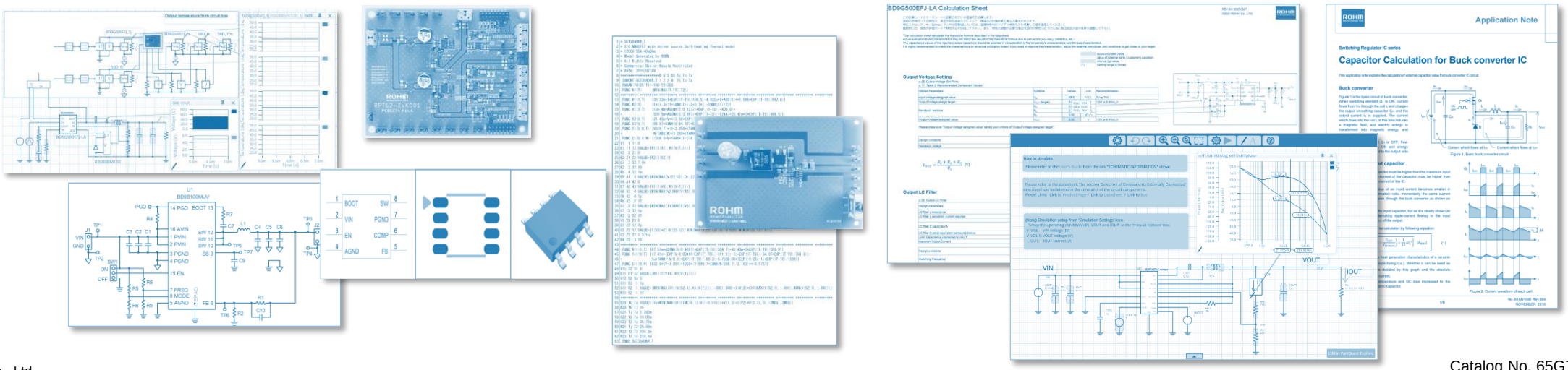
Linear Regulators, Switching Regulator ICs

# LDO, DC-DC Converter Design Tool Selection Guide

## Using the Design Tools on the ROHM Website

Ver. 1.1






Catalog No. 65G7338E-B 03.2023

Linear Regulators, Switching Regulator ICs

# LDO, DC-DC Converter Design Tool Selection Guide

## Using the Design Tools on the ROHM Website

On the ROHM website, we provide technical data including application notes, online simulators, various simulation models, and other design tools such as spreadsheets for calculation of constants. This guide explains how to use various design tools throughout the development steps for LDO and DC-DC converters.

### How to use this guide:

- Since the guide requires access to the ROHM website, ensure you have a reliable Internet connection.
- Do not use the functions of your PDF browser to move back and forth between pages. Use the buttons on the pages instead.
- This guide may not display correctly if the PDF file is viewed with a web browser. Use a PDF reader such as Adobe Acrobat.

Notes

**Tools for each development step**

| Initial Study | Circuit Design | PCB Design | Evaluation |
|---|---|---|---|
| - Topology Selection | - Reference Design | - Package Information | - Application Note |
| - Reference Design | - DATA SHEET | - PCB Library | |
| - DATA SHEET | - Calculation Sheet | - 3D Model | |
| - Evaluation Board (EVK) | - Application Note | - Application Note | |
| - Web Simulation | - Evaluation Board (EVK) | - DATA SHEET | |
| | - Web Simulation | | |
| | - Design Model | | |

Start Here

Tools

## 1 Topology Selection

Shows the devices best suited for the respective topologies.

www

## 2 Reference Design

Evaluation results on the system level and design data are provided as reference designs.

www

## 3 DATA SHEET

Specification documents describing the electrical characteristics of products, precautions, pin layouts, examples of application circuits, etc.

## 4 Evaluation Board (EVK: Evaluation Kit)

Evaluation board to perform initial considerations and characterizations, which can be purchased from online distributors.

## 5 Web Simulation (ROHM Solution Simulator)

Free online simulator allowing you to easily design the constants of peripheral parts.

Catalog www

## 6 Calculation Sheet

Design calculation tool in Excel to assist you in designing the constants of peripheral parts.

## 7 Application Note

Application notes have been published to help circuit design, thermal design, PCB design, and evaluation methods.

Catalog

## 8 Design Model

Provides models for SPICE and other CAE tools including thermal analysis.

## 9 Package Information

Information including reference land patterns and mounting conditions is provided.

## 10 PCB Library

Footprints and symbol data for PCB CAD are provided.

## 11 3D Model

Models representing outline images on 3D CAD are provided as STEP data.

Click the button for the tool you want to view

Button descriptions

- Tool introduction
- www Displays the website
- Catalog Displays the catalog

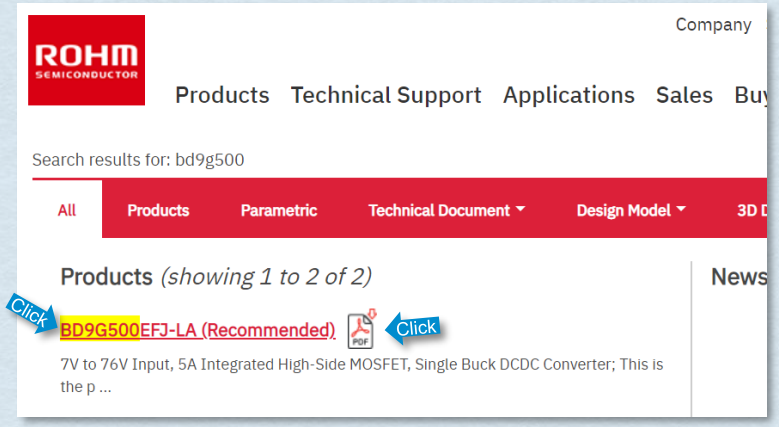
# How to obtain a data sheet

Obtain through one of the following methods:

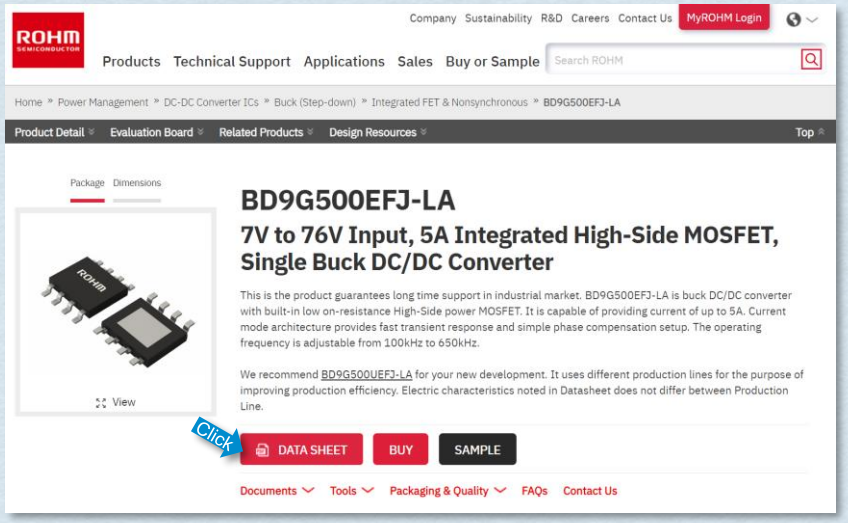
## Method 1. If the product name is known

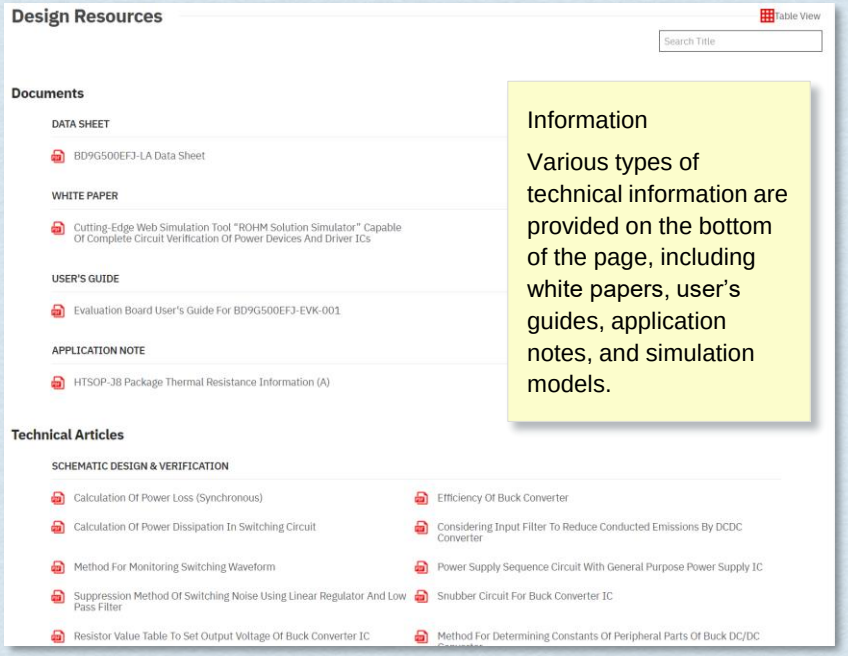
Step 1: Enter the product name into the search window on the upper right of the ROHM website.


Step 2: To take a shortcut, click the PDF icon.
Usually, click the product name (recommended).




Step 3: When the product page is displayed, click the [DATA SHEET] button. In addition, you can obtain further technical information by scrolling down the product page.




Information

Various types of technical information are provided on the bottom of the page, including white papers, user's guides, application notes, and simulation models.

Information

DATA SHEET



Next page

# How to obtain a data sheet (continued)

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DATA SHEET
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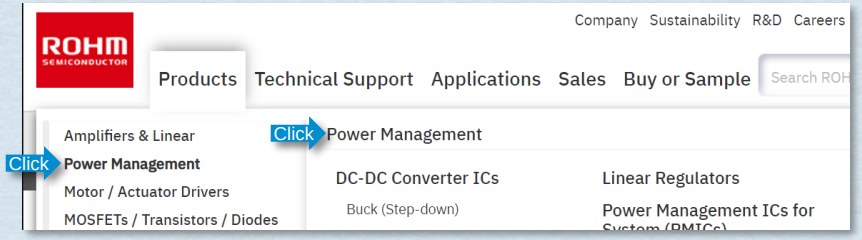
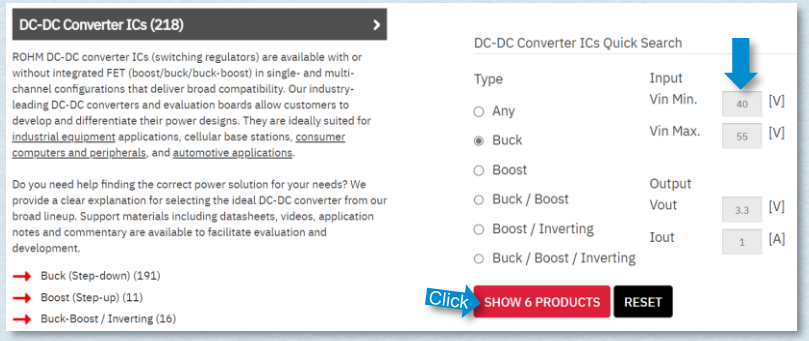
## Method 2. If the product name is not certain

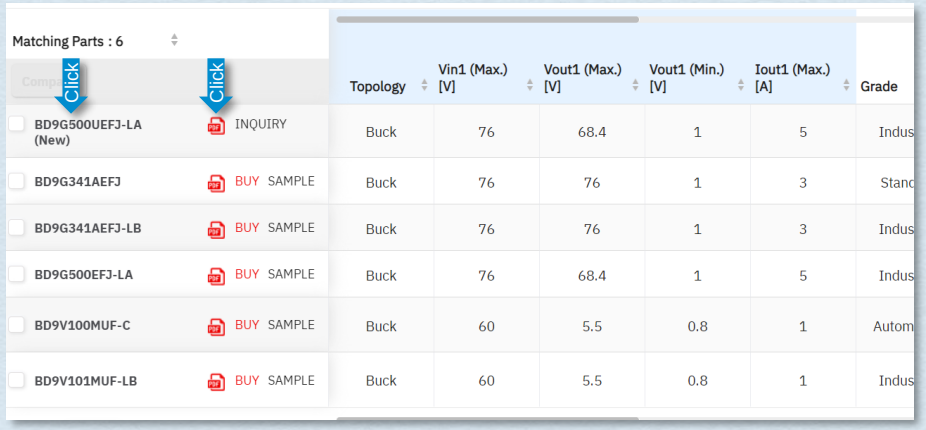
Step 1: Select “Power Management” in “Products” on the ROHM website.



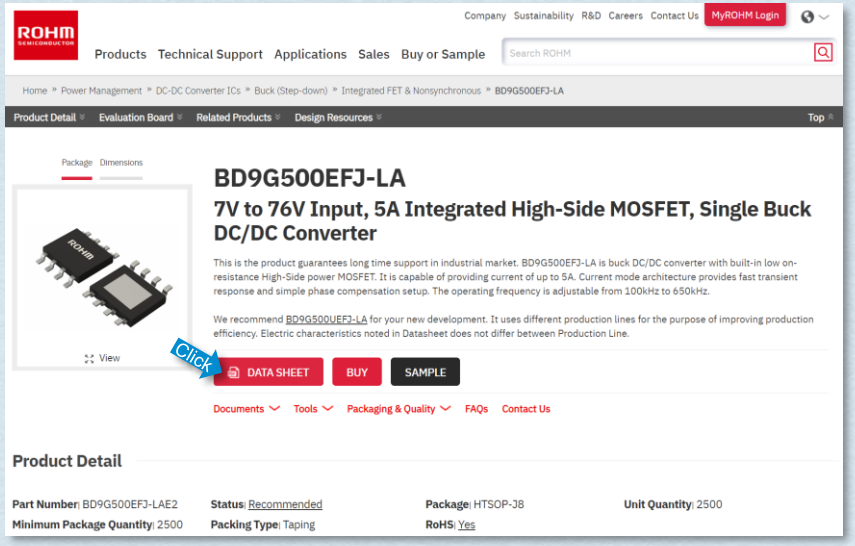

Step 2: Enter the conditions and click the [SHOW] button.

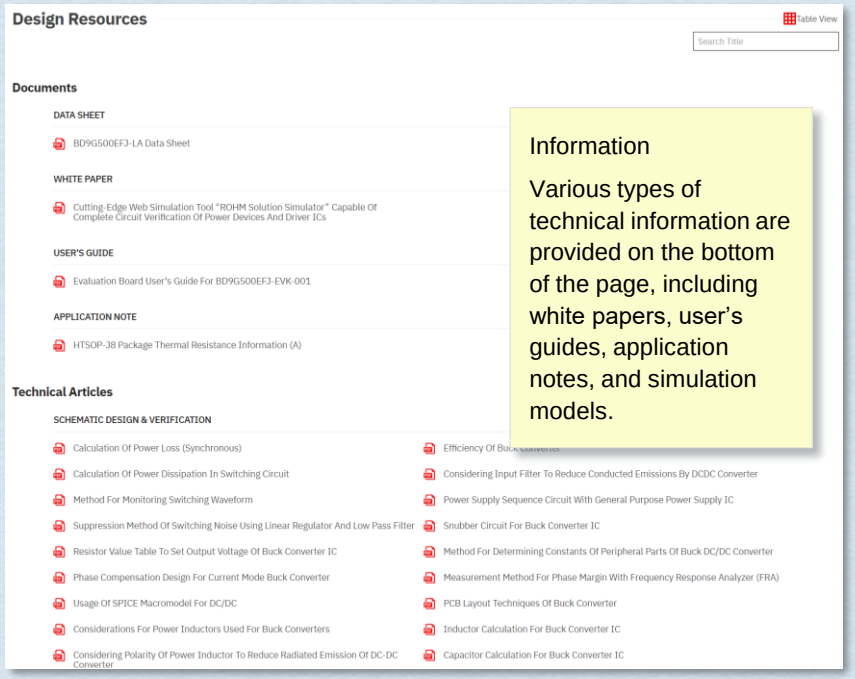



Step 3: The search result is displayed. To take a shortcut, click the PDF icon.
Usually, click the product name (recommended).




Step 4: When the product page is displayed, click the [DATA SHEET] button. In addition, you can obtain further technical information by scrolling down the product page.



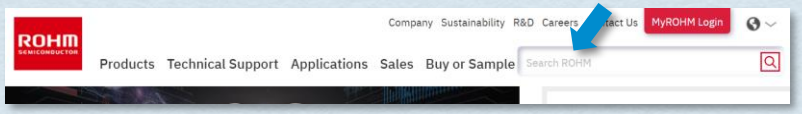




Information

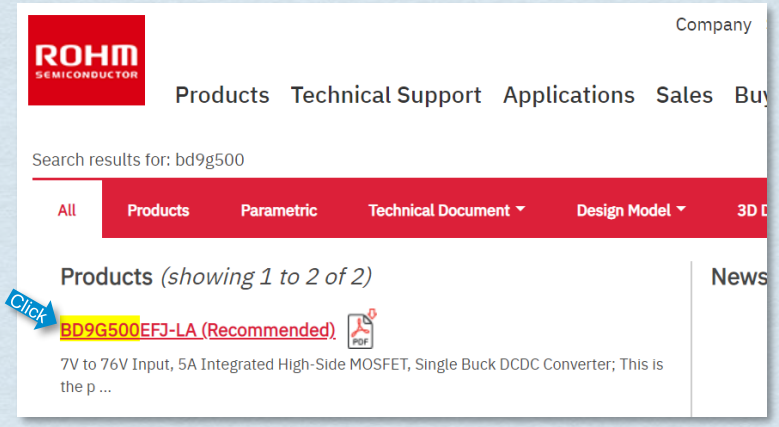
Various types of technical information are provided on the bottom of the page, including white papers, user’s guides, application notes, and simulation models.

# How to obtain EVK

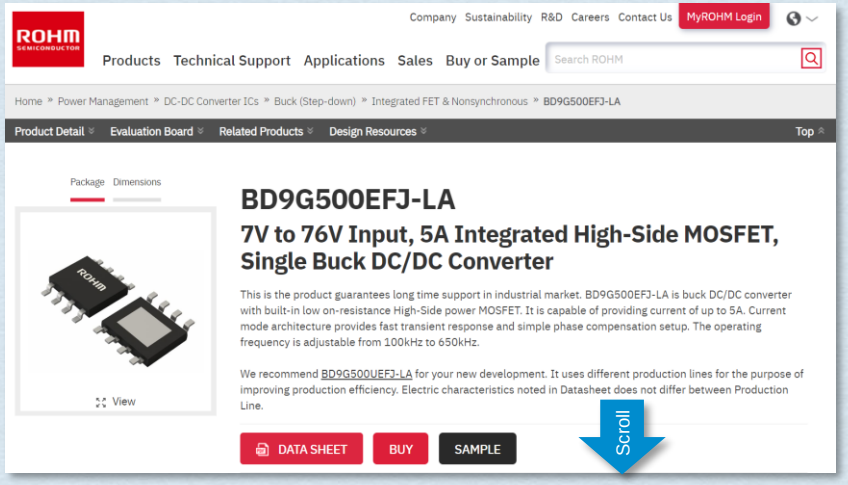
Step 1: Enter the product name into the search window on the upper right of the ROHM website.



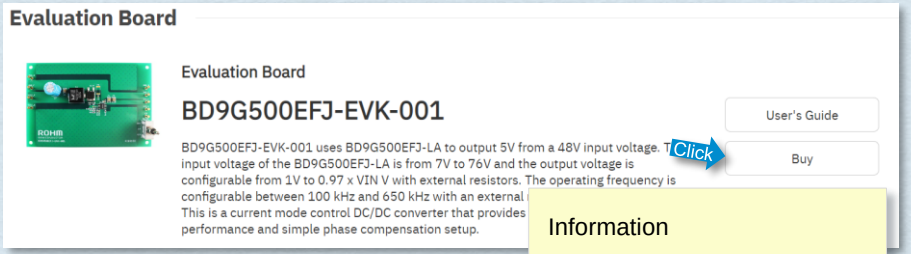

Step 2: Click the product name.




Step 3: When the product page is displayed, scroll down the page.



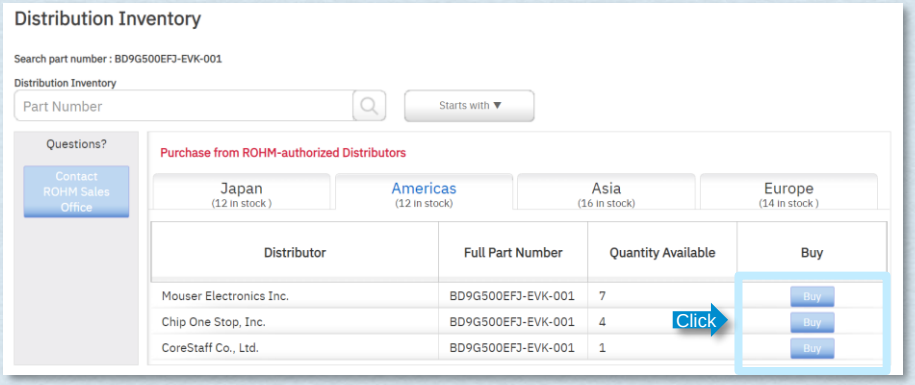

Step 4: If the “Evaluation Board” section is displayed, the board is available for purchase. Click the [Buy] button.




Information

If the product is not available from the online distributor, the [Purchase Inquiry] button is displayed instead of the [Buy] button. Contact the distributor to make an inquiry.

Step5: The availability from online distributors is displayed. Purchase the product through their website.




Information

No document is supplied with the purchased EVK. Obtain the document by clicking the [User’s Guide] button in Step 4.

Information

EVK

Information

ROHM Solution Simulator



# What is the ROHM Solution Simulator?

- ✓ Simulation tool you can run on the website
- ✓ Can verify the designs using circuits close to applications
- ✓ Can select from an extensive range of solution circuits, including mainly power devices and gate drivers
- ✓ High reproducibility of simulations achieved by incorporating high precision SPICE models. Coordination with certain evaluation boards
- ✓ Exportable to external simulators. Can be developed to customer's simulator circuits

Advanced power devices (SiC, etc.)

Driver IC and peripheral parts (Gate drivers, etc.)


To realize the maximum potential of power devices, know-how for tuning between parts is required

While tuning, ideal circuit parameters can be derived

## Using the ROHM Solution Simulator

Utilizing the solutions provided by ROHM

| Functional design | Product selection | Circuit design | Simulation | Pre-Prototype evaluation Solution board available | Prototype board | Prototype system | Mass production |
|---|---|---|---|---|---|---|---|
| | | | System-Level Simulation | | Board evaluation | System evaluation | |

From the steps for selecting parts and considering the validity of circuits, system level simulations can be repeatedly performed for analysis. Therefore, critical problems are less likely to occur after a trial, reducing the number of retrials and the hours for development.

## Provides solution circuits suited for various applications

Simulation circuit diagrams cover various power electronics applications

Power electronics applications

| Traction Inverter | On/Off board charger | PV Inverter | Server, Base station | Home appliances |
|---|---|---|---|---|
|  |  |  |  |  |

Function block

| AC/DC Converter | DC/DC Inverter | DC/DC Converter | Battery Management | PMICs for ECUs |
|---|---|---|---|---|

Circuit topologies provided by ROHM

| Totem pole PFC | Vienna Rectifier | Full/Half Bridge | LLC Resonant | Flyback | Boost | Current Monitoring |
|---|---|---|---|---|---|---|

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# What can be done with the ROHM Solution Simulator

Information

ROHM Solution Simulator



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## Step 1:

www

### Select a solution circuit

Select a solution circuit suited for the application from the solution circuit list

Simulation Circuit

【Power Device Solution Circuit】

- AC-DC PFC
- DC-AC Inverter
- DC-DC Converter
- NEW Other Application

【ICs Solution Circuit】

- Automotive Power Tree
- Click Switching Regulators
- LED Drivers
- Click Linear Regulators
- NEW Operational Amplifiers

【Optical Devices Solution Circuit】

- NEW Laser Diode

## Step 4:

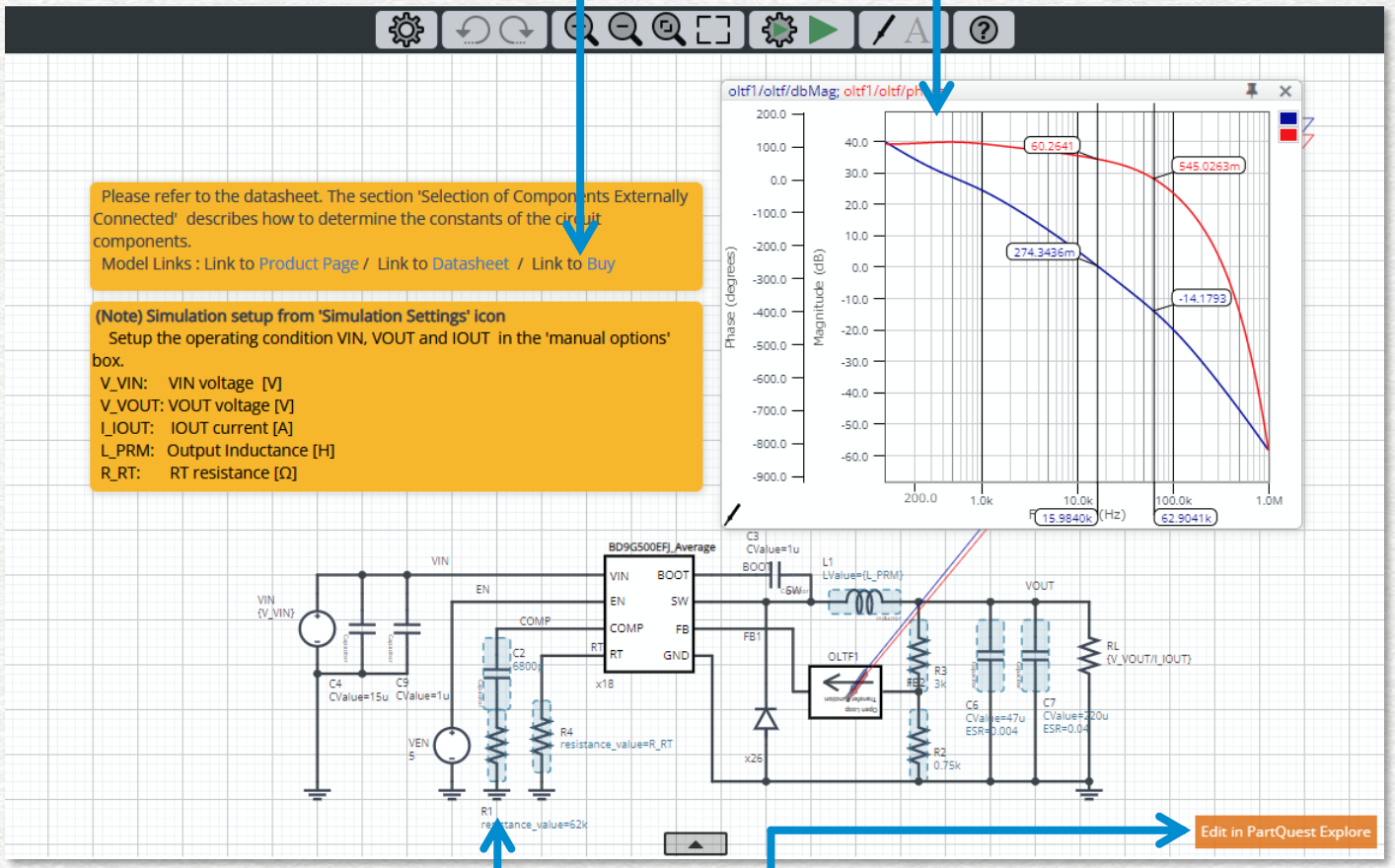
### Order samples

You can purchase samples for trial evaluation and evaluation boards via the links of the distribution partners shown in the circuit diagrams.

## Step 3:

### Perform simulations and monitor results

You can set and operate simulations intuitively. After performing simulations, you can check the results easily with the powerful waveform analysis tool.




## Step 2:

### Select devices and change values

The simulation screen is displayed. The constants recommended by ROHM have been entered in advance. Use these as base values for adjusting the parameters.

## Step 5:

### Expand circuits in an external environment

In addition to adjusting the parameters, you can export the circuit data to PartQuest Explore to expand system circuits and develop original circuits by changing the circuit types or adding different circuits.

# Design calculation tool
# What is the Calculation Sheet?

ROHM has published the Calculation Sheet that assists you in designing peripheral circuits for DC-DC and AC-DC converter ICs.

The Calculation Sheet is a design tool for application circuits based on the method of selecting parts described in product data sheets. Since the tool is equipped with calculation formulas required for determining the peripheral parts and other tasks, you can easily determine the circuit parameters that satisfy desired characteristics by setting values according to the instructions.

This tool is provided in a Microsoft Excel file format.

## DC-DC converter

- ✓ Automatically calculates the theoretical equation for the peripheral circuit design described in the data sheet, and automatically judges whether or not the value is within the setting range
- ✓ Outputs the BOM list and summary sheet of the design result

## AC-DC converter

- ✓ Can calculate coils, transformers, and other peripheral parts of flyback converters and buck converters
- ✓ Main components, including IC and peripheral parts such as Schottky barrier diodes, fast recovery diodes, electrolytic capacitors, and transformers, are compiled into a database, allowing you to sort the parts and select them on the spot.

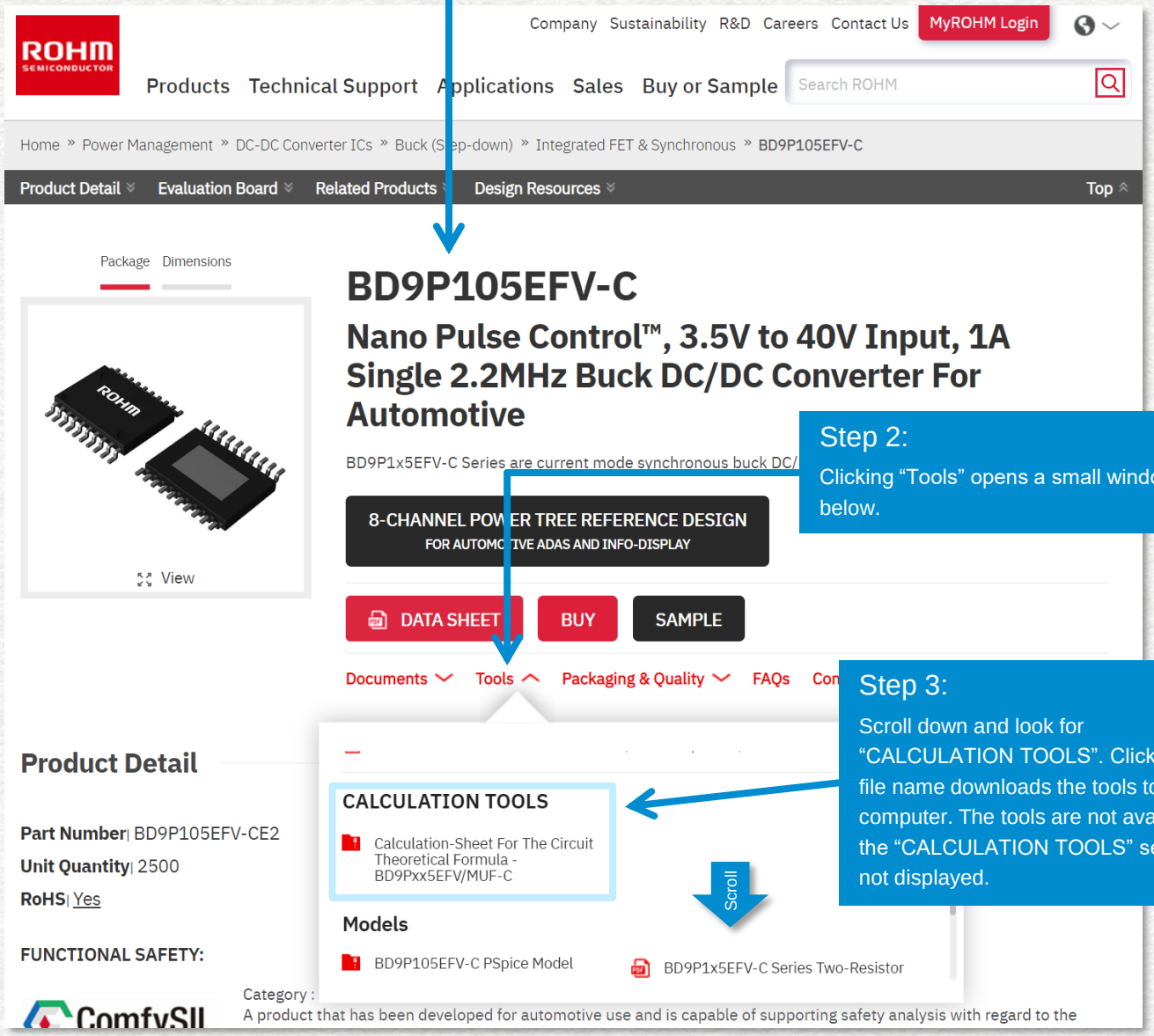
Information

Calculation Sheet



# How to obtain the Calculation Sheet

**Step 1:**
Display the product page of the product name you want.




**Step 2:**
Clicking “Tools” opens a small window below.

**Step 3:**
Scroll down and look for “CALCULATION TOOLS”. Clicking the file name downloads the tools to your computer. The tools are not available if the “CALCULATION TOOLS” section is not displayed.

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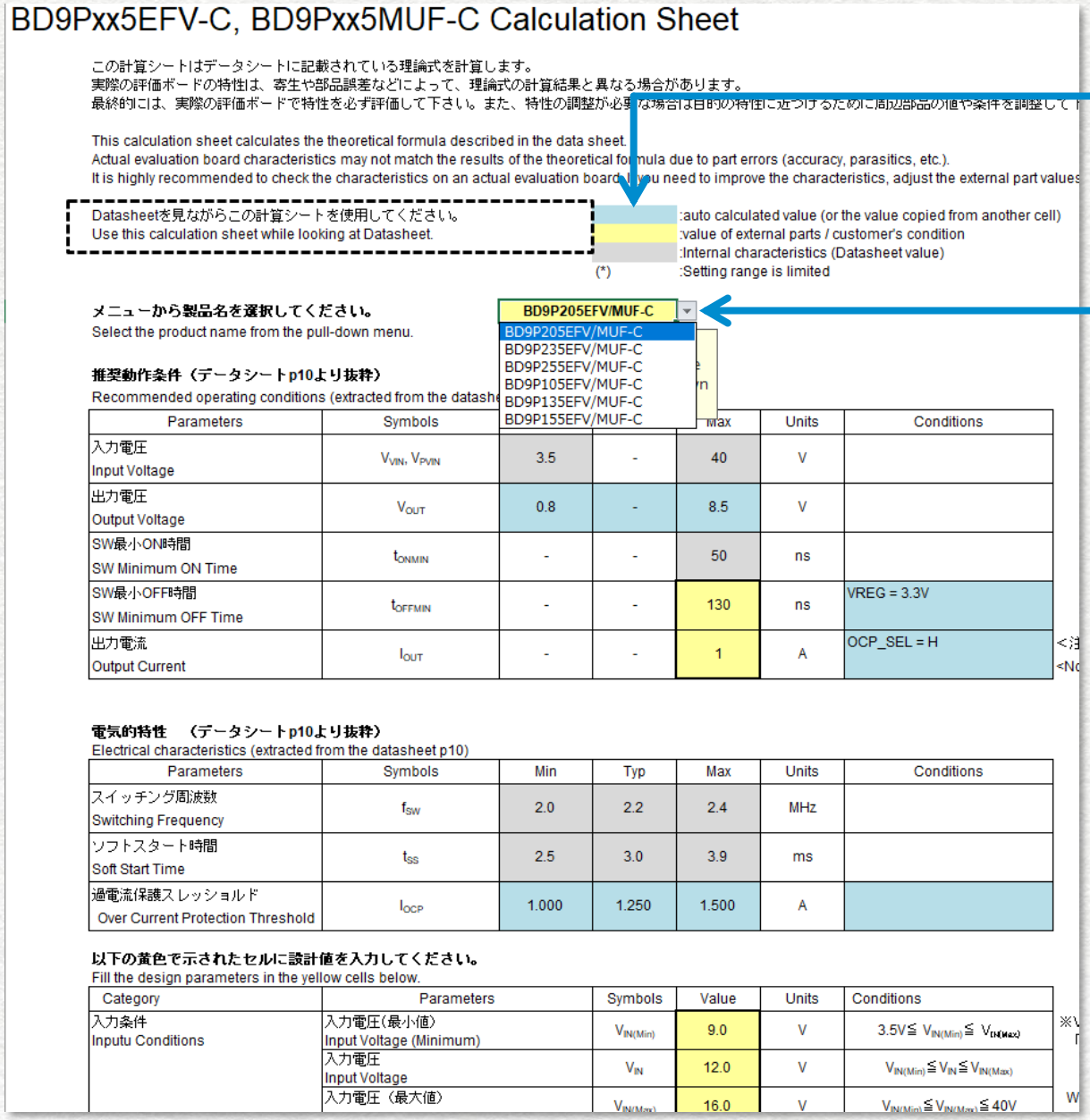

BD9Pxx5EFV-C, BD9Pxx5MUF-C Calculation Sheet

この計算シートはデータシートに記載されている理論式を計算します。
実際の評価ボードの特性は、寄生や部品誤差などによって、理論式の計算結果と異なる場合があります。
最終的には、実際の評価ボードで特性を必ず評価して下さい。また、特性の調整が必要な場合は目的の特性に近づけるために周辺部品の値や条件を調整して下

This calculation sheet calculates the theoretical formula described in the data sheet.
Actual evaluation board characteristics may not match the results of the theoretical formula due to part errors (accuracy, parasitics, etc.).
It is highly recommended to check the characteristics on an actual evaluation board. If you need to improve the characteristics, adjust the external part values

Datasheetを見ながらこの計算シートを使用してください。
Use this calculation sheet while looking at Datasheet.

:auto calculated value (or the value copied from another cell)
:value of external parts / customer's condition
:Internal characteristics (Datasheet value)
(*) :Setting range is limited

メニューから製品名を選択してください。
Select the product name from the pull-down menu.

BD9P205EFV/MUF-C
BD9P205EFV/MUF-C
BD9P235EFV/MUF-C
BD9P255EFV/MUF-C
BD9P105EFV/MUF-C
BD9P135EFV/MUF-C
BD9P155EFV/MUF-C

推奨動作条件（データシートp10より抜粋）
Recommended operating conditions (extracted from the datashe

| Parameters | Symbols | | | Max | Units | Conditions |
|---|---|---|---|---|---|---|
| 入力電圧 Input Voltage | $V_{VIN}$, $V_{PVIN}$ | 3.5 | - | 40 | V | |
| 出力電圧 Output Voltage | $V_{OUT}$ | 0.8 | - | 8.5 | V | |
| SW最小ON時間 SW Minimum ON Time | $t_{ONMIN}$ | - | - | 50 | ns | |
| SW最小OFF時間 SW Minimum OFF Time | $t_{OFFMIN}$ | - | - | 130 | ns | VREG = 3.3V |
| 出力電流 Output Current | $I_{OUT}$ | - | - | 1 | A | OCP_SEL = H |

電気的特性　（データシートp10より抜粋）
Electrical characteristics (extracted from the datasheet p10)

| Parameters | Symbols | Min | Typ | Max | Units | Conditions |
|---|---|---|---|---|---|---|
| スイッチング周波数 Switching Frequency | $f_{SW}$ | 2.0 | 2.2 | 2.4 | MHz | |
| ソフトスタート時間 Soft Start Time | $t_{SS}$ | 2.5 | 3.0 | 3.9 | ms | |
| 過電流保護スレッショルド Over Current Protection Threshold | $I_{OCP}$ | 1.000 | 1.250 | 1.500 | A | |

以下の黄色で示されたセルに設計値を入力してください。
Fill the design parameters in the yellow cells below.

| Category | Parameters | Symbols | Value | Units | Conditions |
|---|---|---|---|---|---|
| 入力条件 Inputu Conditions | 入力電圧(最小値) Input Voltage (Minimum) | $V_{IN(Min)}$ | 9.0 | V | 3.5V≦ $V_{IN(Min)}$ ≦ $V_{IN(Max)}$ |
| | 入力電圧 Input Voltage | $V_{IN}$ | 12.0 | V | $V_{IN(Min)}$ ≦ $V_{IN}$ ≦ $V_{IN(Max)}$ |
| | 入力電圧（最大値） | $V_{IN(Max)}$ | 16.0 | V | $V_{IN(Min)}$ ≦ $V_{IN(Max)}$ ≦ 40V |

## Step 1:

The cells are color-coded according to their functions. The yellow cells are for selecting or inputting values. The blue cells display the calculation results. The gray cells display the setting values on the data sheet.

## Step 2:

If the Calculation Sheet supports the series of models, selecting a product automatically sets the relevant entries such as recommended operation conditions.

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# How to use (continued)

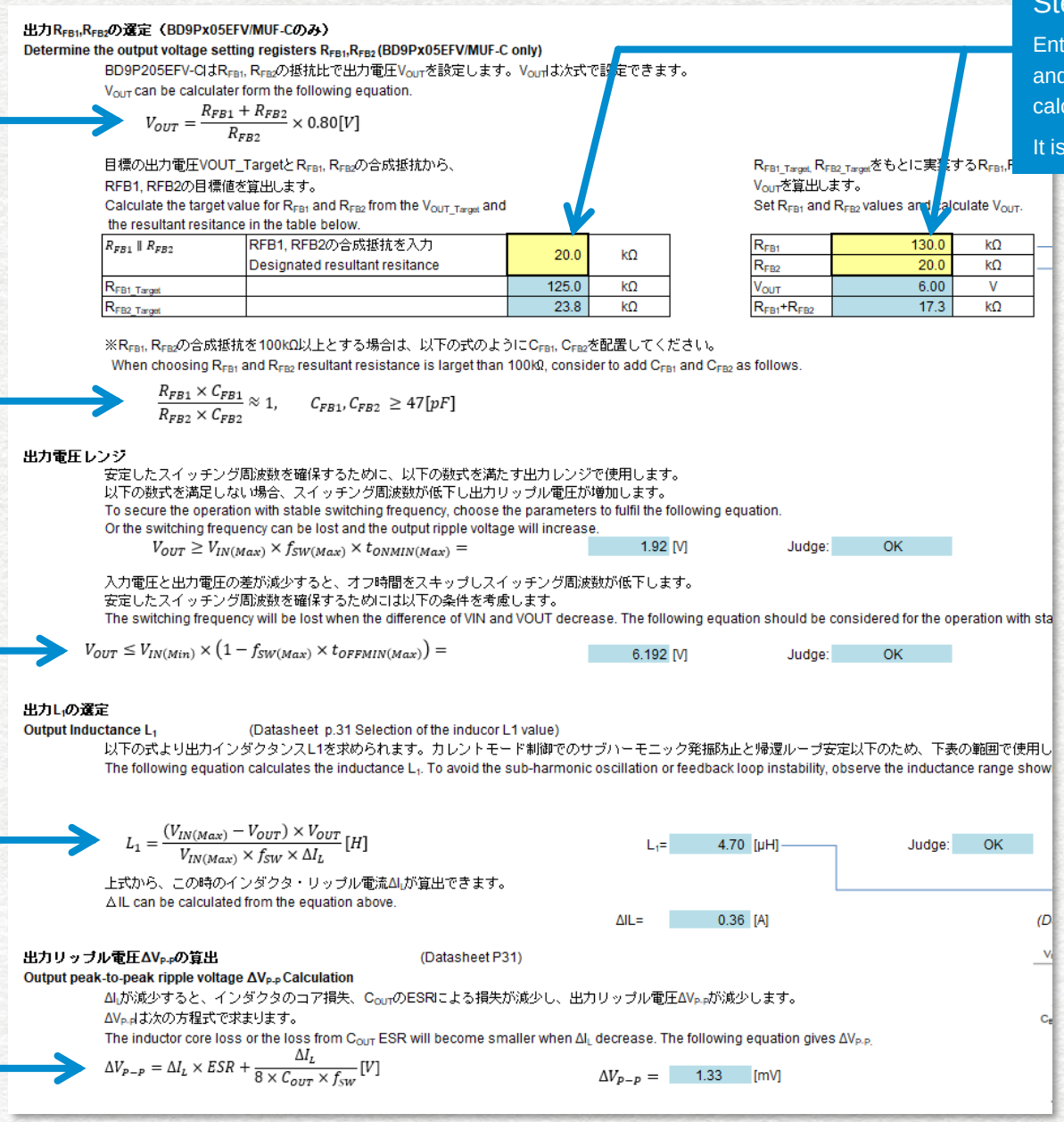
## Step 3:

The Calculation Sheet provides calculation formulas and instructions on how to determine values.

## Step 4:

Entering values according to the data sheet and the instructions updates the entire calculation result immediately.

It is also easy to make changes repeatedly.



**出力$R_{FB1}$,$R_{FB2}$の選定（BD9Px05EFV/MUF-Cのみ）**

**Determine the output voltage setting registers $R_{FB1}$,$R_{FB2}$ (BD9Px05EFV/MUF-C only)**

BD9P205EFV-CはR$_{FB1}$, R$_{FB2}$の抵抗比で出力電圧V$_{OUT}$を設定します。V$_{OUT}$は次式で設定できます。

V$_{OUT}$ can be calculater form the following equation.

$$V_{OUT} = \frac{R_{FB1} + R_{FB2}}{R_{FB2}} \times 0.80[V]$$

目標の出力電圧VOUT_TargetとR$_{FB1}$, R$_{FB2}$の合成抵抗から、RFB1, RFB2の目標値を算出します。

Calculate the target value for R$_{FB1}$ and R$_{FB2}$ from the V$_{OUT_Target}$ and the resultant resitance in the table below.

| | | | |
|---|---|---|---|
| $R_{FB1} \parallel R_{FB2}$ | RFB1, RFB2の合成抵抗を入力 Designated resultant resitance | 20.0 | kΩ |
| $R_{FB1\_Target}$ | | 125.0 | kΩ |
| $R_{FB2\_Target}$ | | 23.8 | kΩ |

R$_{FB1_Target}$, R$_{FB2_Target}$をもとに実装するR$_{FB1}$,R
V$_{OUT}$を算出します。
Set R$_{FB1}$ and R$_{FB2}$ values and calculate V$_{OUT}$.

| | | |
|---|---|---|
| $R_{FB1}$ | 130.0 | kΩ |
| $R_{FB2}$ | 20.0 | kΩ |
| $V_{OUT}$ | 6.00 | V |
| $R_{FB1}$+$R_{FB2}$ | 17.3 | kΩ |

※R$_{FB1}$, R$_{FB2}$の合成抵抗を100kΩ以上とする場合は、以下の式のようにC$_{FB1}$, C$_{FB2}$を配置してください。

When choosing R$_{FB1}$ and R$_{FB2}$ resultant resistance is larget than 100kΩ, consider to add C$_{FB1}$ and C$_{FB2}$ as follows.

$$\frac{R_{FB1} \times C_{FB1}}{R_{FB2} \times C_{FB2}} \approx 1, \quad C_{FB1}, C_{FB2} \geq 47[pF]$$

**出力電圧 レンジ**

安定したスイッチング周波数を確保するために、以下の数式を満たす出力レンジで使用します。
以下の数式を満足しない場合、スイッチング周波数が低下し出力リップル電圧が増加します。
To secure the operation with stable switching frequency, choose the parameters to fulfil the following equation.
Or the switching frequency can be lost and the output ripple voltage will increase.

$V_{OUT} \geq V_{IN(Max)} \times f_{SW(Max)} \times t_{ONMIN(Max)} =$ 1.92 [V] Judge: OK

入力電圧と出力電圧の差が減少すると、オフ時間をスキップしスイッチング周波数が低下します。
安定したスイッチング周波数を確保するためには以下の条件を考慮します。
The switching frequency will be lost when the difference of VIN and VOUT decrease. The following equation should be considered for the operation with sta

$V_{OUT} \leq V_{IN(Min)} \times \left(1 - f_{SW(Max)} \times t_{OFFMIN(Max)}\right) =$ 6.192 [V] Judge: OK

**出力L$_1$の選定**

**Output Inductance L$_1$** (Datasheet p.31 Selection of the inducor L1 value)

以下の式より出力インダクタンスL1を求められます。カレントモード制御でのサブハーモニック発振防止と帰還ループ安定以下のため、下表の範囲で使用し
The following equation calculates the inductance L$_1$. To avoid the sub-harmonic oscillation or feedback loop instability, observe the inductance range show

$$L_1 = \frac{(V_{IN(Max)} - V_{OUT}) \times V_{OUT}}{V_{IN(Max)} \times f_{SW} \times \Delta I_L}[H]$$

L$_1$= 4.70 [µH] Judge: OK

上式から、この時のインダクタ・リップル電流ΔI$_L$が算出できます。
ΔIL can be calculated from the equation above.

ΔIL= 0.36 [A]

**出力リップル電圧ΔV$_{P-P}$の算出** (Datasheet P31)

**Output peak-to-peak ripple voltage ΔV$_{P-P}$ Calculation**

ΔI$_L$が減少すると、インダクタのコア損失、C$_{OUT}$のESRによる損失が減少し、出力リップル電圧ΔV$_{P-P}$が減少します。
ΔV$_{P-P}$は次の方程式で求まります。
The inductor core loss or the loss from C$_{OUT}$ ESR will become smaller when ΔI$_L$ decrease. The following equation gives ΔV$_{P-P}$.

$$\Delta V_{P-P} = \Delta I_L \times ESR + \frac{\Delta I_L}{8 \times C_{OUT} \times f_{SW}}[V]$$

$\Delta V_{P-P} =$ 1.33 [mV]

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Calculation Sheet

# How to use (continued)

Using the Calculation Sheet prevents overlooking the design constraints and allows you to select parts that satisfy the operating conditions.

## Step 5:

If an input value is outside the working range, the tool outputs an error message and urges you to correct the value.

## Step 6:

Judges the calculation result and reports the results If the calculation result does not comply with the specifications, review and reset the input values.

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Calculation Sheet

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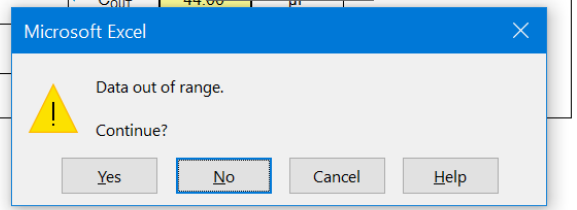
以下の黄色で示されたセルに設計値を入力してください。
Fill the design parameters in the yellow cells below.

| Category | Parameters | Symbols | Value | Units | Conditions |
|---|---|---|---|---|---|
| 入力条件<br>Inputu Conditions | 入力電圧(最小値)<br>Input Voltage (Minimum) | $V_{IN(Min)}$ | 9.0 | V | 3.5V≦ $V_{IN(Min)}$≦ $V_{IN(Max)}$ |
| | 入力電圧<br>Input Voltage | $V_{IN}$ | 12.0 | V | $V_{IN(Min)}$≦$V_{IN}$≦$V_{IN(Max)}$ |
| | 入力電圧（最大値）<br>Input Voltage (Maximum) | $V_{IN(Max)}$ | 16.0 | V | $V_{IN(Min)}$≦$V_{IN(Max)}$≦40V |
| 出力条件<br>Output Conditions | 出力電圧目標値<br>Target of the output voltage $V_{OUT}$ | $V_{OUT\_Target}$ | 10 | V | 0.8V<=VOUT_Target<=8.5V |
| | 起動時負荷による出力電流最大値<br>Maximum load current during startup | $I_{OUT\_START(Max)}$ | 0.5 | | CP(Min) |
| 出力インダクタ<br>Output Inductance | インダクタンス<br>Indcutance | $L_1$ | 4.7 | | µH to 15µH |
| 出力キャパシタ<br>Output Capacitor | 容量<br>Capacitance | $C_{OUT}$ | 44.0 | µF | |
| | 等価直列抵抗<br>Equivalent Series Resistor | | | | |
| | 定格リップル電流<br>Ripple Current Rating | | | | |

Vout range is shown as the output voltage range above.




**出力$R_{FB1}$,$R_{FB2}$の選定（BD9Px05EFV/MUF-Cのみ）**
**Determine the output voltage setting registers $R_{FB1}$,$R_{FB2}$ (BD9Px05EFV/MUF-C only)**

**出力$R_{FB1}$,$R_{FB2}$の選定（BD9Px05EFV/MUF-Cのみ）**
**Determine the output voltage setting registers $R_{FB1}$,$R_{FB2}$ (BD9Px05EFV/MUF-C only)**

BD9P205EFV-Cは$R_{FB1}$, $R_{FB2}$の抵抗比で出力電圧$V_{OUT}$を設定します。$V_{OUT}$は次式で設定できます。
$V_{OUT}$ can be calculater form the following equation.

$$V_{OUT} = \frac{R_{FB1} + R_{FB2}}{R_{FB2}} \times 0.80[V]$$

目標の出力電圧VOUT_Targetと$R_{FB1}$, $R_{FB2}$の合成抵抗から、
RFB1, RFB2の目標値を算出します。
Calculate the target value for $R_{FB1}$ and $R_{FB2}$ from the $V_{OUT\_Target}$ and the resultant resitance in the table below.

| | | | |
|---|---|---|---|
| $R_{FB1} \parallel R_{FB2}$ | RFB1, RFB2の合成抵抗を入力<br>Designated resultant resitance | 20.0 | kΩ |
| $R_{FB1\_Target}$ | | 125.0 | kΩ |
| $R_{FB2\_Target}$ | | 23.8 | kΩ |

$R_{FB1\_Target}$, $R_{FB2_Target}$をもとに実装する$R_{FB1}$,$R_{FB2}$を
$V_{OUT}$を算出します。
Set $R_{FB1}$ and $R_{FB2}$ values and calculate $V_{OUT}$.

| | | |
|---|---|---|
| $R_{FB1}$ | 10.0 | kΩ |
| $R_{FB2}$ | 20.0 | kΩ |
| $V_{OUT}$ | 1.20 | V |
| $R_{FB1}$+$R_{FB2}$ | 6.7 | kΩ |

※$R_{FB1}$, $R_{FB2}$の合成抵抗を100kΩ以上とする場合は、以下の式のようにに$C_{FB1}$, $C_{FB2}$を配置してください。
When choosing $R_{FB1}$ and $R_{FB2}$ resultant resistance is larget than 100kΩ, consider to add $C_{FB1}$ and $C_{FB2}$ as follows.

$$\frac{R_{FB1} \times C_{FB1}}{R_{FB2} \times C_{FB2}} \approx 1, \quad C_{FB1}, C_{FB2} \geq 47[pF]$$

**出力電圧レンジ**
安定したスイッチング周波数を確保するために、以下の数式を満たす出力レンジで使用します。
以下の数式を満足しない場合、スイッチング周波数が低下し出力リップル電圧が増加します。
To secure the operation with stable switching frequency, choose the parameters to fulfil the following equation.
Or the switching frequency can be lost and the output ripple voltage will increase.

$V_{OUT} \geq V_{IN(Max)} \times f_{SW(Max)} \times t_{ONMIN(Max)} =$ 1.92 [V] Judge: NG

入力電圧と出力電圧の差が減少すると、オフ時間をスキップしスイッチング周波数が低下します。
安定したスイッチング周波数を確保するためには以下の条件を考慮します。
The switching frequency will be lost when the difference of VIN and VOUT decrease. The following equation should be considered for the operation with sta

$V_{OUT} \leq V_{IN(Min)} \times \left(1 - f_{SW(Max)} \times t_{OFFMIN(Max)}\right) =$ 6.192 [V] Judge: OK

**出力$L_1$の選定**
**Output Inductance $L_1$** (Datasheet p.31 Selection of the inducor L1 value)
以下の式より出力インダクタンスL1を求められます。カレントモード制御でのサブハーモニック発振防止と帰還ループ安定以下のため、下表の範囲で使用し
The following equation calculates the inductance $L_1$. To avoid the sub-harmonic oscillation or feedback loop instability, observe the inductance range show

$$L_1 = \frac{(V_{IN(Max)} - V_{OUT}) \times V_{OUT}}{V_{IN(Max)} \times f_{SW} \times \Delta I_L}[H]$$

$L_1$= 4.70 [µH] Judge: OK

# How to use (continued)

A summary sheet showing the design result is prepared. You can use it directly in the design report.

Information

Calculation Sheet

Page 5 / 5

Previous page

## Step 7:

Displays the parts constants of the application circuit.

## Step 8:

Displays the list of design values, including the characteristic values.

## Summary : BD9Pxx5EFV-C, BD9Pxx5MUF-C Calculation Sheet

REV.002 20210911


この計算シートはデータシートに記載されている理論式を計算します。
実際の評価ボードの特性は、寄生や部品誤差などによって、理論式の計算結果と異なる場合があります。
最終的には、実際の評価ボードで特性を必ず評価して下さい。また、特性の調整が必要な場合は目的の特性に近づけるために周辺部品の値や条件を調整して下さい。

This calculation sheet calculates the theoretical formula described in the data sheet.
Actual evaluation board characteristics may not match the results of the theoretical formula due to part errors (accuracy, parasitics, etc.).
It is highly recommended to check the characteristics on an actual evaluation board. If you need to improve the characteristics, adjust the external part values and conditions to get closer to your target.

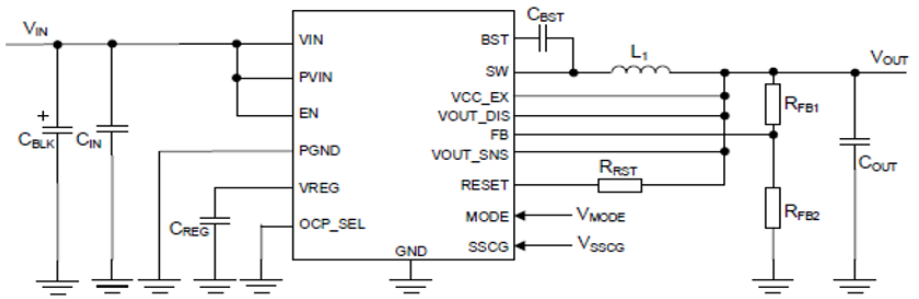
**(1) BOM**

Product No. BD9P205EFV/MUF-C

:Value from 1. Calculation sheet

| Components parameters | | Value | Units | Conditions |
|---|---|---|---|---|
| $R_{FB1}$ | | 130.0 | kΩ | |
| $R_{FB2}$ | | 20.0 | kΩ | |
| $R_{RST}$ | | 10 | kΩ | |
| $C_{BLK}$ | | 220 | µF | Electrolytic capacitor |
| $C_{IN}$ | | 0.1 | µF | Ceramic Capacitor |
| $C_{REG}$ | | 1 | µF | Ceramic Capacitor |
| $C_{BST}$ | | 0.1 | µF | Ceramic Capacitor |
| $C_{OUT}$ | $C_{OUT}$ | 44.00 | µF | |
| | ESR | 2.370E-03 | Ω | |
| | Ripple Current | 1.0 | A | |
| $L_1$ | | 4.7 | µH | |

*(Datasheet p.30, Fig.47 Application Circuit)*




**(2) 計算結果**
**(2) Parameter calculation results**

| | Parameters | Symbols | Value | Units | Judge | Condition |
|---|---|---|---|---|---|---|
| 設計値 | Input Voltage (Minimum) | $V_{IN(Min)}$ | 9.0 | V | OK | |
| | Input Voltage | $V_{IN}$ | 12.0 | V | - | 3.5V to 40V |
| | Input Voltage (Maximum) | $V_{IN(Max)}$ | 16.0 | V | OK | |
| Desigin parameters | Output Voltage | $V_{OUT\_Target}$ | 5.00 | V | OK | 0.8V to 8.5V |
| | SW minimum OFF time | $t_{OFFMIN}$ | 130 | ns | - | VREG = 3.3V |
| | Maximum load current during startup | $I_{OUT\_Start(Max)}$ | 0.50 | A | - | |
| | Output Current | $I_{OUT}$ | 1.00 | A | - | OCP_SEL = H |
| 計算結果 | Output voltage | $V_{OUT}$ | 6.00 | V | OK | 1.92 ≦ $V_{OUT}$ ≦ 6.192 |
| Calculation Results | Output Inductor | $L_1$ | 4.70 | µH | OK | 4.7µH to 15µH |
| | Inductor ripple current | $\Delta I_L$ | 0.36 | A | - | |
| | Output ripple voltage | $\Delta V_{P-P}$ | 1.33 | mV | - | |
| | Cout capacitance | $C_{OUT}$ | 44.00 | µF | OK | $C_{OUT}$ ≧ 44.00 µF |
| | Minimum $C_{OUT}$ capacitance | $C_{OUT\_WORST}$ | 44.00 | µF | OK | $C_{OUT\_WORST}$ ≧ 18.17 µF |
| | Maximum $C_{OUT}$ capacitance | $C_{OUT(Max)}$ | 260.42 | µF | OK | $C_{OUT(Max)}$ ≧ 44.00 µF |
| | RMS value of ripple current | $I_{COUT(RMS)}$ | 0.10 | A | OK | $I_{COUT(RMS)}$ < 1.00 A |
| | Input ripple current (RMS) | $I_{CIN(RMS)}$ | 0.51 | A | - | |

*1 The results of theoretical calculations with ideal parts may not match the part values in the recommended parts list (or the simulation results).
The results of the theoretical calculations are temporary values. The component values must be adjusted by evaluation of the actual board to determine the final value.
理想的な部品を用いた理論計算の結果は、推奨部品リストの部品値（またはシミュレーション結果）と一致しない場合があります。
理論計算の結果は仮の値です。最終的な値を決定するには、実際の基板の評価で部品値を調整する必要があります。

Information

Application Note

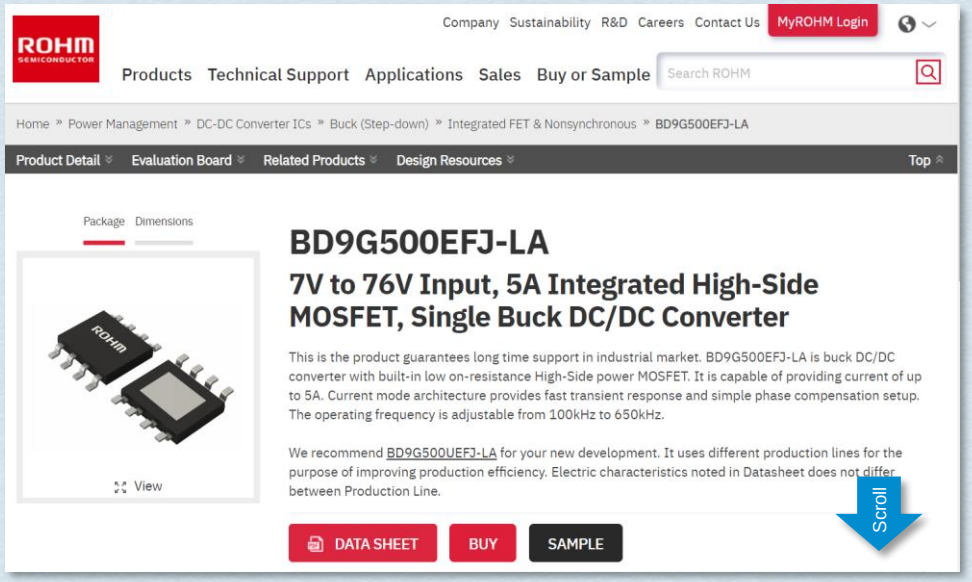


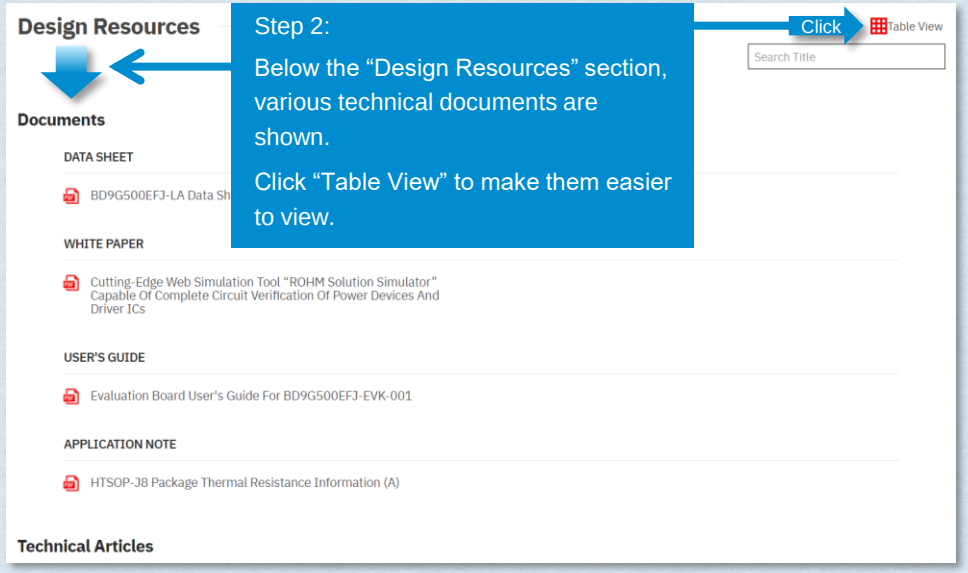
# How to obtain application notes (various technical documents)

Obtain through one of the following methods:

## Method 1. Find application notes on the product page

Step 1: Display the product page of the product name you want and scroll down the page.



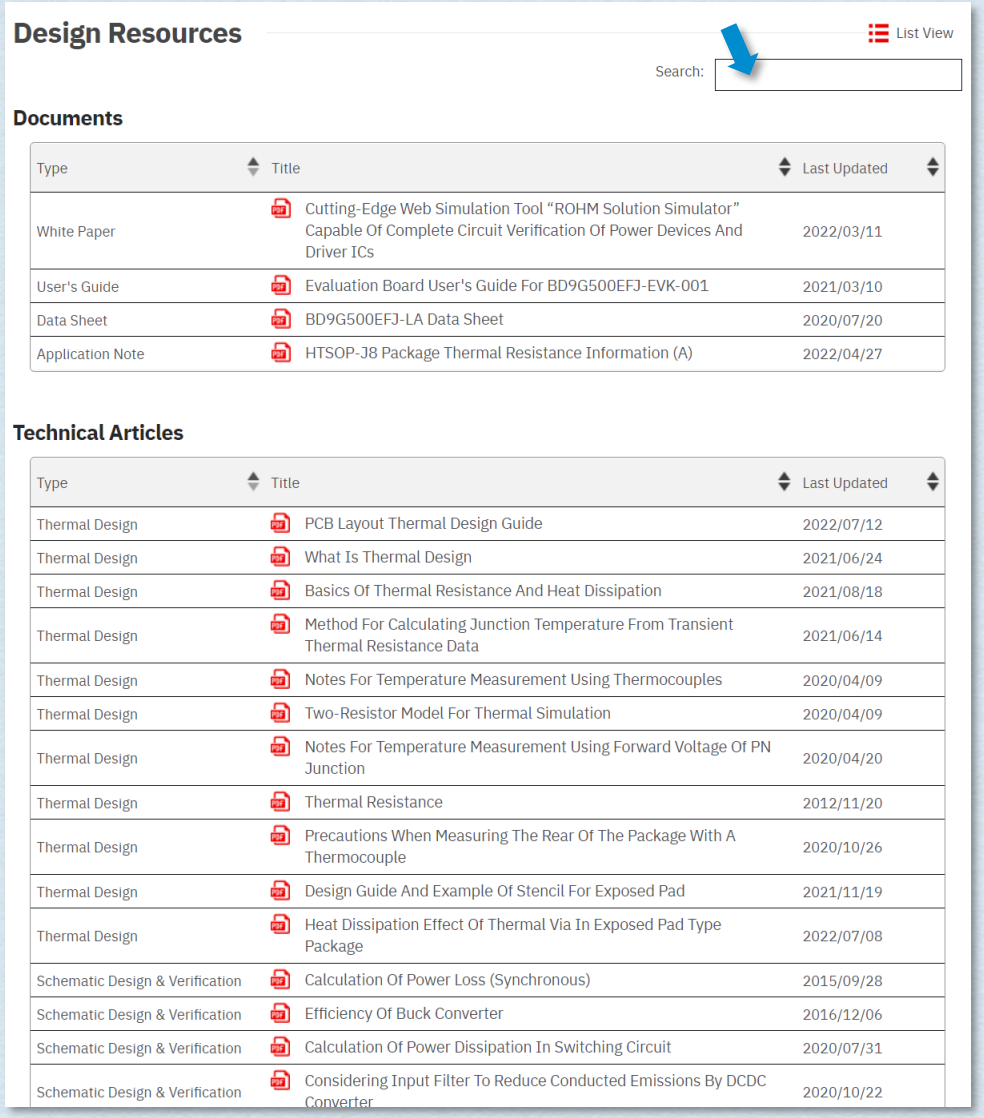




Step 2:

Below the "Design Resources" section, various technical documents are shown.

Click "Table View" to make them easier to view.

Step 3: The "Documents" section shows documents highly relevant to this product name. The "Technical Articles" section shows documents related to this product name. With the "Search" feature on the upper right of the display, you can easily search for document titles.




Next page

# How to obtain application notes (various technical documents) (continued)

Information

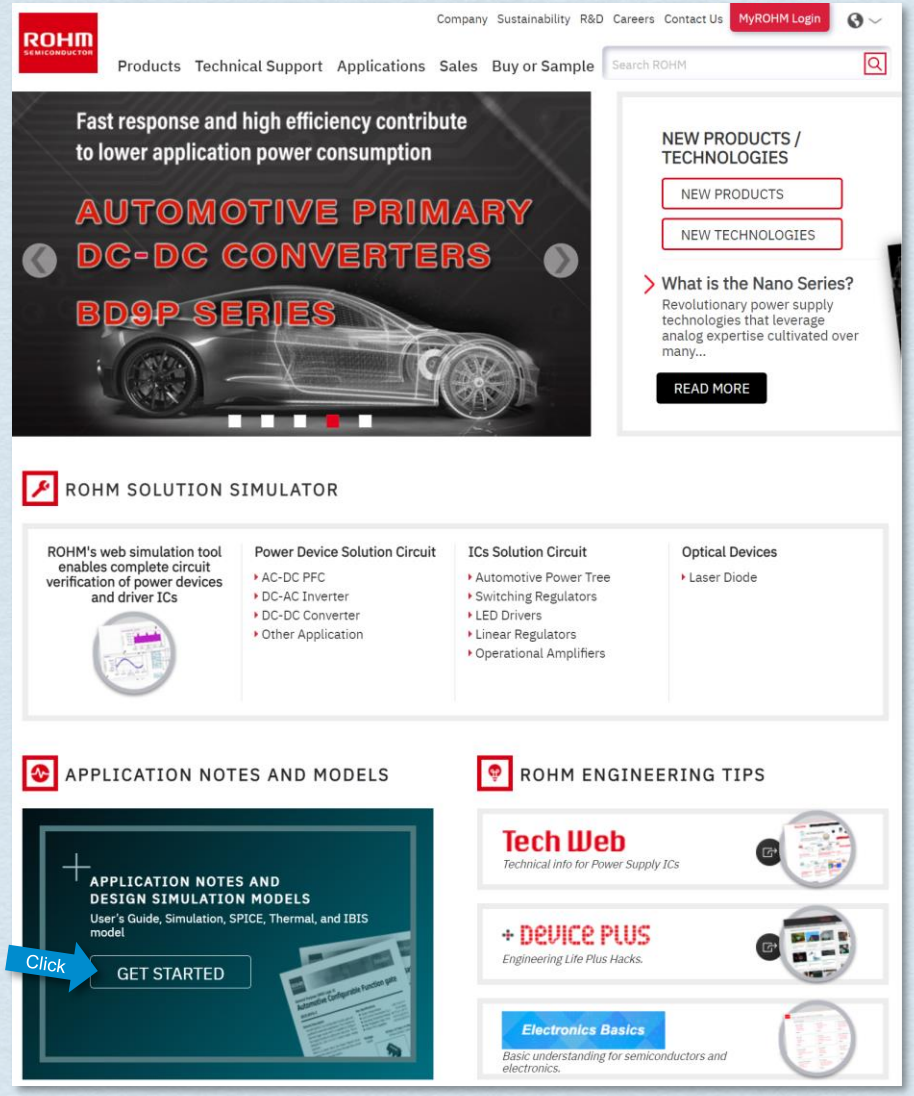
Application Note



Previous page

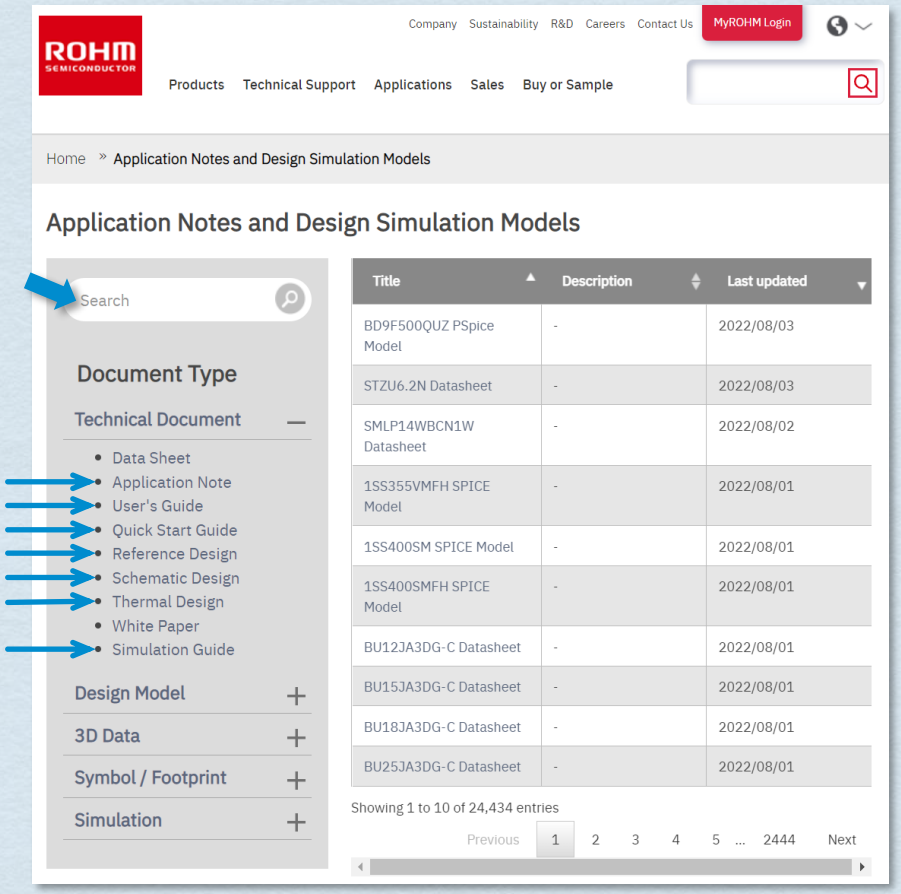
## Method 2. Using keywords to search through the website

Step 1: From the home page, access the document search page.




Step 2: Entering a keyword into the “Search” area on the left side of the screen displays the results in a window on the right. Do not confuse the area with the search field on the upper right of the display. With the default setting, all documents and design models including data sheets are targets of the search. As a result, many unnecessary results may be displayed, hiding necessary information.

In such a case, select the type of documents in the list on the left. This displays filtered results. In case of application notes, they may be contained in different categories, such as Schematic Design or Thermal Design. Select the categories sequentially.



# How to obtain design models

The design models include the following. Different models are provided depending on the product names.

Electrical simulation models for IC

- PSpice Model: encrypted model file for PSpice.
- Unencrypted SPICE Model: unencrypted model file.
- Spice Modeling Report: modeling report for models listed above.

Electrical simulation models for discrete devices

- SPICE Model: unencrypted model file.
- SPICE Thermal Model: thermal model to be used by electrical simulators.
- PLECS Model: model file for PLECS.

For thermal simulations

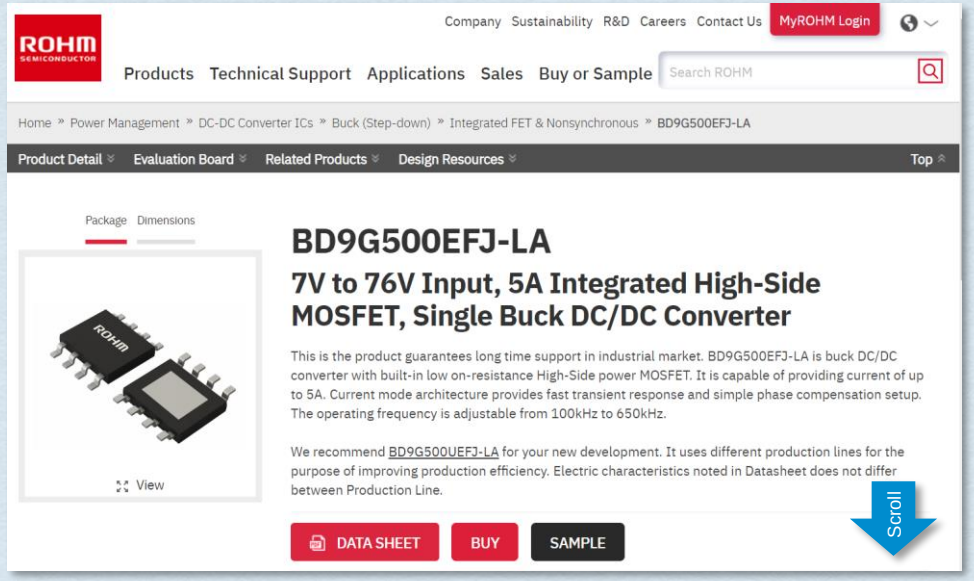
- Tow-Resistor Model Report: document describing the values of the two-resistor model.

Information

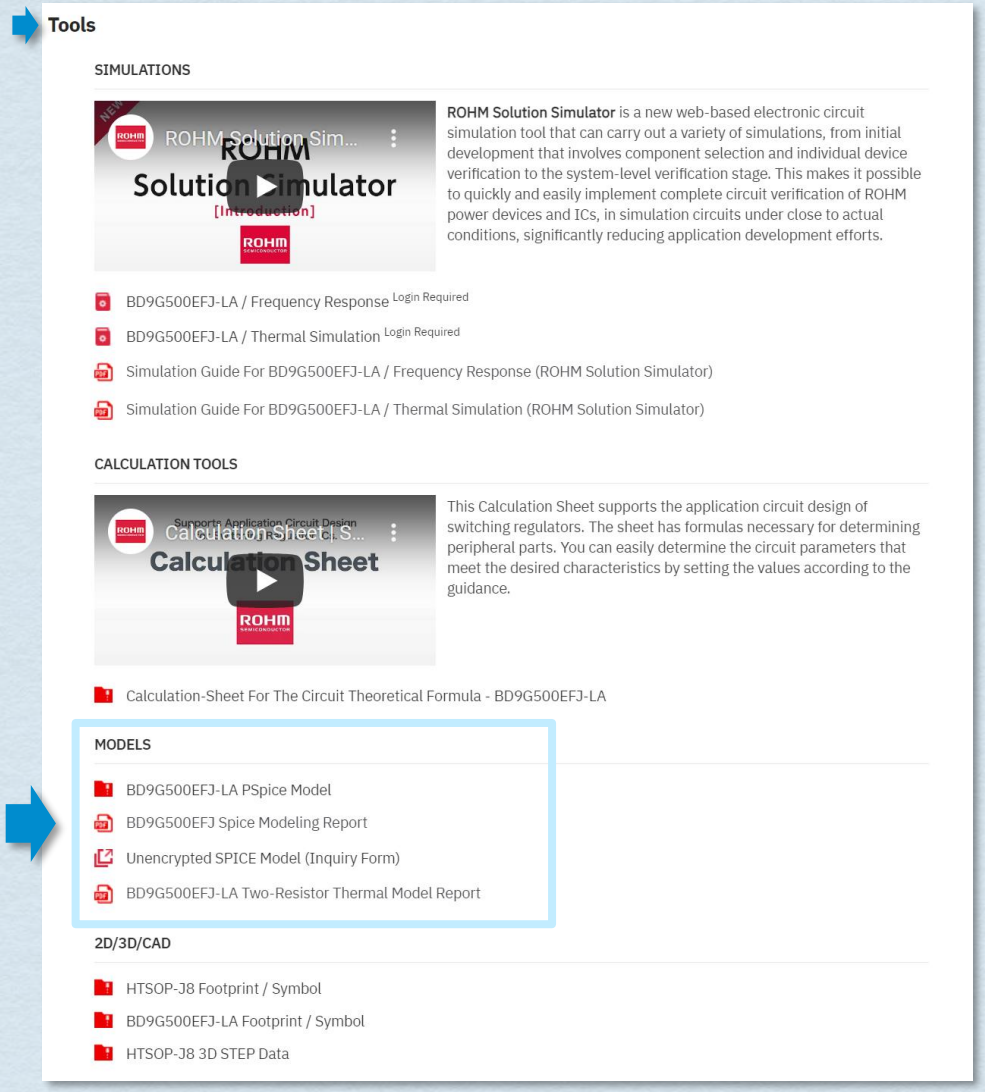
Design Model



Step 1: Display the product page of the product name you want and scroll down the page.




Step 2: “MODELS” is located below the “Tools” section. Models for electrical and thermal simulations are provided. Click the necessary items to download them.

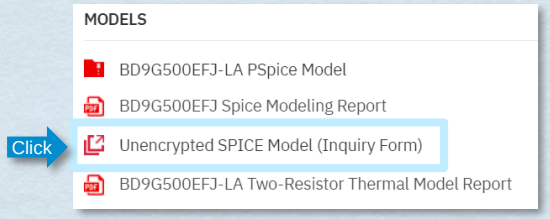



Next page

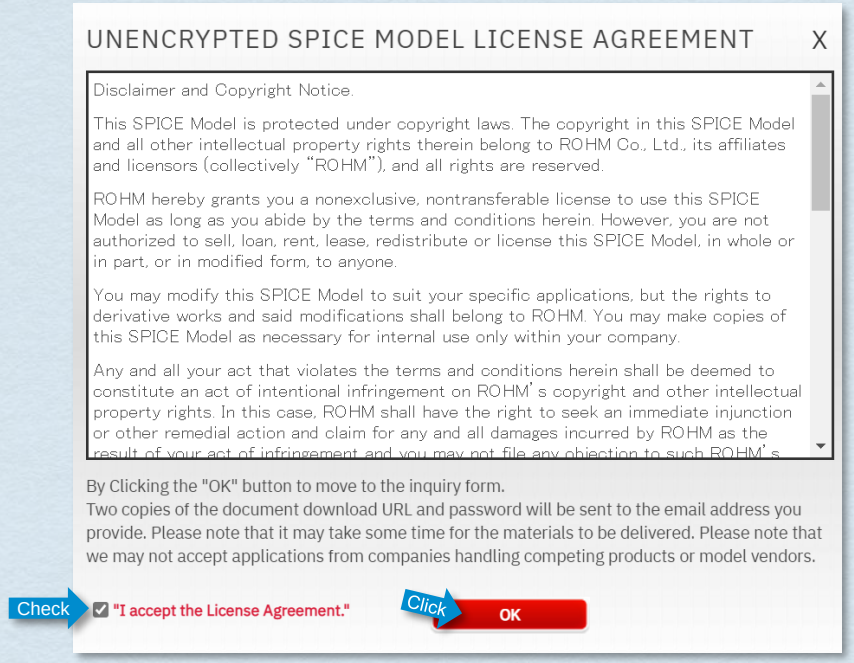
# How to obtain design models (continued)

## How to obtain Unencrypted SPICE Model

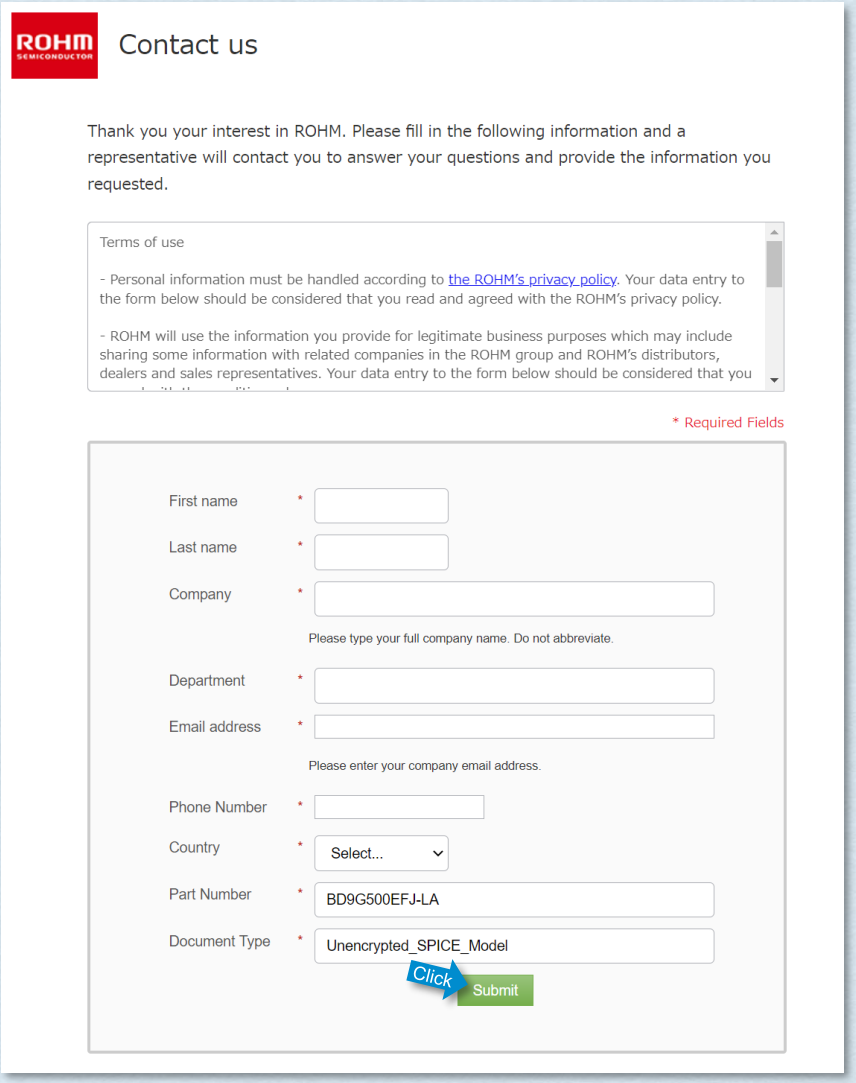
Step 1: Click “Unencrypted SPICE Model (Inquiry Form)”.




Step 2: Read the licensing agreement. If you accept, check “I accept the License Agreement.” and click the [OK] button.




Step 3: When the “Contact us” form is displayed, enter the required details and click the [Submit] button.




Step 4: The URL and password for download are sent to the email address entered. Follow the procedure described in the email to obtain the SPICE Model.

Information
Previous page

Design Model

# How to obtain package information

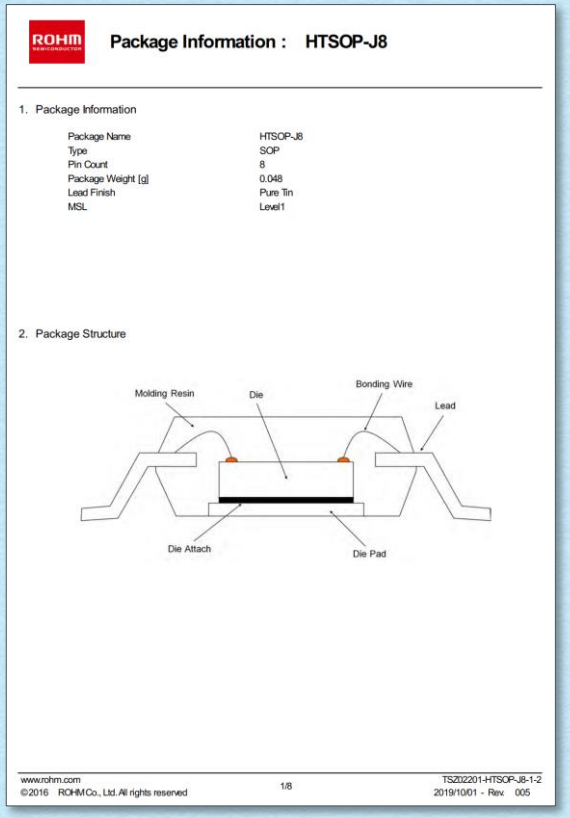
Information

Package Information



The package information contains the following details.

- Package Structure
- Packing Specification
- Footprint dimensions
- Marking Specification
- Storage conditions
- Soldering conditions



ROHM

**Package Information : HTSOP-J8**

1. Package Information

| | |
|---|---|
| Package Name | HTSOP-J8 |
| Type | SOP |
| Pin Count | 8 |
| Package Weight [g] | 0.048 |
| Lead Finish | Pure Tin |
| MSL | Level1 |

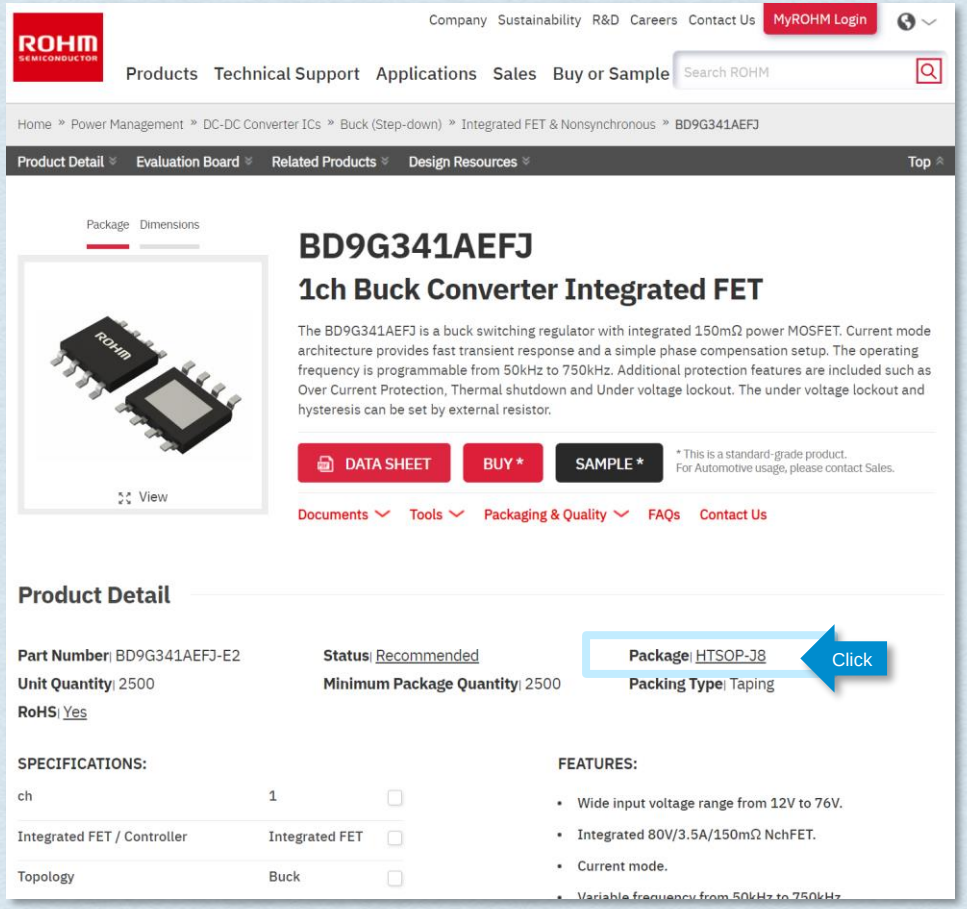
2. Package Structure







Step 1: Display the product page of the product name you want. Clicking the package name displays the package information.



# How to obtain PCB library data

The PCB library data (.bxl file) is neutral CAD data independent of CAD tools.
You can import this file into Ultra Librarian® Free Reader and export symbols and footprints in a specific CAD tool format.

Ultra Librarian® Free Reader supports 30 types of CAD formats and more.

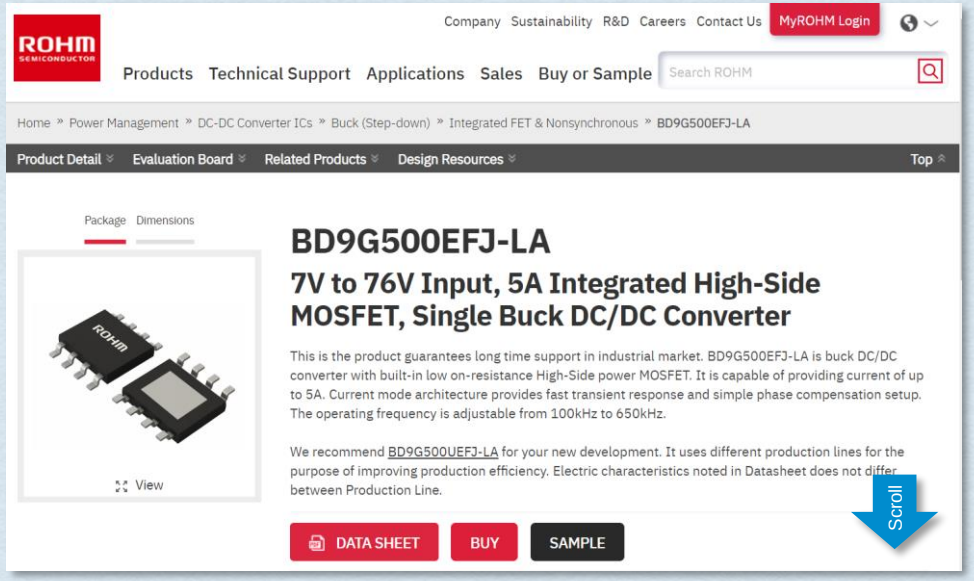
- Accel EDA 14 & 15
- Altium 6 to current version
- Autodesk Fusion 360
- Cadence Allegro
- DesignSpark
- Eagle Libraries
- KiCad
- Mentor Graphics
- BoardStation
- Mentor Graphics Design Architect
- Mentor Graphics Design
- Expedition 99 and 2000
- OrCAD 9.X PCB and Capture
- PADS PowerPCB 3, 3.5, 4.X, and 5.X
- PADS PowerPCB and PowerLogic 3.0
- PCAD 2000, 2001, 2002, 2004, and 2006
- Pulsonix 8.5 or newer
- STL
- 3D STEP
- TARGET 3001!
- View Logic ViewDraw
- Quadcept
- Zuken CadStar 3 and 4
- Zuken CR-5000 and CR-8000
- Zuken eCADSTAR 2020 and 2021

Information

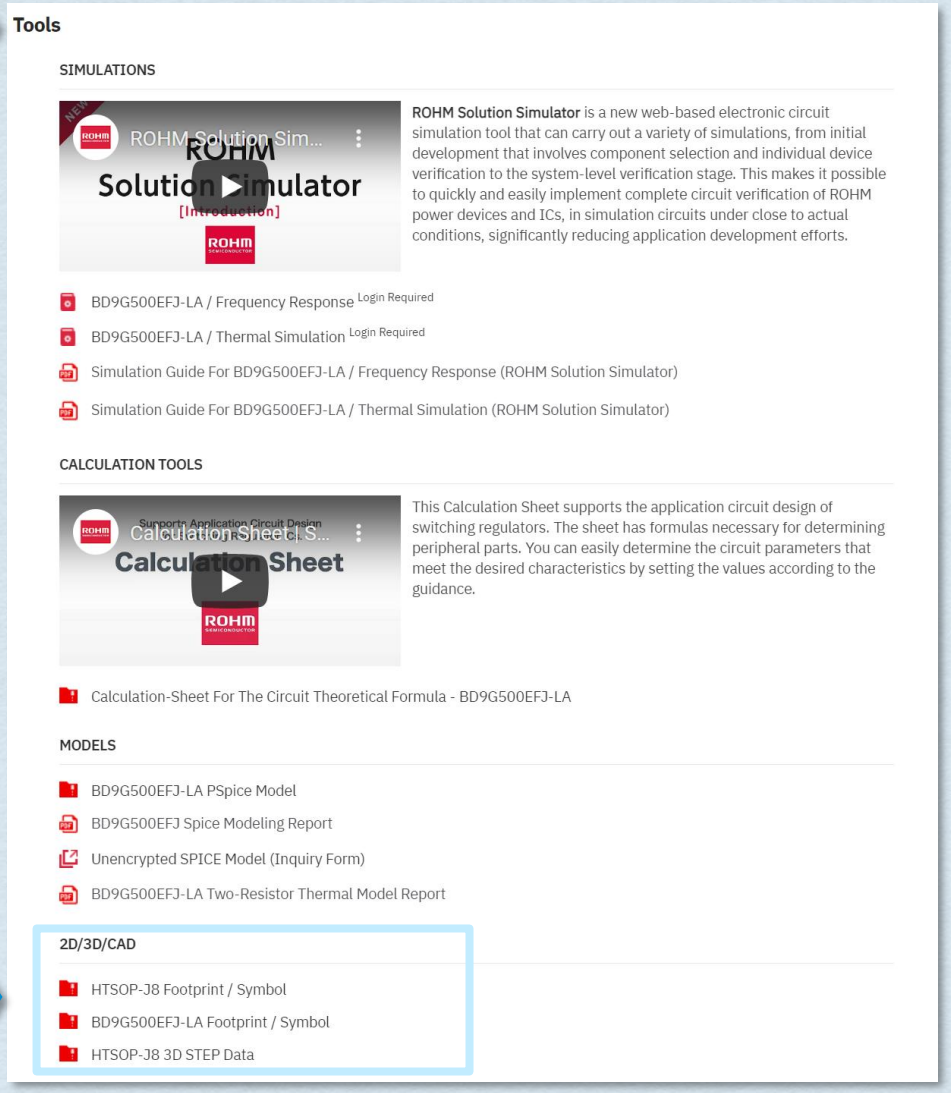
PCB Library



Step 1: Display the product page of the product name you want and scroll down the page.



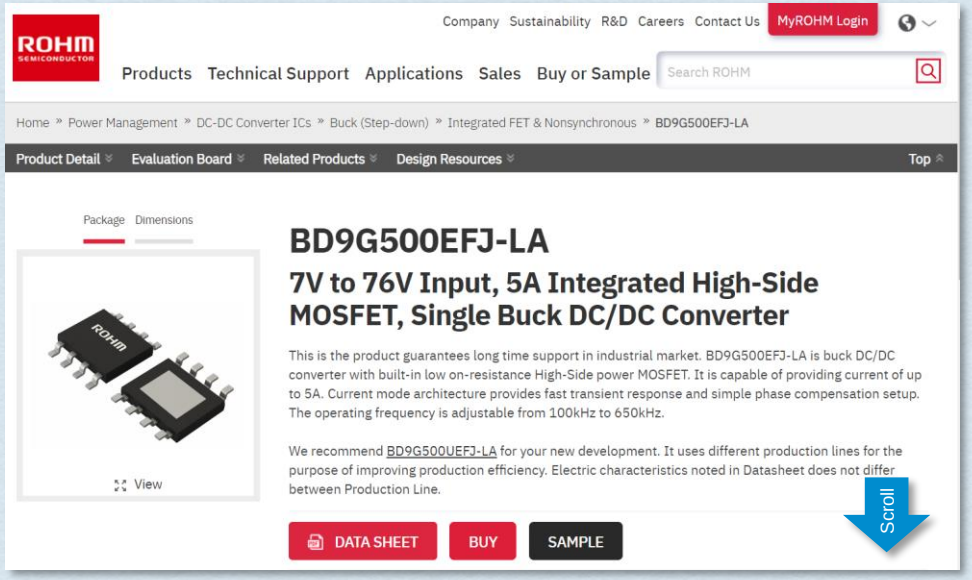

Step 2: “2D/3D/CAD” is located below “Tools”. Clicking “Footprint /Symbol” starts downloading the library.



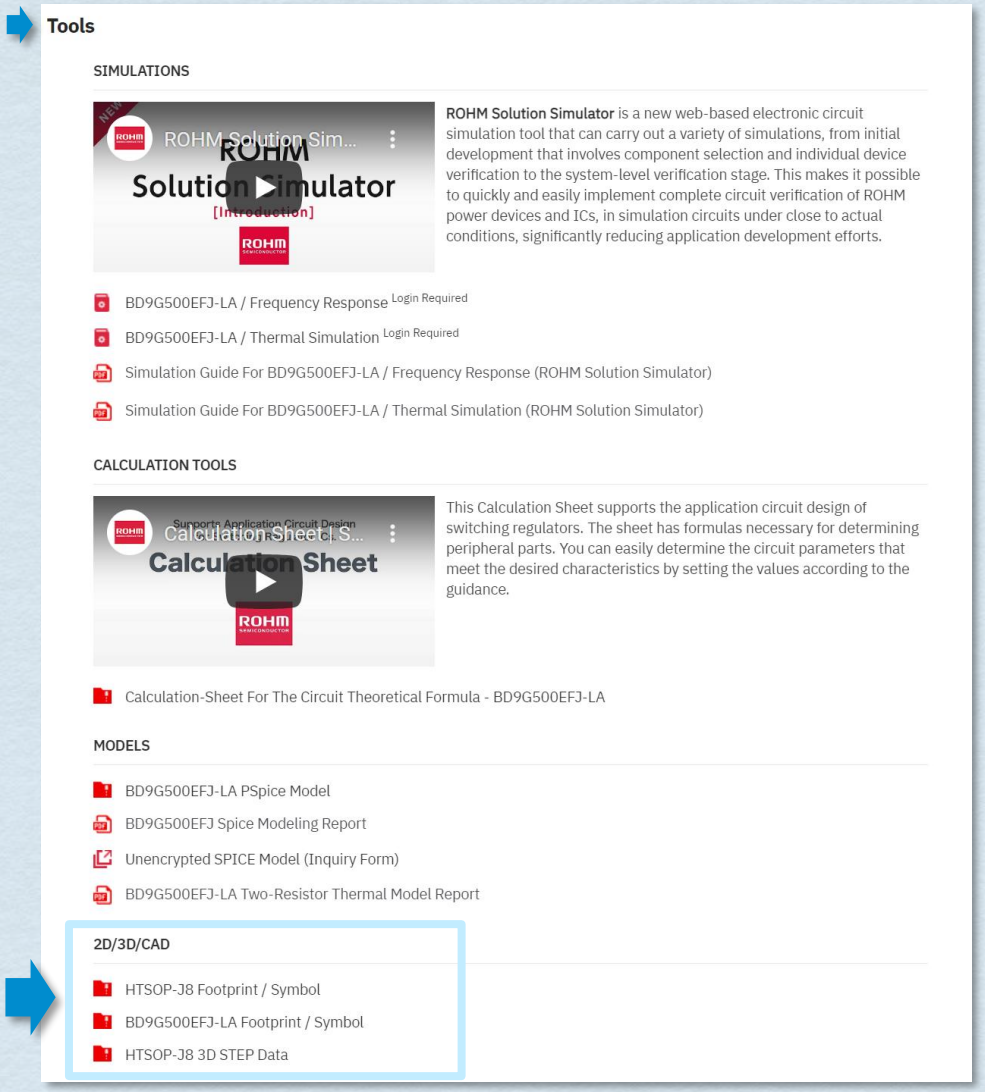
# How to obtain 3D models

The 3D package model data representing the 3D outline images of electronic components is provided as a STEP (Standard for the Exchange of Product data) file. The STEP files comply with the international standard, ISO 10303. They can be imported into many CAD systems. In addition, they are saved in the text format so that various CAD systems can interpret them. The data published on the website are outline models in which internal structures cannot be viewed.

Step 1: Display the product page of the product name you want and scroll down the page.




Step 2: “2D/3D/CAD” is located below “Tools”. Clicking “3D STEP Data” starts downloading the model.




Information

3D Model

# Simulation Circuit

Select a circuit to be simulated

## Switching Regulator ICs : Automotive

| Part number | $I_{OUT}$ [A] | $V_{IN}$ [V] | $V_{OUT}$ [V] | Package | Simulation Circuit | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Frequency Response | Start Up | Load Response | Line Response |
| BD9P105EFV-C | 1 | 3.5 to 40 | 0.8 to 8.5 | HTSSOP-B20 | Online | - | Online | Online |
| BD9P105MUF-C | | | | VQFN20FV4040 | Online | - | Online | Online |
| BD9P135EFV-C | | | 3.3 | HTSSOP-B20 | Online | - | Online | Online |
| BD9P135MUF-C | | | | VQFN20FV4040 | Online | - | Online | Online |
| BD9P155EFV-C | | | 5.0 | HTSSOP-B20 | Online | - | Online | Online |
| BD9P155MUF-C | | | | VQFN20FV4040 | Online | - | Online | Online |
| BD9P205EFV-C | 2 | 3.5 to 40 | 0.8 to 8.5 | HTSSOP-B20 | Online | - | Online | Online |
| BD9P205MUF-C | | | | VQFN20FV4040 | Online | - | Online | Online |
| BD9P235EFV-C | | | 3.3 | HTSSOP-B20 | Online | - | Online | Online |
| BD9P235MUF-C | | | | VQFN20FV4040 | Online | - | Online | Online |
| BD9P255EFV-C | | | 5.0 | HTSSOP-B20 | Online | - | Online | Online |
| BD9P255MUF-C | | | | VQFN20FV4040 | Online | - | Online | Online |
| BD9S200MUF-C | 2 | 2.7 to 5.5 | 0.8 to 4.4 | VQFN16FV3030 | Online | - | - | - |
| BD9S300MUF-C | 3 | | | VQFN16FV3030 | Online | - | - | - |
| BD9S400MUF-C | 4 | | | VQFN16FV3030 | Online | - | - | - |
| BD9S201NUX-C | 2 | 2.7 to 5.5 | 0.8 to 5.5 | VSON008X2020 | Online | - | - | - |
| BD9G401EFJ-M | 3.5 | 4.5 to 42 | 0.8 to 42 | HTSOP-J8ES | Online | - | - | - |
| BD8P250MUF-C | 2 | 3.5 to 36 | 5.0 | VQFN24FV4040 | Online | - | - | - |
| BD90610EFJ-C | 1.25 | 3.5 to 36 | 0.8 to 36 | HTSOP-J8 | Online | Online | - | - |
| BD90620EFJ-C | 2.5 | | | HTSOP-J8 | Online | Online | - | - |
| BD90620HFP-C | | | | HRP7 | Online | Online | - | - |
| BD90640EFJ-C | 4 | | | HTSOP-J8 | Online | Online | - | - |
| BD90640HFP-C | | | | HRP7 | Online | Online | - | - |
| BD8P250MUF-C + BD90302NUF-C | 2 | 2.7 to 36 | 5.0 | VQFN24FV4040 + VSON10FV3030 | Online | - | - | - |

Catalog

ROHM Solution Simulator

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Next page

Information

For the latest lineup of simulation circuits, check our website.

www

# Simulation Circuit (Continued)

Select a circuit to be simulated

## Switching Regulator ICs : Industrial

| Part number | $I_{OUT}$ [A] | $V_{IN}$ [V] | $V_{OUT}$ [V] | Package | Simulation Circuit | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Frequency Response | Start Up | Load Response | Line Response | Thermal |
| BD9A201FP4-LBZ | 2 | 2.7 to 5.5 | 0.8 to 3.85 | TSOT23-8L | Online | - | - | - | - |
| BD9E100FJ-LB | 1 | 7.0 to 36 | 1.0 to 25.2 | SOP-J8 | Online | - | - | - | - |
| BD9E101FJ-LB | | | | | Online | - | - | - | - |
| BD9E300EFJ-LB | 2.5 | | | HTSOP-J8 | Online | - | - | - | - |
| BD9E301EFJ-LB | | | | | Online | - | - | - | - |
| BD9E303EFJ-LB | 3 | | 1.0 to 28.8 | HTSOP-J8 | Online | - | - | - | - |
| BD9E304FP4-LBZ | 3 | 4.5 to 36 | 0.7 to 28 | TSOT23-8L | Online | - | - | - | - |
| BD9G102G-LB | 0.5 | 6 to 42 | 0.75 to 33.6 | SSOP6 | Online | - | - | - | - |
| BD9G201EFJ-LB | 1.5 | 4.5 to 42 | 0.8 to 42 | HTSOP-J8ES | Online | - | - | - | - |
| BD9G341AEFJ-LB | 3 | 12 to 76 | 1.0 to 76 | HTSOP-J8 | Online | - | Online | Online | - |
| BD9G500EFJ-LA | 5 | 7.0 to 76 | 1.0 to 68.4 | HTSOP-J8 | Online | - | - | - | Online |

## Switching Regulator ICs : Standards

| Part number | $I_{OUT}$ [A] | $V_{IN}$ [V] | $V_{OUT}$ [V] | Package | Simulation Circuit | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Frequency Response | Start Up | Load Response | Line Response |
| BD9A300MUV | 3 | 2.7 to 5.5 | 0.8 to 3.85 | VQFN016V3030 | Online | - | - | - |
| BD9D300MUV | 3 | 4 to 17 | 0.9 to 5.25 | VQFN016V3030 | Online | - | - | - |
| BD9E104FJ | 1 | 7.0 to 26 | 1.0 to 13 | SOP-J8 | Online | - | - | - |
| BD9E200FP4-Z | 2 | 4.5  26 | 0.7 to 20.8 | TSOT23-6L | Online | - | Online | - |
| BD9E201FP4-Z | 2 | 4.5  28 | 0.7 to 22 | TSOT23-6L | Online | - | Online | - |
| BD9E302EFJ | 3 | 7.0 to 28 | 1.0 to 19.6 | HTSOP-J8 | Online | - | - | - |
| BD9F500QUZ | 5 | 4.5 to 36 | 0.6 to 14 | VMMP16LZ3030 | Online | | | |
| BD9F800MUX-Z | 8 | 4.5 to 28 | 0.765 to 13.5 | VQFN11X3535A | Online | - | - | - |

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# Simulation Circuit (Continued)

Select a circuit to be simulated

## Linear Regulators : Automotive

| Part number | $I_{OUT}$ [A] | $V_{IN}$ [V] | $V_{OUT}$ [V] | Package | Simulation Circuit | | |
|---|---|---|---|---|---|---|---|
| | | | | | Load Response | Line Response | Thermal |
| BD433M2EFJ-C | 0.2 | 3.9 to 42 | 3.3 | HTSOP-J8 | Online | Online | Online |
| BD433M2FP3-C | | | | SOT223-4F | Online | Online | - |
| BD433M5FP-C | 0.5 | 4.0 to 42 | | TO252-3 | Online | Online | Online |
| BD433M5FP2-C | | | | TO263-3 | Online | Online | Online |
| BD450M2EFJ-C | 0.2 | 5.5 to 42 | 5.0 | HTSOP-J8 | Online | Online | Online |
| BD450M2FP3-C | | | | SOT223-4F | Online | Online | - |
| BD450M5FP-C | 0.5 | 5.5 to 42 | | TO252-3 | Online | Online | Online |
| BD450M5FP2-C | | | | TO263-3 | Online | Online | Online |
| BD733L2EFJ-C | 0.2 | 4.37 to 45 | 3.3 | HTSOP-J8 | Online | Online | - |
| BD733L5FP-C | 0.5 | 4.17 to 45 | | TO252-3 | Online | Online | - |
| BD750L2EFJ-C | 0.2 | 5.8 to 45 | 5.0 | HTSOP-J8 | Online | Online | - |
| BD750L5FP-C | 0.5 | 5.6 to 45 | | TO252-3 | Online | Online | - |
| BD933N1G-C | 0.15 | 4.5 to 42 | 3.3 | SSOP5 | Online | Online | - |
| BD933N1WG-C | | | | | Online | Online | - |
| BD933N1EFJ-C | | | | HTSOP-J8 | Online | Online | - |
| BD933N1WEFJ-C | | | | | Online | Online | - |
| BD950N1G-C | | 6.0 to 42 | 5.0 | SSOP5 | Online | Online | - |
| BD950N1WG-C | | | | | Online | Online | - |
| BD950N1EFJ-C | | | | HTSOP-J8 | Online | Online | - |
| BD950N1WEFJ-C | | | | | Online | Online | - |
| BD00C0AWFP-C | 1 | 4.0 to 26.5 | 1.0 to 15 | TO252-5 | Online | Online | - |
| BD80C0AWFP-C | | | 8.0 | | Online | Online | - |

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## A. Linear Regulators

### A-1. Circuit Design

| Online Browsing | Title |
|---|---|
| [EN] [JP] [CN] [KR] | Basics of Linear Regulators |
| [EN] [JP] [CN] | Linear Regulator Specifications |
| [EN] [JP] | Table of resistance for output voltage setting on linear regulator ICs |
| [EN] [JP] | Reverse Voltage Protection |
| [EN] [JP] | Power Source ON/OFF Characteristics for Linear Regulator |
| [EN] [JP] | Connecting LDOs in Parallel |
| [EN] [JP] | Problem Situations: Power Supply Does Not Start |
| [EN] [JP] | BAxxCC0 Series Circuit Using a Ceramic Output Capacitor |
| [EN] [JP] | Suppression Method of Switching Noise Using Linear Regulator and Low Pass Filter |
| [EN] [JP] [CN] [KR] | Impedance Characteristics of Bypass Capacitor |

### A-2. Simulation

| Online Browsing | Title |
|---|---|
| [EN] [JP] | Usage of SPICE MacroModel (for LDO) |

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### A-3. Thermal Design

| Online Browsing | Title |
|---|---|
| [EN] [JP] [CN] | What Is Thermal Design? |
| [EN] [JP] [CN] | Basics of Thermal Resistance and Heat Dissipation |
| [EN] [JP] [CN] [KR] | Thermal resistance and thermal characterization parameter |
| [EN] [JP] [CN] | $\theta_{JA}$ and $\Psi_{JT}$ |
| [EN] [JP] [CN] | $\theta_{JC}$ and $\Psi_{JT}$ |
| [EN] [JP] [CN] | How to Use the Thermal Resistance and Thermal Characteristics Parameters |
| [EN] [JP] [CN] | Judgment Criteria of Thermal Evaluation |
| [EN] [JP] | Thermal Design for Three-Terminal Voltage Regulators |
| [EN] [JP] | Thermal Calculation for Linear Regulator |
| [EN] [JP] [CN] | Two-Resistor Model for Thermal Simulation |
| [EN] [JP] [CN] | Method for Calculating Junction Temperature from Transient Thermal Resistance Data |
| [EN] [JP] [CN] | Calculating Junction Temperature from Inrush Current |
| [EN] [JP] [CN] | TO252 Package Thermal Resistance Information |
| [EN] [JP] [CN] | HTSOP-J8 Package Thermal Resistance Information |
| [EN] [JP] | Thermal Resistance Data: TO220CP-V5 |
| [EN][JP] | Thermal Resistance Data: TO263-5 (BD4xxM5WFP2-C) |
| [EN] [JP] | Thermal Resistance Data: SSOP5 (BUxxJA2DC-C, VG-C) |
| [EN] [JP] | Thermal Resistance Data: SSOP5 (BUxxJA3DC-C) |
| [EN] [JP] | Thermal Resistance Data: SSOP5 (BUxxTD3WG) |
| [EN] [JP] | Thermal Resistance Data: SSOP5 (BD7xxL05G-C) |
| [EN] [JP] | Thermal Resistance Data: SSOP5 (BD9xxN1G-C) |
| [EN] [JP] | Thermal Resistance Data: VSON008X2030 (BDxxGA3WNUX) |
| [EN] [JP] | Thermal Resistance Data: HVSOF6 (BD00IA5MHFV-M) |
| [EN] [JP] | Thermal Resistance Data: SSON004X1010 (BUxxTD2WNVX) |

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## A-4. Design Data

| | Part number | Application Information<br>Provides hints for IC mounting | Reference Circuit | Dropout Voltage<br>Design reference values | Typical Performance Curves | PCB Layout |
|---|---|---|---|---|---|---|
| BA | BA178xx series | [EN] [JP] | - | [EN] [JP] | [EN] [JP] | [EN] [JP] |
| | BA178Mxx series | [EN] [JP] | - | [EN] [JP] | [EN] [JP] | |
| | BA1117 series | [EN] [JP] | - | [EN] [JP] | - | [EN] [JP] |
| | BAxxBC0 series | [EN] [JP] | - | [EN] [JP] | [EN] [JP] | [EN] [JP] |
| | BAxxCC0 series | [EN] [JP] | - | [EN] [JP] | [EN] [JP] | |
| | BAxxDD0 series | [EN] [JP] | - | [EN] [JP] | [EN] [JP] | |
| | BAxxJC5 series | - | - | [EN] [JP] | - | |
| BD | BDxxGC0 series | [EN] [JP] | [EN] [JP] | [EN] [JP] | - | [EN] [JP] |
| | BDxxGA5 series | [EN] [JP] | [EN] [JP] | [EN] [JP] | - | |
| | BDxxGA3 series | [EN] [JP] | [EN] [JP] | [EN] [JP] | - | |
| | BDxxHC5 series | [EN] [JP] | [EN] [JP] | [EN] [JP] | - | |
| | BDxxHC0 series | [EN] [JP] | [EN] [JP] | [EN] [JP] | - | |
| | BDxxHA5 series | [EN] [JP] | [EN] [JP] | [EN] [JP] | - | |
| | BDxxHA3 series | [EN] [JP] | [EN] [JP] | [EN] [JP] | - | |
| | BDxxIC0 series | [EN] [JP] | [EN] [JP] | [EN] [JP] | - | |
| | BDxxIA5 series | [EN] [JP] | [EN] [JP] | [EN] [JP] | - | |
| | BDxxKA5 series | [EN] [JP] | [EN] [JP] | [EN] [JP] | - | [EN] [JP] |
| | BD00D0A series | - | - | [EN] [JP] | - | - |
| | BD00EA5 series | - | - | [EN] [JP] | - | - |
| | BDxxFC0 series | - | [EN] [JP] | [EN] [JP] | - | [EN] [JP] |
| | BDxxFD0 series | - | - | [EN] [JP] | - | - |

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## A-4. Design Data (Continued)

| | Part number | Application Information<br>Provides hints for IC mounting | Reference Circuit | Dropout Voltage<br>Design reference values | Typical Performance Curves | PCB Layout |
|---|---|---|---|---|---|---|
| BD | BDxxC0A series | - | [EN] [JP] | - | - | [EN] [JP] |
| | BDxxD0A series | - | [EN] [JP] | - | - | |
| | BDxxFA1MG-M series | [EN] [JP] | - | [EN] [JP] | - | [EN] [JP] |
| | BDxxFA1FP3 series | [EN] [JP] | - | [EN] [JP] | - | |
| | BD35395FJ | - | - | - | - | [EN] [JP] |
| BU | BUxxJA2MNVX-C series | - | - | [EN] [JP] | - | [EN] [JP] |
| | BUxxJA2DG,VG series | - | - | [EN] [JP] | - | - |
| | BUxxTD2 series | - | - | [EN] [JP] | - | [EN] [JP] |
| | BUxxTD3 series | [EN] [JP] | - | [EN] [JP] | - | [EN] [JP] |
| | BUxxSA4 series | - | - | [EN] [JP] | - | [EN] [JP] |
| | BUxxSA5 series | - | - | [EN] [JP] | - | [EN] [JP] |
| | BUxxTA2 series | - | - | [EN] [JP] | - | [EN] [JP] |
| | BUxxSD2 series | - | - | [EN] [JP] | - | [EN] [JP] |
| | BUxxSD5 series | - | - | [EN] [JP] | - | [EN] [JP] |
| BH | BHxxM0A series | - | - | - | - | [EN] [JP] |
| | BHxxMA3 series | - | - | - | - | [EN] [JP] |
| | BHxxNB1 series | - | - | - | - | [EN] [JP] |
| | BHxxPB1 series | - | - | - | - | [EN] [JP] |
| | BHxxRB1 series | - | - | - | - | [EN] [JP] |
| | BHxxSA3 series | - | - | - | - | [EN] [JP] |

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## A-5. PCB Design

| Online Browsing | Title |
|---|---|
| [EN] [JP] [CN] | Design Guide and Example of Stencil for Exposed Pad |
| [EN] [JP] [CN] | PCB Layout Thermal Design Guide |
| [EN] [JP] [CN] | Heat Dissipation Effect of Thermal Via in Exposed Pad Type Package |

## A-6. Evaluation

| Online Browsing | Title |
|---|---|
| [EN] [JP] | Measurement Method for Phase Margin with Frequency Response Analyzer (FRA) |
| [EN] [JP] | Simple Test Method for Estimating the Stability of Linear Regulators |
| [EN] [JP] | Problem Situations: Power Supply Does Not Start |

## A-7. Thermal Measurement

| Online Browsing | Title |
|---|---|
| [EN] [JP] | Notes for Temperature Measurement Using Thermocouples |
| [EN] [JP] | Notes for Temperature Measurement Using Forward Voltage of PN Junction |
| [EN] [JP] [CN] [KR] | Precautions When Measuring the Rear of the Package with a Thermocouple |

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Application Note

B. Switching Regulator ICs

## B-1. Circuit Design

| Online Browsing | Title |
|---|---|
| [EN] [JP] [CN] | Precautions When Measuring the Rear of the Package with a Thermocouple |
| [EN] [JP] [CN] | Capacitor Calculation for Buck converter IC |
| [EN] [JP] [CN] | The Important Points of Multi-layer Ceramic Capacitor Used in Buck Converter circuit |
| [EN] [JP] [CN] | Calculation of Power Loss (Synchronous) |
| [EN] [JP] [CN] | Considerations for Power Inductors Used for Buck Converters |
| [EN] [JP] [CN] | Snubber Circuit for Buck Converter IC |
| [EN] [JP] [CN] | Efficiency of Buck Converter |
| [EN] [JP] [CN] [KR] | Phase Compensation Design for Current Mode Buck Converter |
| [EN] [JP] | Bootstrap Circuit in the Buck Converter |
| [EN] [JP] [CN] | Method for Determining Constants of Peripheral Parts of Buck DC/DC Converter |
| [EN] [JP] [CN] | Resistor Value Table to set Output Voltage of Buck Converter IC |
| [EN] [JP] | Power Supply Sequence Circuit with General Purpose Power Supply IC |
| [EN] [JP] | Suppression Method of Switching Noise Using Linear Regulator and Low Pass Filter |
| [EN] [JP] [CN] [KR] | Impedance Characteristics of Bypass Capacitor |
| [EN] [JP] | Types of Capacitors Used for Output Smoothing of Switching Regulators and their Precautions |
| [EN] [JP] | Design and Application Considerations of Input Filter to reduce Conducted Emissions caused by DC/DC converter |
| [EN] | Considerations for Power Inductors: How Flux Orientation Can Reduce Radiated Emission |
| [EN] [JP] | Diode Selection Method for Asynchronous Converter |

## B-2. Thermal Design

| Online Browsing | Title |
|---|---|
| [EN] [JP] [CN] | What Is Thermal Design? |
| [EN] [JP] [CN] | Basics of Thermal Resistance and Heat Dissipation |
| [EN] [JP] [CN] [KR] | Thermal resistance and thermal characterization parameter |
| [EN] [JP] [CN] | $\theta_{JA}$ and $\Psi_{JT}$ |
| [EN] [JP] [CN] | $\theta_{JC}$ and $\Psi_{JT}$ |
| [EN] [JP] [CN] | How to Use the Thermal Resistance and Thermal Characteristics Parameters |
| [EN] [JP] [CN] | Judgment Criteria of Thermal Evaluation |
| [EN] [JP] [CN] | Two-Resistor Model for Thermal Simulation |
| [EN] [JP] [CN] | Method for Calculating Junction Temperature from Transient Thermal Resistance Data |
| [EN] [JP] [CN] | HTSOP-J8 Package Thermal Resistance Information |
| [EN] [JP] [CN] | TO252 Package Thermal Resistance Information |

## B-3. Simulation

| Online Browsing | Title |
|---|---|
| [EN] [JP] [CN] [KR] | Usage of SPICE MacroModel (for DC/DC) |

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B. Switching Regulator ICs (Continued)

## B-4. Design Data

| | Part number | Reference Circuit | PCB Layout |
|---|---|---|---|
| BD9Axxx series | BD9A100MUV | [EN] [JP] | [EN] [JP] |
| | BD9A101MUV-LB | | |
| | BD9A300MUV | [EN] [JP] | |
| | BD9A301MUV-LB | | |
| | BD9A400MUV | [EN] [JP] | |
| | BD9A600MUV | [EN] [JP] | |
| BD9Bxxx series | BD9B100MUV | [EN] [JP] | [EN] [JP] |
| | BD9B200MUV | [EN] [JP] | |
| | BD9B300MUV | [EN] [JP] | |
| | BD9B301MUV | | |
| | BD9B400MUV | [EN] [JP] | |
| | BD9B500MUV | [EN] [JP] | |
| | BD9B600MUV | [EN] [JP] | |
| BD9Cxxx series | BD9C301FJ | [EN] [JP] | [EN] [JP] |
| | BD9C401EFJ | [EN] [JP] | |
| | BD9C501EFJ | [EN] [JP] | |
| | BD9C601EFJ | [EN] [JP] | |
| BD9Dxxx series | BD9D320EFJ | [EN] [JP] | [EN] [JP] |
| | BD9D321EFJ | [EN] [JP] | |
| BD9Exxx series | BD9E100FJ | [EN] [JP] | [EN] [JP] |
| | BD9E101FJ | [EN] [JP] | |
| | BD9E104FJ | - | |
| | BD9E300EFJ | [EN] [JP] | [EN] [JP] |
| | BD9E301EFJ | [EN] [JP] | |
| | BD9E302EFJ | [EN] [JP] | - |
| | BD9E303EFJ | [EN] [JP] | [EN] [JP] |
| BD9Fxxx series | BD9F800MUX | [EN] [JP] | - |
| | | | |
| BD9Gxxx series | BD9G101G | [EN] [JP] | - |
| | BD9G201EFJ-M | [EN] [JP] | - |
| | BD9G341AEFJ | [EN] [JP] | - |
| | BD9G401EFJ-M | [EN] [JP] | - |
| others | BD9106FVM | [EN] [JP] | - |
| | BD9130NV | [EN] [JP] | - |
| | BD9137MUV | [EN] [JP] | - |
| | BD9139MUV | [EN] [JP] | - |
| | BD9141MUV | [EN] [JP] | - |
| | BD9611MUV | [EN] [JP] | - |
| | BD9851EFV | [EN] [JP] | - |
| | BD70522GUL | [EN] [JP] | - |
| | BD95821NUV | [EN] [JP] | - |
| | BD95831NUV | [EN] [JP] | - |
| | BD95841NUV | [EN] [JP] | - |
| | BD95861NUV | [EN] [JP] | - |
| Buck DC/DC Converter Recommended Inductor List | | [EN] [JP] | |

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## B. Switching Regulator ICs (Continued)

### B-5. PCB Design

| Online Browsing | Title |
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| [EN] [JP] [CN] [KR] | PCB Layout Techniques of Buck Converter |
| [JP] | PCB Layout Techniques of Boost Converter |
| [EN] [JP] [CN] | Design Guide and Example of Stencil for Exposed Pad |
| [EN] [JP] [CN] | PCB Layout Thermal Design Guide |
| [EN] [JP] [CN] | Heat Dissipation Effect of Thermal Via in Exposed Pad Type Package |

### B-6. Evaluation

| Online Browsing | Title |
|---|---|
| [EN] [JP] | Measurement Method for Phase Margin with Frequency Response Analyzer (FRA) |
| [EN] [JP] [CN] | Method for Monitoring Switching Waveform |
| [EN] [JP] [CN] [KR] | Calculation of Power Dissipation in Switching Circuit |
| [EN] [JP] [CN] [KR] | Calculating Power Loss from Measured Waveforms |
| [EN] [JP] [CN] [KR] | Importance of Probe Calibration When Measuring Power: Deskew |

### B-7. Thermal Measurement

| Online Browsing | Title |
|---|---|
| [EN] [JP] | Notes for Temperature Measurement Using Thermocouples |
| [EN] [JP] | Notes for Temperature Measurement Using Forward Voltage of PN Junction |
| [EN] [JP] [CN] [KR] | Precautions When Measuring the Rear of the Package with a Thermocouple |

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## C. Power Devices

### C-1. Simulation

| Online Browsing | Title |
|---|---|
| [EN] [JP] | How to Create Symbols for PSpice Models |
| [EN] [JP] | How to Use LTspice Models |
| [EN] [JP] | How to Use LTspice Models: Tips for Improving Convergence |
| [EN] [JP] [CN] [KR] | What is a Thermal Model? |
| [EN] [JP] [CN] [KR] | How to Use Thermal Models |

### C-2. Thermal Design

| Online Browsing | Title |
|---|---|
| [EN] [JP] [CN] | Notes for Calculating Power Consumption: Static Operation |
| [EN] [JP] [CN] | Example of Heat Dissipation Design for TO Packages: Effect of Heat Dissipation Materials |
| [EN] [JP] [CN] | Precautions for Thermal Resistance of Insulation Sheet |

### C-3. Thermal Measurement

| Online Browsing | Title |
|---|---|
| [EN] [JP] [CN] [KR] | Measurement Method and Usage of Thermal Resistance RthJC |

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