

Manual of Power Inductors loss simulator for Automotive application

ver 1.0

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<Update History>

2024.5.24 Issuance of the 1st edition (ver 1.0)

1. What is the Power Inductor loss simulator for automotive application?

The Power Inductor loss simulator for automotive application enables the simulation of losses and temperature rises according to the current for Panasonic's power inductors designed for automotive use.

2. Features

- Two types of conditions can be simulated: power circuit conditions and current waveform conditions.
- Two types of substrates can be simulated: a four-layer substrate (t:1.6) and a heat-insulating multilayer substrate.
- Simulation results can be exported as PDF

3. Overall Site Structure

The inductor loss simulator consists of three main sections.

The in-page jump function will take you to the place you want to browse.

- (a) Tables for inputting simulation conditions or displaying information on selected part numbers.
- (b) Inductor current waveform parameter, Inductor current waveform
- (c) Calculation Results

For power supply circuit conditions

Simulation condition

Select simulation condition: Power Circuit Condition, Current Waveform

Selecting Power Circuit

Selecting Power Type: Power Type 1 (1.6), Power Type 2 (1.6)

Inductor inductance (mH): 10.0, 10.0, 10.0, 10.0

SR Frequency (kHz): 10.0, 10.0, 10.0, 10.0

Input Voltage (V): 12.0, 12.0, 12.0, 12.0

Output Voltage (V): 5.0, 5.0, 5.0, 5.0

Output Current (A): 1.0, 1.0, 1.0, 1.0

Table Number	Inductor Part Number	Inductance (mH)	SR Frequency (kHz)	Input Voltage (V)	Output Voltage (V)	Output Current (A)	Link
Table 1	4T07080000	10.0	10.0	12.0	5.0	1.0	Link
Table 2	4T07080000	10.0	10.0	12.0	5.0	1.0	Link
Table 3	4T07080000	10.0	10.0	12.0	5.0	1.0	Link
Table 4	4T07080000	10.0	10.0	12.0	5.0	1.0	Link

Inductor Current Waveform

Table Number	Inductor Part Number	Inductance (mH)	SR Frequency (kHz)	Input Voltage (V)	Output Voltage (V)	Output Current (A)
Table 1	4T07080000	10.0	10.0	12.0	5.0	1.0
Table 2	4T07080000	10.0	10.0	12.0	5.0	1.0
Table 3	4T07080000	10.0	10.0	12.0	5.0	1.0
Table 4	4T07080000	10.0	10.0	12.0	5.0	1.0

Calculation Results

Table Number	Inductor Part Number	Inductance (mH)	SR Frequency (kHz)	Input Voltage (V)	Output Voltage (V)	Output Current (A)	Loss (W)	Temp Rise (°C)
Table 1	4T07080000	10.0	10.0	12.0	5.0	1.0	0.000	0.000
Table 2	4T07080000	10.0	10.0	12.0	5.0	1.0	0.000	0.000
Table 3	4T07080000	10.0	10.0	12.0	5.0	1.0	0.000	0.000
Table 4	4T07080000	10.0	10.0	12.0	5.0	1.0	0.000	0.000

1. How to Use

4-1. Input simulation conditions.

Select simulation conditions from “power circuit conditions” or “current waveform conditions”.

① . When the simulation condition selection is “power circuit condition”

- (1) For simulation input condition selection, select “power circuit condition.”
- (2) Select the power supply circuit from “buck circuit”, “boost circuit” or “step-up/step-down circuit”.
- (3) Select the substrate type from “4-layer substrate (t:1.6)” or “high heat dissipation multilayer substrate”.
 - * Different boards have different heat dissipation constants, resulting in different temperature rises of the components.
 - * Calculated component temperatures (Temp. Rise & Parts Temp.) are lower for “high heat dissipation multilayer boards”.
- (4) Enter the temperature around the component between “-55degC” and “250degC” using one-byte numbers.
- (5) Enter the SW frequency between “0.001 kHz” and “100,000 kHz” using one-byte numbers.
- (6) Input the input voltage between “0.1V” and “1,000V” using one-byte numbers.
- (7) Input the output voltage between “0.1V” and “1,000V” using one-byte numbers.
- (8) Input the output current between “0.001A” and “1,000A” using one-byte numbers.
- (9) Click the “Open Part Number Selection Screen” button. (The inductor parts list is overlaid on the screen.)

Simulation condition

[Inductor Current Waveform](#) [Calculation Results](#)

These setting values are not guaranteed for use at Min/Max, but are only calculated conditions.
Please check the SPEC in the datasheet when actually selecting a device.

(1) Select simulation conditions	Power Circuit Condition	▼
(2) Selecting Power Circuit	Step-down Circuit	▼
(3) Selecting Board Type	Four-layer board (t:1.6)	▼
(4) Temperature around the Component: -55degC to 250degC	<input type="text"/>	degC
(5) SW Frequency: 0.001kHz to 100,000kHz	<input type="text"/>	kHz
(6) Input Voltage: 0.1V to 1,000V	<input type="text"/>	V
(7) Output Voltage: 0.1V to 1,000V	<input type="text"/>	V
(8) Output Current: 0.001A to 1,000A	<input type="text"/>	A

(9) [Open the part number selection screen](#)

② . When simulation condition selection is “current waveform condition”

- (1) Select “Current waveform condition” for input condition selection. (The parameter image of the current waveform is displayed.)
- (2) Select the substrate type from “4-layer substrate (t:1.6)” and “High heat dissipation multilayer substrate”.
 - * Different boards have different heat dissipation constants, resulting in different temperature rise of components.
 - * With a “high heat-dissipating multilayer board,” the calculated component temperatures (Temp. Rise & Parts Temp.) will be lower.
- (3) Enter the temperature around the component between “-55degC” and “250degC” using one-byte numbers.
- (4) Enter the SW frequency between “0.001 kHz” and “100,000 kHz” using one-byte numbers.
- (5) Enter “Duty” as a one-byte number between “0.1%” and “99.9%”.
- (6) Enter Idc between “0.0A” and “1,000A” using one-byte numbers. (Idc+Iac=0.0A cannot be set.)
- (7) Enter Iac between “0.0A” and “1,000A” using one-byte numbers. (Idc+Iac=0.0A cannot be set.)
- (8) Press the “Open Part Number Selection Screen” button. (The inductor parts list is overlaid on the screen.)

Simulation condition

[Inductor Current Waveform](#) [Calculation Results](#)

These setting values are not guaranteed for use at Min/Max, but are only calculated conditions.
Please check the SPEC in the datasheet when actually selecting a device.

(1) Select simulation conditions Current Waveform Condition ▾

(2) Selecting Board Type Four-layer board (t:1.6) ▾

(3) Temperature around the Component: -55degC to 250degC degC

(4) SW Frequency: 0.001kHz to 100,000kHz kHz

(5) Duty: 0.1% to 99.9% %

(6) Idc: 0.0A to 1,000A A

(7) Iac: 0.0A to 1,000A A

(8) Open the part number selection screen

4-2. Select the part number.

Select the inductor component to simulate.

Press the Close button in the upper right corner of the screen to close the screen.

- (a) Select a parameter in the drop-down to narrow down the part numbers in the part number information area. Pressing the Reset button will initialize the drop-down.
- (b) Part number search allows you to narrow down the part numbers in the part number information area.
- (c) 1. Check the part number to be simulated in (d) and press the Select Part Number button in (c)1.

If you press the Close button without pressing the Select Part Number button, the following message will be displayed.

The part number has not been selected. Are you sure to close the inductor parts list?

If you press Yes, the screen is closed without keeping the checked part number.

2. The number of search results of inductor parts. The number of results will change when (a) and (b) are executed.

3. The number of part number selections. Check (d) and click the "Select part number" button to change the number of items.

- (d) Part number information area. Check the checkbox for the part number to be simulated.

(c)1 Select Part Number

(c)2 Search Results : 107 Items

(c)3 Part Number : 0 / 5 Items

Select Part Number	Series Name	Inductance[μF]	Tolerance[%]	Rated Current[A]	DC resistance[mΩ]	Dimension[mm]	
						L*W	H
<input type="checkbox"/> ▲ETQP3M1R0YFP	PCC-M0530M	1	±20	6.6	12	5.5*5	3
<input type="checkbox"/> ▲ETQP3M1R5YFP	PCC-M0530M	1.5	±20	5.6	16.7	5.5*5	3
<input type="checkbox"/> ▲ETQP3M1R5YFP	PCC-M0530M	1.5	±20	5.6	16.7	5.5*5	3

4-3. Flow of inputting simulation conditions and selecting part numbers

Set the simulation conditions by following steps (a) to (d)

(a) Set the simulation conditions

(b) Press the button to open the part number selection screen to overlay the inductor parts list.

(c-1) Narrow down the part numbers in (c-2) Part Number Information Area by selecting parameters or searching for part numbers.

(c-2) From the part number information area, check the part number you want to simulate and press the Select Part Number button.

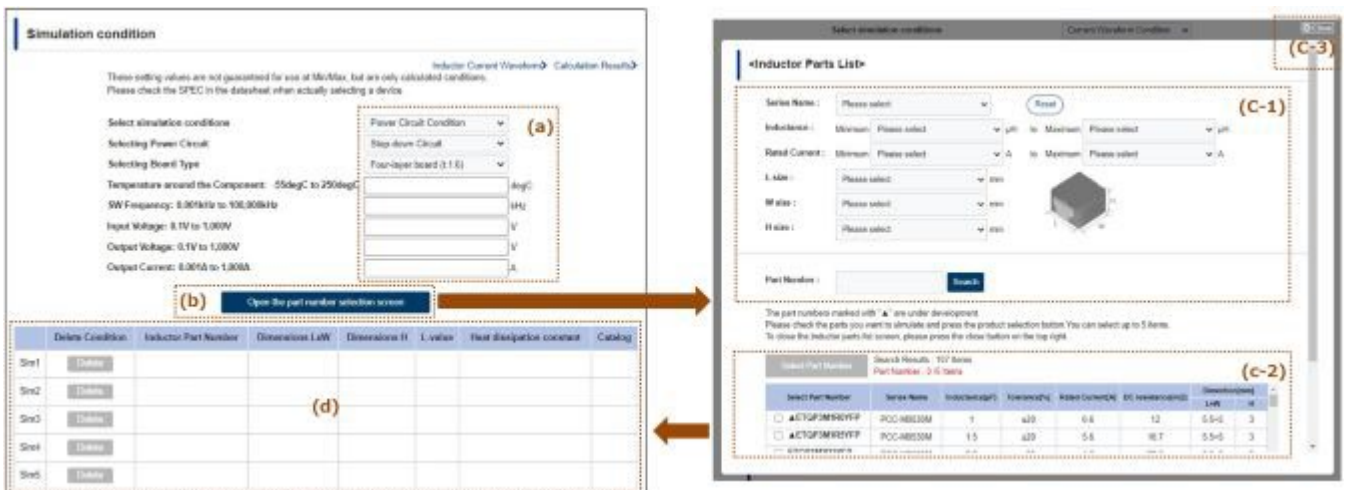
※The number of cases that can be checked in (c-2) is as follows

- Part number selection: 0/5 case...Selection limit of 5 – Part number selected 0 = 5 selections available
- Part number selection: 2/5 case...Selection limit of 5 – Part number selected 2 = 3 selection available
- Part number selection: 5/5 case...Selection limit of 5 – Part number selected 5 = Selection not allowed

(c-3) Press the Close button to close the inductor parts list.

(d) Displays the part number information selected in the inductor parts list.



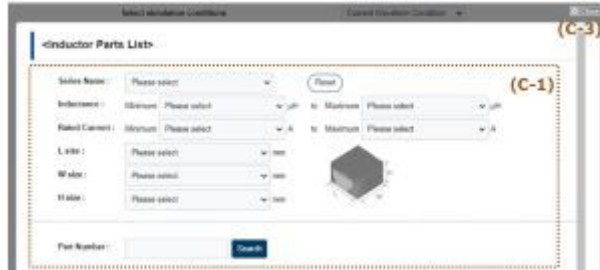



- The Delete button deletes the selected part number in the inductor parts list.
- Clicking the Catalog button will display the catalog for the part number in question in a separate URL.



From the next page, the flow of setting simulation conditions and selecting part numbers will be explained.

4-3. Flow of inputting simulation conditions and selecting part numbers

① . Case with part number selection from 0 to 2》

No	Details	Display																																																	
1	Select and enter simulation condition parameters.																																																		
2	Press the button to open the part number selection screen. (The inductor parts list will be overlaid.)																																																		
3	Select a parameter or search for a part number to narrow down the part numbers in the part number information area.																																																		
4	Check the part number to be simulated. (In this explanation, we will check two cases.)	 <table border="1"> <thead> <tr> <th>Select Part Number</th> <th>Series Name</th> <th>Inductance[L]</th> <th>Tolerance[%]</th> <th>Rated Current[A]</th> <th>DC resistance[mΩ]</th> <th>Dimensions L*W*H</th> </tr> </thead> <tbody> <tr> <td><input checked="" type="checkbox"/></td> <td>AETQPMR3YFP</td> <td>PCC-M0530M</td> <td>1</td> <td>±20</td> <td>8.8</td> <td>12 5.5*5 3</td> </tr> <tr> <td><input checked="" type="checkbox"/></td> <td>AETQPMR3YFP</td> <td>PCC-M0530M</td> <td>1.5</td> <td>±20</td> <td>5.5</td> <td>16.7 5.5*5 3</td> </tr> <tr> <td><input type="checkbox"/></td> <td>ETQPMR3YFP</td> <td>PCC-M0530M</td> <td>2.2</td> <td>±20</td> <td>4.8</td> <td>22.8 5.5*5 3</td> </tr> <tr> <td><input type="checkbox"/></td> <td>ETQPMR3YFP</td> <td>PCC-M0530M</td> <td>3.3</td> <td>±20</td> <td>4.1</td> <td>31.3 5.5*5 3</td> </tr> <tr> <td><input type="checkbox"/></td> <td>ETQPMR3YFP</td> <td>PCC-M0540M</td> <td>4.6</td> <td>±20</td> <td>4</td> <td>38 5.5*5 4</td> </tr> <tr> <td><input type="checkbox"/></td> <td>AETQPMR3YFP</td> <td>PCC-M0540M</td> <td>6.0</td> <td>±20</td> <td>3.1</td> <td>58 5.5*5 4</td> </tr> </tbody> </table>	Select Part Number	Series Name	Inductance[L]	Tolerance[%]	Rated Current[A]	DC resistance[mΩ]	Dimensions L*W*H	<input checked="" type="checkbox"/>	AETQPMR3YFP	PCC-M0530M	1	±20	8.8	12 5.5*5 3	<input checked="" type="checkbox"/>	AETQPMR3YFP	PCC-M0530M	1.5	±20	5.5	16.7 5.5*5 3	<input type="checkbox"/>	ETQPMR3YFP	PCC-M0530M	2.2	±20	4.8	22.8 5.5*5 3	<input type="checkbox"/>	ETQPMR3YFP	PCC-M0530M	3.3	±20	4.1	31.3 5.5*5 3	<input type="checkbox"/>	ETQPMR3YFP	PCC-M0540M	4.6	±20	4	38 5.5*5 4	<input type="checkbox"/>	AETQPMR3YFP	PCC-M0540M	6.0	±20	3.1	58 5.5*5 4
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6	Press Close button. (The inductor parts list is closed and the two selected part numbers are displayed.)	 <table border="1"> <thead> <tr> <th>Series Name</th> <th>Inductor Part Number</th> <th>Dimensions L*W</th> <th>Dimensions H</th> <th>L value</th> <th>First inductor constant</th> <th>Rating</th> </tr> </thead> <tbody> <tr> <td><input checked="" type="checkbox"/></td> <td>AETQPMR3YFP</td> <td>12*5.5</td> <td>3</td> <td>8.8</td> <td>1.00000</td> <td>Rating</td> </tr> <tr> <td><input checked="" type="checkbox"/></td> <td>AETQPMR3YFP</td> <td>16.7*5.5</td> <td>3</td> <td>5.5</td> <td>1.00000</td> <td>Rating</td> </tr> <tr> <td><input type="checkbox"/></td> <td>ETQPMR3YFP</td> <td>22.8*5.5</td> <td>3</td> <td>4.8</td> <td>1.00000</td> <td>Rating</td> </tr> <tr> <td><input type="checkbox"/></td> <td>ETQPMR3YFP</td> <td>31.3*5.5</td> <td>3</td> <td>4.1</td> <td>1.00000</td> <td>Rating</td> </tr> <tr> <td><input type="checkbox"/></td> <td>ETQPMR3YFP</td> <td>38*5.5</td> <td>4</td> <td>4</td> <td>1.00000</td> <td>Rating</td> </tr> <tr> <td><input type="checkbox"/></td> <td>AETQPMR3YFP</td> <td>58*5.5</td> <td>4</td> <td>3.1</td> <td>1.00000</td> <td>Rating</td> </tr> </tbody> </table>	Series Name	Inductor Part Number	Dimensions L*W	Dimensions H	L value	First inductor constant	Rating	<input checked="" type="checkbox"/>	AETQPMR3YFP	12*5.5	3	8.8	1.00000	Rating	<input checked="" type="checkbox"/>	AETQPMR3YFP	16.7*5.5	3	5.5	1.00000	Rating	<input type="checkbox"/>	ETQPMR3YFP	22.8*5.5	3	4.8	1.00000	Rating	<input type="checkbox"/>	ETQPMR3YFP	31.3*5.5	3	4.1	1.00000	Rating	<input type="checkbox"/>	ETQPMR3YFP	38*5.5	4	4	1.00000	Rating	<input type="checkbox"/>	AETQPMR3YFP	58*5.5	4	3.1	1.00000	Rating
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4-3. Flow of inputting simulation conditions and selecting part numbers

«② . Case with part number selection from 2 to 5»

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*If you want to re-set part numbers after selecting 5, please refer to the next page

«③ . Case with part number selection from 5 to 4».

4-3. Flow of inputting simulation conditions and selecting part numbers

《③.Case with part number selection from 5 to 4》

No	内容	表示																																																			
1	<p>Press the Delete button for the condition you wish to delete.</p> <p>(In our explanation, we will delete Sim2.)</p>	<table border="1"> <thead> <tr> <th>Simulation</th> <th>Delete</th> <th>Inductor Part Number</th> <th>Dimensions LxW</th> <th>Dimensions H</th> <th>L value</th> <th>Heat dissipation coefficient</th> <th>Catalog</th> </tr> </thead> <tbody> <tr> <td>Sim1</td> <td>Delete</td> <td>ETQPMBR2YFP</td> <td>5.0-5mm</td> <td>3mm</td> <td>0.885µH</td> <td>78K/W</td> <td>Catalog</td> </tr> <tr style="border: 2px dashed red;"> <td>Sim2</td> <td>Delete</td> <td>ETQPMBR2YFP</td> <td>5.0-5mm</td> <td>3mm</td> <td>1.4231µH</td> <td>78K/W</td> <td>Catalog</td> </tr> <tr> <td>Sim3</td> <td>Delete</td> <td>ETQPMBR2YFP</td> <td>5.0-5mm</td> <td>3mm</td> <td>2.2µH</td> <td>78K/W</td> <td>Catalog</td> </tr> <tr> <td>Sim4</td> <td>Delete</td> <td>ETQPMBR2YFP</td> <td>5.0-5mm</td> <td>3mm</td> <td>3.8885µH</td> <td>78K/W</td> <td>Catalog</td> </tr> <tr> <td>Sim5</td> <td>Delete</td> <td>ETQPMBR2YFP</td> <td>5.0-5mm</td> <td>3mm</td> <td>4.7µH</td> <td>78K/W</td> <td>Catalog</td> </tr> </tbody> </table>	Simulation	Delete	Inductor Part Number	Dimensions LxW	Dimensions H	L value	Heat dissipation coefficient	Catalog	Sim1	Delete	ETQPMBR2YFP	5.0-5mm	3mm	0.885µH	78K/W	Catalog	Sim2	Delete	ETQPMBR2YFP	5.0-5mm	3mm	1.4231µH	78K/W	Catalog	Sim3	Delete	ETQPMBR2YFP	5.0-5mm	3mm	2.2µH	78K/W	Catalog	Sim4	Delete	ETQPMBR2YFP	5.0-5mm	3mm	3.8885µH	78K/W	Catalog	Sim5	Delete	ETQPMBR2YFP	5.0-5mm	3mm	4.7µH	78K/W	Catalog			
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This is the end of the simulation input and part number selection process.

Simulation results will be explained from the next page.

4-4. Simulation Results

When all setting of conditions input and part number selection are completed, the inductor current waveform and calculation result will be displayed.

《Inductor current waveform》

- ① Inductor current waveform parameters, ② Parameter explanation graph, and ③ Current waveform graph are displayed.
- Uncheck the Graph Display ON checkbox in ①-1 to hide the current waveform graph for that part number.
- ② The parameter explanation graph is displayed when the simulation condition is a power circuit.
- ③ Hovering the cursor over a graph vertex displays the X-axis and Y-axis values.

Power supply circuit		Current waveform	

《Calculation Results》

- ④ Displays the results of loss calculation and temperature rise of the components.
- ⑤ Click the PDF output button to download the simulation results in PDF format.