https://ds.murata.co.jp/bist/?lcid=en-us

Bias-T Inductor Design Support Tool

Operation Manual

May 2020

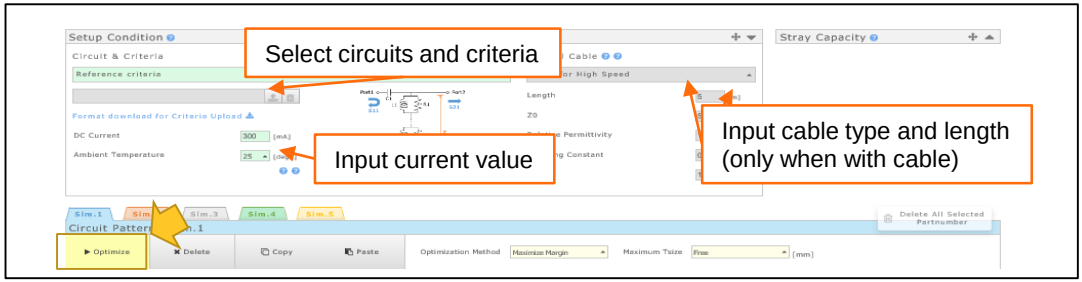
Murata Manufacturing Co., Ltd.

Tool Overview

Find optimal products combination for PoC bias-T inductors by simple operations.

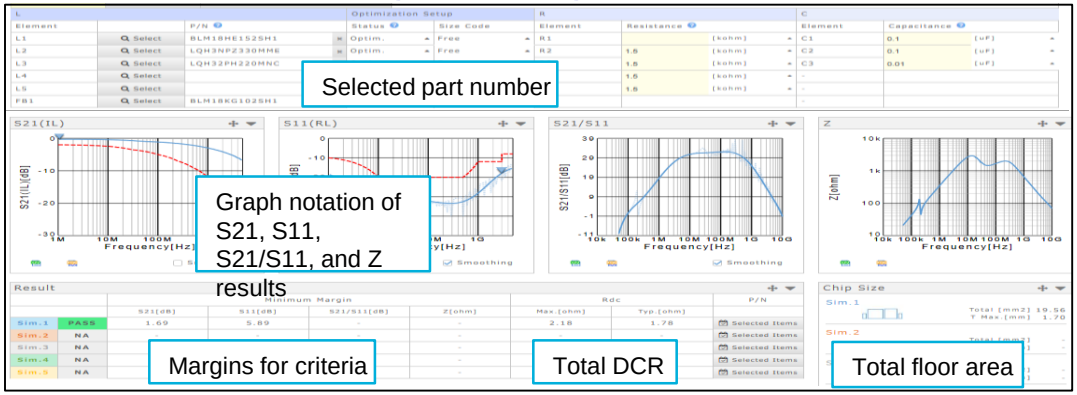
Operations

- setting conditions (circuit, criteria, current, cable (In case selected “with cable ”))
- pressing the Optimize button to discover



Result

- optimal products combination
- the graph display of S21 (IL), S11 (RL), S21/S11, Z
- Pass/Fail for standards that are to be cleared
- the smallest margin, total DCR/area of filters, largest height



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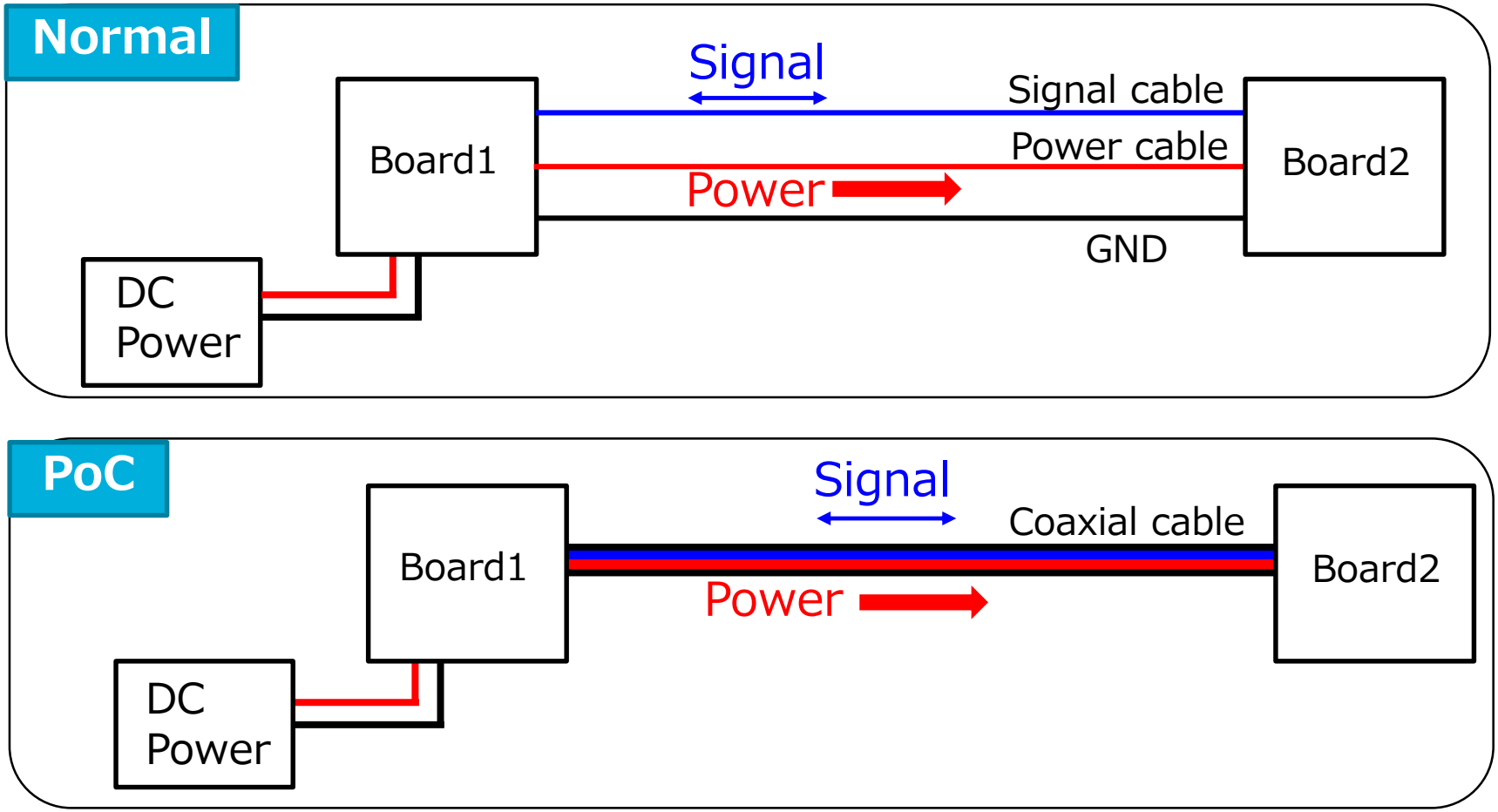
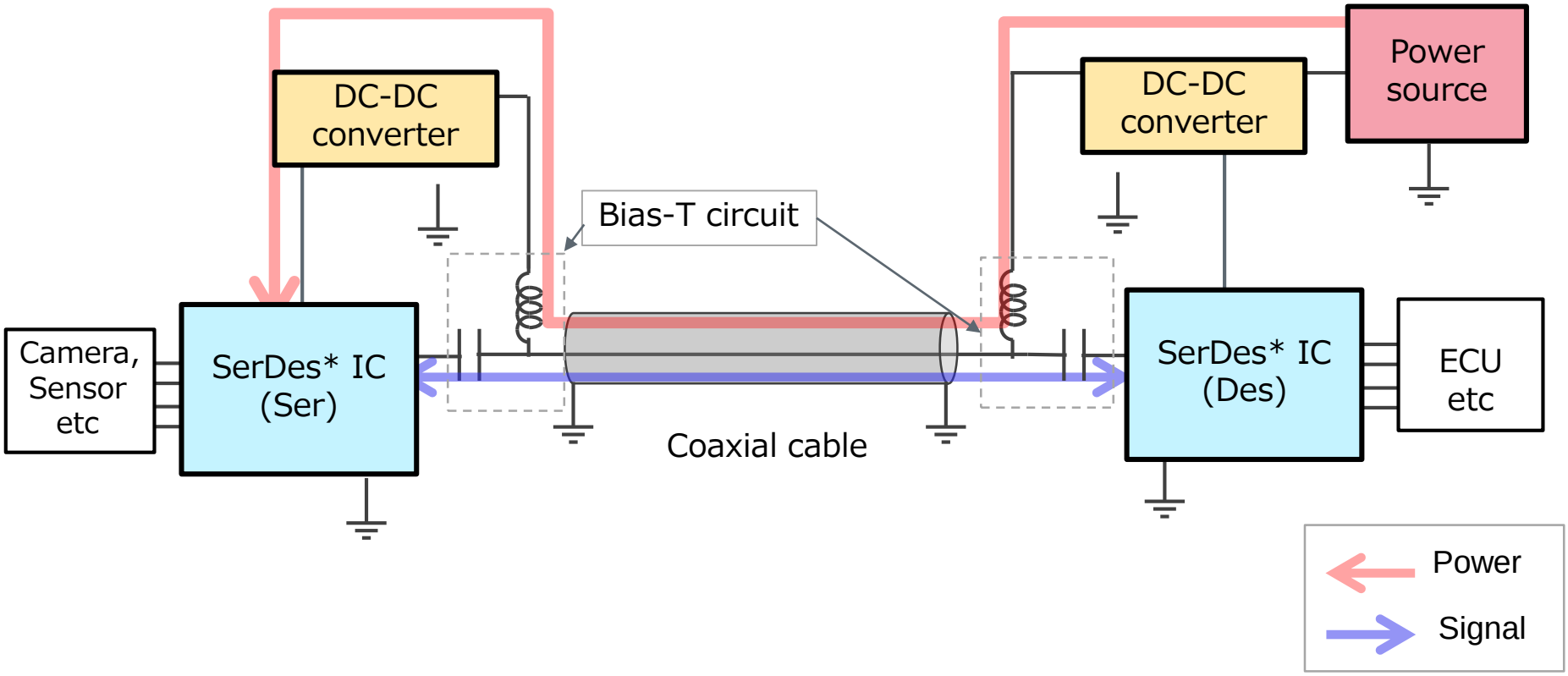
1-1, What Is PoC



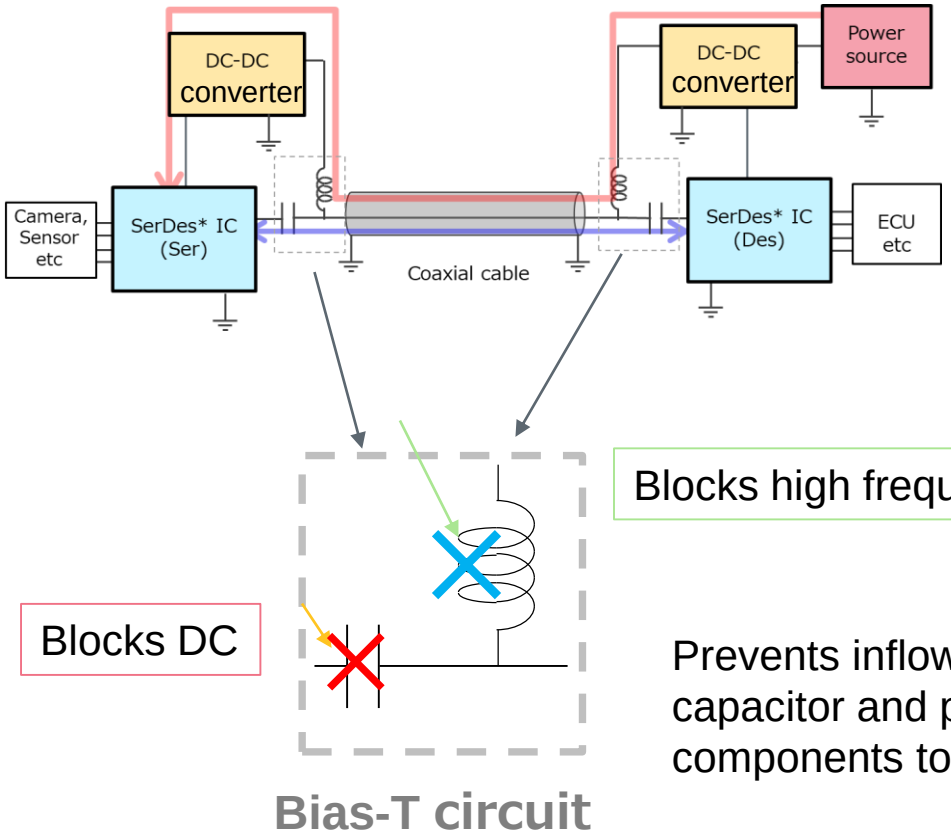
PoC (power over coaxial) is a technology that transmits both power and signal simultaneously through 1 coaxial cable. (This contributes to reduce the number of cables)

1-2, Typical Circuit Diagram of PoC Systems



The high frequency signal and DC power are separated through the Bias-T circuit.

1-3, Roles of PoC System Bias-T Inductors

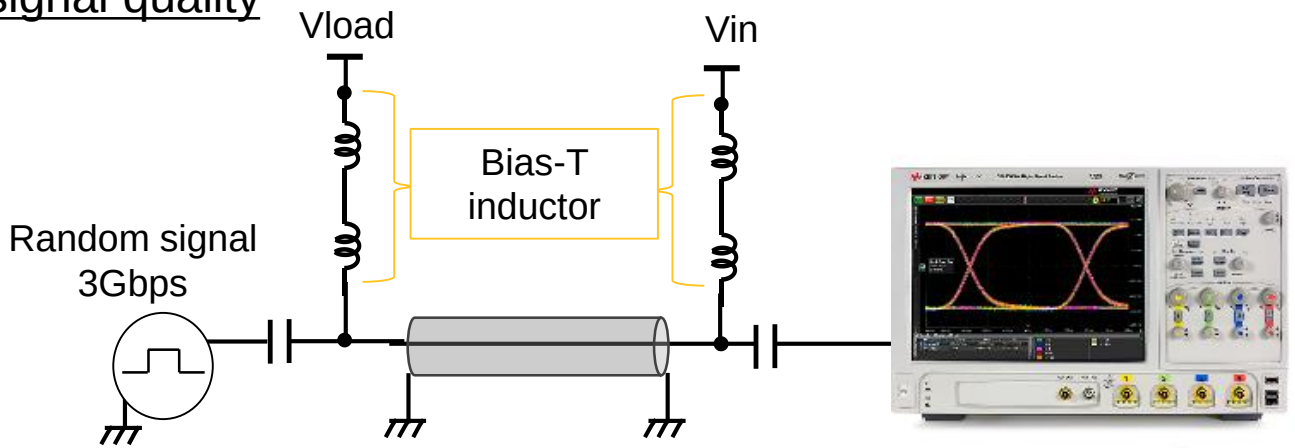


Prevents inflow of DC components to the IC with the capacitor and prevents inflow of high frequency components to the power line with the inductor.

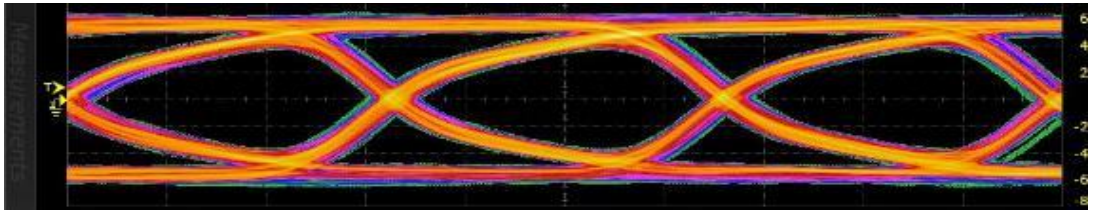
It is particularly necessary to select a Bias-T inductor since it greatly affects transmission characteristics.

1-4, Effects Bias-T Inductor Characteristics Apply on Signal Quality

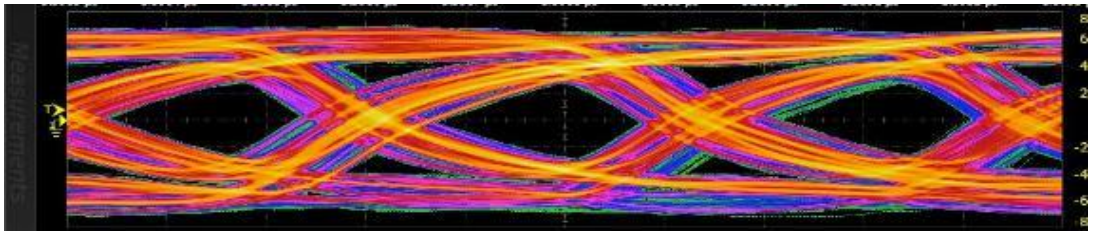
Measuring signal quality



Bias-T inductor with good characteristics



Bias-T inductor with insufficient characteristics



It is required to select a Bias-T inductor that can ensure signal quality.

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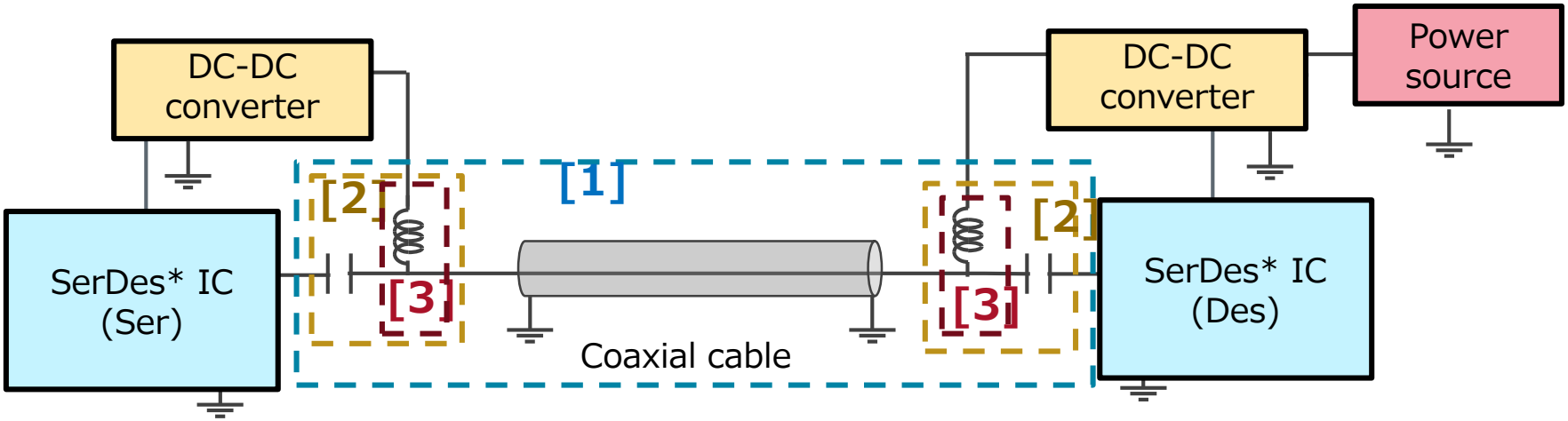
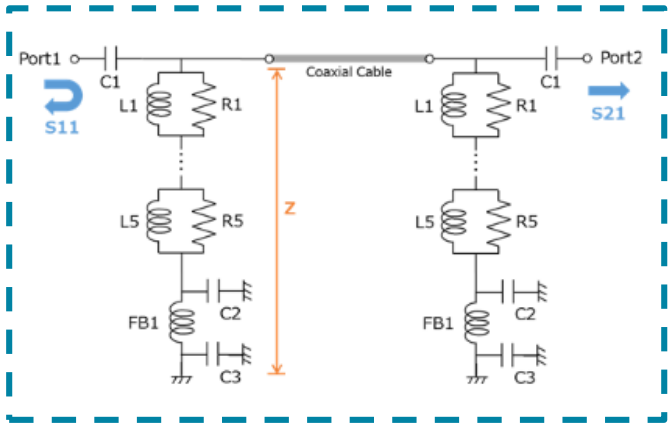
2-1, Circuits That Can Be Simulated

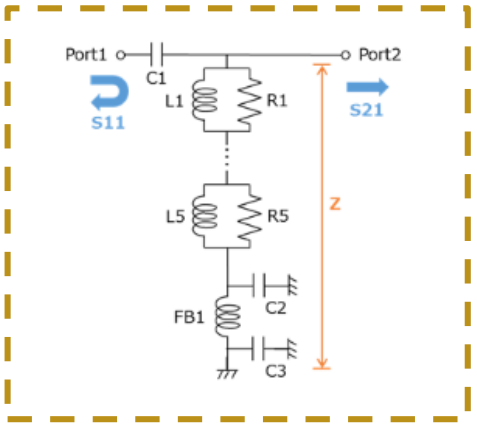
Simulation with 3 types of circuits available.



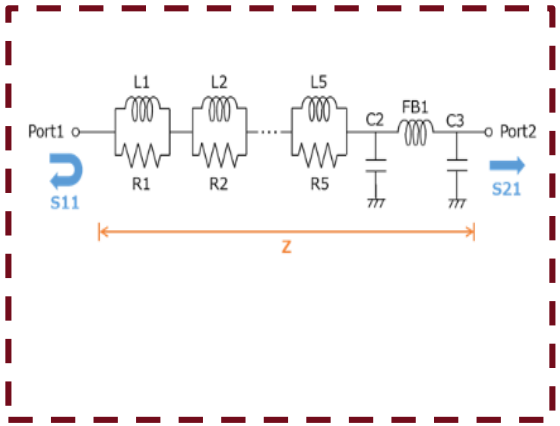
[1] With cable



[2] Without cable



[3] Only circuit



2-2, Criteria

S21, S11, S21/S11 criteria values that must be cleared to ensure signal quality are set by each IC manufacturers or customers.

Automatically selects products combinations that clear these criteria.

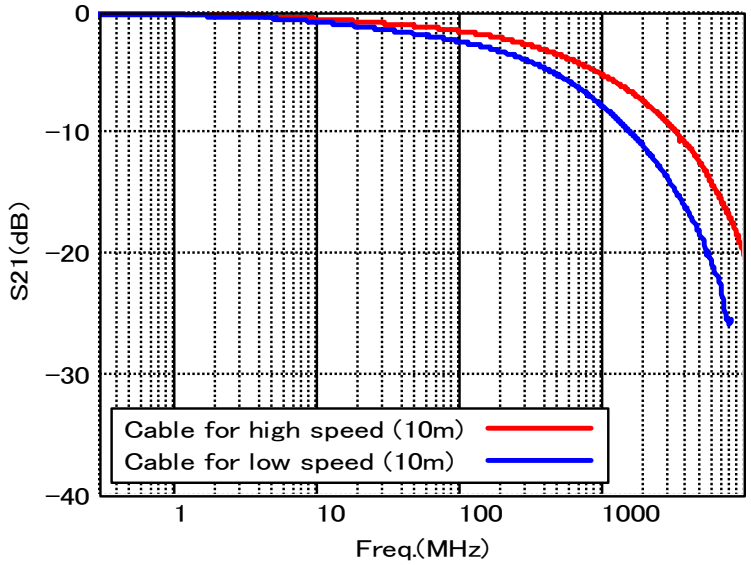
This tool can be selected from the following.

- Select the IC manufacturer recommended criteria
- Select the criteria set by MURATA
- Upload your criteria

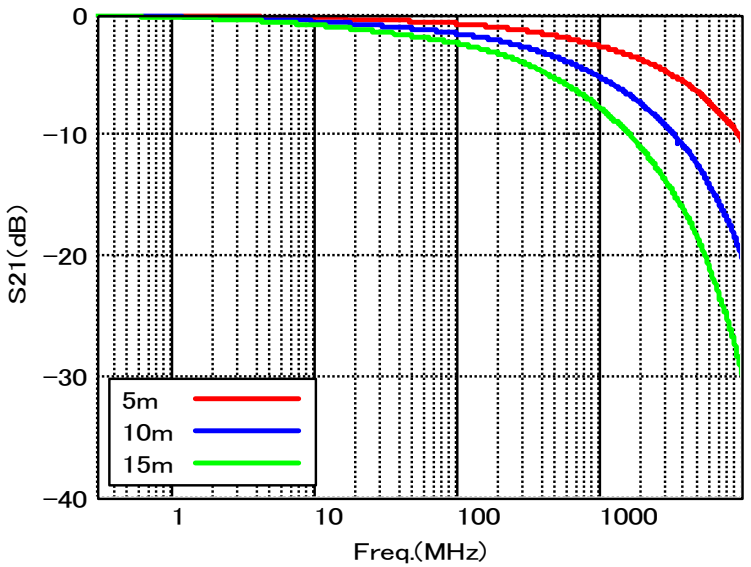
2-3, Coaxial Cable

Loss varies by cable type and length.
To run simulations on circuits with cables, settings considering cable characteristics must be applied.

Relationship between cable length and S-parameter



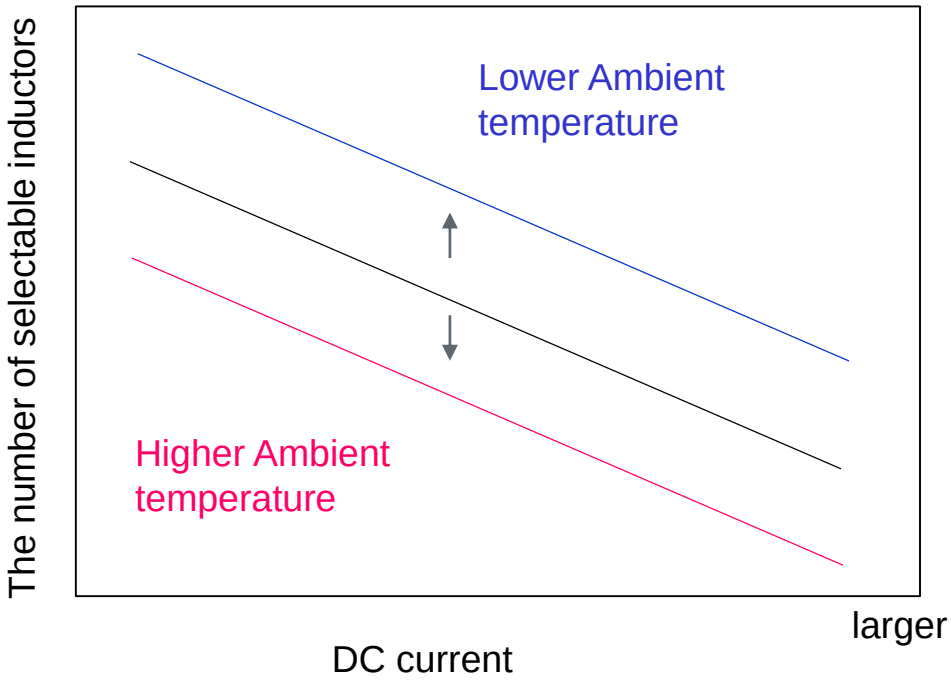
2 types of cables can be selected on this simulator.



Input an applicable value for cable length.
(Usually about 15 m or less)

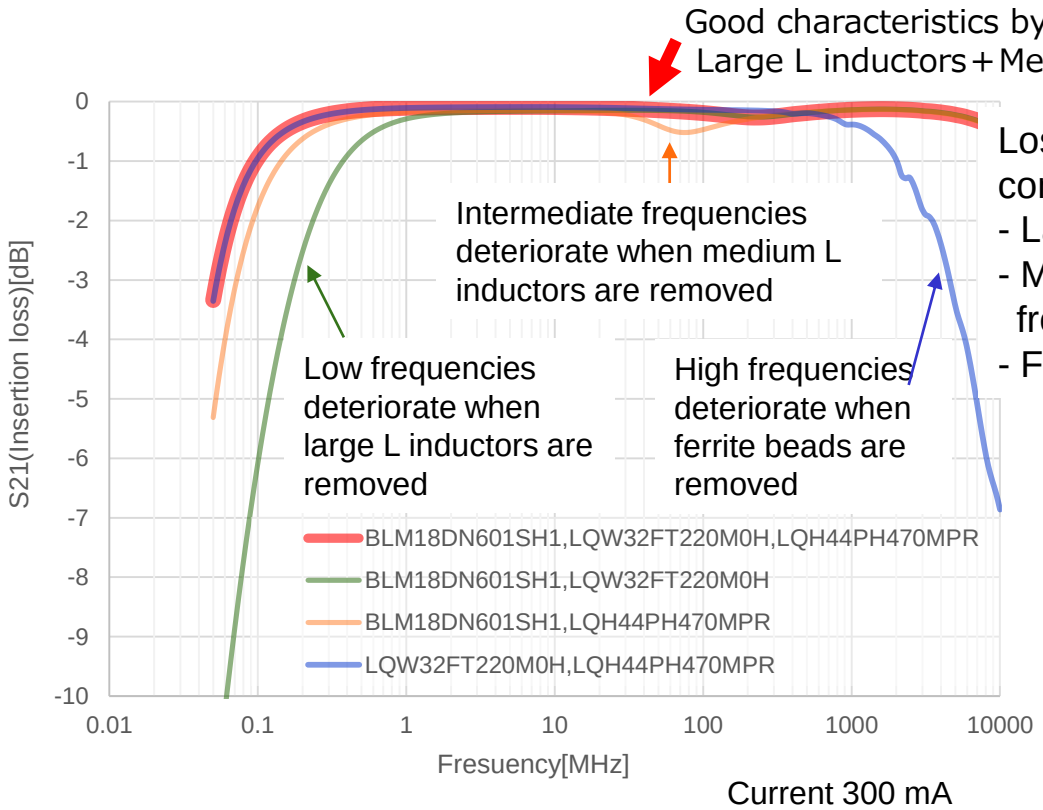
2-4, Current, Temperature, and Size Settings

Inductors that match the conditions set in condition settings are provided.
Applying less options for ambient temperature conditions and current conditions provide more inductors that can be selected.

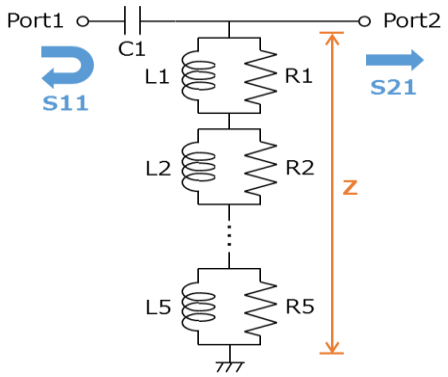


2-5, Serial Connection of Bias-T Inductors

In Bias-T circuits, to ensure signal quality by reducing loss in wide bandwidths ranging from low frequencies to high frequencies, **Multiple inductors must be used in series.**



Loss in wide bandwidths can be reduced by combining the following:
- Large L inductors that cover low frequencies
- Medium L inductors that cover intermediate frequencies
- Ferrite beads that cover high frequencies

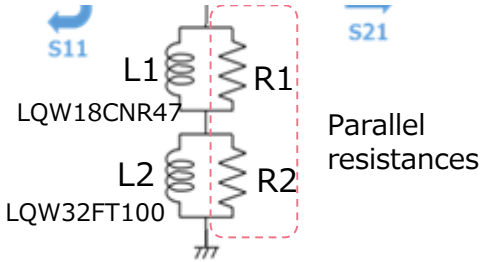


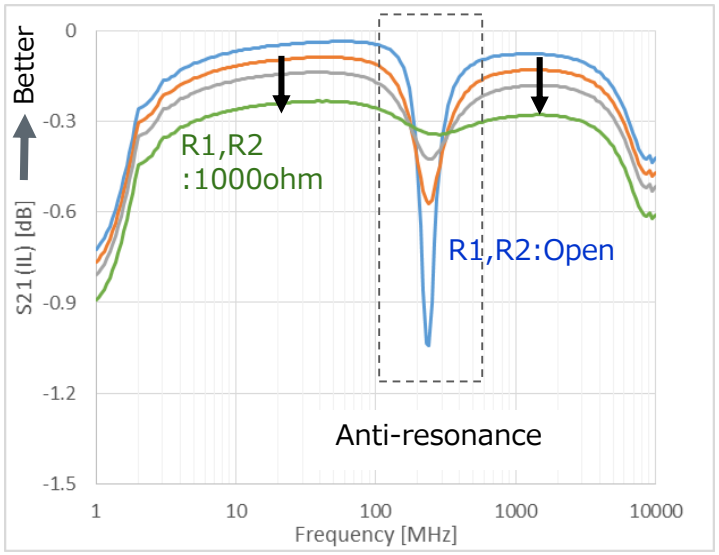
Simulations with up to 5 parallelly connected inductors are available on this tool.
Bias-T inductors are automatically selected.

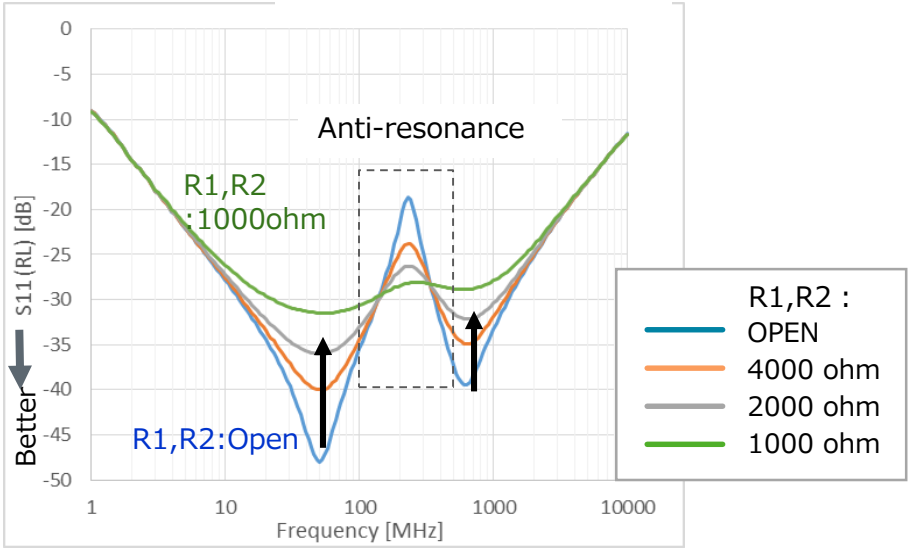
2-6, How to Select Parallel Resistances

Anti-resonance will occur when several Bias-T inductors are connected serially.
By adding a parallel resistance to each inductor, anti-resonance can be suppressed.
On the other hand, **characteristics other than anti-resonance will deteriorate.**
By selecting a suitable resistance value, a filter characteristic that fulfills the target characteristic will be achieved.

The following are results when “L1: LQW18CNR47” and “L2: LQW32FT100” are used, and their parallel resistances R1 and R2 are Open, 1000 ohm, 2000 ohm, or 4000 ohm.



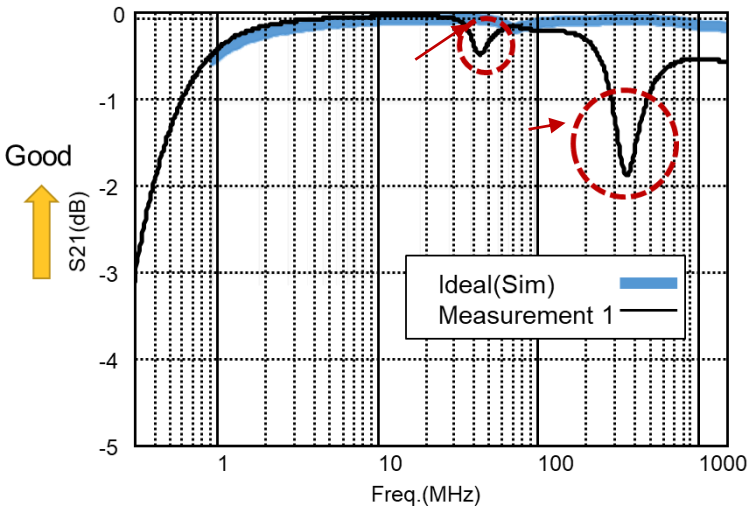




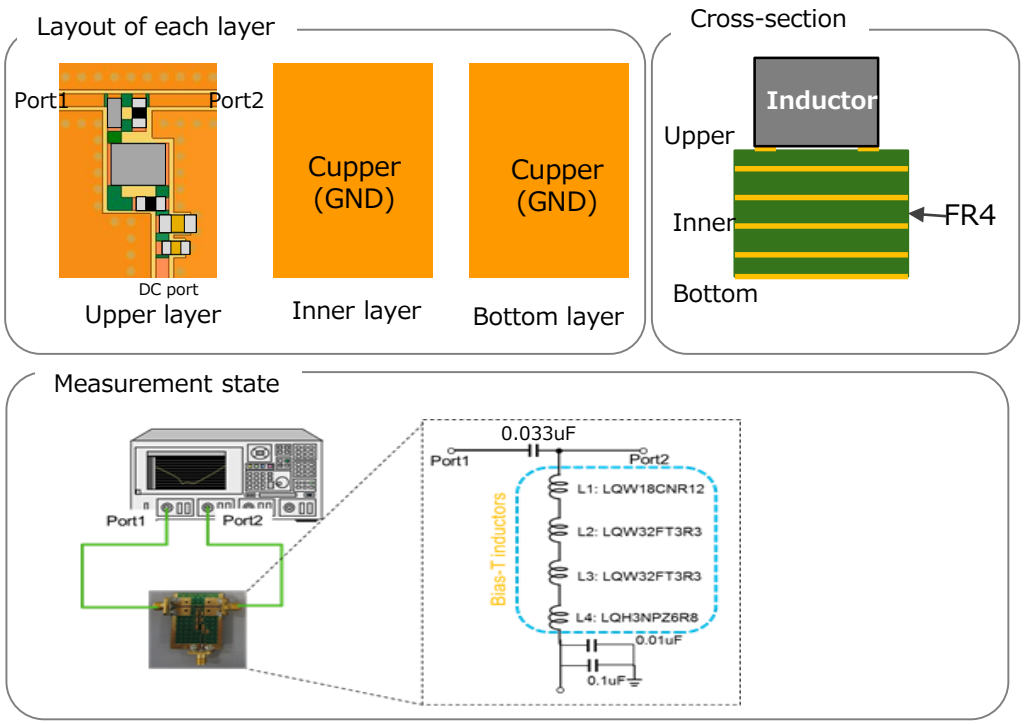
2-7, Effects of Board Stray Capacitance 1

A difference in characteristic results occurs between the simulation value (ideal state) and actual value (board implementation).
Anti-resonance is present more noticeably in the actual value.

Simulation value vs. (ideal state) Actual value (board implementation))



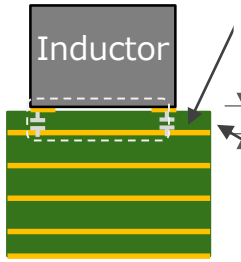
Actual board layout and measurement state



2-7, Effects of Board Stray Capacitance 1

In the actual state, the stray capacitance that occurs between the inductor and inner layer of PCB is present on the characteristic.

If simulations are performed considering the stray capacitance, the calculated value becomes closer to the actual value.



Stray capacitance

Layer-to-layer thickness of boards d = 0.2mm

Permittivity of boards ε_r=4.5

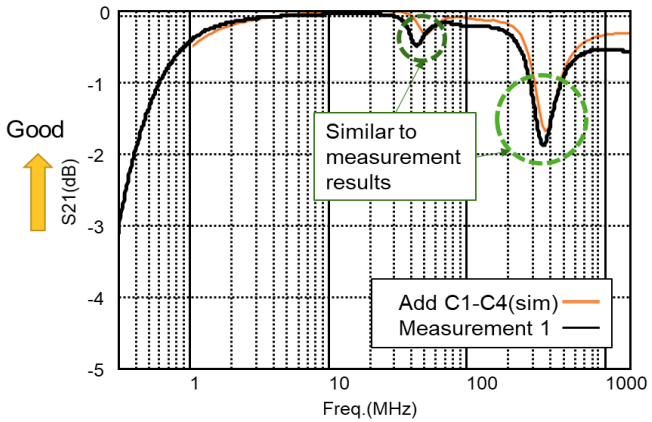
Calculating the stray capacitance from the part size and board information.
[C=ε×S/d] (S: area)

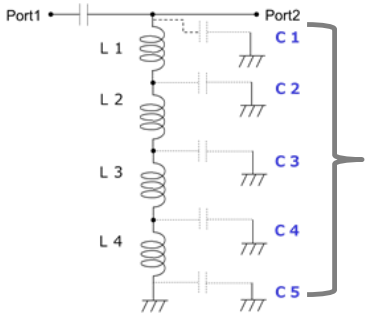
In this case

C1	C2	C3	C4
0.25pF	1.6pF	1.6pF	1.8pF

Reflected on the simulation

Simulation value (including stray capacitance) versus actual value (board implementation)





C1～C5 :
Stray capacitance

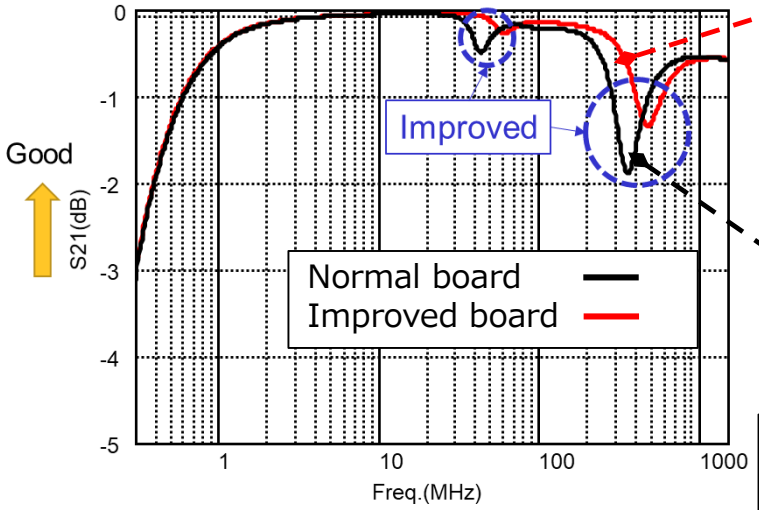
This simulator enables stray capacitance setting that allows calculation of results close to the actual characteristic.

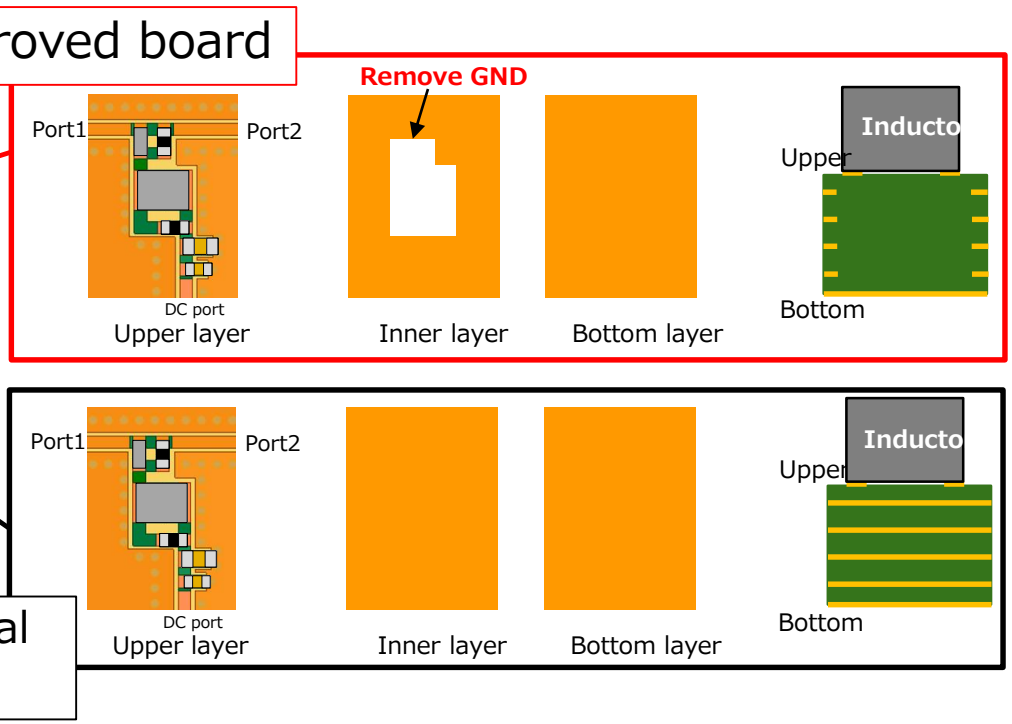
2-7, Effects of Board Stray Capacitance 2

The smaller stray capacitance is, anti-resonance becomes smaller as well.

Deleting the interior ground of the board suppresses anti-resonance.

Normal board (actual measurement) versus improved board (actual measurement)





The stray capacitance value of the improved board is set as the default value on this simulator. Since the values change depending on the part size and board characteristics, simulations can be performed with the users freely changing the values.

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3-1, User Interface

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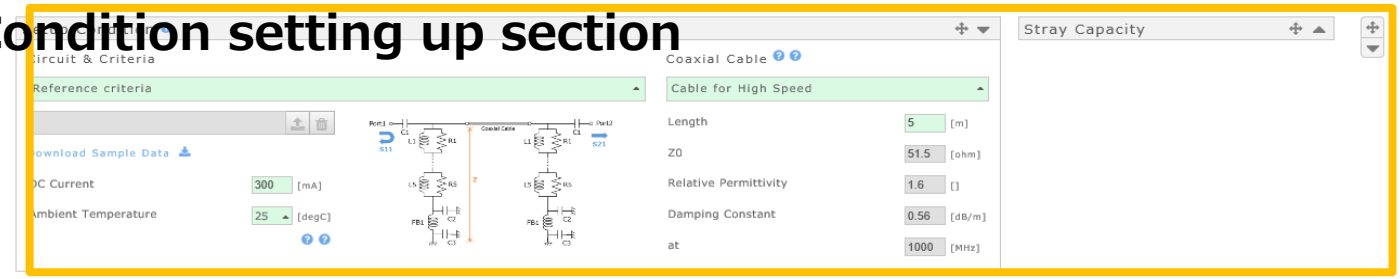
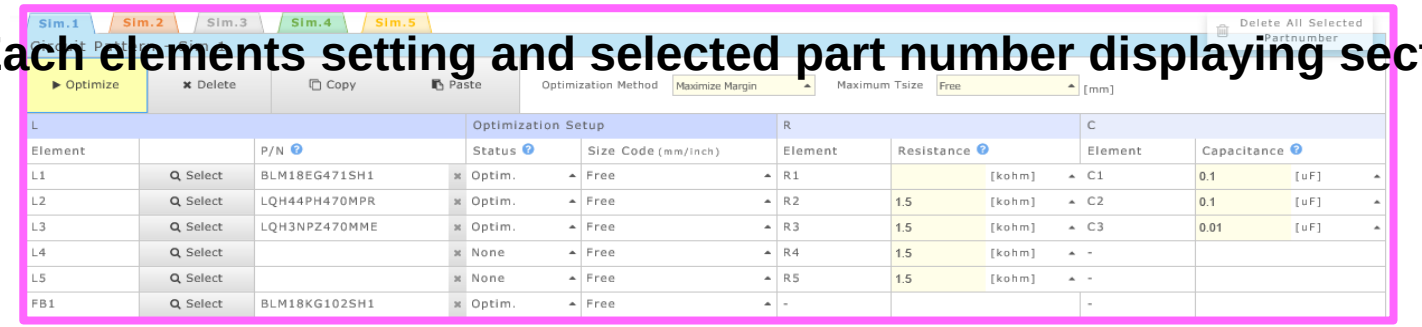
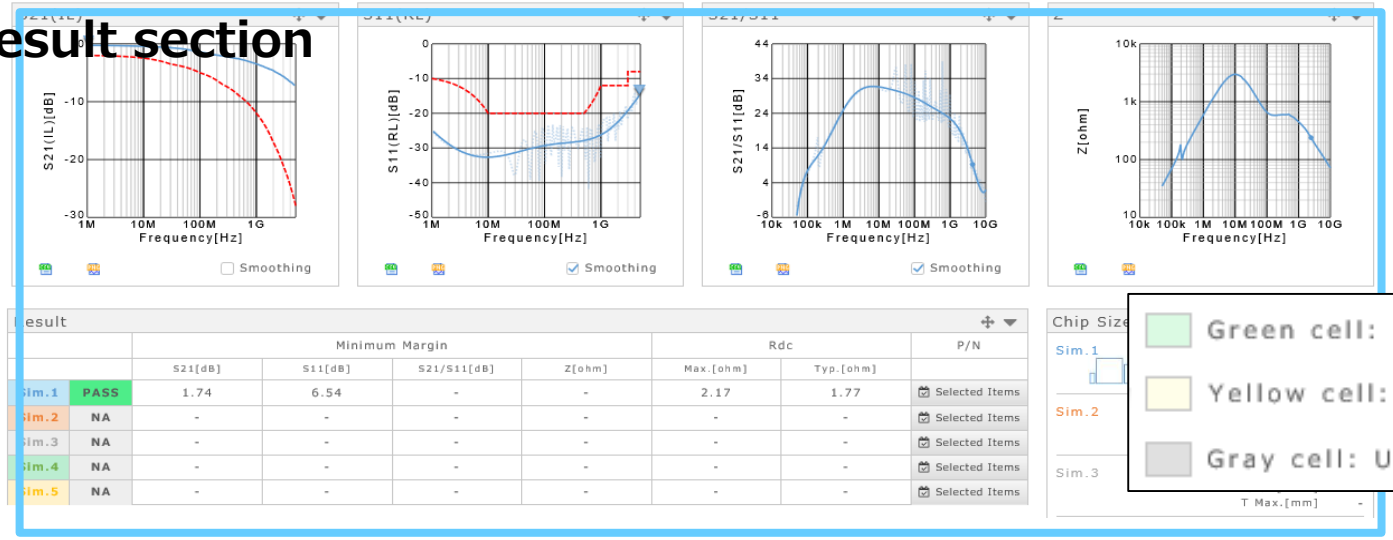
Condition setting up section



Each elements setting and selected part number displaying section



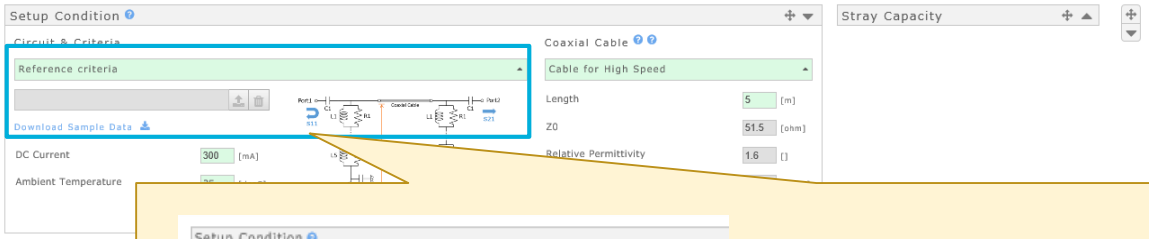
Result section

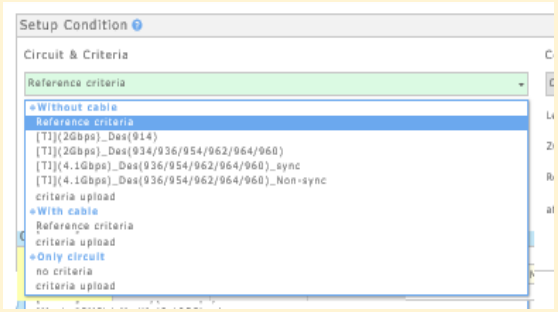


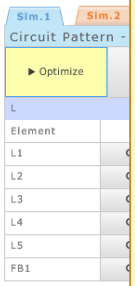
3-2, Details of each sections

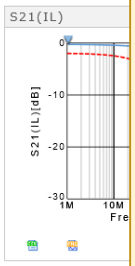
Condition setting up section

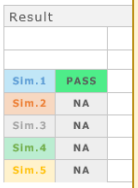
Circuit and criteria







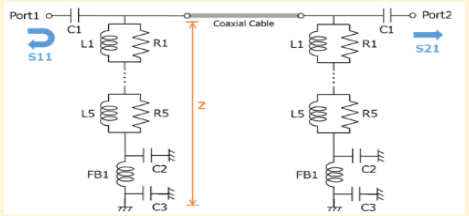




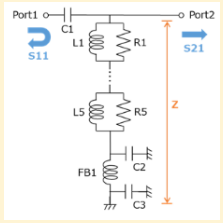
Circuits and criteria can be selected from the pull-down menu

◆ **Selectable circuit**

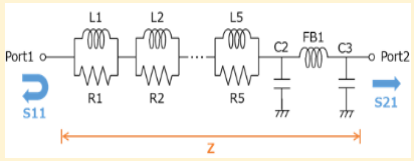
- With cable



- Without cable



- Only circuit



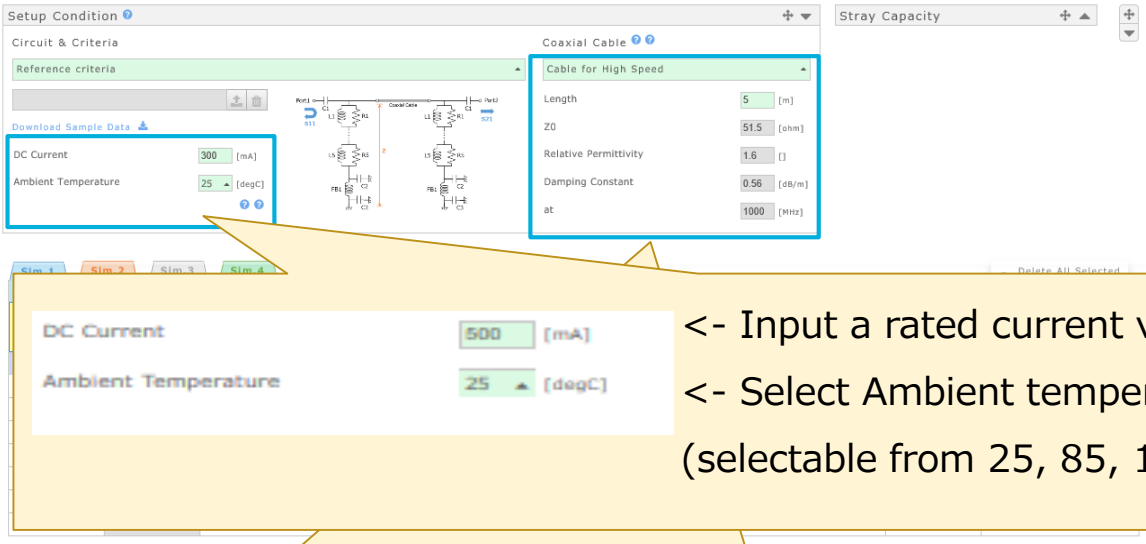
◆**Selectable criteria**

- The IC manufacturer recommended criteria
- The criteria set by MURATA
- Upload your criteria

3-2, Details of each sections

Condition setting up section

Current and Ambient temperature, cable conditions



<- Input a rated current value required for parts

<- Select Ambient temperature

(selectable from 25, 85, 105, 115, 125°C)

In case selected “with cable ” as the circuit

< Select cable (High speed:Max20GHz、Low speed:Max8.5GHz)

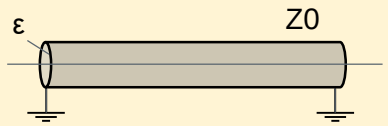
< Input cable length

Cable factor (editing available if “Edit” is selected in cable selection)

・Z0: Characteristic impedance

・ Relative permittivity: Cable permittivity

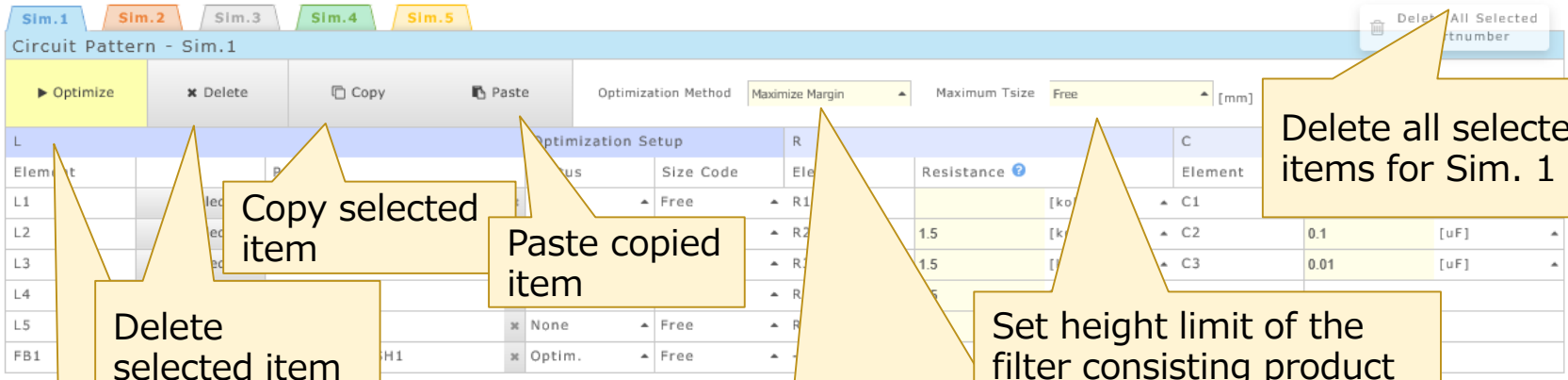
・Damping constant: Cable loss



Damping constant

3-2, Details of each sections

Each elements setting and selected part number displaying section



Delete all selected items for Sim. 1 to 5

Copy selected item

Paste copied item

Delete selected item

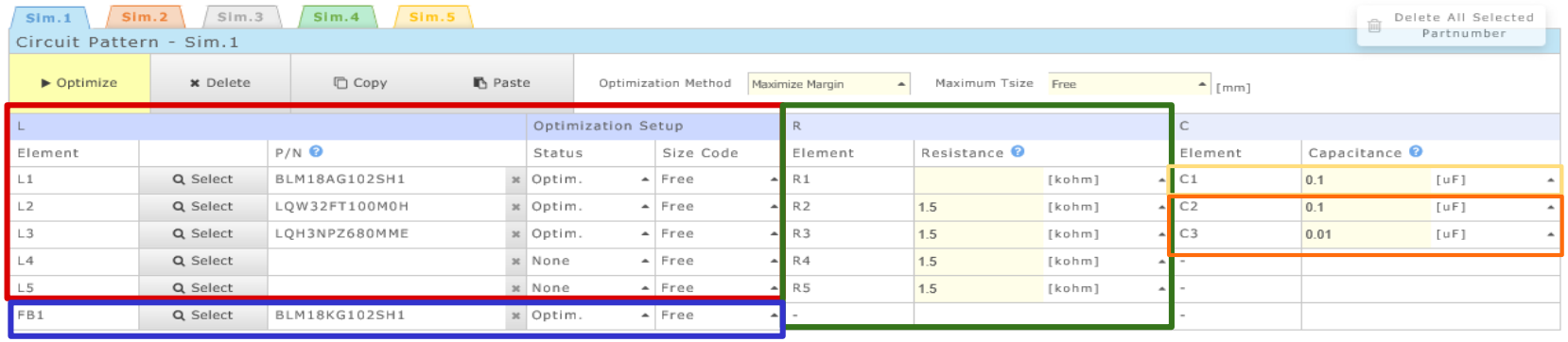
Set height limit of the filter consisting product

Perform automatic selection of optimal part number combinations

Optimization method
-Maximize Margin :
Find the part numbers combination that provides the best characteristics
-Minimize Size :
Find a combination of parts numbers with the smallest size that meets the criteria.

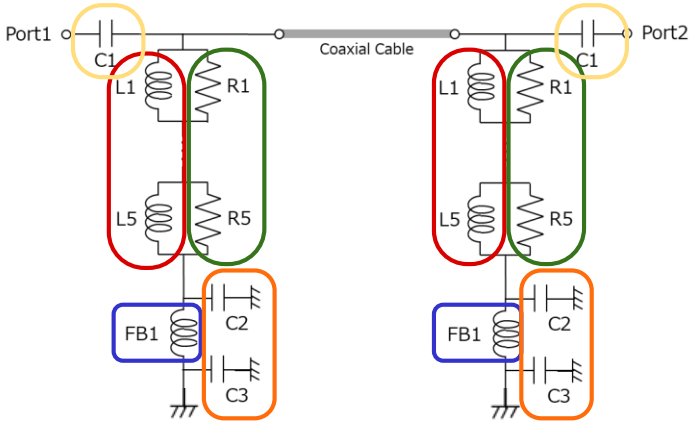
3-2, Details of each sections

Each elements setting and selected part number displaying section

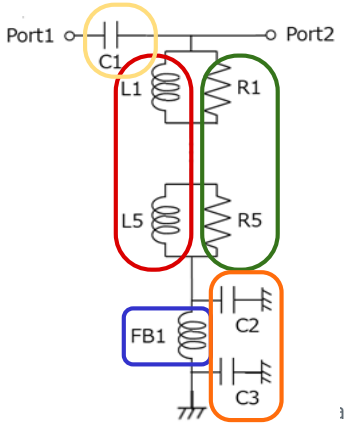


L1 - L5 : Part number that consist of the Bias-T filter
R1 - R5 : Parallel resistance
C1 : DC cut capacitor
C2, C3 : Decoupling capacitor
FB : Ferrite Beads as a noise filter

With cable

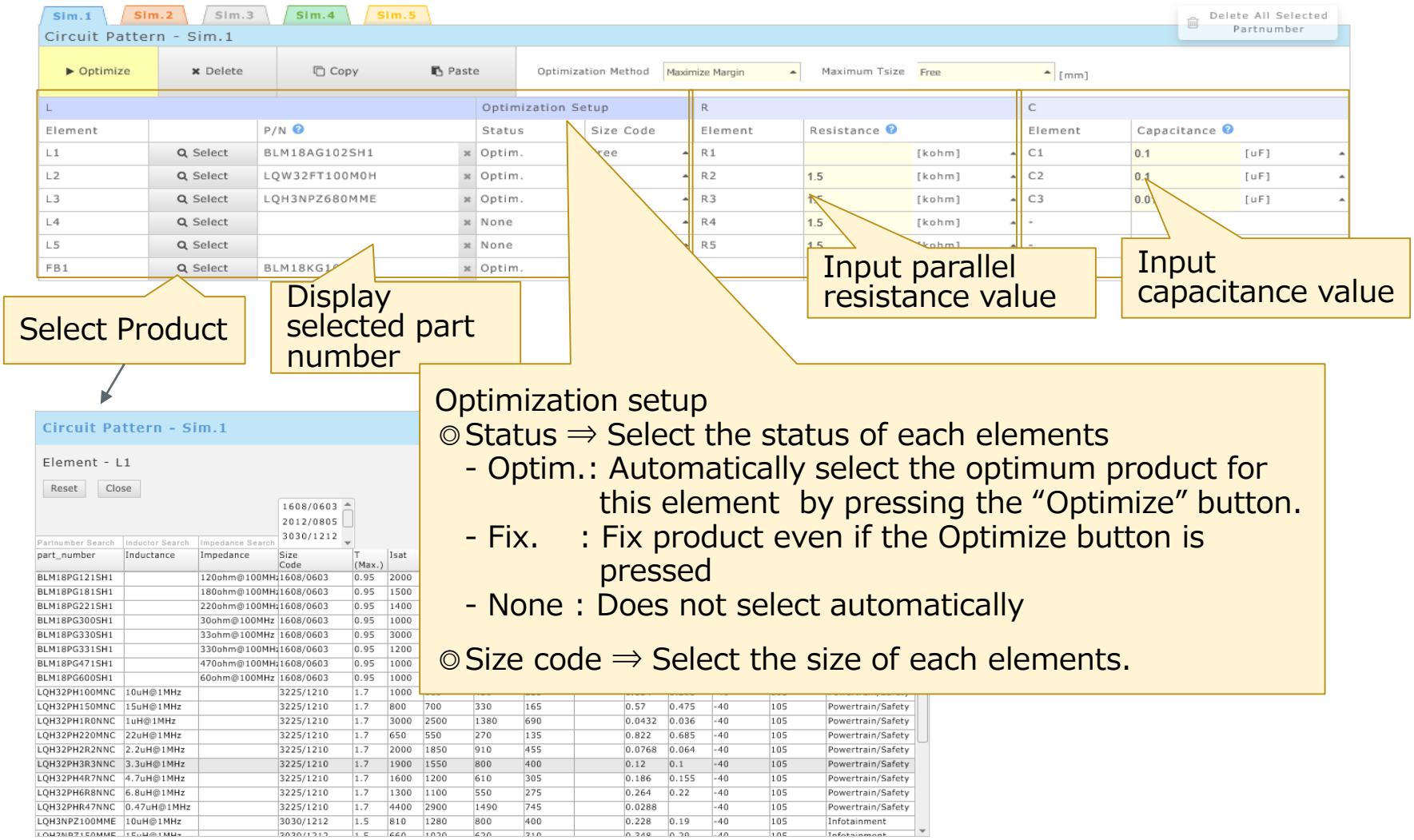


Without cable



3-2, Details of each sections

Each elements setting and selected part number displaying section



Optimization setup

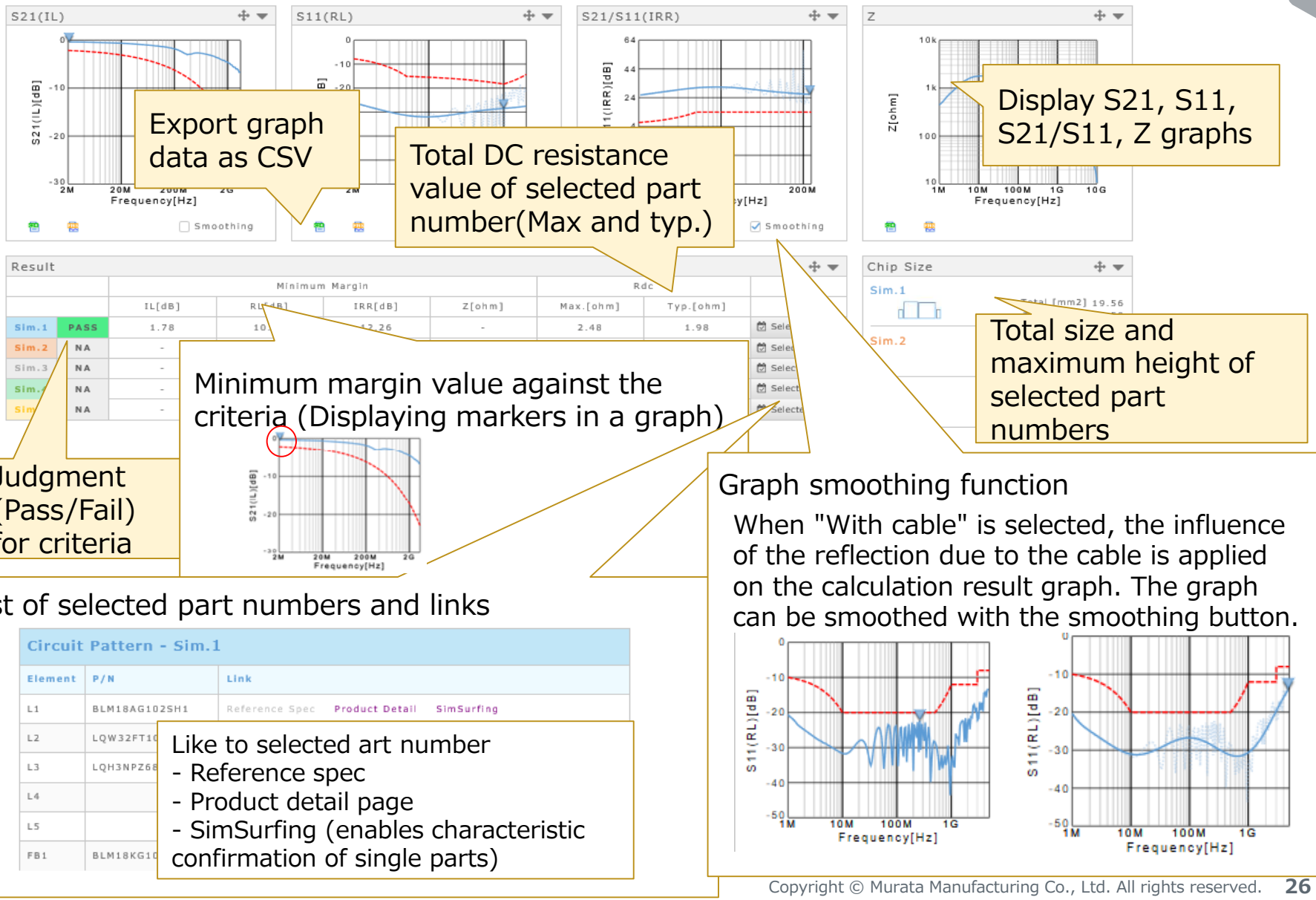
◎Status ⇒ Select the status of each elements

- Optim.: Automatically select the optimum product for this element by pressing the “Optimize” button.
- Fix. : Fix product even if the Optimize button is pressed
- None : Does not select automatically

◎Size code ⇒ Select the size of each elements.

3-2, Details of each sections

Result section

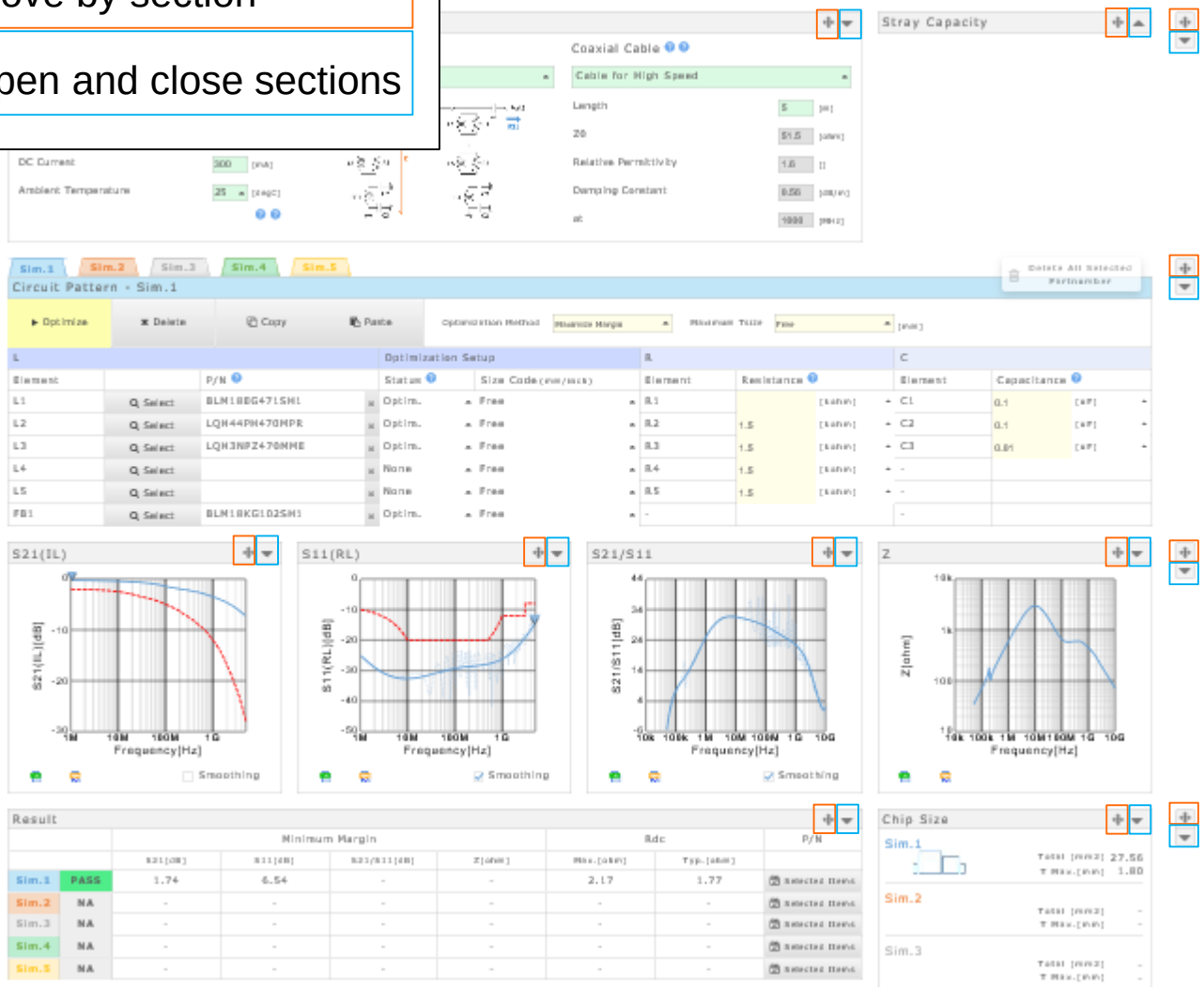


3-2, Details of each sections

Other features

Move by section

Open and close sections



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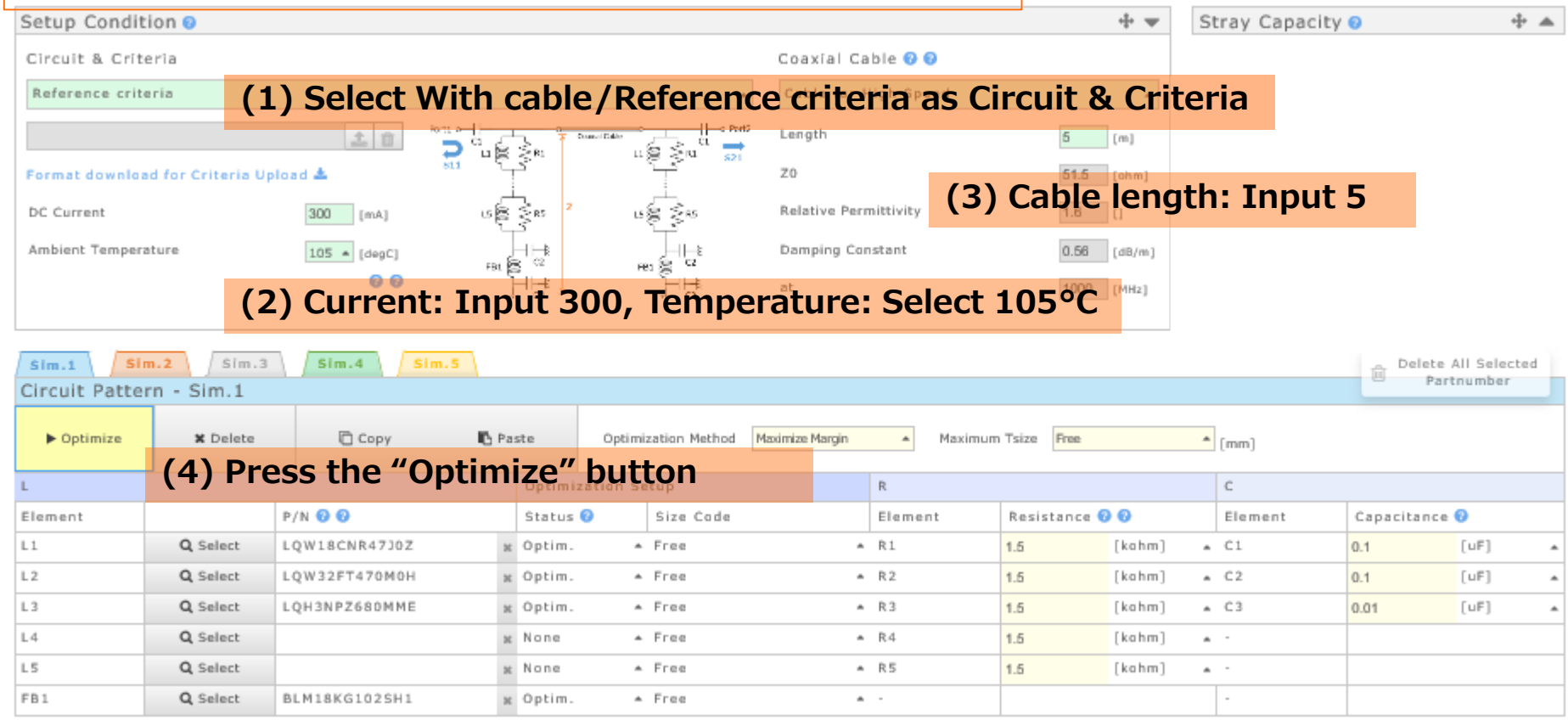
Use Case 1
(Automatic selection with “with cable” circuit)　1/2

PoC Bias-T filter design for ADAS cameras (With cable)
- Current　: 300 mA
- Ambient temperature : 105°C
- Cable length : 5 m
- Criteria : Reference criteria

Perform automatic selection



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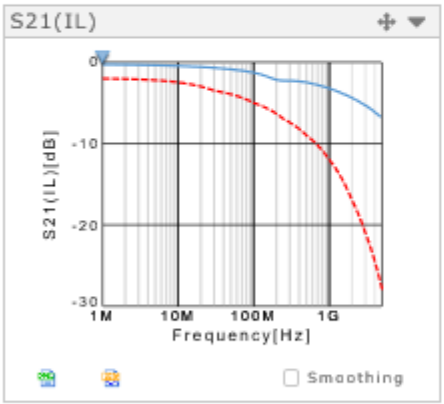
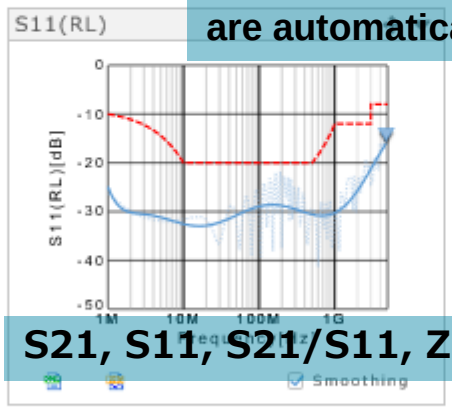
Use Case 1

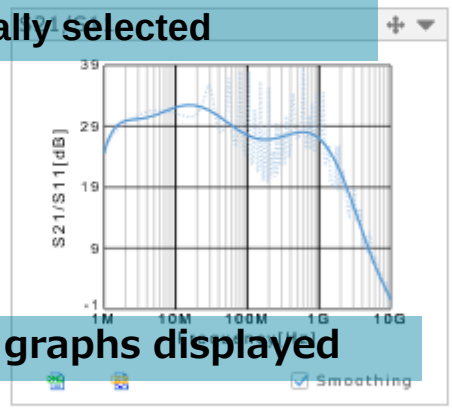
(Automatic selection with “with cable” circuit)　2/2

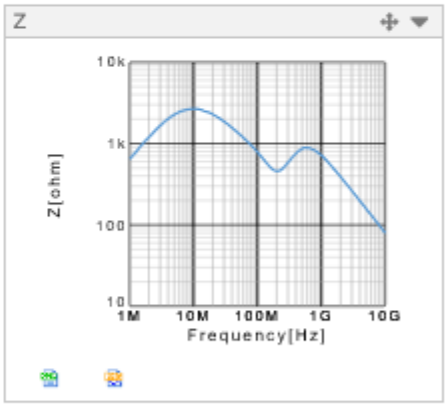
L			Optimization Setup	R			C		
Element		P/N	Status	Element	Resistance		Element	Capacitance	
L1	Select	LQW18CNR47J0Z	Optim.	R1	1.5	[kohm]	C1	0.1	[uF]
L2	Select	LQW32FT470M0H	Optim.	R2	1.5	[kohm]	C2	0.1	[uF]
L3	Select	LQH3NPZ680MME	Optim.	R3	1.5	[kohm]	C3	0.01	[uF]
L4	Select		None	R4	1.5	[kohm]	-		
L5	Select		None	R5	1.5	[kohm]	-		
FB1	Select	BLM18KG102SH1	Optim.				-		

(5) Results are displayed
In this case
L1 : LQW18CNR47J0Z
L2 : LQW32FT470M0H
L3 : LQH3NPZ680MME
FB : BLM18KG102SH1
are automatically selected









S21, S11, S21/S11, Z graphs displayed

Result

		Minimum Margin				Rdc		P/N
		S21[dB]	S11[dB]	S21/S11[dB]	Z[ohm]	Max.[ohm]	Typ.[ohm]	
Sim.1	PASS	1.73	7.51	-	-	2.93	2.47	Selected Items

Chip Size

Sim.1

Total [mm2] 19.56
T Max.[mm] 2.50

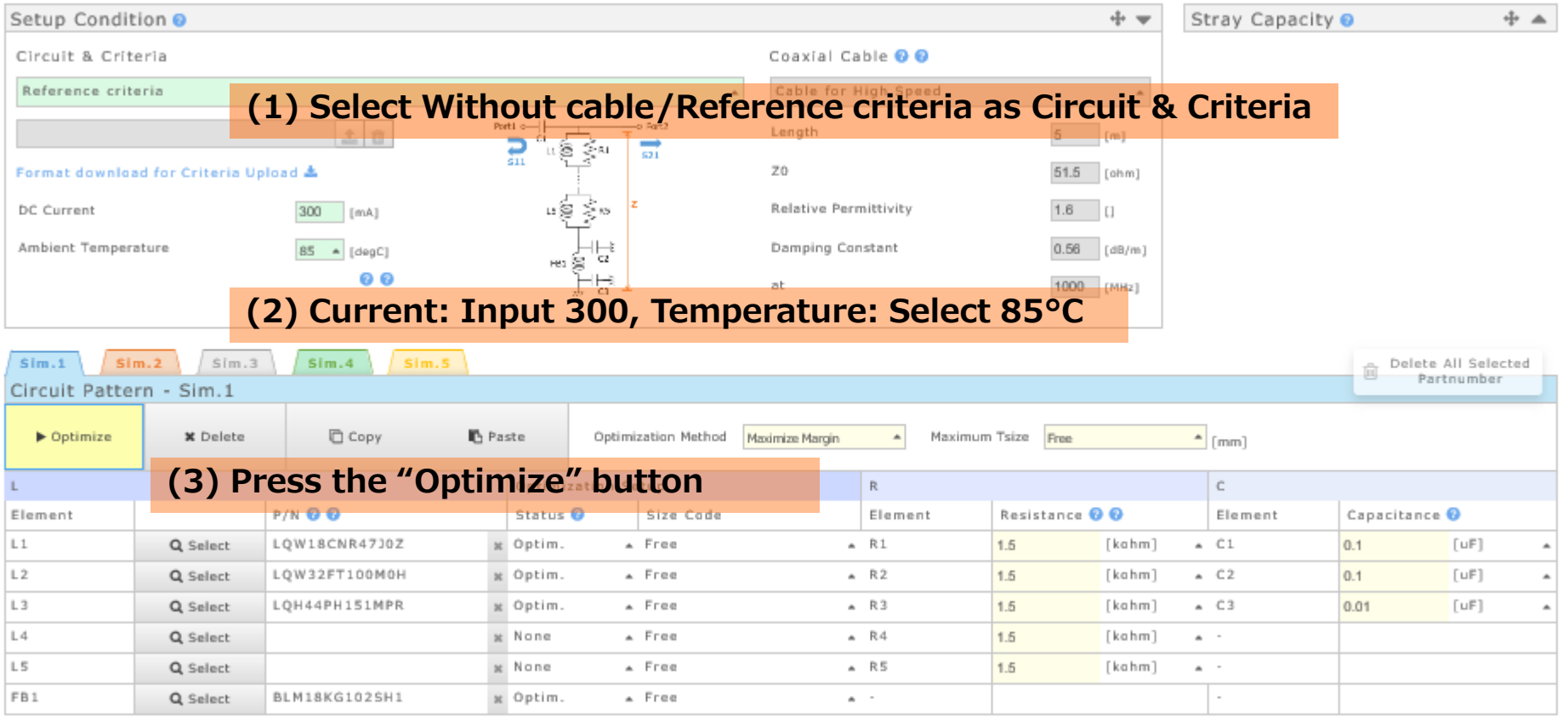
Pass or Fail against selected criteria, minimum margin value, total DCR, and total area are displayed

Use Case 2

(Automatic selection with “without cable” circuit) 1/2

PoC Bias-T filter design for ADAS cameras (Without cable)
- Current : 300 mA
- Ambient temperature : 85°C
- Criteria : Reference criteria

Perform automatic selection



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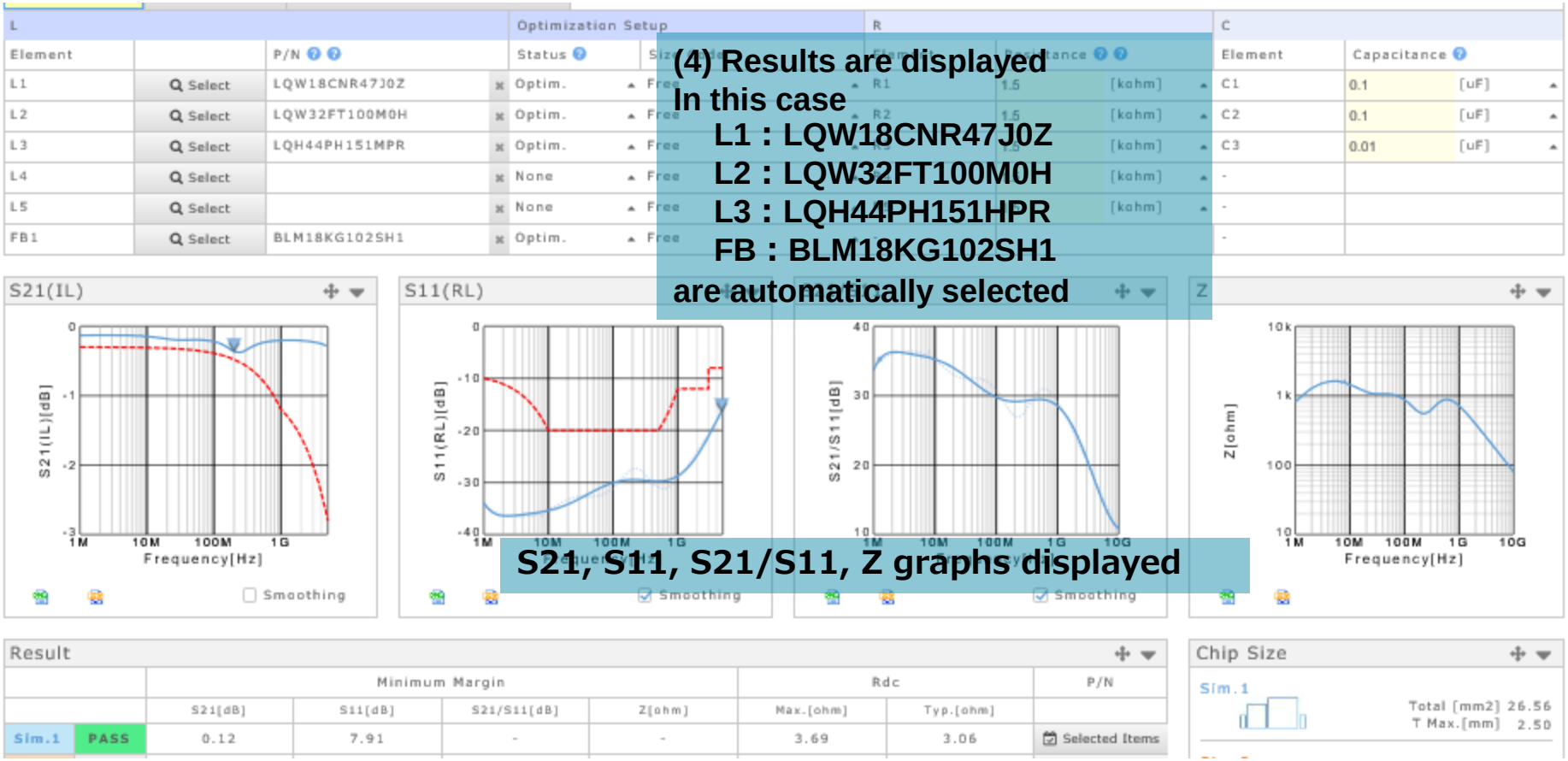
Use Case 2

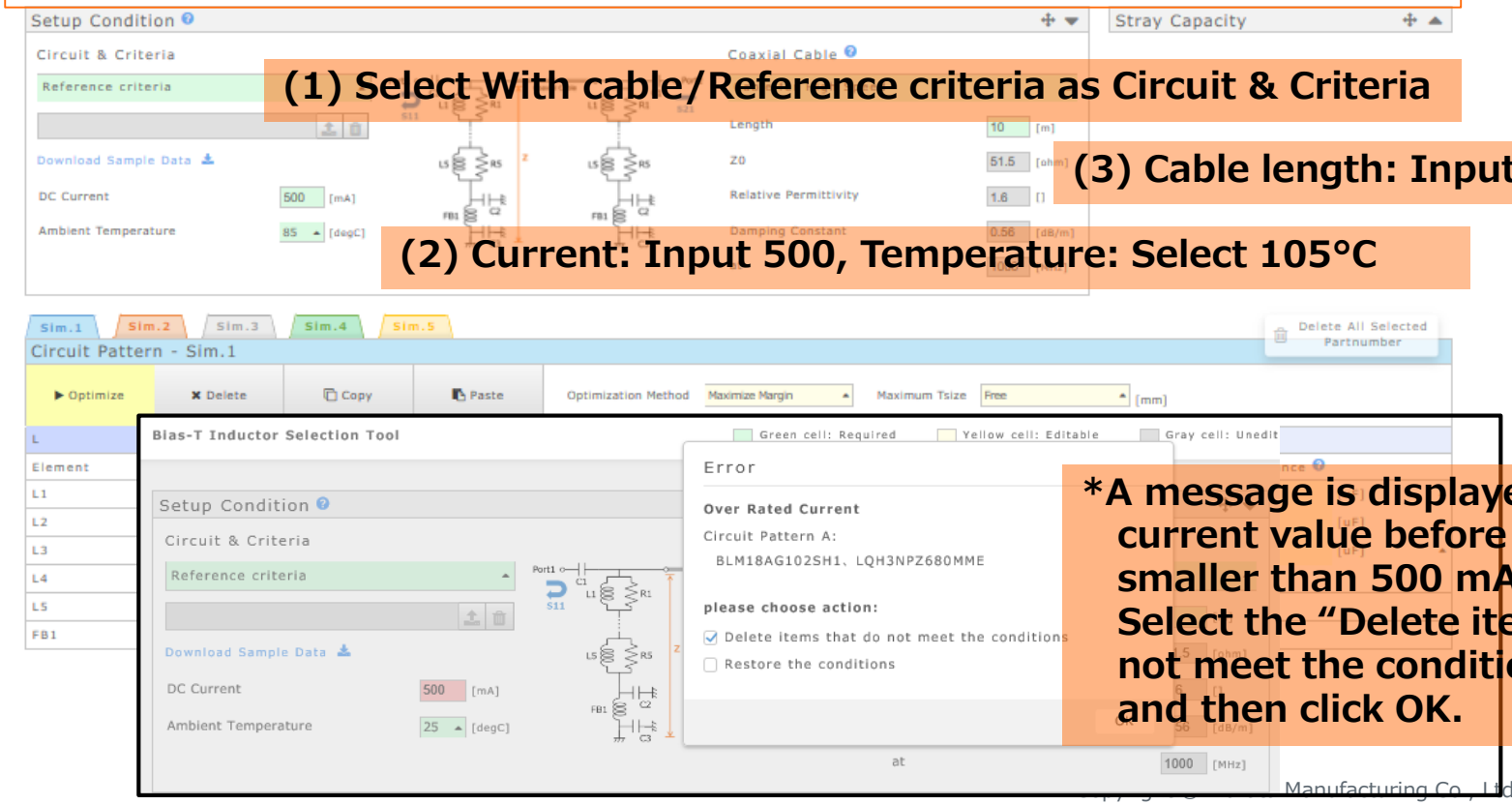
(Automatic selection with “without cable” circuit) 2/2



Use Case 3
(Change optimization method and Compare) 1/2

PoC Bias-T filter design for ADAS cameras (with cable)
- Current :500 mA
- Ambient temperature : 105°C
- Cable length : 10 m
- Criteria : Reference criteria

Compare the results when “maximum margin” and “minimum size” are selected as the "Optimization method “



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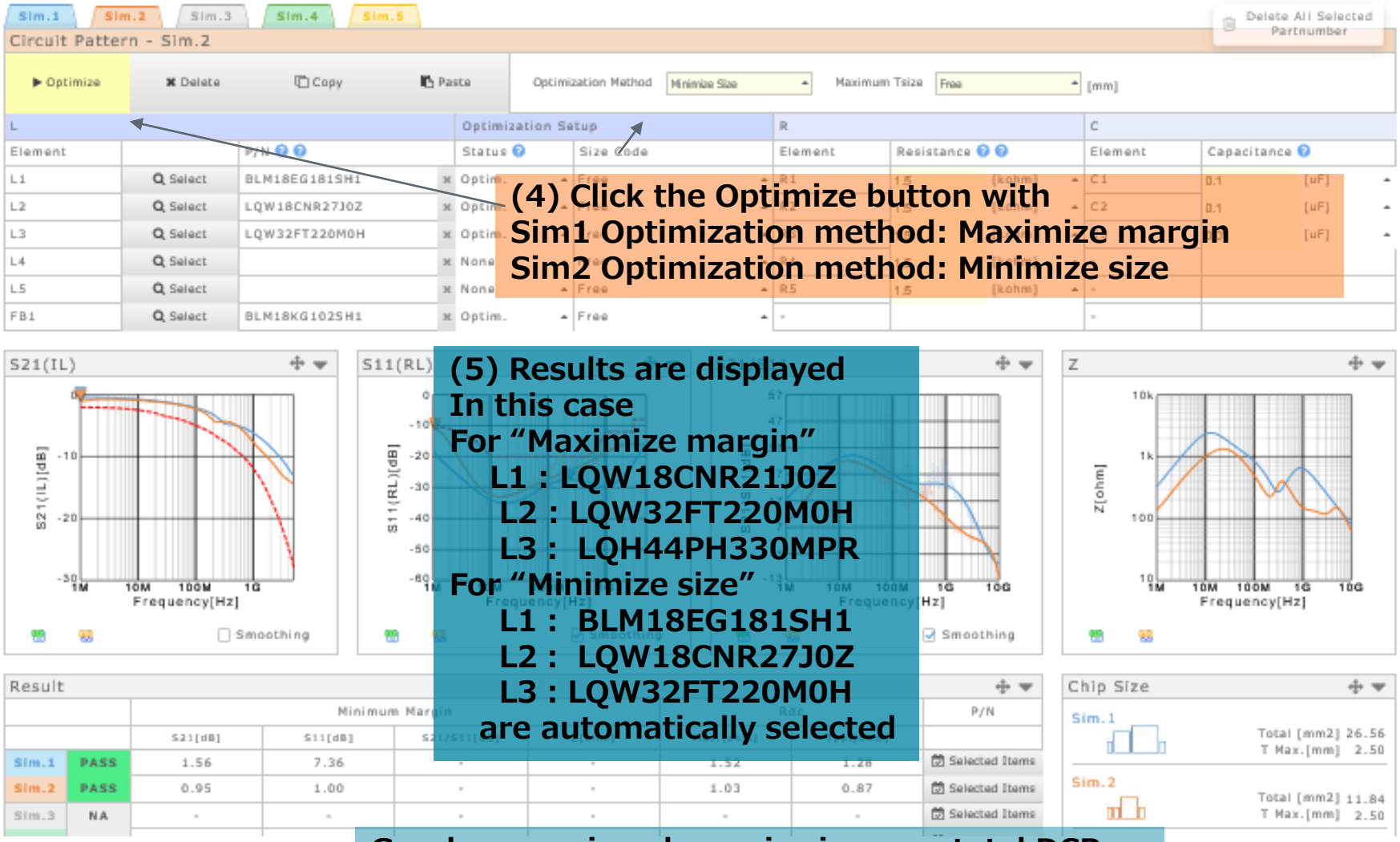
Use Case 3
(Change optimization method and Compare) 2/2



Graphs, margin values, size images, total DCR values, and total size values can be compared

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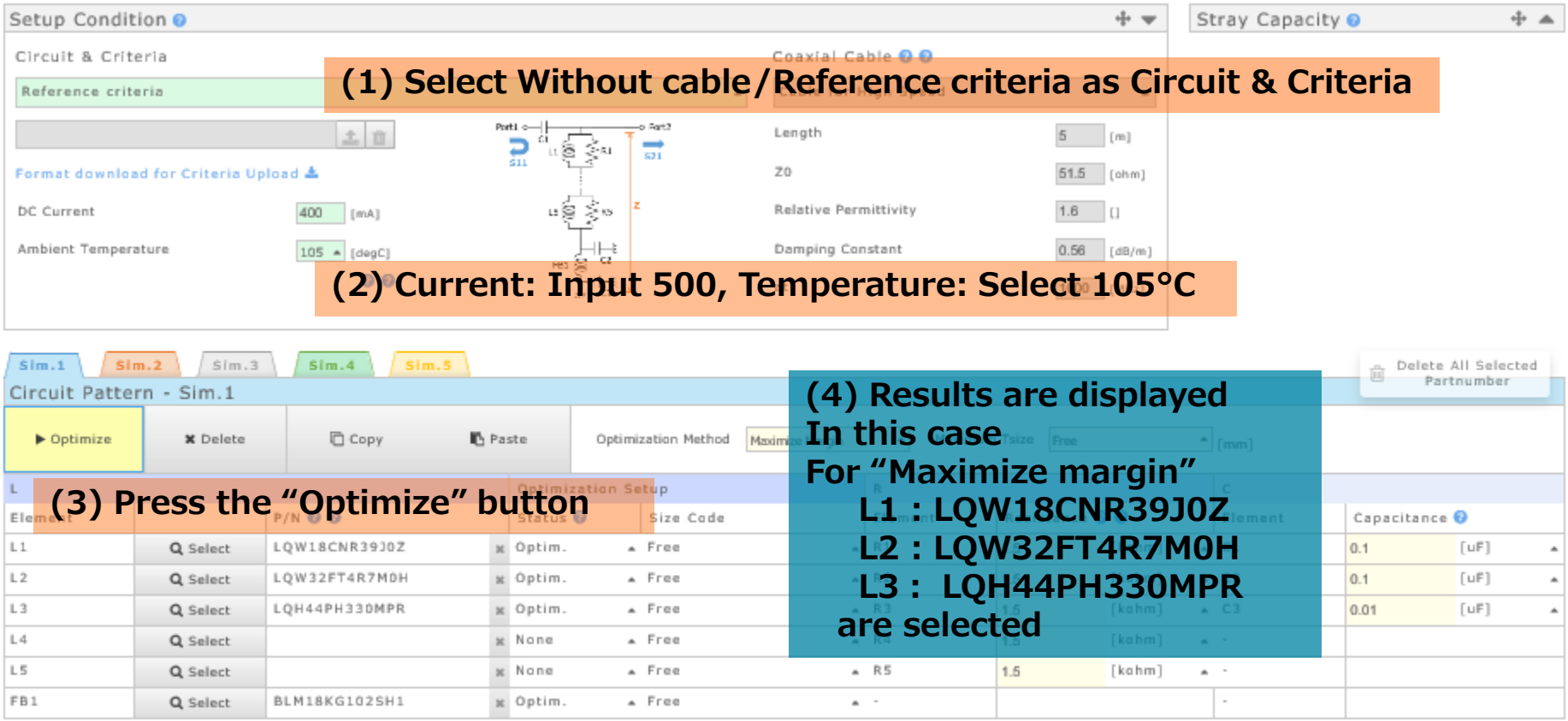
Use Case 4
(Reselect L from inductor list)　1/3

PoC Bias-T filter design for ADAS cameras (without cable)
- Current　: 400mA
- Ambient temperature :105℃
- Criteria : Reference Criteria

Reselect the L1 element after automatic selection and compare.



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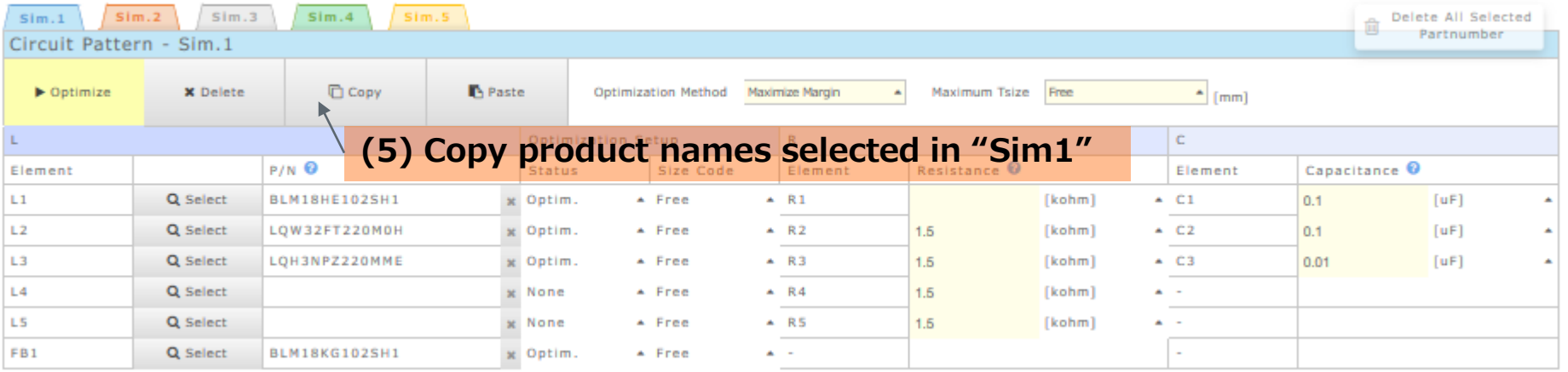
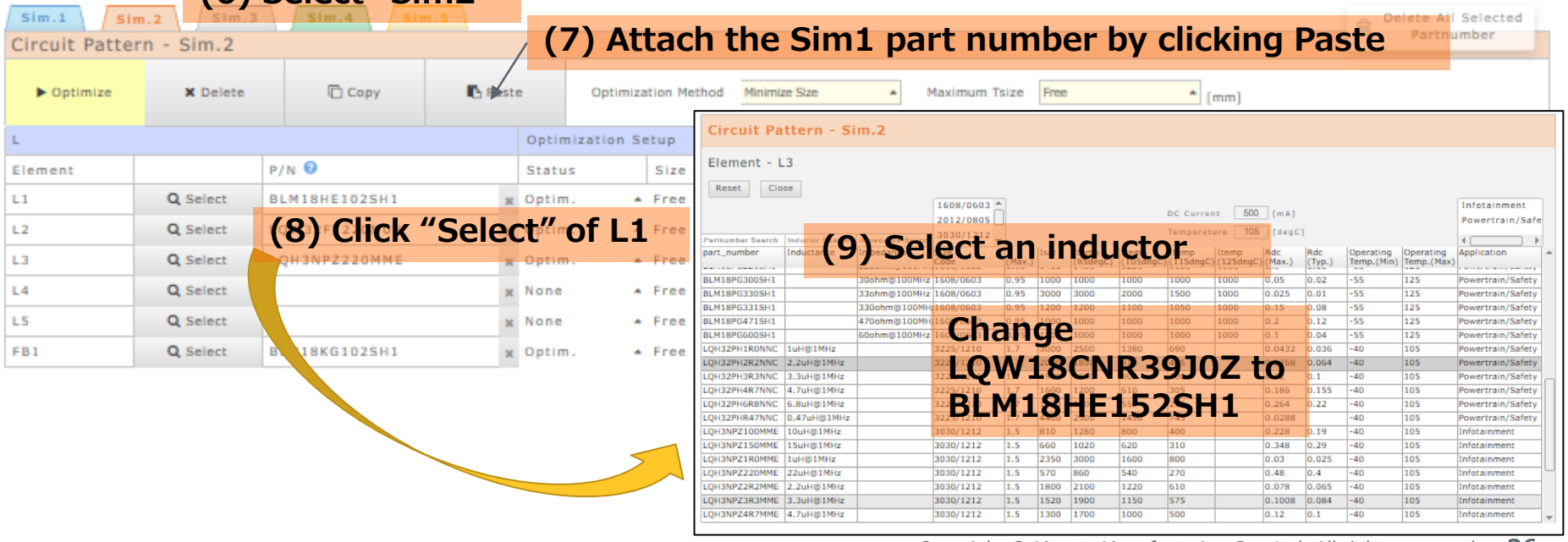
Use Case 4
(Reselect L from inductor list)　2/3



(6) Select “Sim2”

(7) Attach the Sim1 part number by clicking Paste



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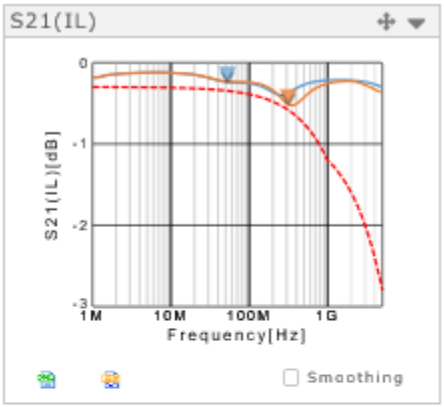
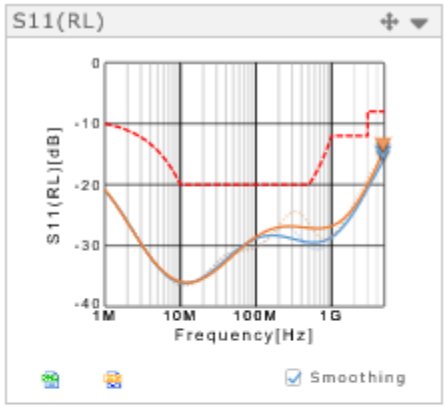
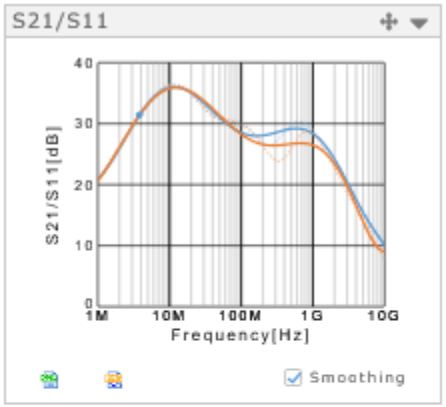
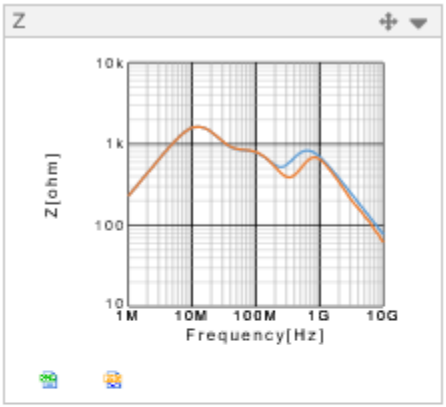
Use Case 4
(Reselect L from inductor list)　3/3









Result

		Minimum Margin				Rdc		P/N
		S21[dB]	S11[dB]	S21/S11[dB]	Z[ohm]	Max.[ohm]	Typ.[ohm]	
Sim.1	PASS	0.11	7.75	-	-	1.31	1.09	Selected Items
Sim.2	PASS	0.07	6.31	-	-	1.53	1.26	Selected Items
Sim.3	NA	-	-	-	-	-	-	Selected Items
Sim.4	NA	-	-	-	-	-	-	Selected Items
Sim.5	NA	-	-	-	-	-	-	Selected Items

Chip Size

Sim.1	Total [mm2]	26.56
	T Max.[mm]	2.50
Sim.2	Total [mm2]	26.56
	T Max.[mm]	2.50
Sim.3	Total [mm2]	-
	T Max.[mm]	-

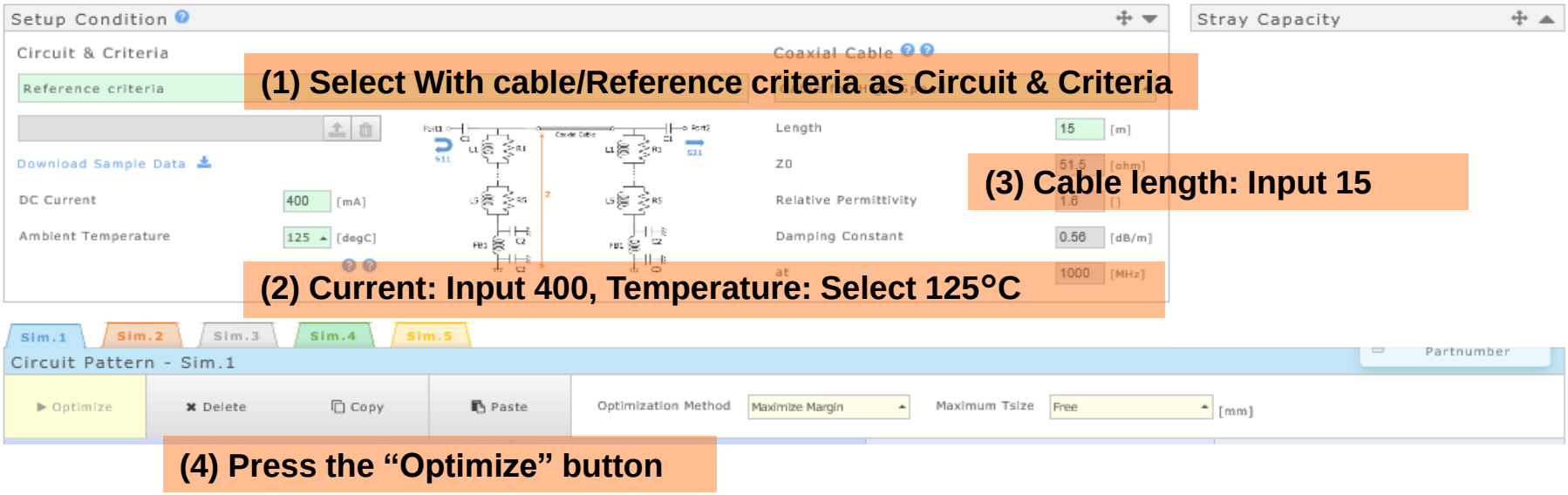
(10) Results are displayed
Comparison of results when
LQW18CNR39J0Z or BLM18HE152SH1
is used for L1

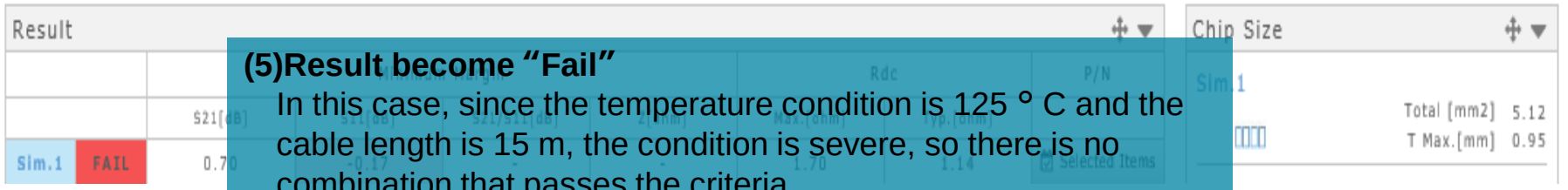
Use Case 5

(Relax the set up condition after the result become “Fail”) 1/3

PoC Bias-T filter design for ADAS cameras (With cable)
- Current : 400 mA
- Ambient temperature : 125°C
- Cable length : 15 m
- Criteria : Reference criteria

Relax the set up condition after the result become “Fail”

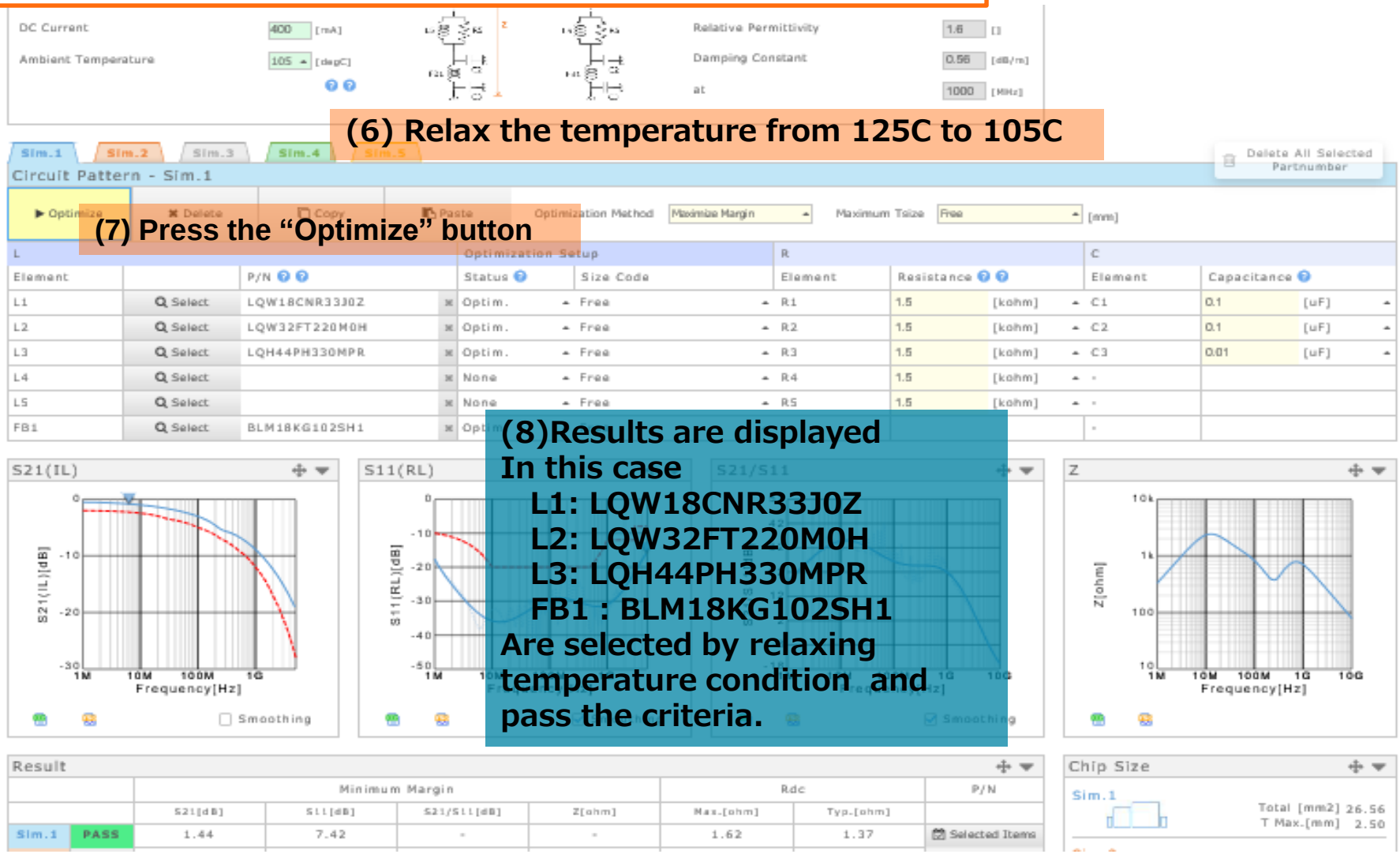




Use Case 5

(Relax the set up condition after the result become “Fail”) 2/3

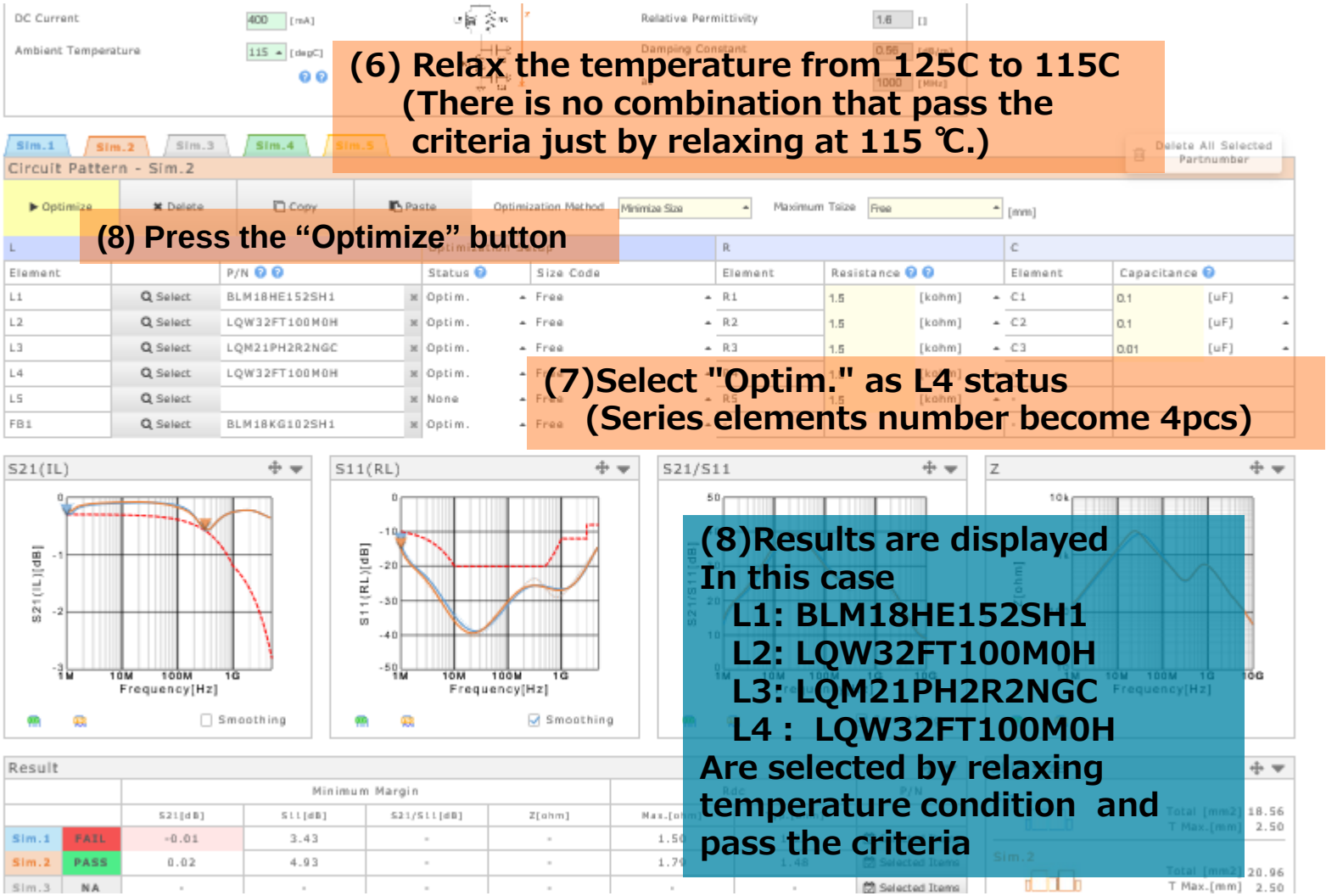
i , Relax the temperature condition (125℃->105℃)



Use Case 5

(Relax the set up condition after the result become “Fail”) 3/3

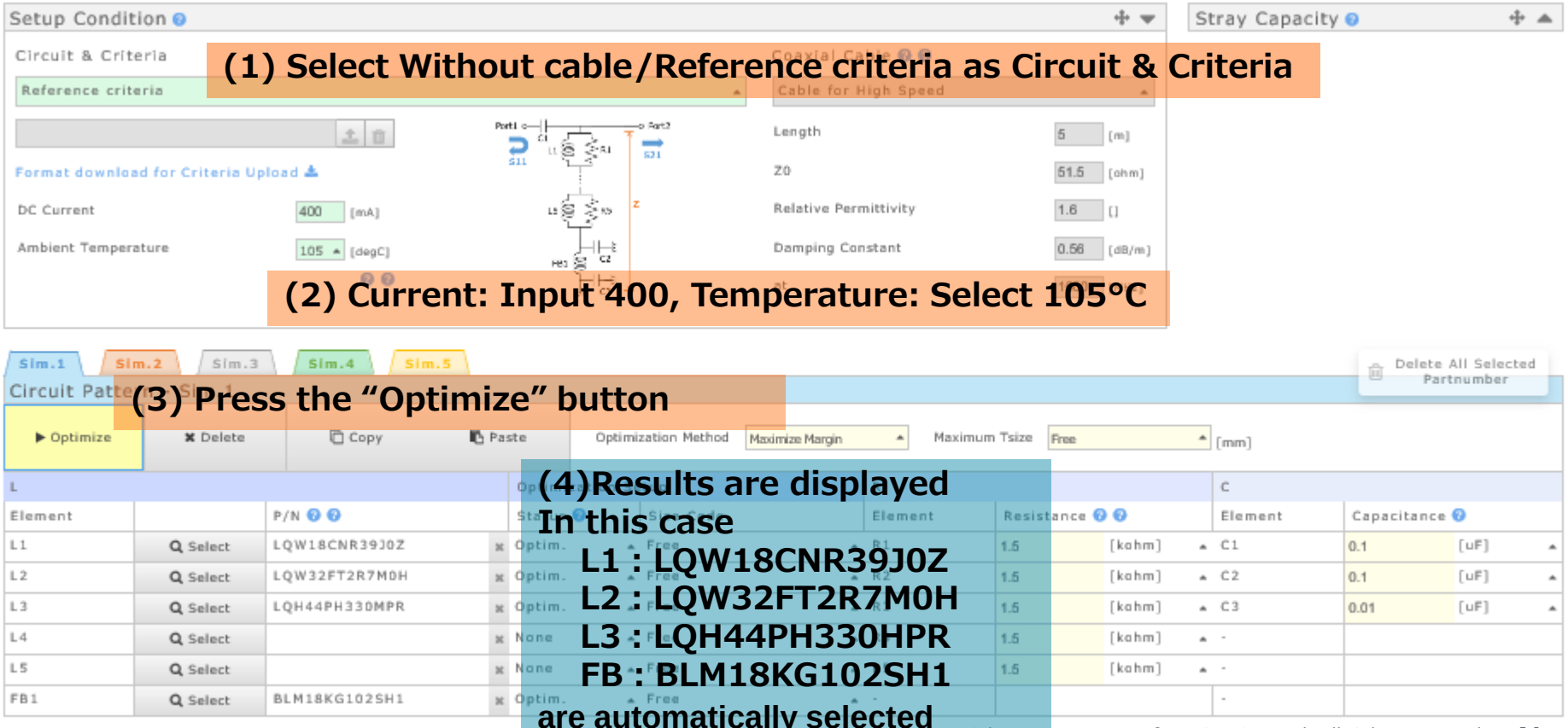
ii , Relax the temperature condition (125℃->105℃)+add element in series



Use Case 6 (Reduce parallel R) 1/2

PoC Bias-T filter design for ADAS cameras (Without cable)
- Current : 400 mA
- Ambient temperature : 105°C
- Criteria : Reference criteria

Reduce parallel R



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Use Case 6 (Reduce parallel R) 2/2

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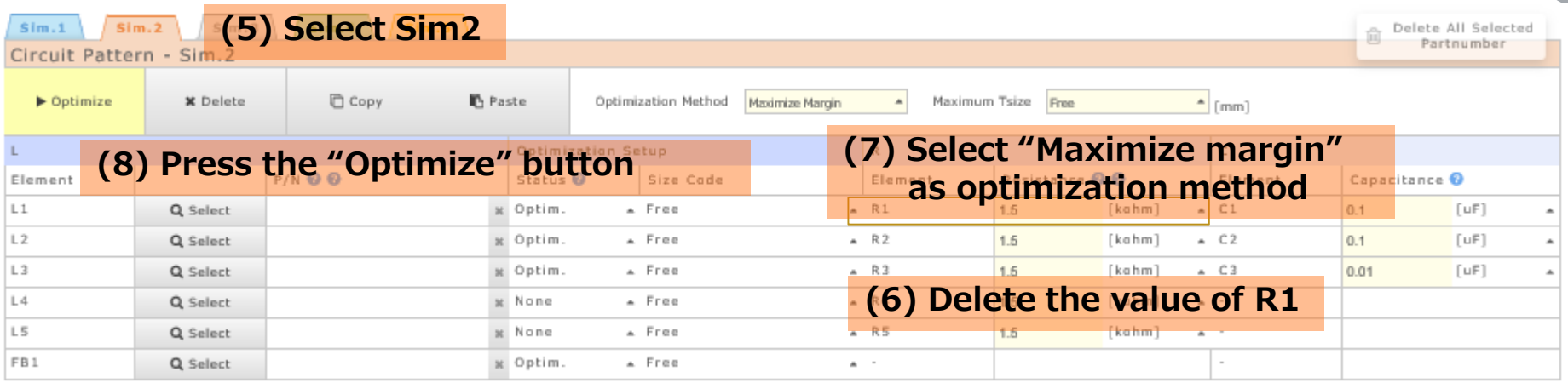

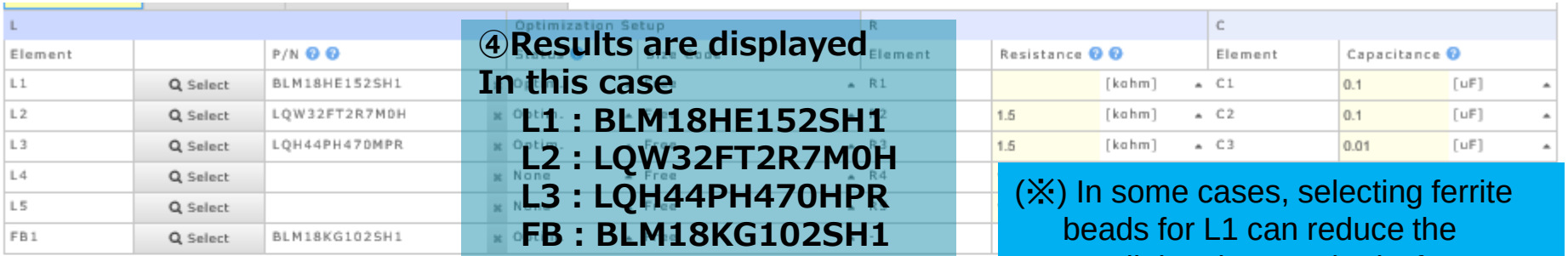

④Results are displayed
In this case
L1 : BLM18HE152SH1
L2 : LQW32FT2R7M0H
L3 : LQH44PH470HPR
FB : BLM18KG102SH1
Are selected by removing the R1

(※) In some cases, selecting ferrite beads for L1 can reduce the parallel resistance (R1) of L1.

End