# User’s Guide

## ROHM Solution Simulator

### 3.5V to 40V Input, 1A Single 2.2MHz Buck DC/DC Converter for Automotive

# BD9P105MUF-C / Load Response

This circuit simulate the load response of BD9P105MUF-C. 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, 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.

## 1. Simulation Schematic

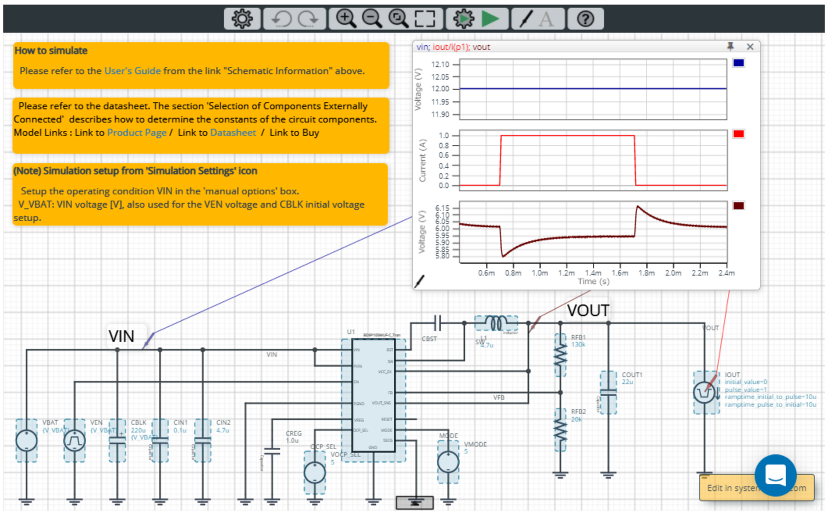



Figure 1. Simulation Schematic

## 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.
The default statement “.tran 0 2.4m 0.4m” in ‘Manual Options’ sets the simulation execution options. By default, run for t=2.4ms and save the waveforms after t=0.4ms. You can modify or delete it.
Refer to Section 3 about the sentence “.param V_VBAT=12”.

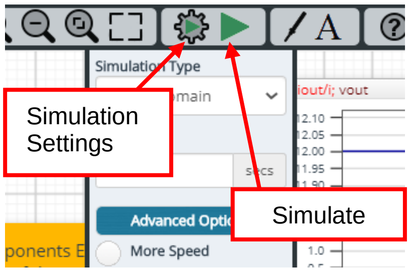



Figure 2. Simulation Settings and execution

Table 1. Simulation settings default setup

| Parameters | Default | Note |
|---|---|---|
| Simulation Type | Time-Domain | Do not change Simulation Type |
| End Time | 2.4ms | |
| Advanced options | Balanced | |
| | Convergence Assist | |
| Manual Options | “.tran 0 2.4m 0.4m” | Run simulation for t=2.4ms, record waveforms after t=0.4ms. |
| | “.param V_VBAT = 12” | VIN voltage level. See Section 3. |

## 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 | {V_VBAT} | 3.5 | 40 | V |
| VEN | Voltage Source | Pulse_value | {V_VBAT} | 3.5 | 40 | V |
| VOCP_SEL | Voltage Source | Voltage_level | 5 | 0: Max output current =0.5A, or 5: Max output current=1.0A | | V |
| VMODE | Voltage Source | Voltage_level | 5 | 0: Auto mode, or 5: FPWM mode | | V |
| IOUT | Current source | Initial_value | 0 | 0 | 1 | A |
| | | Pulse_value | 1 | 0 | 1 | A |
| | | Ramptime_initial_to_pulse | 10 | No constraint(Note1) | | µs |
| | | Ramptime_pulse_to_initial | 10 | No constraint(Note1) | | µs |
| | | Start_delay | 0.7 | - | | ms |
| | | Pulse_width | 1.0 | - | | ms |
| | | Period | 3.0 | - | | s |

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

### 3.1 How to define VIN voltage (VBAT and VEN setting)

The VBAT and VEN voltages are set in the 'Manual Options' text box for parameter setting consistency. The voltage level of VBAT and VEN, and the initial voltage of CBLK refer to the variable V_VBAT. To define the voltage level, set the V_VBAT value in '.param' sentence in the text box from 'Simulation Settings' > 'Advanced Options' as shown in Figure 3.

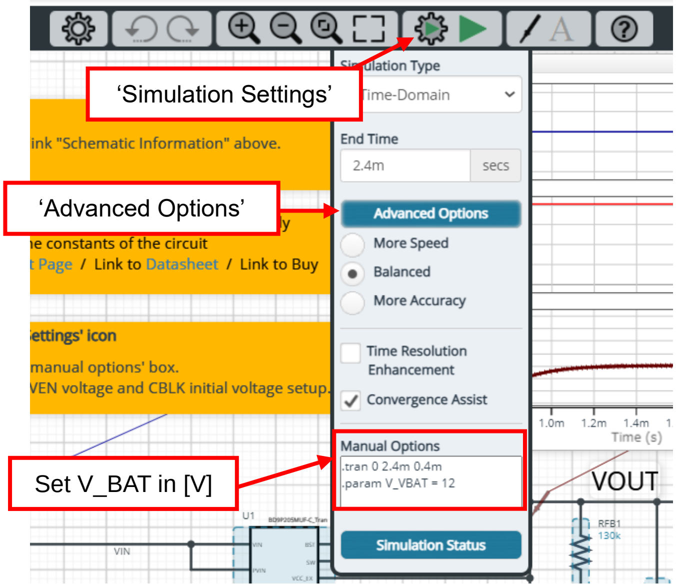
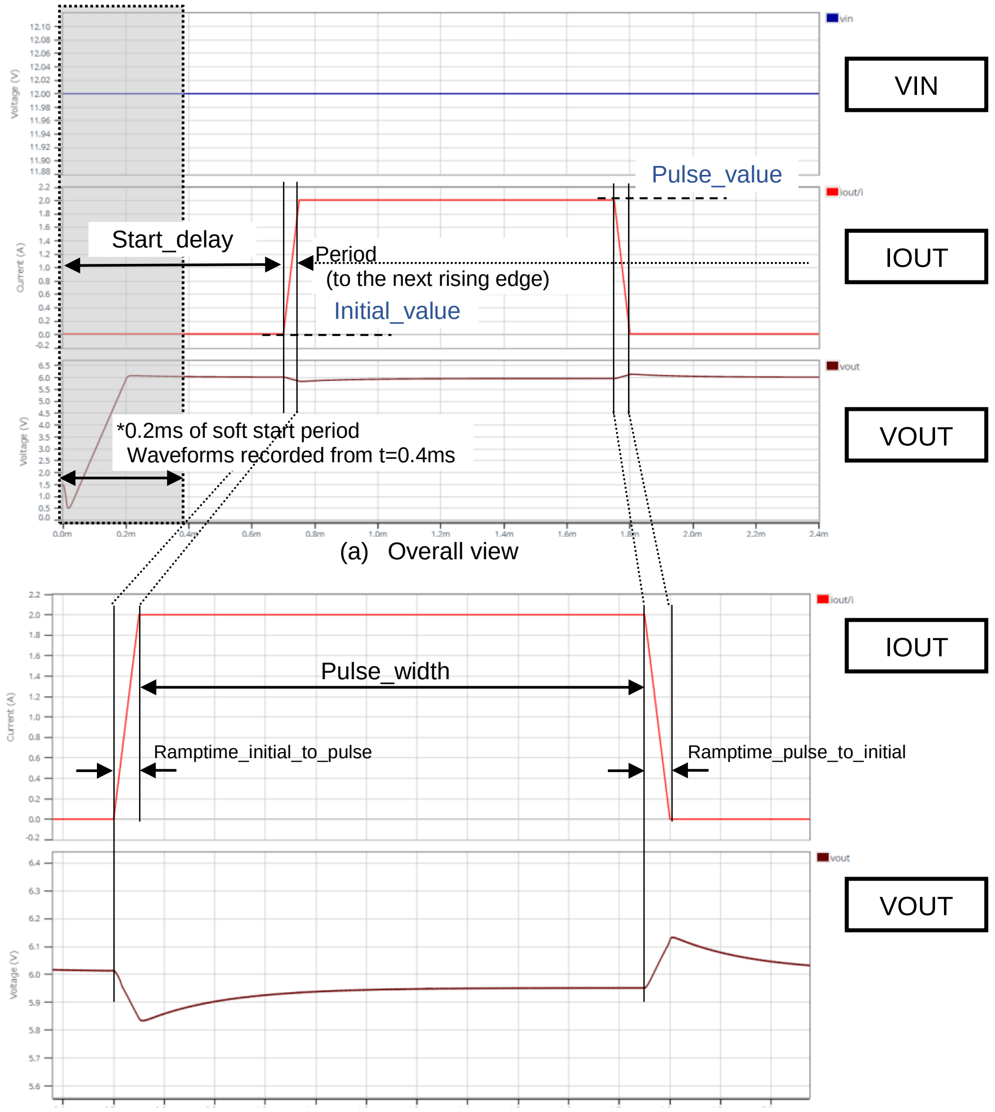



Figure 3. Definition of VIN voltage.

In order to secure the simulation stability those three parameters should be the same. So do not change those parameters respectively.

### 3.2 IOUT parameter setup

Figure 4 shows how the IOUT parameters correspond to the IOUT stimulus waveform.




(a) Overall view

(b) Magnified view

Figure 4. IOUT parameters and its waveforms

## 4. BD9P105MUF-C_Tran model

Table 3 and Table 4 shows the model terminal function implemented. Note that BD9P105MUF-C_Tran is the behavior model for its load/line response operation, and no protection circuits or the functions not related to the purpose are not implemented.

Table 3. BD9P105MUF-C_Tran 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. BD9P105MUF-C_Tran 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 | The function is not implemented |
| VCC_EX | Input is ignored (function not implemented) |

*(Note 2)* This model is not compatible with the influence of ambient temperature.
*(Note 3)* This model is not compatible with the external synchronization function.
*(Note 4)* Use the simulation results only as a design guide and the data reported herein is not a guaranteed value.

### 4.1 Parameter TSS

BD9P105MUF-C_Tran model has the property 'TSS', which is the soft start time described in page 7 of the datasheet. The product has 3ms (typical) of the startup time of the output voltage. You can short cut the soft start by changing TSS value. The default TSS value is set to 0.2ms in this simulation and you can modify the value in the property editor.

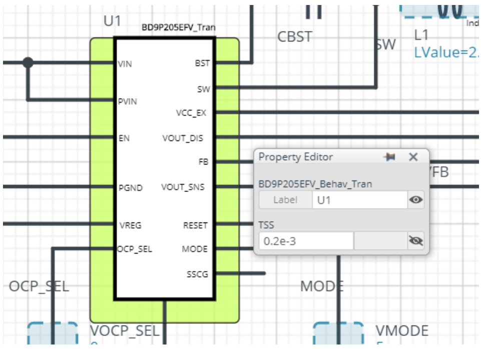



Figure 5. TSS property of BD9P105MUF-C_Tran

## 5. Peripheral Components

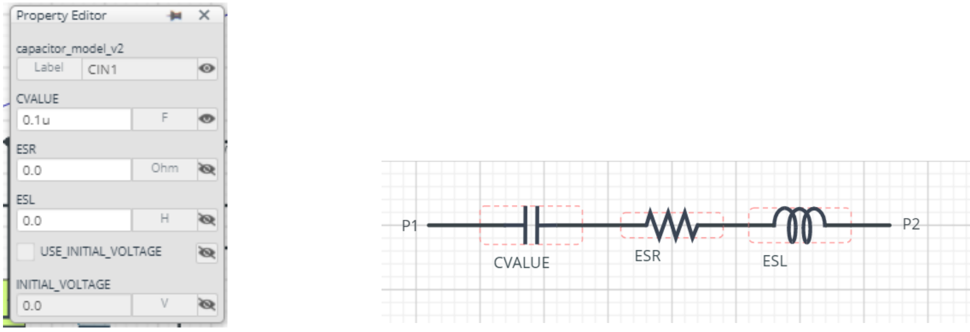
### 5.1 Bill of Material

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.

Table 5. List of capacitors used in the simulation circuit

| Type | Instance Name | Default Value | Units |
|---|---|---|---|
| Capacitor | CBLK | 220 | µF |
| | CIN1 | 0.1 | µF |
| | CIN2 | 4.7 | µF |
| | CREG | 1.0 | µF |
| | COUT1 | 22 | µF |
| Inductor | L1 | 4.7 | µH |
| Resistor | RFB1 | 130 | kohm |
| | RFB2 | 20 | kohm |

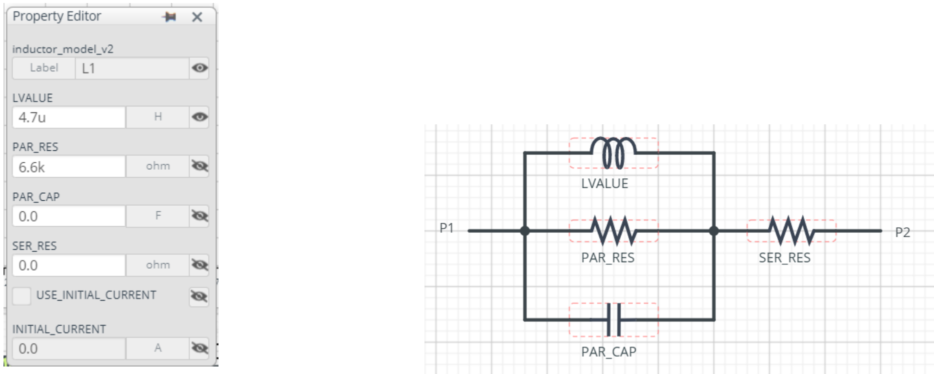
### 5.2 Capacitor Equivalent Circuits




(a) Property editor (b) Equivalent circuit

Figure 6. Capacitor property editor and equivalent circuit

### 5.3 Inductor Equivalent Circuits




(a) Property editor (b) Equivalent circuit

Figure 7. Inductor property editor and equivalent circuit

The default value of PAR_RES is 6.6kohm.

*(Note 5)* 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 Product webpage link: https://www.rohm.com/products/power-management/switching-regulators/integrated-fet/buck-converters-synchronous/bd9p105muf-c-product

6.2 Related documents

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

6.3 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.

## Notes

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