

# **Industrial & Automotive use**

## **LC Filter Simulator Instruction Manual**

ver 1.0

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### <Update History>

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Device Solutions Business Division  
Panasonic Industry Co., Ltd.

## 1. What is the Industrial & Automotive use LC Filter Simulator?

The Industrial & Automotive use LC filter simulator enables the simulation of attenuation amounts when configuring a filter using Panasonic's power inductor and aluminum electrolytic capacitor suitable for industrial & automotive use.

## 2. Features

- $\pi$  type, T-type, and L-type filter circuits can be simulated.
- Five circuits can be compared at the same time.
- Parallel and series connections of components can also be simulated.
- Data download of configured parts and simulation results are available.

## 3. Overall Site Structure

The screenshot displays the Panasonic Industrial & Automotive LC Filter Simulator interface. It is divided into three main sections, each with a 'Page jump' button at the top right:

- (a) Simulation conditions:** This section allows users to configure simulation parameters. It includes a table for 'Simulation condition' with columns for 'Band', 'Frequency', 'Input voltage', 'Output voltage', 'Inductor', and 'Capacitor'. A 'Page jump' button is located at the top right of this section.
- (b) Part selection:** This section shows a circuit diagram and a table for selecting components. It includes a 'Page jump' button at the top right. The circuit diagram shows a  $\pi$ -type filter with an input, a series inductor, and two shunt capacitors.
- (c) Simulation Results:** This section displays the simulation results, including a graph of 'Attenuation (dB)' versus 'Frequency (kHz)'. A 'Page jump' button is located at the top right of this section.

Red dashed boxes and labels are used to highlight the 'Page jump' buttons and the corresponding sections: (a) Simulation conditions, (b) Part selection, and (c) Simulation Results.

The simulator consists of the following three items

(a) Simulation conditions

(b) Part selection

(c) Simulation results

In addition, the "Part selection" allows you to view a single component impedance characteristic graph of the selected components.

A page jump function is provided at the right end of each of the three items.

You can scroll to the place you want to browse with a single click.

The following page describes how to use it.

## 4. How to Use

### [4-1] How to set the simulation conditions

The LC Filter Simulator allows you to set simulation conditions for up to 5 circuits (Sim1 to Sim5).

1. Press the Sim1 radio button to configure settings from Sim1.
2. Select the basic configuration of the filter circuit from "π-type", "T-type", and "L-type".
3. Enter the impedance value numerically in the "Input Z" and "Output Z" fields. (Initial value is 50)
4. Set the part configuration ①, ②, and ③. Select each part configuration from the pull-down menu.

Filter circuit	Part structure		
	①	②	③
π type	C Single item C parallel2~5	L Single item L parallel2, L series2	C Single item C parallel2~5
T type	L Single item L parallel2, L series22	C Single item C parallel2~5	L Single item L parallel2, L series2
L type	-	L Single item L parallel2, L series2	C Single item C parallel2~5

simulation condition

(1)

(2)

(3)

(4)

	filter circuit	Input Z	Output Z	part structure		
				①	②	③
Sim1 ●	π - t y p e ▼	50	50	C Single item ▼	L Single item ▼	C Single item ▼
Sim2 ○	π - t y p e ▼	50	50	C Single item ▼	L Single item ▼	C Single item ▼
Sim3 ○	π - t y p e ▼	50	50	C Single item ▼	L Single item ▼	C Single item ▼
Sim4 ○	π - t y p e ▼	50	50	C Single item ▼	L Single item ▼	C Single item ▼
Sim5 ○	π - t y p e ▼	50	50	C Single item ▼	L Single item ▼	C Single item ▼

parts usedselect

simulation condition : Sim1

< π - t y p e >

part structure①

part structure②

part structure③

\*Displays a schematic diagram according to the selected simulation conditions.

5. To set multiple simulation conditions, return to step (1). Be sure to set simulation conditions in the order of Sim1, Sim2, Sim3, and so on.

#### [4-2] How to set up the components

All the parts displayed on the schematic can be set using either "Selected Parts", "User Defined Parts" or "Recommended Parts". "Recommended Parts" can be used only when "User Defined" is selected.

parts usedselect

simulation condition > simulation results >

simulation condition : Sim1

<  $\pi$  - type >

list

part structure ①

part structure ②

part structure ③

part structure ①	
circuit number	part number
	EEETP1A221AP
C11	<div>part selection or user defined</div> <div>recommended parts</div>

I . The "Parts Selection" is set by the Panasonic part number.

part structure ②	
circuit number	part number
	ETQP3M2R2YFP
L21	<div>part selection or user defined</div> <div>recommended parts</div>

II . "User-defined" is set by entering your own numerical values.

part structure ③	
circuit number	part number
	EEETP1A221AP
C31	<div>part selection or user defined</div> <div>recommended parts</div>

III . The "Recommended Parts" are Panasonic part numbers are set based on the values set in "User Defined".

The following pages explain how to set up the parts (the following three types).

- I . How to set up by "Part Selection" (P.5)
- II . How to set up by "User-defined" (P.6)
- III . How to set up by "Recommended Parts" (P.7~8)

## I. How to set up by "Part Selection"

(1) Click "Select Parts" to display the setting screen. Click "close" in the upper right corner to close the setting screen.

- ③The search results table displays all parts (You can narrow down your search by ① and ②.)
- Part numbers with ▲ at the beginning of the part number in the search result table are under development. \*1

**<inductor parts list>**

series name :  inductance[μH] :

rated current[A] :  ① W size[mm] :

L size[mm] :

② part number :

search results : 136items ▲ : under development

③	series name	part number	inductance [μH]	tolerance [%]	rated current [A]	DC resistance [mΩ]	dimension[mm]	
							L×W	H
<input type="button" value="select"/>	PCC-M0530M	*1 ▲ETQP3M1R0YFP	1	±20	6.6	12	5 × 5.5	3
<input type="button" value="select"/>	PCC-M0530M	▲ETQP3M1R5YFP	1.5	±20	5.6	16.7	5 × 5.5	3
<input type="button" value="select"/>	PCC-M0530M	ETQP3M2R2YFP	2.2	±20	4.8	22.6	5 × 5.5	3
<input type="button" value="select"/>	PCC-M0530M	ETQP3M3R3YFP	3.3	±20	4.1	31.3	5 × 5.5	3
<input type="button" value="select"/>	PCC-M0530M-H	ETQP3M2R2HFP	2.2	±20	5.2	19.5	5 × 5.5	3
<input type="button" value="select"/>	PCC-M0530M-LP	ETQP3M100KVP	10	±20	2.4	96	5 × 5.5	3

- (2) You can narrow down the ③"Search Results and List" by setting the series name, size, etc. in the drop-down menu in ①. Search for part numbers by entering one-byte alphanumeric characters in ②. Partial match search is available.
- (3) By entering ①"Refine" and ②"Part No. Search", the ③"Number of search results and list" will change. Click "Select" of the part you want to use from the list.

(4) The selected part number will be displayed.

The screenshot shows a software interface with three tabs: 'list', 'part structure①', and 'part structure②'. Below the tabs are three panels, each representing a part structure. Each panel has a 'circuit number' field (C11, L21, C31) and a 'part number' field. The 'part number' field is divided into 'part selection' and 'user defined' sections. A red dashed box highlights the 'part selection' button for part structure 2, and a red callout bubble says 'Setup completed'.

## II. How to set up by "User-defined"

- (1) Press "User Defined" to display the settings screen.
- (2) For capacitors, enter "Capacitance," "ESL," and "ESR" in one-byte numbers and press "Setting". For inductors, enter "L value," "Parasitic Capacitance," "DCR," and "ACR" in one-byte numbers, and press "Setting".

The screenshot shows the 'user defined' settings screen for capacitor C11. The screen has a title bar with '<user defined> C11'. Below the title bar are three input fields: 'capacitance' (uF), 'ESL' (nH), and 'ESR' (mΩ). A blue 'setting' button is at the bottom.

The screenshot shows the 'user defined' settings screen for inductor L21. The screen has a title bar with '<user defined> L21'. Below the title bar are four input fields: 'L-value' (uH), 'parasitic capacity' (pF), 'DCR' (mΩ), and 'ACR' (Ω). A blue 'setting' button is at the bottom.

(3) The set value and unit are displayed on the part number.  
 Since "user-defined" is set, "recommended parts" can be used.

list part structure① part structure② part structure③

part structure①

circuit number	part number
C11	33uF 2nH 20mΩ

part selection or user defined

recommended parts

part structure②

circuit number	part number
L21	ETQP3M2R2YFP

part selection or user defined

recommended parts

part structure③

circuit number	part number
C31	EEETP1A221AP

part selection or user defined

recommended parts

please select

part selection or user defined

recommended parts

Setup completed

Recommended parts are become available

### III. How to set up by "Recommended Parts"

- (1) After setting "User Defined", click "Recommended Parts" to display the setting screen.
- (2) Enter the "Rated voltage" for capacitors and the "Rated current" for inductors using one-byte numbers, and click "Setting".

part structure① part structure② part structure③

<user defined> C11

capacitance  uF

ESL  nH

ESR  mΩ

setting

part structure① part structure② part structure③

<recommended parts> C11

rated voltage  V

setting

rated voltage is a required item. ▲ : under development

series name	part number	rated voltage[V]	capacitance [μF]	tolerance	ripple current	ESR	tanδ	characteristic	dimension(mm)	L	AxB

(3) Click "Select" of the part you want to use from the list of search results.

<recommended parts> C31

rated voltage  V

**setting**

search results : 1 items ▲ : under development

	series name	part number	rated voltage[V]	capacitance [μF]	tolerance	characteristic			dimension[mm]		
						ripple current	ESR	tanδ	φ	L	A×B
<b>select</b>	ZS-A	EEHAZS1J101B	63.00	100	±20%	3000	19	0.08	10	11.7	-

(4) Displays the part number of the selected recommended part.

**list** **part structure①** **part structure②** **part structure③**

part structure①		part structure②		part structure③	
circuit number	part number	circuit number	part number	circuit number	part number
C11	33uF 2nH 20mΩ <b>part selection</b> or <b>user defined</b> <b>recommended parts</b>	L21	ETQP3M2R2YFP <b>part selection</b> or <b>user defined</b> <b>recommended parts</b>	C31	EEHAZS1J101B <b>part selection</b> or <b>user defined</b> <b>recommended parts</b>
		L22	please select <b>part selection</b> or <b>user defined</b> <b>recommended parts</b>		

**Set up completed**

#### [4-3] View the part information you have set up

(1) There are two ways to view the part information you have set up.

- Viewing method 1: By pressing the "Part Structure" tab.
- Viewing method 2: Press "Circuit No. (button)" or "Part No. (text link)" to display.



## 《Viewing method 1: By pressing the "Part Structure" tab》

Example: Click the tab "Part Structure③" to display "Part Structure③".

The screenshot illustrates the process of viewing a part's structure. At the top, three tabs are visible: 'part structure①' (red), 'part structure②' (green), and 'part structure③' (blue). A dashed orange box highlights the 'part structure③' tab, with a callout 'Method 1 . part structure③ tab' and a hand icon pointing to it. Below the tabs, three tables are shown, each corresponding to a part structure. The third table, 'part structure③', is highlighted with a dashed orange box and a callout 'Display part structure③'. This table lists two parts: C31 (EEHAZS1J101B) and C32 (EEETP1A221AP). For each part, there are buttons for 'part selection' or 'user defined' and a 'recommended parts' section. To the right of the table, a graph titled 'EEHAZS1J101B' shows the impedance |Z| and equivalent series resistance (ESR) versus frequency f [MHz]. The graph has a logarithmic scale for both axes. The |Z| curve (orange) starts at approximately 0.1 ohms at 0.01 MHz, dips to a minimum of about 0.01 ohms at 0.1 MHz, and then rises to about 1.0 ohms at 100 MHz. The ESR curve (blue) starts at approximately 0.01 ohms at 0.01 MHz, dips to a minimum of about 0.005 ohms at 0.1 MHz, and then rises to about 0.1 ohms at 100 MHz. Below the graph, a disclaimer states: 'The results of this simulation are calculated based on input data and assumptions. They are reference data and do not guarantee product characteristics.' At the bottom, there are four buttons: 'PDF', 'CSV', 'catalog', and 'Sim model'.

## 《Viewing Method 2: Click on the "Circuit No. (button)" or "Part No. (text link)" 》

- When a part number is set, "Circuit No." changes to a button and "Part No." changes to a text link.
- The "Circuit No." and "Part No. (Please select)" with no part number set will not respond even if they are pressed.
  - For example, L22 does not respond when "Circuit No." or "Part No." is pressed because the part has not yet been set.
  - For other than L22, parts have already been set, so pressing the "Circuit No." and "Part No." will change the display.

list   part structure①   part structure②   part structure③

part structure①

circuit number	part number
C11	33uF 2nH 20mΩ

part structure②

circuit number	part number
L21	ETQP3M2R2YFP

part structure③

circuit number	part number
C32	EEETP1A221AP

Method 2. Circuit No. button

Method 2. Part number link

Since no parts are set, pressing "Circuit No." or "Part No." does not respond.

Display C32 in the part structure③.

part structure③

circuit number	part number	parts information
C31	EEHAZS1J101B	rated voltage: 10.00V capacitance: 220μF
C32	EEETP1A221AP	rated voltage: 10.00V capacitance: 220μF

Graph showing  $|Z|, ESR$  [ohm] vs  $f$  [MHz].

The results of this simulation are calculated based on input data and assumptions. They are reference data and do not guarantee product characteristics.

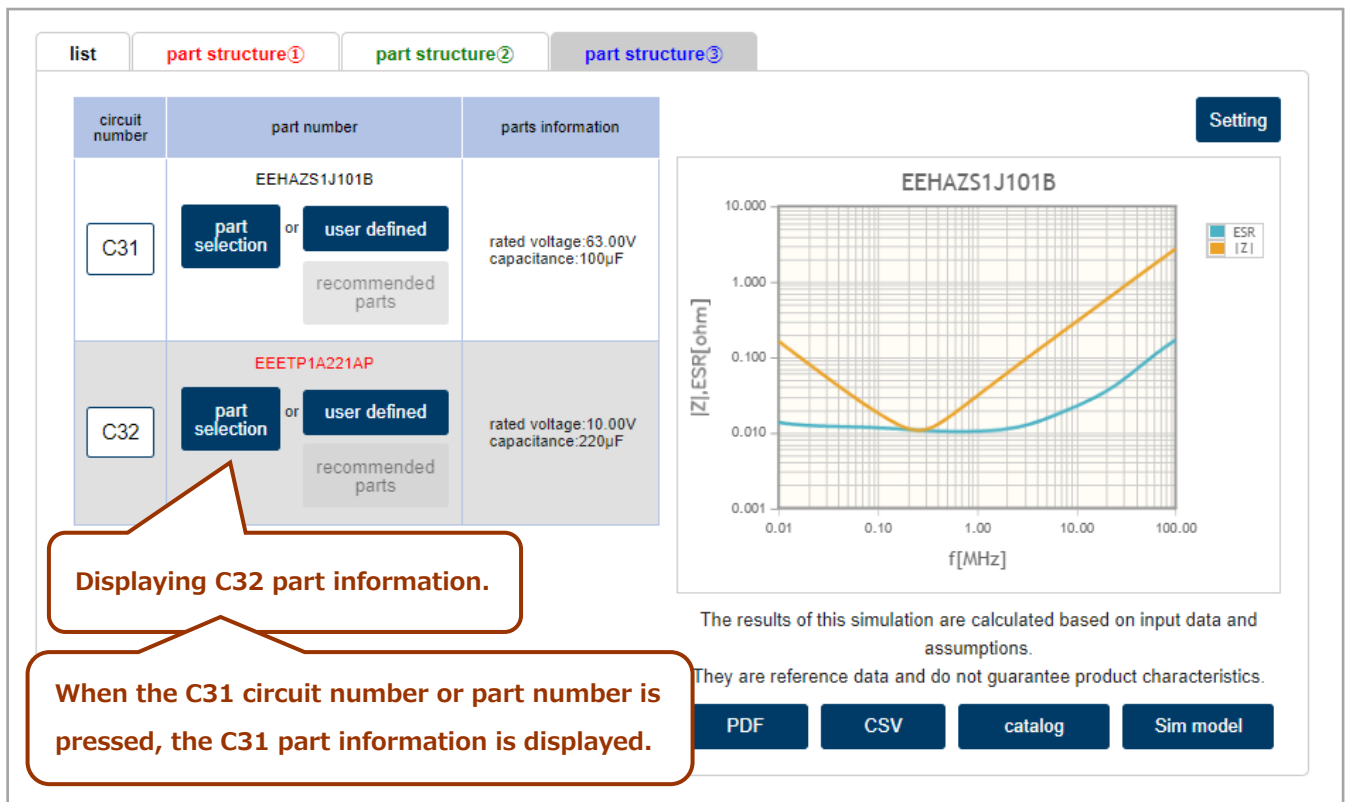
PDF   CSV   catalog   Sim model

#### [4-3] View the part information you have set up

(2) The part being viewed is displayed with a gray background and the part number in red.

(2-1) Pressing "Circuit No." or "Part No." toggles the display of the part to be viewed.

(2-2) To view part information for a different part structure, click the "Part Structure" tab, or click the "List" tab, and then click the "Circuit Number" or "Part Number" of the part you want to view. Click the "Circuit No." or "Part No." of the component you want to view to switch the display.



(3) You can change the display scale of the horizontal and vertical axis of the graph by clicking "Setting" in the upper right corner of the impedance graph.

The settable range differs between capacitors and inductors.

#### 《For capacitors》

**X Axis**

☐ Linear   ☒ Log

☒ Default

Minimum Value  
0.01

Maximum Value  
100

**Y Axis**

☐ Linear   ☒ Log

☒ Default

Minimum Value  
0.001

Maximum Value  
10

**Reset**   **OK**

#### Horizontal axis (X Axis)

Linear : Displays the scale at equal intervals.

Log : Set the scale to logarithmic.

Default (checked) : Initial value (min. 0, max. 100)

Default (unchecked) : Minimum and maximum values can be entered

→Minimum Value: 0.01

→Maximum Value: 1000

#### Vertical axis (Y Axis)

Linear : Displays the scale at equal intervals.

Log : Set the scale to logarithmic.

Default (checked) : Initial value (min. 0.001, max. 10)

Default (unchecked) : Minimum and maximum values can be entered

→Minimum Value: 0.001

→Maximum Value: 10

Reset : Restore the impedance graph to the display before the Setting operation.

OK : Change the graph X-axis and Y-axis to the setting values and display them.

《For inductor》

X Axis

Linear

Log

Default

Minimum Value

0.01

Maximum Value

100

Y Axis

Linear

Log

Default

Minimum Value

0.001

Maximum Value

10

Reset

OK

Horizontal axis (X Axis)

Linear : Displays the scale at equal intervals.

Log : Set the scale to logarithmic.

Default (checked) : Initial value (min. 0.01, max. 100)

Default (unchecked) : Minimum and maximum values can be entered

→Minimum Value : 0.01

→Maximum Value : 1000

Vertical axis (Y Axis)

Linear : Displays the scale at equal intervals.

Log : Set the scale to logarithmic.

Default (checked) : Initial value (min. 0.01, max. 100000)

Default (unchecked) : Minimum and maximum values can be entered

→Minimum Value : 0.01

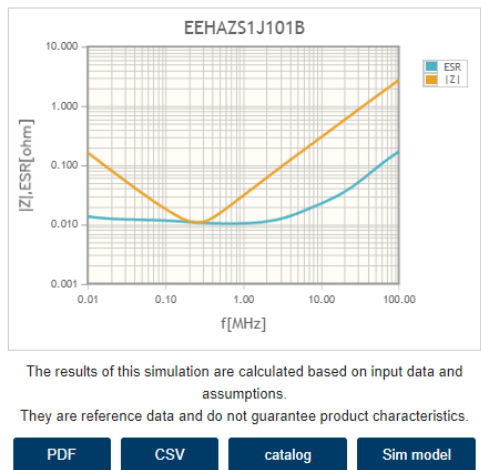
→Maximum Value : 100000

Reset : Restore the impedance graph to the display before the Setting operation.

OK : Change the graph X-axis and Y-axis to the setting values and display them.

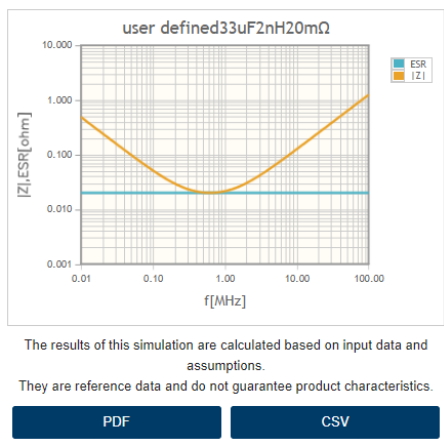
(4) A button for downloading data is displayed below the graph. (The contents of the display will vary depending on how the component is set up.)

《For "Parts Selection" and "Recommended Parts"》



PDF	Outputs a graph image of the configured parts in PDF format.
CSV	Outputs numerical data of configured parts in Excel format.
Catalog	Displays the catalog for configuration parts in a separate tab.*Part numbers under development are displayed on the Product Under Development page instead of the catalog page.
Sim model	Outputs simulation models (S-parameters, etc.) of configuration parts in Zip format.

《For "user-defined"》



PDF	Outputs a graph image of the configured parts in PDF format.
CSV	Outputs numerical data of configured parts in Excel format.

[4-4] View Simulation Results

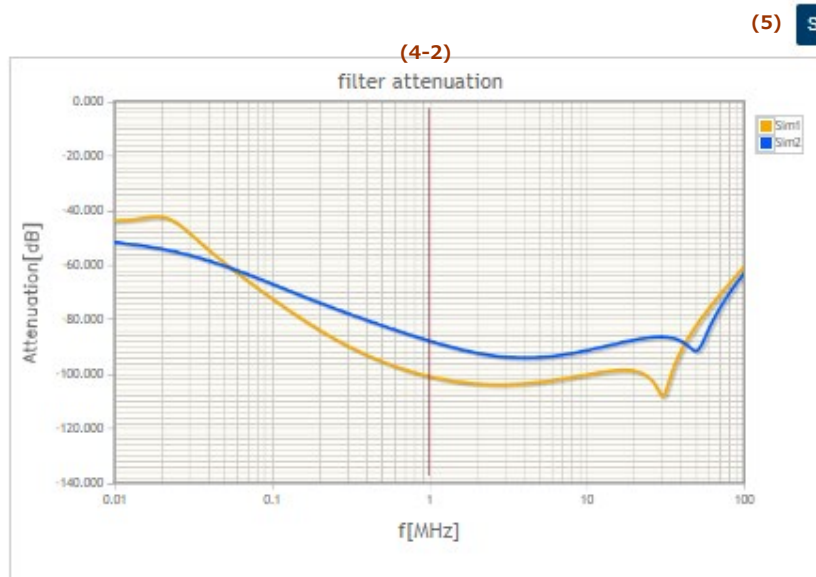
After setting all the components, simulation results (list) and filter attenuation graphs are displayed.

- (1) Circuits with graph display ON checked are displayed in the filter attenuation graph.
- (2) The parts set in the simulation conditions and the selection of parts to be used are displayed.
- (3) Displays the part proprietary surface (sum of all parts). Items containing user definitions are displayed with a hyphen. \*1
- (4-1) Attenuation is displayed at 1 MHz as default, and the frequency can be changed by pull-down.
- (4-2) Draws a vertical line on the X axis where the frequency selected for attenuation and the filter attenuation graph intersect.
- (5) The display range of the filter attenuation graph can be changed by "Setting". \*2
- (6) A button for data download is displayed below the graph. \*3

## simulation results

(1) graph display ON	filter circuit	Input Z	Output Z	(2) part structure			(3) simulation condition	(4-1) select the component	attenuation amount[dB]
				①	②	③	parts occupied area [mm <sup>2</sup> ]		
Sim1 <input checked="" type="checkbox"/>	$\pi$ -type	50	50	C Single item C11:EEETP1A221AP	L parallel2 L21:ETQP3M2R2YFP L22:ETQP3M100KVP	C Single item C31:33uF 2mH 20mD	※1		-100.9
Sim2 <input checked="" type="checkbox"/>	$\pi$ -type	50	50	C Single item C11:EEETP1A221AV	L Single item L21:▲ETQP3M1R5YFP	C Single item C31:EEETP1A471AP	202.5		-87.8
Sim3 <input checked="" type="checkbox"/>	$\pi$ -type	50	50	C Single item	L Single item	C Single item			
Sim4 <input checked="" type="checkbox"/>	$\pi$ -type	50	50	C Single item	L Single item	C Single item			
Sim5 <input checked="" type="checkbox"/>	$\pi$ -type	50	50	C Single item	L Single item	C Single item			

## filter characteristic



The results of this simulation are calculated based on input data and assumptions.  
They are reference data and do not guarantee product characteristics.

(6) PDF CSV

- \*2. The display range of the filter attenuation graph can be changed by "Setting".  
"Setting" is a function to change the display scale of the horizontal axis (X Axis) and the vertical axis (Y Axis) of the graph.

## 《Filter attenuation》

### Horizontal Axis (X Axis)

Linear : Displays the scale at equal intervals.

Log : Set the scale to logarithmic.

Default (checked) : Initial value (min. 0.01, max. 100)

Default (unchecked) : Minimum and maximum values can be entered

→Minimum Value: 0.01

→Maximum Value:1000

### Vertical Axis (Y Axis)

Linear : Displays the scale at equal intervals.

Log : Set the scale to logarithmic.

Default (checked) : Initial value (min. -140.0, max. 0)

Default (unchecked) : Minimum and maximum values can be entered

→Minimum Value : -200.0

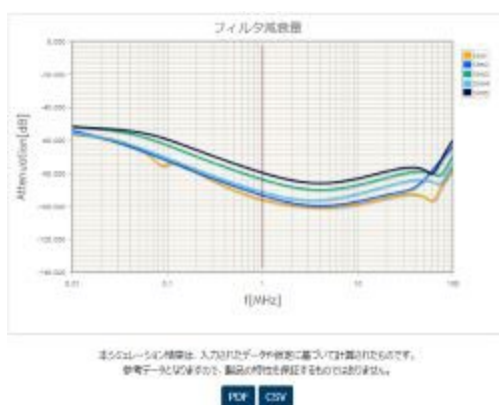
→Maximum Value : 0

Reset : Restore the impedance graph to the display before the Setting operation.

OK : Change the graph X-axis and Y-axis to the setting values and display them.

\*3. Displays a button for downloading data below the graph

## 《filter attenuation》



PDF	Output filter attenuation graph images in PDF format.
CSV	Output numerical data of simulation results in Excel format.