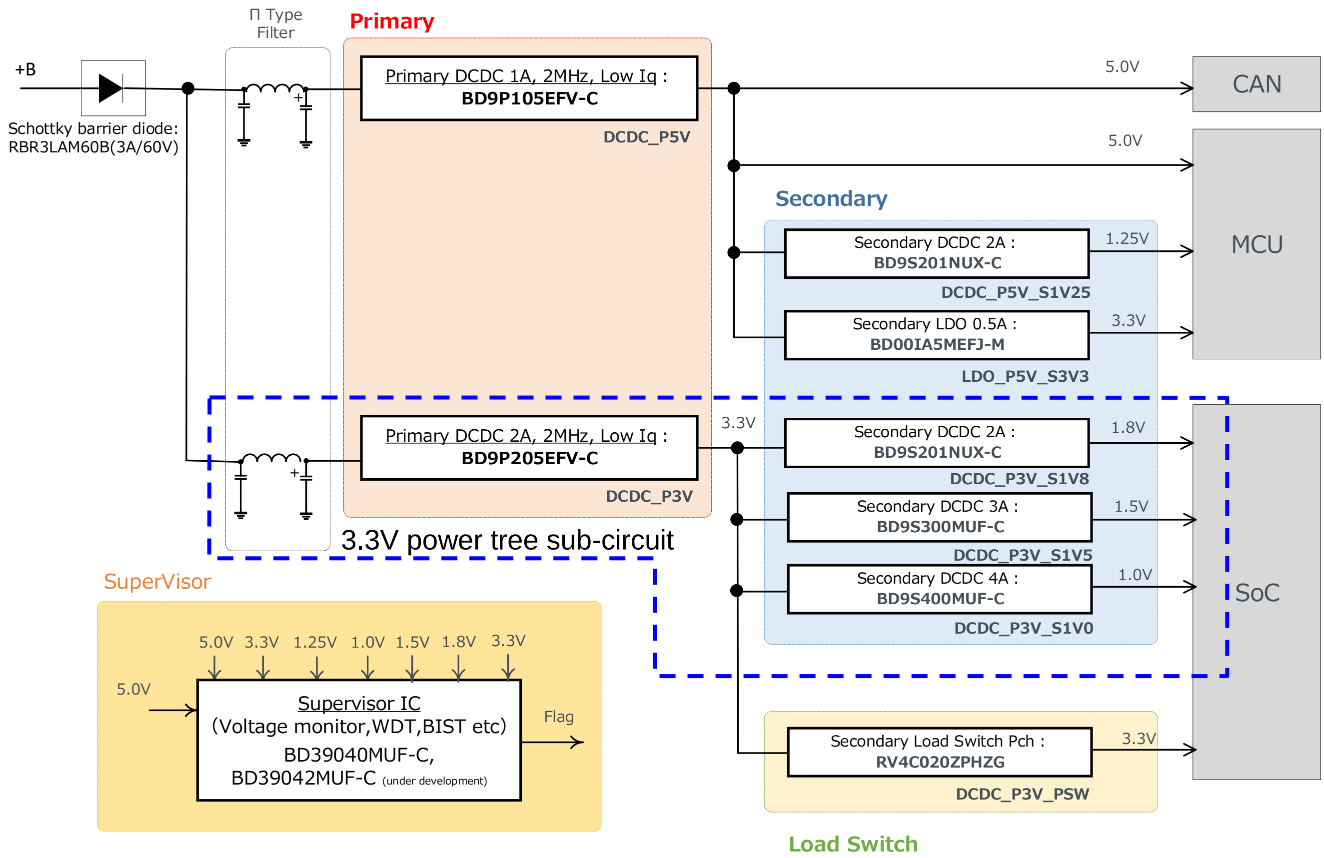
User's Guide

ROHM Solution Simulator

Automotive Power tree reference design for ADAS/Info-Display application

REFRPT001 / Load Response for 3.3V power tree sub-circuit

This circuit simulate the load response of REFRPT001 reference design. The REFRPT001 is the reference design, designed for infotainment devices such as vehicle clusters and center information displays, as well as for ADAS ECUs. It is consist of multiple rails of power supply from Battery in the car converting to required voltage and current supply for MCU or SoCs.



In this circuit, you can observe the fluctuation of the output voltage when the load current is abruptly changed. You can customize the parameters of the components shown in blue, such as VIN, IOUT_SXXX, or peripheral components, and simulate the load response with desired operating condition.

General Cautions

Caution 1: The values from the simulation results are not guaranteed. Please use these results as a guide for your design.
Caution 2: These model characteristics are specifically at Ta=25°C. Thus, the simulation result with temperature variances may significantly differ from the result with the one done at actual application board (actual measurement).
Caution 3: Please refer to the datasheet for details of the technical information.
Caution 4: The characteristics may change depending on the actual board design and ROHM strongly recommend to double check those characteristics with actual board where the chips will be mounted on.

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1. Simulation Schematic

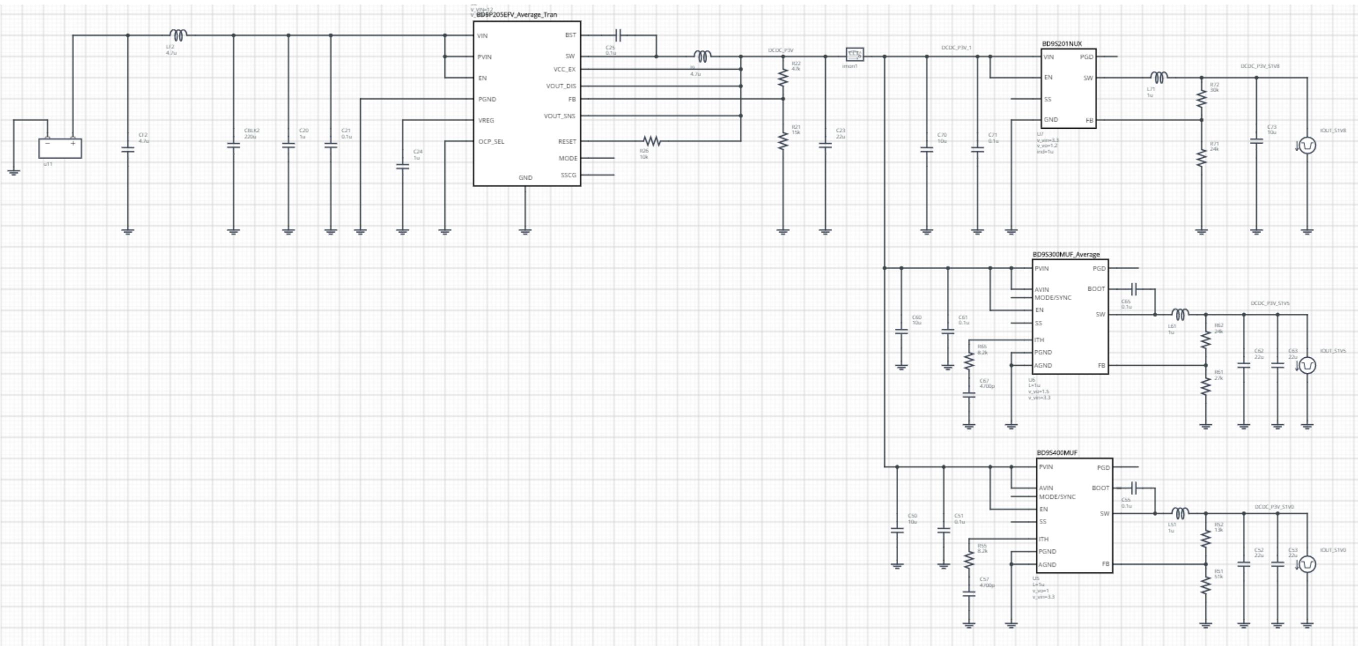


Figure 1. Simulation Schematic

2. How to simulate

The simulation settings, such as simulation time or convergence options, are configurable from the 'Simulation Settings' shown in Figure 2, and Table 1 shows the default setup of the simulation.

In case of simulation convergence issue, you can change advanced options to solve. Default statement in 'Manual Options' sets the option to avoid non-convergence error. You can modify or delete it.

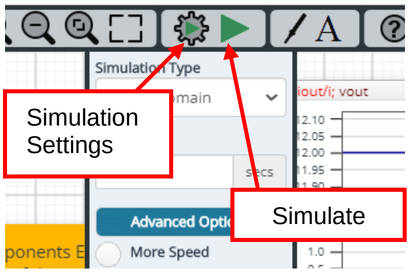


Figure 2. Simulation Settings and execution

Table 1. Simulation settings default setup

Parameters	Default	Note
Simulation Type	Time-Domain	(Do not change Simulation Type)
End Time	6.0ms	
Advanced options	Balanced	
	Convergence Assist	
Manual Options	.tran 0 6m 1m	

3. Simulation Conditions

Table 2. List of the simulation condition parameters

Instance Name	Type	Parameters	Default Value	Variable Range		Units
				Min	Max	
VBAT	Voltage Source	voltage_level	12	3.5	40	V
VEN	Voltage Source	Pulse_value	12	Pulse_value should be the same as voltage_level of VBAT		V
VOCP_SEL	Voltage Source	voltage_level	0	0: Max output current =2A, or 5: Max output current=1.5A		V
VMODE	Voltage Source	voltage_level	5	0: Auto mode, or 5: FPWM mode		V
IOUT_S1V8	Current source	initial_value	0	0	2.0	A
		pulse_value	1.3	0	2.0	A
		ramptime_initial_to_pulse	13	No constraint(Note2)		µs
		ramptime_pulse_to_initial	13	No constraint(Note2)		µs
		Start_delay	2.5	-		ms
		Pulse_width	2.0	-		ms
		Period	1.0	-		s
IOUT_S1V5	Current source	initial_value	0	0	3.0	A
		pulse_value	1.3	0	3.0	A
		ramptime_initial_to_pulse	13	No constraint(Note2)		µs
		ramptime_pulse_to_initial	13	No constraint(Note2)		µs
		Start_delay	2.5	-		ms
		Pulse_width	2.0	-		ms
		Period	1.0	-		s
IOUT_S1V0	Current source	initial_value	0	0	4.0	A
		pulse_value	1.3	0	4.0	A
		ramptime_initial_to_pulse	13	No constraint(Note2)		µs
		ramptime_pulse_to_initial	13	No constraint(Note2)		µs
		Start_delay	2.5	-		ms
		Pulse_width	2.0	-		ms
		Period	1.0	-		s

(Note 1) This is a constraint of the simulation settings and does not guarantee the operation of the IC.

3.1 IOUT parameter setup

Figure 3 shows how the IOUT_SXXX parameters (Here, XXX: 1V8, 1V5 or 1V0) correspon DCDC_P3V_S1V8 lus waveform.

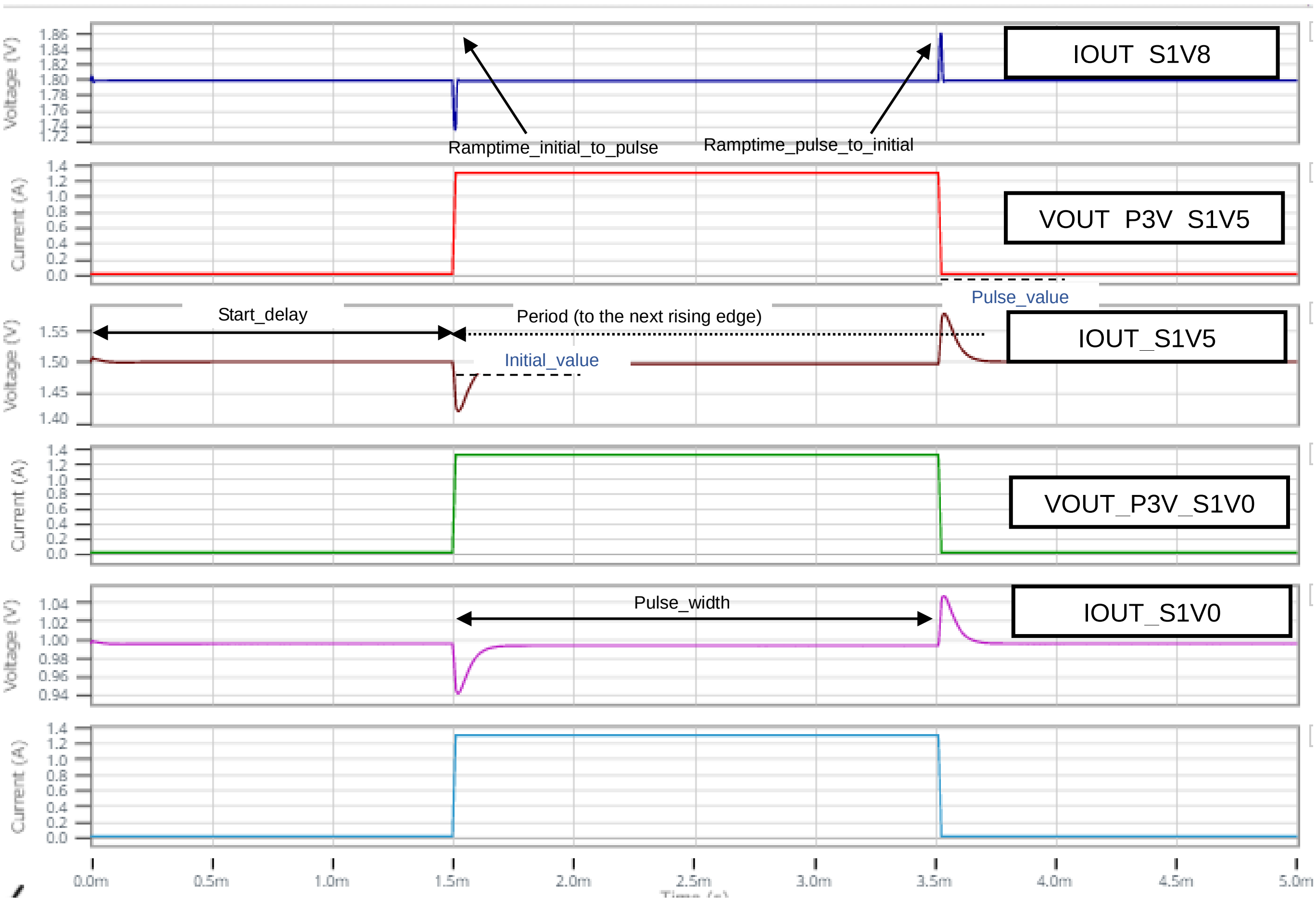


Figure 3. IOUT_SXXX parameters and its waveform

4. Simulation models

4.1 BD9P205EFV-C simulation model

Table 3 and Table 4 shows the model terminal function implemented. Note that BD9P205EFV-C_Tran is the behavior model for its load/line regulation operation, and no protection circuits or the functions not related to the purpose are not implemented.

Table 3. BD9P205EFV-C model terminals used for the simulation

Terminals	Description
EN	Enable input
VIN	Power supply input
PVIN	Power supply input
PGND	Power ground
SW	Switching node
OCP_SEL	Over current selector input
MODE	PWM mode selector input
GND	Ground
VOUT_SNS	Phase compensation.
FB	Feedback voltage input
VREG	3.3V output for internal circuit.

Table 4. BD9P205EFV-C model terminals NOT used for the simulation

Terminals	Description
EN	Input is ignored (always enable)
BST	Input is ignored (Bootstrap not implemented)
SSCG	Input is ignored (SSCG not implemented)
RESET	Input is ignored (always negate)
VOUT_DIS	Input is ignored
VCC_EX	Input is ignored (function not implemented)

4.2 BD9S201NUX-C simulation model

Table 5 and shows the model terminal function implemented. Note that BD9S201NUX-C is the behavior model for its load regulation operation, and no protection circuits or the functions not related to the purpose are not implemented.

Table 5. BD9S201NUX-C model terminals used for the simulation

Terminals	Description
VIN	Power supply input
EN	Enable input
SS	Input is ignored (SSCG function is not implemented)
GND	Ground
FB	Feedback voltage input
SW	Switching node
PGD	Not implemented power good function

4.3 BD9S300MUF-C simulation model

Table 6 shows the model terminal function implemented. Note that BD9S300MUF-C is the behavior model for its load regulation operation.

Table 6. BD9S300MUF-C_Tran model terminals used for the simulation

Terminals	Description
PVIN	Power supply input
AVIN	Power supply input
MODE/SYNC	MODE/SYNC function are not implemented in this simulation
EN	Enable input
SS	Input is ignored (SSCG function is not implemented)
ITH	ITH feature is not implemented in this simulation
PGND	Ground
AGND	Ground
FB	Feedback voltage input
SW	Switching node
BOOT	Not implemented Boot pin function
PGD	Not implemented power good function

BD9S400MUF-C simulation model

4.4 BD9S400MUF-C simulation model

Table 7 shows the model terminal function implemented. Note that BD9S400MUF-C is the behavior model for its load regulation operation.

Table 7. BD9S400MUF-C_Tran model terminals used for the simulation

Terminals	Description
PVIN	Power supply input
AVIN	Power supply input
MODE/SYNC	MODE/SYNC function are not implemented in this simulation
EN	Enable input
SS	Input is ignored (SSCG function is not implemented)
ITH	ITH feature is not implemented in this simulation
PGND	Ground
AGND	Ground
FB	Feedback voltage input
SW	Switching node
BOOT	Not implemented Boot pin function
PGD	Not implemented power good function

(Note 4) This model is not compatible with the influence of ambient temperature.
(Note 5) This model is not compatible with the external synchronization function.
(Note 6) Use the simulation results only as a design guide and the data reported herein is not a guaranteed value.

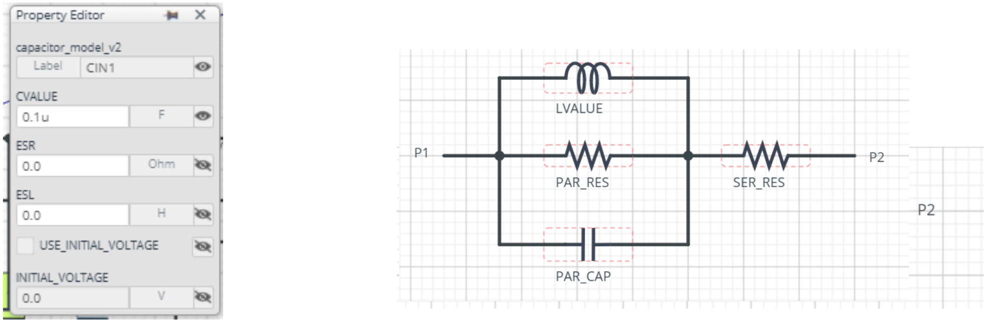
5. Peripheral Components

5.1 Bill of Material

Table 5 shows the list of components used in the simulation schematic. Each of the capacitor and inductor has the parameters of equivalent circuit shown below. The default value of equivalent components are set to zero except for the parallel resistance of L1. You can modify the values of each component.

Type	Instance Name	Default Value	Units
Capacitor	CF2	4.7	µF
	CBLK2	220	µF
	C20	1.0	µF
	C21	0.1	µF
	C23	22	µF
	C24	1.0	µF
	C25	0.1	µF
	C50	10	µF
	C51	0.1	µF
	C52	22	µF
	C53	22	µF
	C55	0.1	µF
	C57	4700	pF
	C60	10	µF
	C61	0.1	µF
	C62	22	µF
	C63	22	µF
	C65	0.1	µF
	C67	4700	pF
	C70	10	µF
	C71	0.1	µF
	C73	10	µF
Inductor	LF2	4.7	µH
	L21	4.7	µH
	L51	1.0	µH
	L61	1.0	µH
	L71	1.0	µH
Resistor	R21	15	kΩ
	R22	47	kΩ
	R26	10	kΩ
	R51	51	kΩ
	R52	13	kΩ
	R55	8.2	kΩ
	R61	24	kΩ
	R62	27	kΩ
	R65	8.2	kΩ

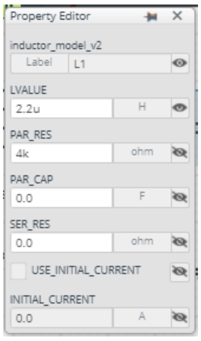
5.2 Capacitor Equivalent Circuits



(a) Property editor (b) Equivalent circuit

Figure 5. Capacitor property editor and equivalent circuit

5.3 Inductor Equivalent Circuits



(b) Property editor (b) Equivalent circuit

Figure 6. Inductor property editor and equivalent circuit

The default value of PAR_RES is 6.6kΩ.
(Note 7) These parameters can take any positive value or zero in simulation but it does not guarantee the operation of the IC in any condition. Refer to the datasheet to determine adequate value of parameters.

6. Link to the product information and tools

6.1 BD9P205EFV-C

6.1.1 Product webpage link

https://www.rohm.com/products/power-management/switching-regulators/integrated-fet/buck-converters-synchronous/bd9p205efv-c-product

6.1.2 Related documents

The application notes are available from 'Documentation' tab of the product page.

6.1.3 Tools and models

Design assist tools are available from 'Tools' tab of the product page.
The Circuit constant calculation sheet is useful for deciding the application circuit constants.

6.2 BD9S201NUX-C

6.2.1 Product webpage link

https://www.rohm.com/products/power-management/switching-regulators/integrated-fet/buck-converters-synchronous/bd9s201nux-c-product

6.2.2 Related documents

The application notes are available from 'Documentation' tab of the product page.

6.2.3 Tools and models

Design assist tools are available from 'Tools' tab of the product page.
The Circuit constant calculation sheet is useful for deciding the application circuit constants.

6.3 BD9S300MUF-C

6.3.1 Product webpage link

https://www.rohm.com/products/power-management/switching-regulators/integrated-fet/buck-converters-synchronous/bd9s300muf-c-product

6.3.2 Related documents

The application notes are available from 'Documentation' tab of the product page.

6.3.3 Tools and models

Design assist tools are available from 'Tools' tab of the product page.
The Circuit constant calculation sheet is useful for deciding the application circuit constants.

6.4 BD9S400MUF-C

6.4.1 Product webpage link

https://www.rohm.com/products/power-management/switching-regulators/integrated-fet/buck-converters-synchronous/bd9s400muf-c-product

6.4.2 Related documents

The application notes are available from 'Documentation' tab of the product page.

6.4.3 Tools and models

Design assist tools are available from 'Tools' tab of the product page.
The Circuit constant calculation sheet is useful for deciding the application circuit constants.

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