	40	-	4.5	3.8	30	Variable	±1.5	100 ～ 600	±7	Voltage	7	✓	✓	✓	-	-	SR	SR	✓	-40 ～ 125	HTSSOP-B24

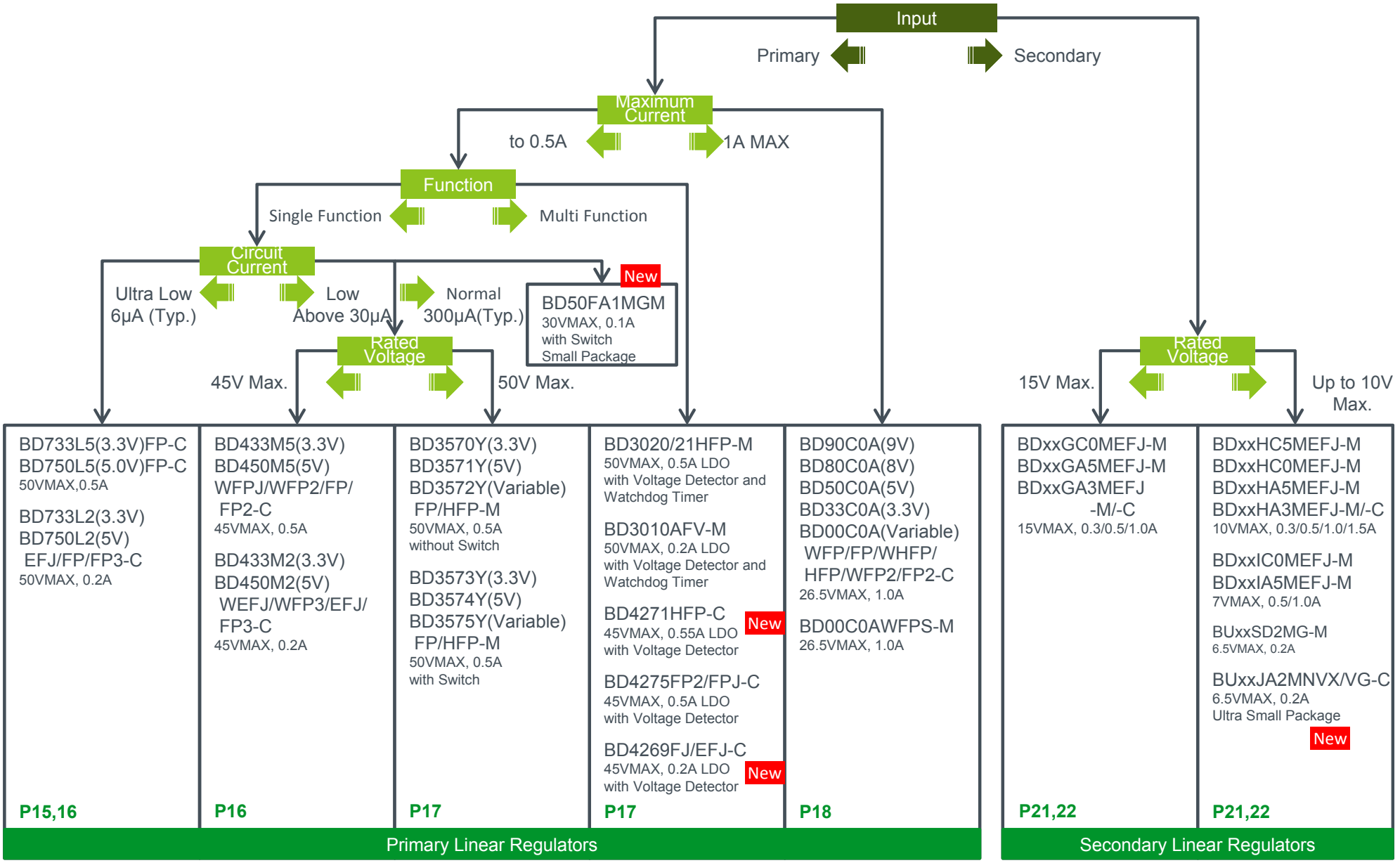
※ SR：Self Recovery

Automotive Linear Regulator Lineup



Automotive Linear Regulator Product Family

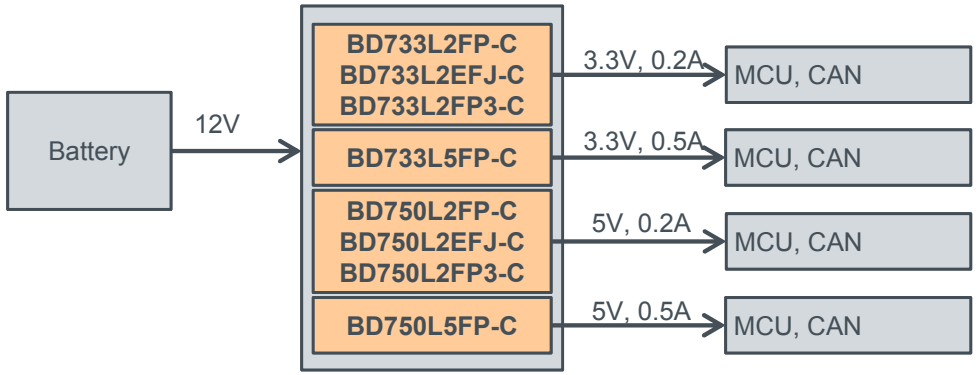
AEC-Q100 Qualified

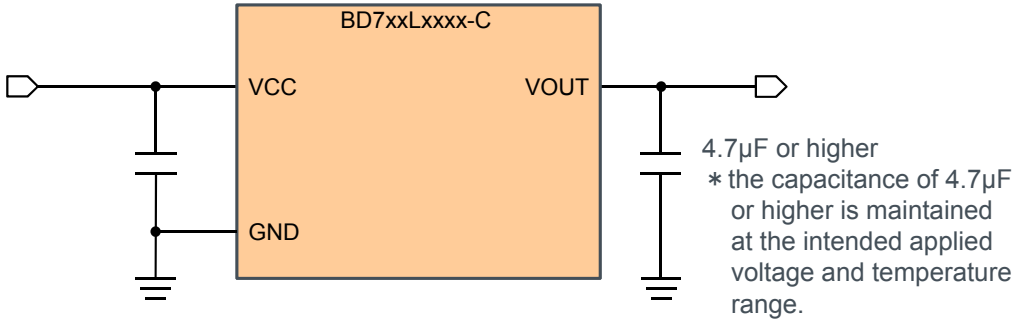


Low Quiescent Current

Low Quiescent Current Solutions

The BD7xxLxxxx-C series of low quiescent current regulators features a rated voltage of 50V, 200/500mA output current, an output voltage accuracy of ±2%, and current consumption of only 6μA (Typ.).
There regulators are therefore ideal for applications requiring a direct connection to the battery and a low current consumption. Ceramic capacitors can be used for compensation of the output capacitor phase.
Furthermore, these ICs also feature overcurrent protection to protect the device from damage caused by short-circuiting and an integrated thermal shutdown to protect the device from Overheating at overload conditions.

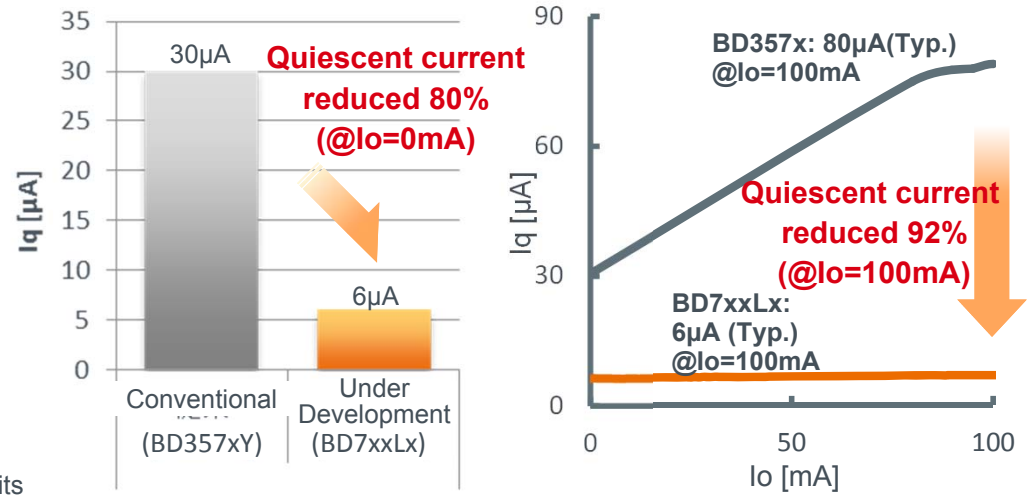




BD7xxLxxxx-C Application Circuit

Product Overview: BD7xxLxxxx-C

- Ultra-low quiescent current: 6μA (Typ.)
- Output transistor : Low saturation Pch DMOS (3Ω Typ.)
- VCC maximum voltage : 50V
- Output current : 200mA (Max.) / 500mA (Max.)
- Output voltage : 3.3V±2% / 5.0V±2%
- Enables low ESR ceramic capacitors to be used for output phase compensation
- Integrated output current control circuit protects the IC against damage due to short circuits
- Built-in thermal shutdown prevents IC overheating due to overload conditions.



BD7xxLxxxx-C Quiescent Current Comparison

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

HTSOPJ-8
BD733L2EFJ-C
BD750L2EFJ-C

SOT223-4
BD733L2FP3-C
BD750L2FP3-C

Primary Linear Regulator Selection Guide

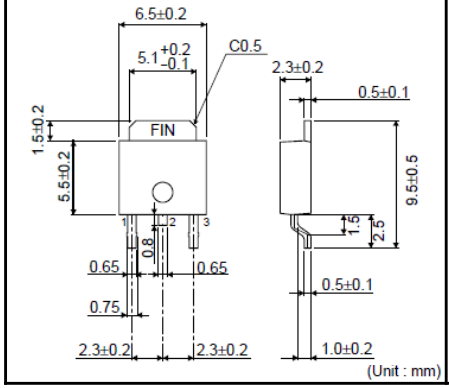
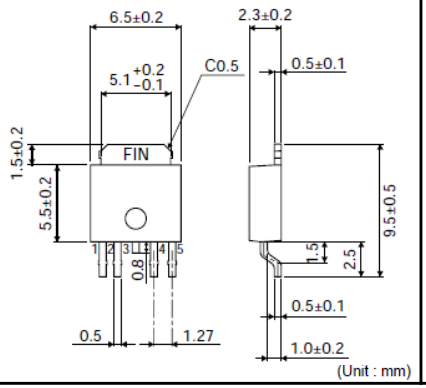
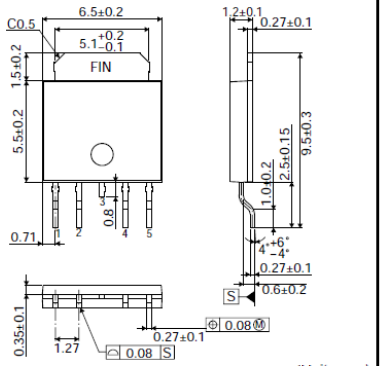
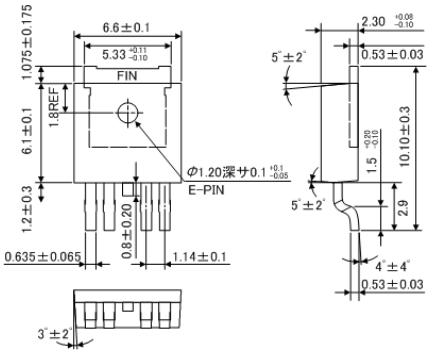
Part No.	Rated Voltage (V)	Input Voltage Range (V)		Output Voltage (V) Typ.	Output Current (A) Max.	Output Voltage Accuracy (%)	Dropout Voltage (V) Typ.	Circuit Current (μA) Typ.	Shutdown Switch	Others	Functions					Operating Temperature Range (℃)	Package
		Min.	Max.								Variable Detection Voltage	Fixed Detection Voltage	Detection Accuracy (%)	WDT	WDT (Switchable)		
BD733L2FP-C	50	4.37	45	3.3	0.20	±2	0.60@0.20A	6	-	-	-	-	-	-	-	-40～+125@Ta	TO252-3
BD733L2EFJ-C									-	-	-	-	-	-	-		HTSOP-J8
BD733L2FP3-C									-	-	-	-	-	-	-		SOT223-4
BD733L5FP-C		4.17			0.50		0.40@0.20A		-	-	-	-	-	-	-		TO252-3
BD750L2FP-C		5.8		5.0	0.20		0.40@0.20A		-	-	-	-	-	-	-		TO252-3
BD750L2EFJ-C									-	-	-	-	-	-	-		HTSOP-J8
BD750L2FP3-C									-	-	-	-	-	-	-		SOT223-4
BD750L5FP-C		5.6			0.50		0.25@0.20A		-	-	-	-	-	-	-		TO252-3
BD433M2EFJ-C	45	4.3 @0.20A / 3.9 @0.10A	42	3.3	0.20	±2	0.20@0.10A	40	-	-	-	-	-	-	-	-40～+150@Tj	HTSOP-J8
BD433M2FP3-C									-	-	-	-	-	-	-		SOT223-4
BD433M2WEFJ-C									Internal	-	-	-	-	-	-		HTSOP-J8
BD433M2WFP3-C									Internal	-	-	-	-	-	-		SOT223-4
BD433M5FP-C		4.6 @0.50A / 4.0 @0.25A			0.50		0.25@0.30A	38	-	-	-	-	-	-	-		TO252-3
BD433M5FP2-C									-	-	-	-	-	-	-		TO263-3
BD433M5WFP2-C									Internal	-	-	-	-	-	-		TO263-5
BD433M5WFPJ-C									Internal	-	-	-	-	-	-		TO252-J5
BD450M2EFJ-C		5.8 @0.20A / 5.5 @0.10A		5.0	0.20		0.16@0.10A	40	-	-	-	-	-	-	-		HTSOP-J8
BD450M2FP3-C									-	-	-	-	-	-	-		SOT223-4
BD450M2WEFJ-C									Internal	-	-	-	-	-	-		HTSOP-J8
BD450M2WFP3-C									Internal	-	-	-	-	-	-		SOT223-4
BD450M5FP-C		5.9 @0.50A / 5.5 @0.25A			0.50		0.20@0.30A	38	-	-	-	-	-	-	-		TO252-3
BD450M5FP2-C									-	-	-	-	-	-	-		TO263-3
BD450M5WFP2-C									Internal	-	-	-	-	-	-		TO263-5
BD450M5WFPJ-C									Internal	-	-	-	-	-	-		TO252-J5
New BD50FA1MG-M	30	Vo+3.0	25	5.0	0.10	±2	3.00@0.10A	300	Internal	-	-	-	-	-	-	-40～+105@Ta	SSOP5

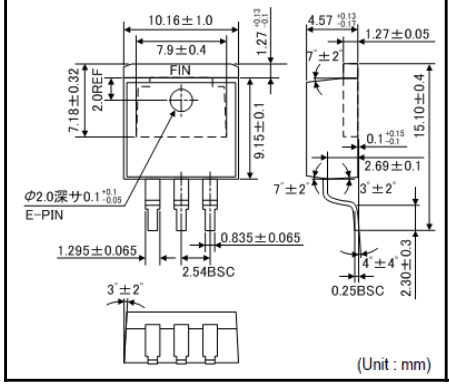
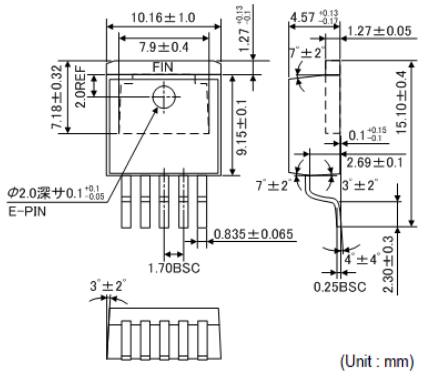
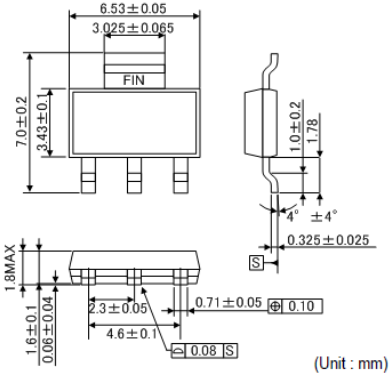
Primary Linear Regulator Selection Guide

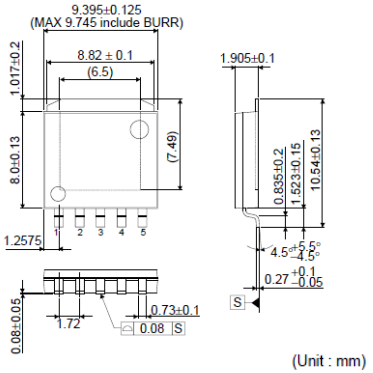
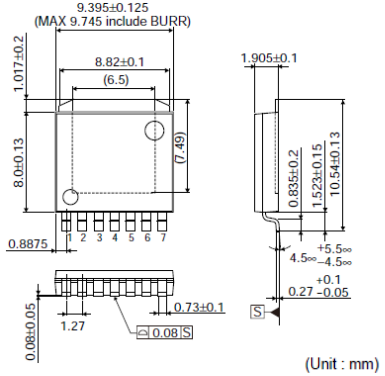
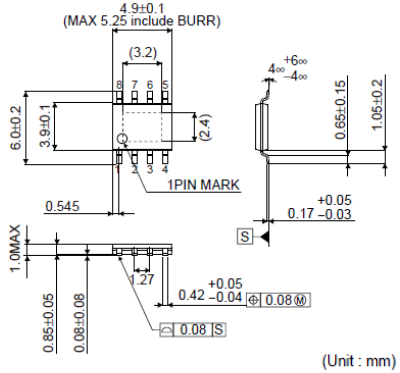
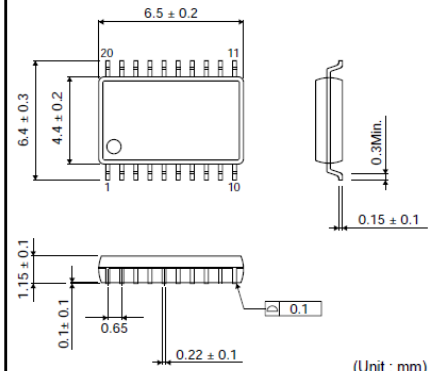
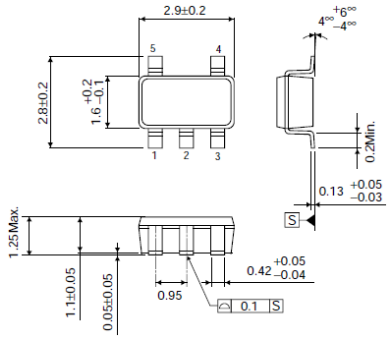
Part No.	Rated Voltage (V)	Input Voltage Range (V)		Output Voltage (V) Typ.	Output Current (A) Max.	Output Voltage Accuracy (%)	Dropout Voltage (V) Typ.	Circuit Current (μA) Typ.	Shutdown Switch	Others	Functions					Operating Temperature Range (°C)	Package
		Min.	Max.								Variable Detection Voltage	Fixed Detection Voltage	Detection Accuracy (%)	WDT	WDT (Switchable)		
BD3570YFP-M	50	4.5	36	3.3	0.50	±2	-	30	-	-	-	-	-	-	-	-40～+125@Ta	TO252-5
BD3571YFP-M				5.0			0.25@0.20A			-	-	-	-	-	-		
BD3572YFP-M				Variable (2.8-12.0)						-	-	-	-	-	-		
BD3573YFP-M				3.3			-		Internal	-	-	-	-	-	-		
BD3574YFP-M				5.0			0.25@0.20A			-	-	-	-	-	-		
BD3575YFP-M				Variable (2.8-12.0)						-	-	-	-	-	-		
BD3570YHFP-M				3.3			-		-	-	-	-	-	-	-		HRP5
BD3571YHFP-M				5.0			0.25@0.20A			-	-	-	-	-	-		
BD3572YHFP-M				Variable (2.8-12.0)						-	-	-	-	-	-		
BD3573YHFP-M				3.3			-		Internal	-	-	-	-	-	-		
BD3574YHFP-M				5.0			0.25@0.20A			-	-	-	-	-	-		
BD3575YHFP-M				Variable (2.8-12.0)						-	-	-	-	-	-		
BD3650FP-M	36	5.6	30	5.0	0.30	±2	0.20@0.20A	500	-	-	-	-	-	-	-	-40～+125@Ta	TO252-3
BD3020HFP-M	50	5.6	36	5.0	0.50	±2	0.30@0.20A	80	-	-	✓	4.10	±2	✓	-	-40～+125@Ta	HRP7
BD3021HFP-M											-	4.50	±2	-	✓		HRP7
BD3010AFV-M	50	6.0	36	5.0	0.20	±2	0.25@0.15A	80	-	-	✓	4.25	±3		✓	-40～+125@Ta	SSOP-B20
BD4275FP2-C	45	5.5@0.3A / 5.9@0.5A	45	5.0	0.50	±2	0.25@0.30A	65	-	-	-	4.62	-2.6 / +2.8	-	-	-40～+125@Ta -40～+150@Tj	TO263-5
BD4275FPJ-C																	TO252-J5
BD4269FJ-C	45	5.5	45	5.0	0.20	±2	0.25@0.10A	70	-	-	✓	4.62	±2.6	-	-	-40～+125@Ta -40～+150@Tj	SOP-J8
New BD4269EFJ-C					0.30												HTSOP-J8
New BD4271HFP-C	45	5.5@0.3A / 6.0@0.55A	45	5.0	0.55	±2	0.20@0.30A	75	有	-	-	4.65	±2.6	-	-	-40～+125@Ta -40～+150@Tj	HRP7

Part No.	Rated Voltage (V)	Input Voltage Range (V)		Output Voltage (V) Typ.	Output Current (A) Max.	Output Voltage Accuracy (%)	Dropout Voltage (V) Typ.	Circuit Current (μA) Typ.	Shutdown Switch	Others	Functions					Operating Temperature Range (℃)	Package
		Min.	Max.								Variable Detection Voltage	Fixed Detection Voltage	Detection Accuracy (%)	WDT	WDT (Switchable)		
BD00C0AWFPS-M	35	4.0 or Vo+1.0	26.5	Variable (3.0-15.0)	1.00	±3	0.30 @0.50A Vo ≥ 5.0	500	Internal	-	-	-	-	-	-	-40～+105@Ta	TO252S-5
BD33C0AFP-C	35	4.3	26.5	3.3	1.00	±3	-	500	-	-	-	-	-	-	-	-40～+125@Ta	TO252-3
BD33C0AFP2-C									-	-	-	-	-	-	-		TO263-3
BD33C0AHFP-C									-	-	-	-	-	-	-		HRP5
BD50C0AFP-C		6.0		5.0			0.30 @0.50A		-	-	-	-	-	-	-		TO252-3
BD50C0AFP2-C									-	-	-	-	-	-	-		TO263-3
BD50C0AHFP-C									-	-	-	-	-	-	-		HRP5
BD80C0AFP-C		9.0		8.0					-	-	-	-	-	-	-		TO252-3
BD80C0AFP2-C									-	-	-	-	-	-	-		TO263-3
BD80C0AHFP-C									-	-	-	-	-	-	-		HRP5
BD90C0AFP-C		10.0		9.0					-	-	-	-	-	-	-		TO252-3
BD90C0AFP2-C									-	-	-	-	-	-	-		TO263-3
BD90C0AHFP-C									-	-	-	-	-	-	-		HRP5
BD00C0AWFP-C		4.0 or Vo+1.0		Variable (1.0-15.0)			0.30@0.50A Vo ≥ 5.0		Internal	-	-	-	-	-	-		TO252-5
BD00C0AWFP2-C										-	-	-	-	-	-		TO263-5
BD00C0AWHFP-C										-	-	-	-	-	-		HRP5
BD33C0AWFP-C		4.3		3.3			-			-	-	-	-	-	-		TO252-5
BD33C0AWFP2-C										-	-	-	-	-	-		TO263-5
BD33C0AWHFP-C										-	-	-	-	-	-		HRP5
BD50C0AWFP-C		6.0		5.0			0.30@0.50A			-	-	-	-	-	-		TO252-5
BD50C0AWFP2-C										-	-	-	-	-	-		TO263-5
BD50C0AWHFP-C										-	-	-	-	-	-		HRP5
BD80C0AWFP-C		9.0		8.0						-	-	-	-	-	-		TO252-5
BD80C0AWFP2-C										-	-	-	-	-	-		TO263-5
BD80C0AWHFP-C										-	-	-	-	-	-		HRP5
BD90C0AWFP-C		10.0		9.0						-	-	-	-	-	-		TO252-5
BD90C0AWFP2-C										-	-	-	-	-	-		TO263-5
BD90C0AWHFP-C										-	-	-	-	-	-		HRP5

Primary Linear Regulator Selection Guide

TO252-3	TO252-5	TO252S-5	TO252-J5	
				
				

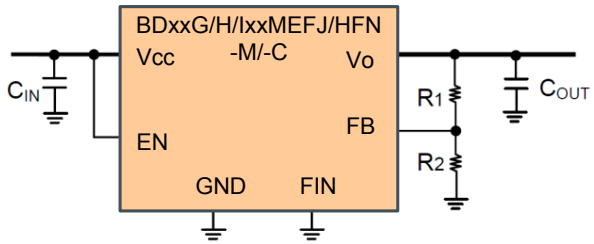
TO263-3	TO263-5	SOT223-4		
				
				

HRP5	HRP7	HTSOP-J8	SSOP-B20	SSOP5
				
				

Compact

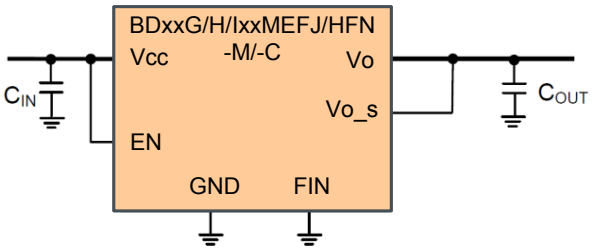
【BDxxG/H/IxxMEFJ/HFN-M/-C】

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



C_{IN},C_{OUT} : Ceramic Capacitor

Variable Output Type
Application Circuit

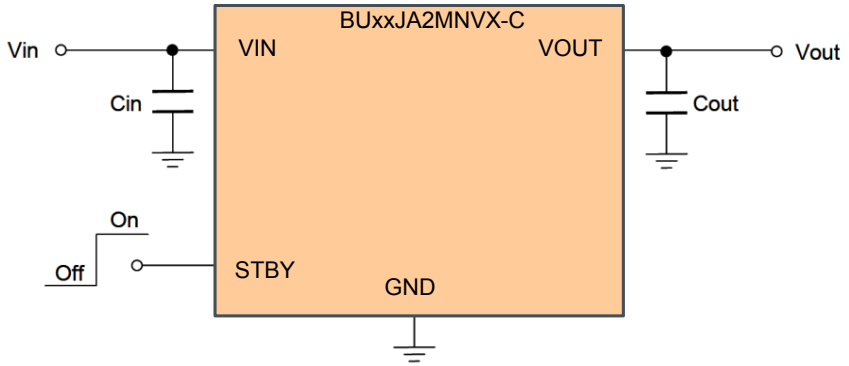


C_{IN},C_{OUT} : Ceramic Capacitor

Fixed Output Type
Application Circuit

【BUxxJA2MNVX-C】

Absolute Maximum Rating 6.5V



Application Circuit

Part No. Explanation/Overview: BDxxG/H/IxxEEFJ/HFN-M/-C

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

- Output Voltage: 00: ADJ, xx: Fixed
- Series (ABS max input voltage): G: 15V, H: 10V, I: 7V
- Output Current: A3 : 0.3A, A5 : 0.5A, C0 : 1.0A, C5 : 1.5A
- M: Automotive
- Package: EFJ: HTSOP-J8, HFN:HSON8
- Automotive Grade

- Shutdown circuit current: 0μA (Typ.)
- Output voltage accuracy: -M=±3% (Ta: -40˚C ~ +105˚C)
  -C=±2% (Ta: -40˚C ~ +125˚C)
- Internal standby function
- Enables the use of low ESR ceramic capacitors for output phase compensation (1.0μF Min.)
- Integrated output current control circuit protects the IC from damage due to output short circuits
- Built-in thermal shutdown to prevents IC overheating during overload

Product Overview: BUxxJA2MNVX-C

- Input Voltage Range: 1.7V to 6.0V (6.5V Rating)
- Low Quiescent Current: 35μA (Typ.)
- Output Current: 200mA (Max.)
- Output Voltage Accuracy: ±2% (Ta: -40˚C to +125˚C)
- High PSRR (Ripple Rejection): 70dB Typ.@1kHz
- Integrated Standby function
- Enables the use of low ESR ceramic capacitors for output phase compensation (0.22μF Min.)
- Integrated overcurrent protection protects the IC from damage due to output short circuits
- Built-in thermal shutdown function prevents IC overheating during overload

HTSOPJ-8

SSOP5

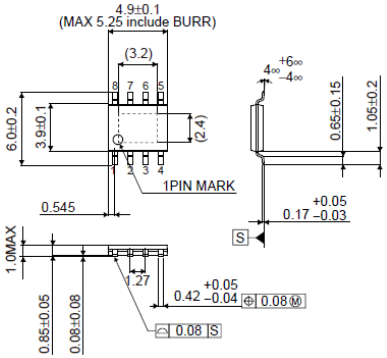
SSON004R1010

Technology for the automotive future

Secondary Linear Regulator Selection Guide

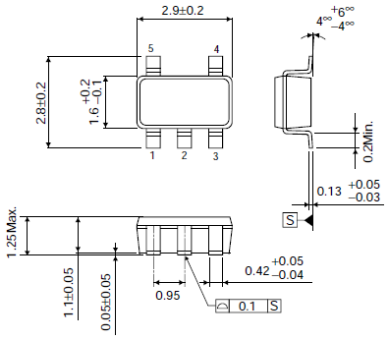
Part No.	Maximum Voltage (V)	Input Voltage Range (V)		Output Voltage (V) Typ.	Output Current (A) Max.	Output Voltage Accuracy (%)	Dropout Voltage (V) Typ.	Circuit Current (μA) Typ.	Shut-down Switch	Others	Functions					Operating Temperature Range (°C)	Package
		Min.	Max.								Variable Detection Voltage	Fixed Detection Voltage	Detection Accuracy(%)	WDT	WDT (Switchable)		
BDxxGC0MEFJ-M	15	4.5	14	Variable(1.5-13.0) / 1.5 / 1.8 / 2.5 / 3.0 / 3.3 / 5.0 / 6.0 / 7.0 / 8.0 / 9.0/10.0/12.0	1.00	±3	0.60@1.00A	600	Internal	-	-	-	-	-	-	-40～+105@Ta	HTSOP-J8
BDxxGA5MEFJ-M	15	4.5	14		0.50	±3	0.60@0.50A	600	Internal	-	-	-	-	-	-		HTSOP-J8
BDxxGA3MEFJ-M	15	4.5	14		0.30	±3	0.60@0.30A	600	Internal	-	-	-	-	-	-		HTSOP-J8
BDxxGA3MEFJ-C	15	4.5	14	Variable / 3.3 / 5.0	0.30	±2	0.60@0.30A	600	Internal	-	-	-	-	-	-	-40～+125@Ta	HTSOP-J8
BDxxHC5MEFJ-M	10	4.5	8.0	Variable(1.5-7.0) / 1.5 / 1.8 / 2.5 / 3.0 / 3.3 / 5.0 / 6.0 / 7.0	1.50	±3	0.60@1.50A	600	Internal	-	-	-	-	-	-		HTSOP-J8
BDxxHC0MEFJ-M	10	4.5	8.0		1.00	±3	0.60@1.00A	600	Internal	-	-	-	-	-	-	-40～+105@Ta	HTSOP-J8
BDxxHA5MEFJ-M	10	4.5	8.0		0.50	±3	0.60@0.50A	600	Internal	-	-	-	-	-	-		HTSOP-J8
BDxxHA3MEFJ-M	10	4.5	8.0		0.30	±3	0.60@0.30A	600	Internal	-	-		-	-	-		HTSOP-J8
BDxxHA3MEFJ-C	10	4.5	8.0		0.30	±2	0.60@0.30A	600	Internal	-	-	-	-	-	-	-40～+125@Ta	HTSOP-J8
BDxxIC0MEFJ-M	7	2.4	5.5	Variable(0.8-4.5) / 1.0 / 1.2 / 1.5 / 1.8 / 2.5 / 3.0 / 3.3	1.00	±3	0.40@1.00A	250	Internal	-	-	-	-	-	-	-40～+105@Ta	HTSOP-J8
BDxxIA5MEFJ-M	7	2.4	5.5		0.50	±3	0.40@0.50A	250	Internal	-	-	-	-	-	-		HTSOP-J8
BUxxSD2MG-M	6.5	1.7	6.0	1.2 / 1.5 / 1.8 / 2.5 / 2.8 / 3.0 / 3.3	0.20	±2	0.28 / 0.18 / 0.15 / 0.10 / 0.085@0.10A	33	Internal	-	-	-	-	-	-	-40～+105@Ta	SSOP5
New BUxxJA2MNVX-C	6.5	1.7	6.0	1.0 / 1.2 / 1.25 / 1.5	0.20	±54mV	0.8 / 0.6 / 0.44@0.20A	35	Internal	-	-	-	-	-	-	-40～+125@Ta	SSON004R1010
				1.8 / 2.5 / 2.8 / 2.85 / 3.0/ 3.3		±3	0.38 / 0.28 / 0.26 / 0.24 / 0.22 @0.20A										
New BUxxJA2VG-C	6.5	1.7	6.0	1.8 / 3.3	0.20	±2	0.16 / 0.085@0.10A	33	Internal	-	-	-	-	-	-		SSOP5

HTSOP-J8



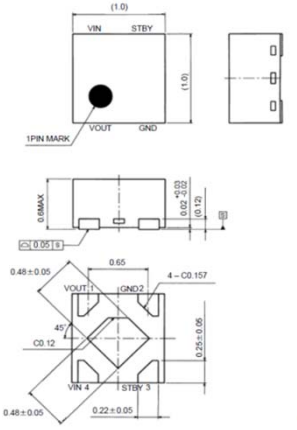
(Unit : mm)

SSOP5



(Unit : mm)

SSON004R1010



(Unit : mm)

Technology for the automotive future

Thermal Characteristics Noise

Thermal Resistance · Characteristics

The following definitions comply with JEDEC Standard JESD51

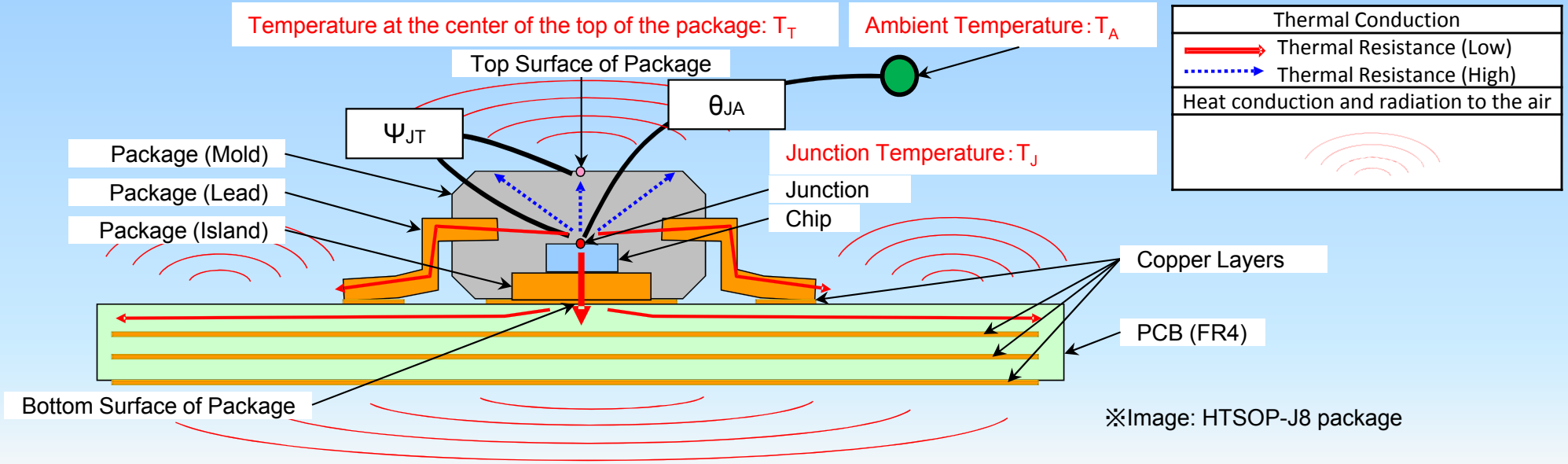
Symbol	Definition	Applications	Formula
θ_{JA}	Thermal resistance between junction temperature (T_J) and ambient temperature (T_A) when the package is mounted on a PCB.	Comparison of heat dissipation characteristics between different packages.	$\theta_{JA} = (T_J - T_A) / P$
Ψ_{JT}	Thermal characteristics parameter representing the temperature difference between the junction temperature (T_J) and the temperature of the center of the top surface of the package (T_T), caused by the power consumption (P) of the device.	Estimation of the junction temperature.	$\Psi_{JT} = (T_J - T_T) / P$
$\theta_{JC\text{-}TOP}$	The thermal resistance between the junction temperature (T_J) and the top surface of the package ($T_{C\text{-}TOP}$). Heat is dissipated only through the top surface of the package – all other pathways are insulated.	Can be used in simulations using the 2-resistance model.	$\theta_{JC\text{-}TOP} = (T_J - T_{C\text{-}TOP}) / P$
$\theta_{JC\text{-}BOT}$	The thermal resistance between the junction temperature (T_J) and the bottom surface of the package ($T_{C\text{-}BOT}$). Heat is dissipated only through the bottom surface of the package – all other pathways are insulated.	Used to estimate the junction temperature for packages where metal is exposed at the bottom for heat dissipation, since the majority of heat is dissipated through the bottom.	$\theta_{JC\text{-}BOT} = (T_J - T_{C\text{-}BOT}) / P$

Note 1: θ_{JA} and Ψ_{JT} are obtained when mounted on a JEDEC board.
Note 2: Data provided as θ_{JC} conventionally is Ψ_{JT} in this definition.

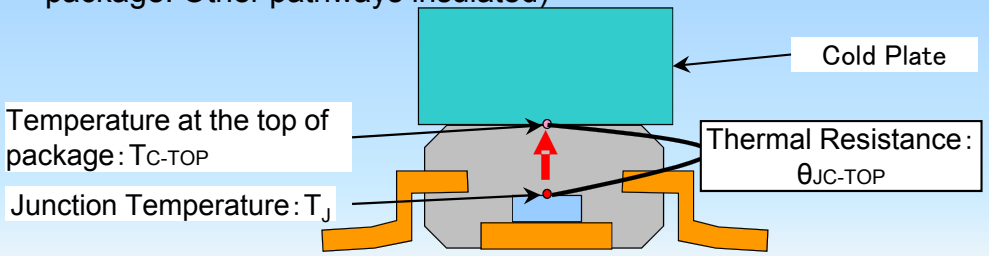
Thermal Resistance · Characteristics

Cf. JEDEC（JESD51）

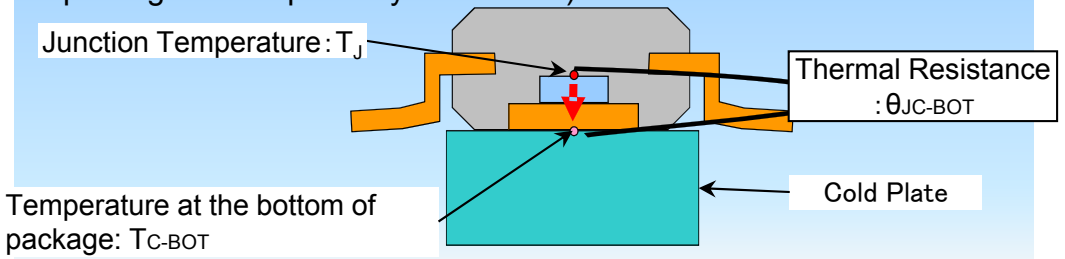
●θ_{JA}: Thermal resistance from the junction to the ambient environment (Heat conduction and radiation through multiple pathways)
●ψ_{JT}: Thermal characteristics parameter from the junction to the center of the top surface of the package
(Heat conduction not only through the top surface, but also any surface)



●$\theta_{JC\text{-}TOP}$: Thermal resistance from the junction to the top surface of the package. (Heat radiated only through top of package. Other pathways insulated)



●$\theta_{JC\text{-}BOT}$: Thermal resistance from the junction to the bottom surface of the package. (Heat radiated only through the bottom of package. Other pathways insulated.)



Thermal Characteristics **Noise**

Noise Characteristics · Tolerance

EMC (Electromagnetic Compatibility)

It is important that electronic devices: 1) Do not interfere with other devices, and 2) Are able to maintain normal performance even when receiving interference.
The need to balance both of these requirements gives rise to the term Electromagnetic Compatibility, which can be broken down into 2 components – EMI and EMS.

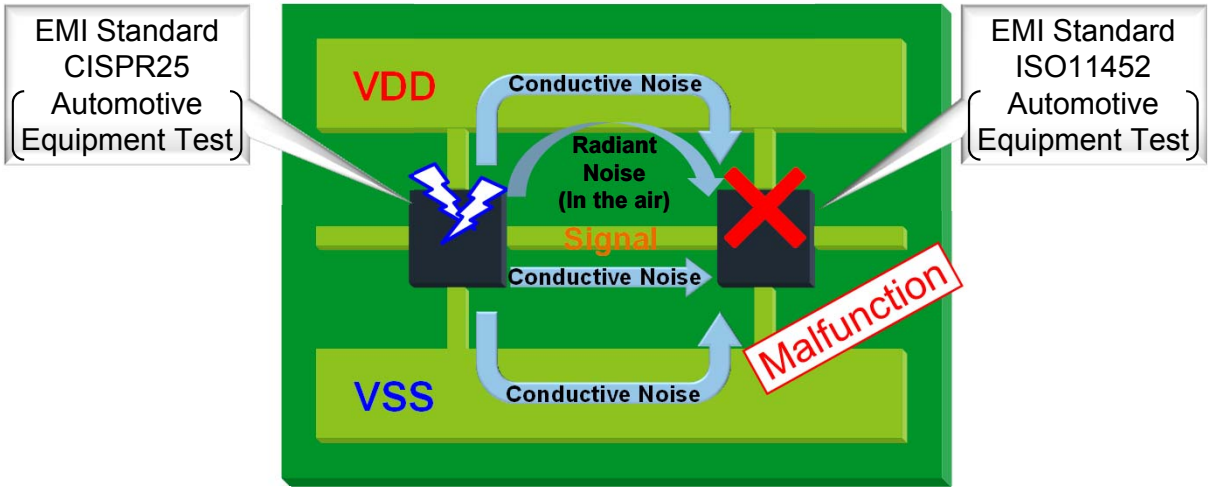
EMI (Electromagnetic Interference – Emission)

Operating the target IC may cause noise to be generated, which can lead to operation stoppage due to system and/or peripheral circuit malfunction.
To prevent this, delicate, complex circuit design is necessary.

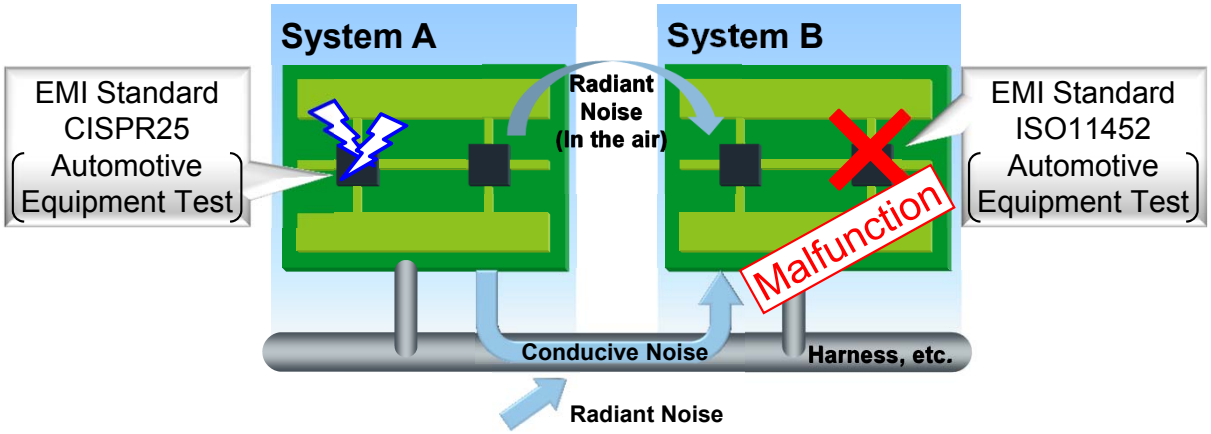
EMS (Electromagnetic Susceptibility – Immunity)

Conversely, peripheral IC and/or system operation may generate noise which can interfere with the target IC and lead to malfunction and cause operation to fail.
In this case robust circuit design is required.

EMC problems on the same board



EMC malfunction from external interference



PCB Design Checkpoints

Possible Concerns Regarding Improper DC/DC PCB Layout

EMC performance, PI（Power Integrity）decrease

Deterioration in basic performance (i.e. output voltage accuracy)

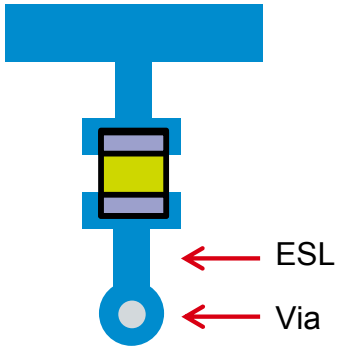
Unstable operation (e.g. oscillation, SW　waveform splitting）

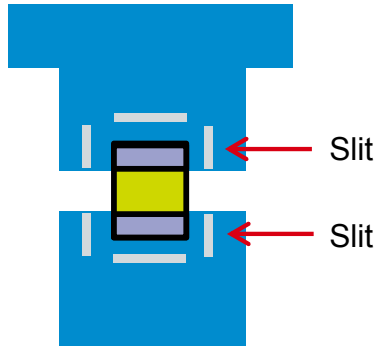
Recommendations on PCB Design

1. Power lines should be as short and wide as possible.
2. Please place the input decoupling (ceramic) capacitor as close as possible to the IC power supply-GND pin. (GND side of the IC power supply-SBD for chopper types) ⇒ Shortest AC current path
3. The resistor RT for determining the oscillating frequency should be located near to the GND pin (reference GND).
4. Position the feedback resistor for variable output voltage types as close to the feedback pin, shortening the wiring from the feedback resistor to the feedback terminal.
5. The feedback resistor should be located far from noise sources such as inductors and switching lines. It is good practice for dual-sided boards to place power components on the same side as the IC and the rest of the components on the other side. (When doing so, please do not pass the feedback line under the inductor.)
6. Separating power GND (SBD, input/output capacitor GND) and reference GND (RT, GND) will minimize the effects of switching noise. However, please make them common through a GND plane.
7. Do not use thermal relief whenever possible.
   ⇒ Deteriorating high frequency characteristics

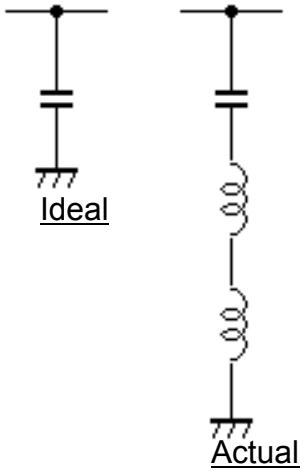
Notes on Thermal Relief

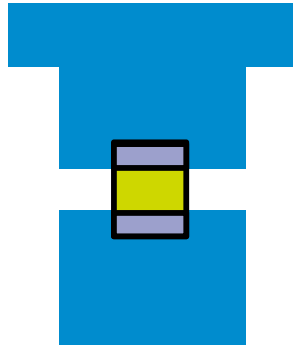
Please consider capacitor layout to minimize noise.





In the above layout since the ESL component of the PCB is added, the resonant frequency from the formula on Page 28 moves to the low frequency side. As a result, it may not be possible to achieve the desired noise removal effects.

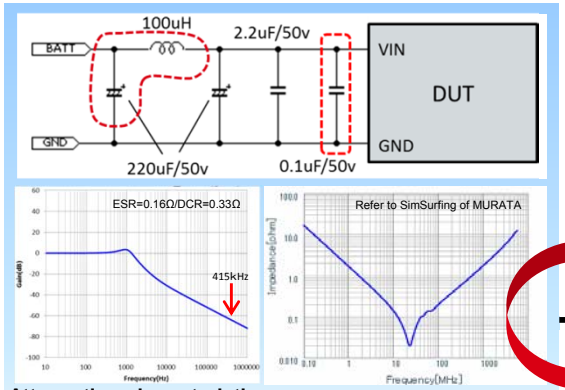




Ideal Layout

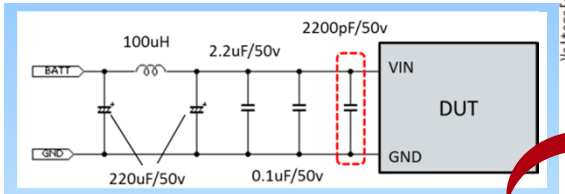
Thermal Characteristics **Noise**

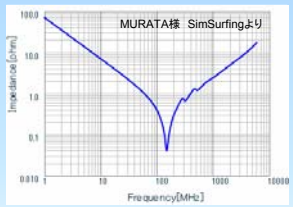
Conductive Noise Countermeasure Example



Attenuation characteristics as seen from the DUT side of the low pass filter

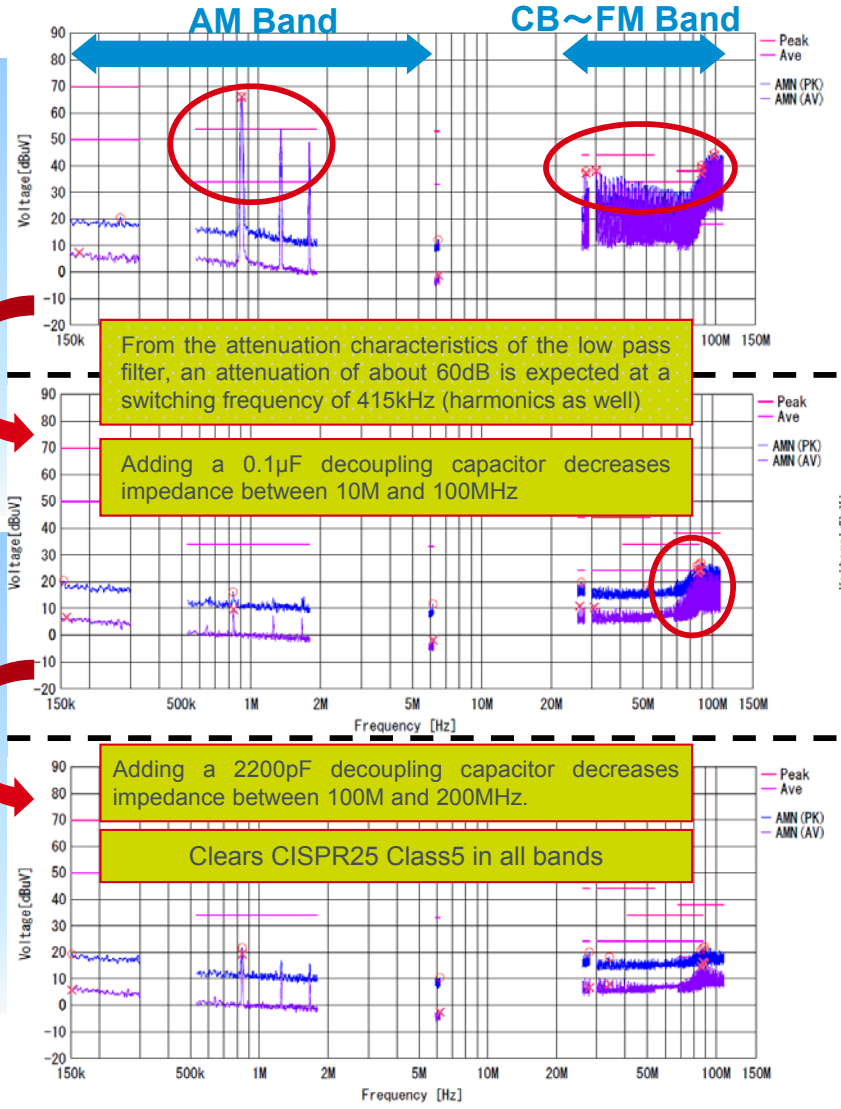
Impedance of the 0.1μF /50v bypass capacitor





Impedance of Bypass Capacitor 2200pF /50v

Conductive Noise (Battery Side)



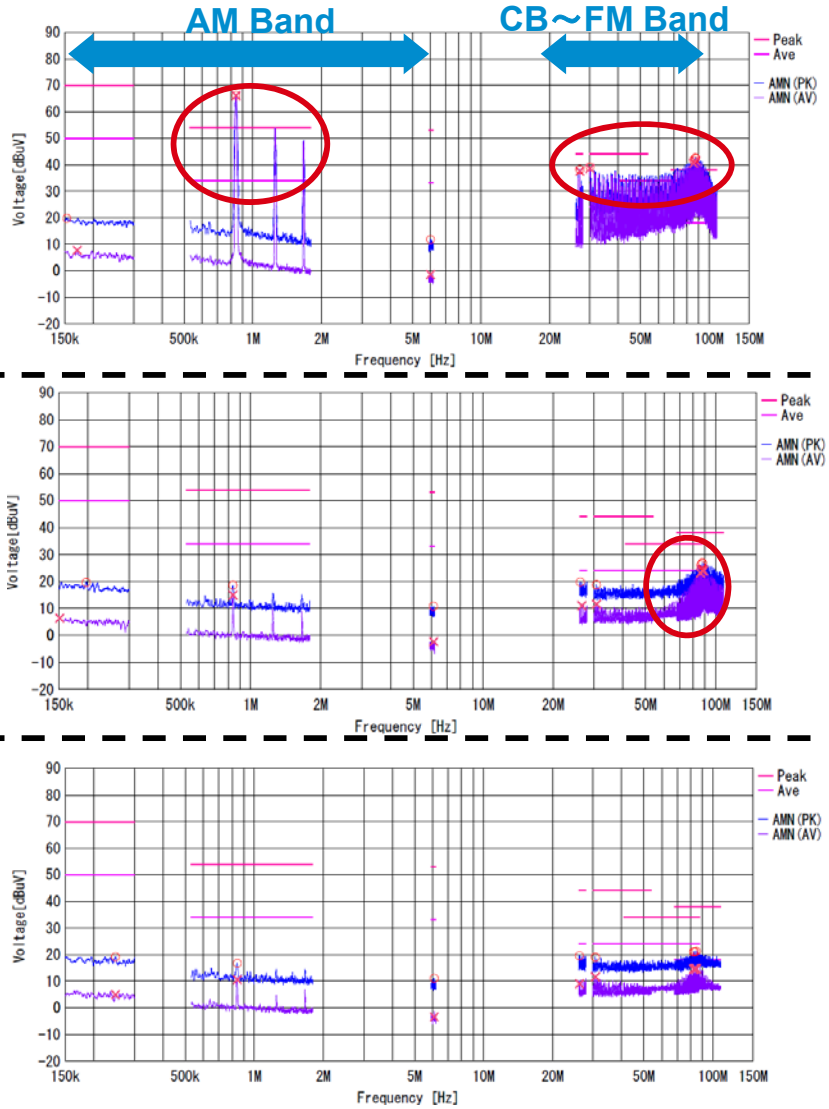
From the attenuation characteristics of the low pass filter, an attenuation of about 60dB is expected at a switching frequency of 415kHz (harmonics as well)

Adding a 0.1μF decoupling capacitor decreases impedance between 10M and 100MHz

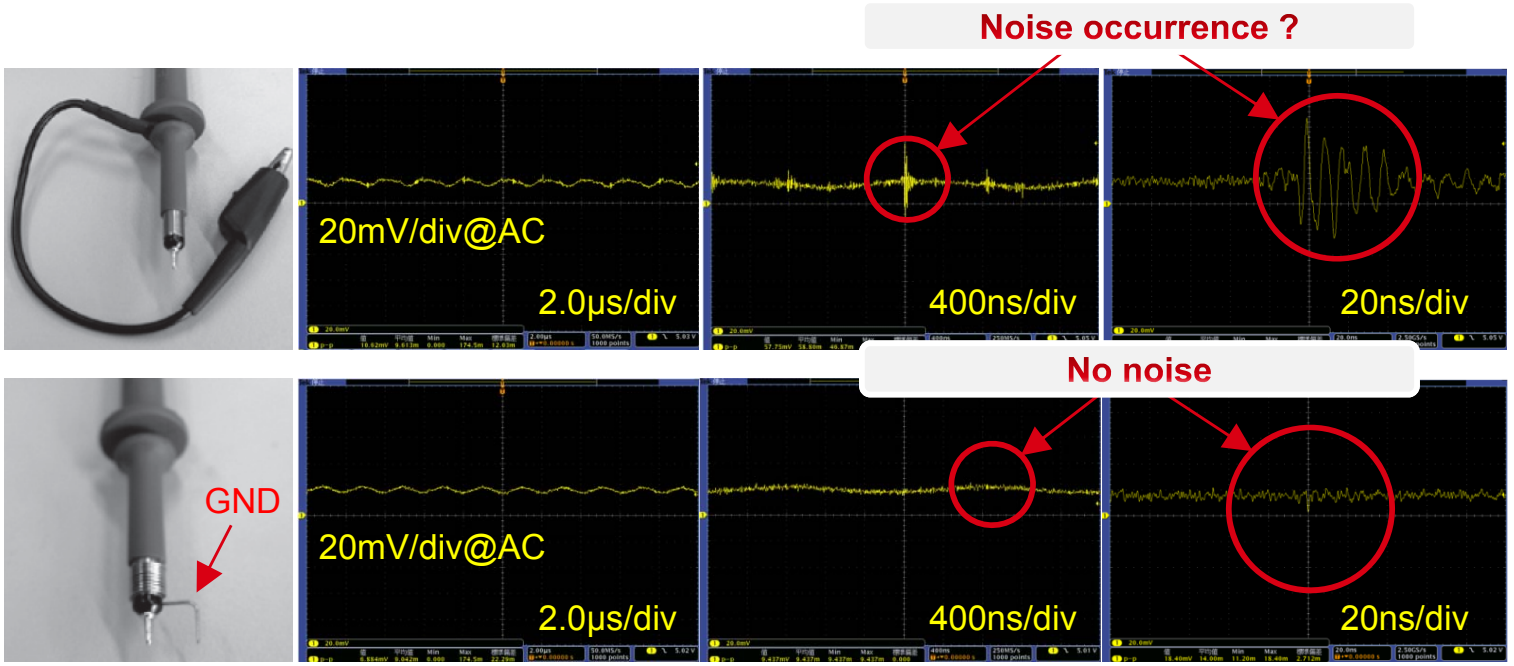
Adding a 2200pF decoupling capacitor decreases impedance between 100M and 200MHz.

Clears CISPR25 Class5 in all bands

Conductive Noise (Ground Side)



Appendix : Waveform Data Acquisition Techniques

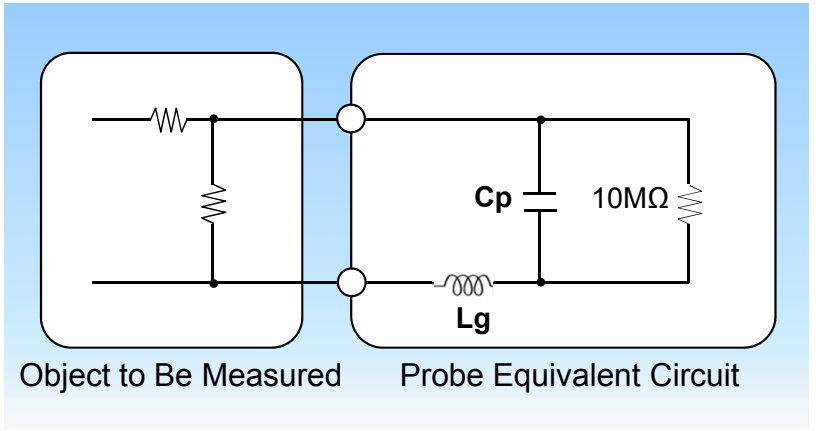


The waveforms at the top were obtained using a GND lead attached to a probe.
The waveforms below were taken by measuring the output ripple voltage using a tin plated wire wound to GND in a short distance.
Although at 2.0µs/div there does not appear to be a large difference, upon magnification spikes can be seen.
These spikes are largely due to the resonance of the inductance of the GND lead and capacitance of the probe input.

$$\text{Resonant Frequency} = \frac{1}{2*\pi\sqrt{(Lg * Cp)}}$$

Lg : Probe Ground Lead Inductance

Cp : Probe Input Capacitance



In order to prevent such resonance, optimized probing must be conducted where Cp and Lg in the equivalent circuit is as small as possible.
Since the input capacitance of a standard passive probe is limited to around 10pF, it is clear that reducing the GND lead inductance Lg (nH/mm) will lead to improved measurement accuracy.
In order to further improve accuracy use of an active probe (FET probe) is recommended.

INDEX

◆ Primary Switching ◇ Secondary Switching ● Primary Linear ○ Secondary Linear

Notice

Precaution on using ROHM Products

1. If you intend to use our Products in devices requiring extremely high reliability (such as medical equipment (Note 1), aircraft/spacecraft, nuclear power controllers, etc.) and whose malfunction or failure may cause loss of human life, bodily injury or serious damage to property ("Specific Applications"), please consult with the ROHM sales representative in advance. Unless otherwise agreed in writing by ROHM in advance, ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of any ROHM's Products for Specific Applications.

(Note1) Medical Equipment Classification of the Specific Applications

JAPAN	USA	EU	CHINA
CLASSⅢ	CLASSⅢ	CLASSⅡb	CLASSⅢ
CLASSⅣ		CLASSⅢ	

2. ROHM designs and manufactures its Products subject to strict quality control system. However, semiconductor products can fail or malfunction at a certain rate. Please be sure to implement, at your own responsibilities, adequate safety measures including but not limited to fail-safe design against the physical injury, damage to any property, which a failure or malfunction of our Products may cause. The following are examples of safety measures:
   [a] Installation of protection circuits or other protective devices to improve system safetya
   [b] Installation of redundant circuits to reduce the impact of single or multiple circuit failure

3. Our Products are not designed under any special or extraordinary environments or conditions, as exemplified below. Accordingly, ROHM shall not be in any way responsible or liable for any damages, expenses or losses arising from the use of any ROHM's Products under any special or extraordinary environments or conditions. If you intend to use our Products under any special or extraordinary environments or conditions (as exemplified below), your independent verification and confirmation of product performance, reliability, etc, prior to use, must be necessary:
   [a] Use of our Products in any types of liquid, including water, oils, chemicals, and organic solvents
   [b] Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust
   [c] Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including Cl_2, H_2S, NH_3, SO_2, and NO_2
   [d] Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
   [e] Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
   [f] Sealing or coating our Products with resin or other coating materials
   [g] Use of our Products without cleaning residue of flux (even if you use no-clean type fluxes, cleaning residue of flux is recommended); or Washing our Products by using water or water-soluble cleaning agents for cleaning residue after soldering
   [h] Use of the Products in places subject to dew condensation

4. The Products are not subject to radiation-proof design.

5. Please verify and confirm characteristics of the final or mounted products in using the Products.

6. In particular, if a transient load (a large amount of load applied in a short period of time, such as pulse. is applied, confirmation of performance characteristics after on-board mounting is strongly recommended. Avoid applying power exceeding normal rated power; exceeding the power rating under steady-state loading condition may negatively affect product performance and reliability.

7. De-rate Power Dissipation (Pd) depending on Ambient temperature (Ta). When used in sealed area, confirm the actual ambient temperature.

8. Confirm that operation temperature is within the specified range described in the product specification.

9. ROHM shall not be in any way responsible or liable for failure induced under deviant condition from what is defined in this document.

Precaution for Mounting / Circuit board design

1. When a highly active halogenous (chlorine, bromine, etc.) flux is used, the residue of flux may negatively affect product performance and reliability.

2. In principle, the reflow soldering method must be used on a surface-mount products, the flow soldering method must be used on a through hole mount products. If the flow soldering method is preferred on a surface-mount products, please consult with the ROHM representative in advance.

For details, please refer to ROHM Mounting specification

Precautions Regarding Application Examples and External Circuits

1. If change is made to the constant of an external circuit, please allow a sufficient margin considering variations of the characteristics of the Products and external components, including transient characteristics, as well as static characteristics.

2. You agree that application notes, reference designs, and associated data and information contained in this document are presented only as guidance for Products use. Therefore, in case you use such information, you are solely responsible for it and you must exercise your own independent verification and judgment in the use of such information contained in this document. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of such information.

Precaution for Electrostatic

This Product is electrostatic sensitive product, which may be damaged due to electrostatic discharge. Please take proper caution in your manufacturing process and storage so that voltage exceeding the Products maximum rating will not be applied to Products. Please take special care under dry condition (e.g. Grounding of human body / equipment / solder iron, isolation from charged objects, setting of Ionizer, friction prevention and temperature / humidity control).

Precaution for Storage / Transportation

1. Product performance and soldered connections may deteriorate if the Products are stored in the places where:
   [a] the Products are exposed to sea winds or corrosive gases, including Cl2, H2S, NH3, SO2, and NO2
   [b] the temperature or humidity exceeds those recommended by ROHM
   [c] the Products are exposed to direct sunshine or condensation
   [d] the Products are exposed to high Electrostatic

2. Even under ROHM recommended storage condition, solderability of products out of recommended storage time period may be degraded. It is strongly recommended to confirm solderability before using Products of which storage time is exceeding the recommended storage time period.

3. Store / transport cartons in the correct direction, which is indicated on a carton with a symbol. Otherwise bent leads may occur due to excessive stress applied when dropping of a carton.

4. Use Products within the specified time after opening a humidity barrier bag. Baking is required before using Products of which storage time is exceeding the recommended storage time period.

Precaution for Product Label

QR code printed on ROHM Products label is for ROHM's internal use only.

Precaution for Disposition

When disposing Products please dispose them properly using an authorized industry waste company.

Precaution for Foreign Exchange and Foreign Trade act

Since our Products might fall under controlled goods prescribed by the applicable foreign exchange and foreign trade act, please consult with ROHM representative in case of export.

Precaution Regarding Intellectual Property Rights

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Other Precaution

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Application Engineering Div.