

(C-014-D) DC-DC LLC Full-Bridge Converter (Discrete)

Simulation Parameters (Dialog)

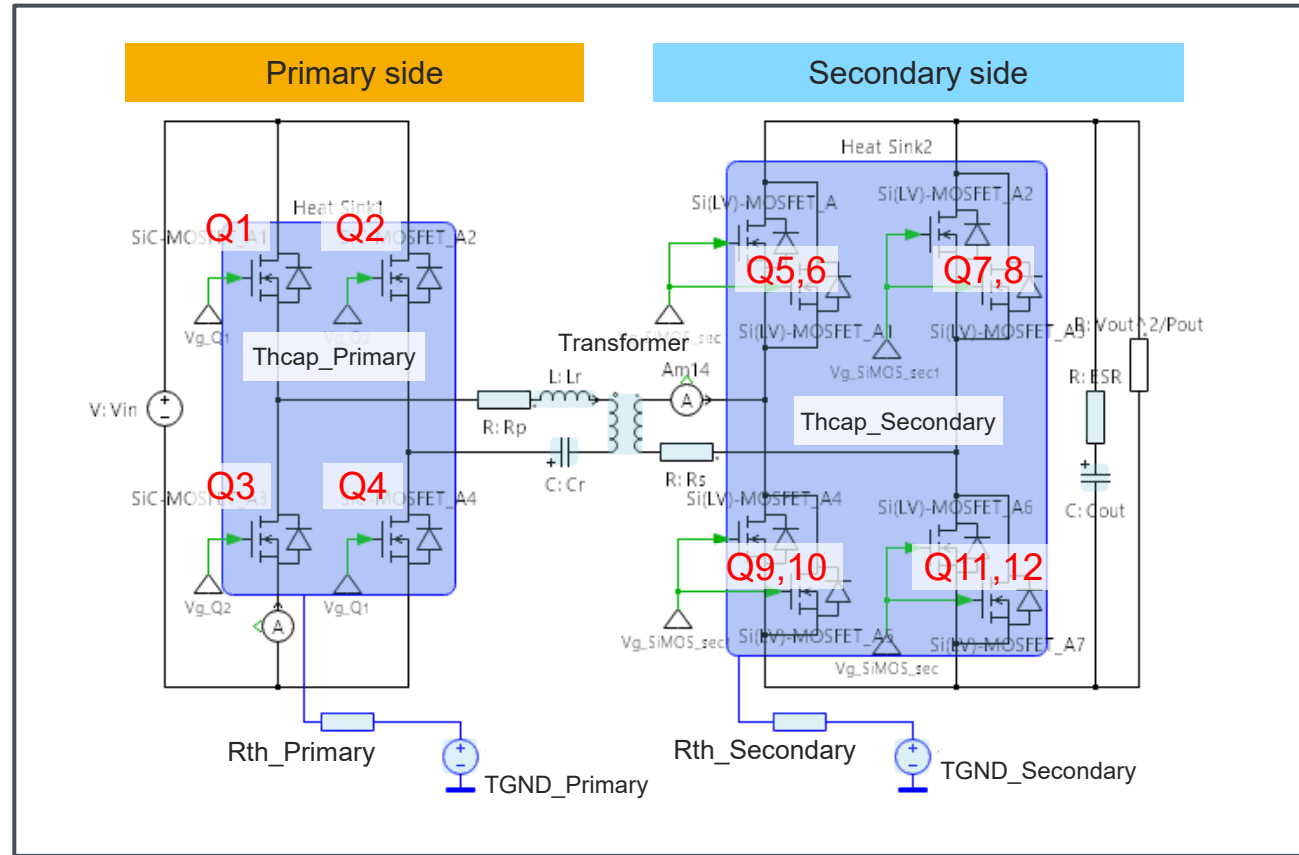
Name	Content	unit	Default Value	Variable Range
Transformer	Np: Primary-turns	turns	18	1 ~ 1000
	Ns: Secondary-turns	turns	1	1 ~ 1000
	Lm: Magnetizing Inductance	H	60u	1n~1
Rp	Transformer Resistance	Ω	5m	1m ~ 1
Rs	Transformer Resistance	Ω	1m	1m ~ 1
Lr	Resonant Inductance	H	12u	1n ~ 1
Cr	Resonant Capacitance	F	100n	1n ~ 1
Cout	Output Capacitance	F	4.7m	1n ~ 1
	Initial Voltage	V	50	0 ~ 80
ESR	ESR of Cout	Ω	15m	1m ~ 1
Primary	Thcap_Primary	Thermal Capacitance	J/K	0.1 ~ 100
	Rth_Primary	Thermal Resistance	K/W	0.1 ~ 100
	TGND_Primary	Ambient Temperature	°C	-40 ~ 175
Secondary	Thcap_Secondary	Thermal Capacitance	J/K	0.1 ~ 100
	Rth_Secondary	Thermal Resistance	K/W	0.1 ~ 100
	TGND_Secondary	Ambient Temperature	°C	-40 ~ 175

Simulation Parameters (Table)

Name	Content	unit	Default Value	Variable Range	
Test_time	Test time in simulation	s	0.2	10u ~ 0.5	
Vin_dc	Input Voltage	V	800	400 ~ 1,200	
Vout_dc	Output Voltage	V	50	10 ~ 80	
Pout	Output Power	W	10k	100~30k	
fs_ref	Target Carrier Frequency	Hz	100k	10k~500k	
Primary	Rg_on 1*	Gate Resistance (Source)	Ω	15	0.1 ~ 100
	Rg_off 1*	Gate Resistance (Sink)	Ω	2.2	0.1 ~ 100
	DT1	Dead Time	s	100n	0 ~ 1m
Secondary	Rg_on 2*	Gate Resistance (Source)	Ω	10	0.1 ~ 100
	Rg_off 2*	Gate Resistance (Sink)	Ω	10	0.1 ~ 100
	DT2	Dead Time	s	100n	0 ~ 1m
T_init**	Initial Junction Temp.	°C	25	-40 ~ 175	

*Common for all MOSFETs in the same side. **Common for all devices

Simulation Circuit



Power Devices

Name	Device Type	Part No.	Specification
Q1~4	SiC MOSFET	SCT4018KR	1200V/ 81A/ 18mΩ/ TO-247-4L
Q5~12	Si MOSFET	RS7N200BH	80V/ 200A/ 1.7mΩ/ DFN5060-8S

Schematic window

- Dialog parameters setting
- Results display

The screenshot displays the PLECS simulation environment. On the left, a schematic diagram of a power converter is shown with various MOSFETs and components. A text box above the schematic states: "Clicking blue-colored symbols will allow you to change the parameters." Below the schematic, there are two tables for MOSFET parameters and loss calculations.

MOSFET secondary

T _{junction} (mossfet_sec) [°C]	52.38
T _{junction} (mossfet_sec) [°C]	59.25
Conduction Loss (mossfet_sec) [W]	29.47
Switching Loss (mossfet_sec) [W]	183.72
Other Loss (Others) [W]	54.45
Total Loss (mossfet_sec) [W]	367.86

MOSFET primary

T _{junction} (mossfet_pri) [°C]	35.62
T _{junction} (mossfet_pri) [°C]	39.25
Conduction Loss (mossfet_pri) [W]	6.66
Switching Loss (mossfet_pri) [W]	0.28
Other Loss (Others) [W]	51.66
Total Loss (mossfet_pri) [W]	58.56

Below the schematic is the "Simulation Control" panel with buttons for "Startup", "Steady-state", "Hold Result", and "Simulation Completed".

The "Traces" section shows a list of traces, including "[file:SCT4018KR], RS7N200BH (80V/1.7mΩ/DFN5060-8S), Trace 1".

On the right, a "Waveforms" window displays several plots over time (5.000 to 5.008 x 1e-2 s):

- Vin [V]: A constant red line at 800V.
- in [A]: A blue waveform showing the input current.
- Vout [V]: A red waveform showing the output voltage.
- Iout [A]: A blue waveform showing the output current.
- Junction Temp. [deg.C]: A magenta waveform showing the MOSFET junction temperature.
- Heatsink Temp. [deg.C]: A green waveform showing the heatsink temperature.

At the bottom, a "Table parameters setting" window is open, showing the following parameters:

Parameter	Value
Test_time	0.2 sec
Vin_dc	800 V
Vout_dc	50 V
Pout	10000 W
Switching Frequency (Design Value)	100000 Hz

Waveforms

Simulation control

Trace selection

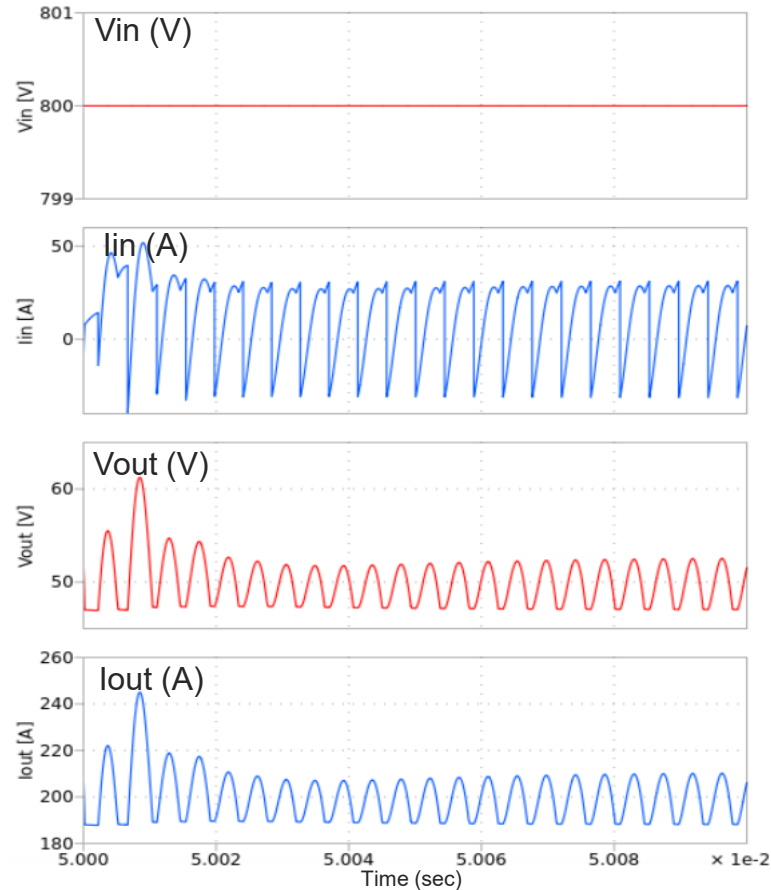
Table parameters setting

Simulation Results

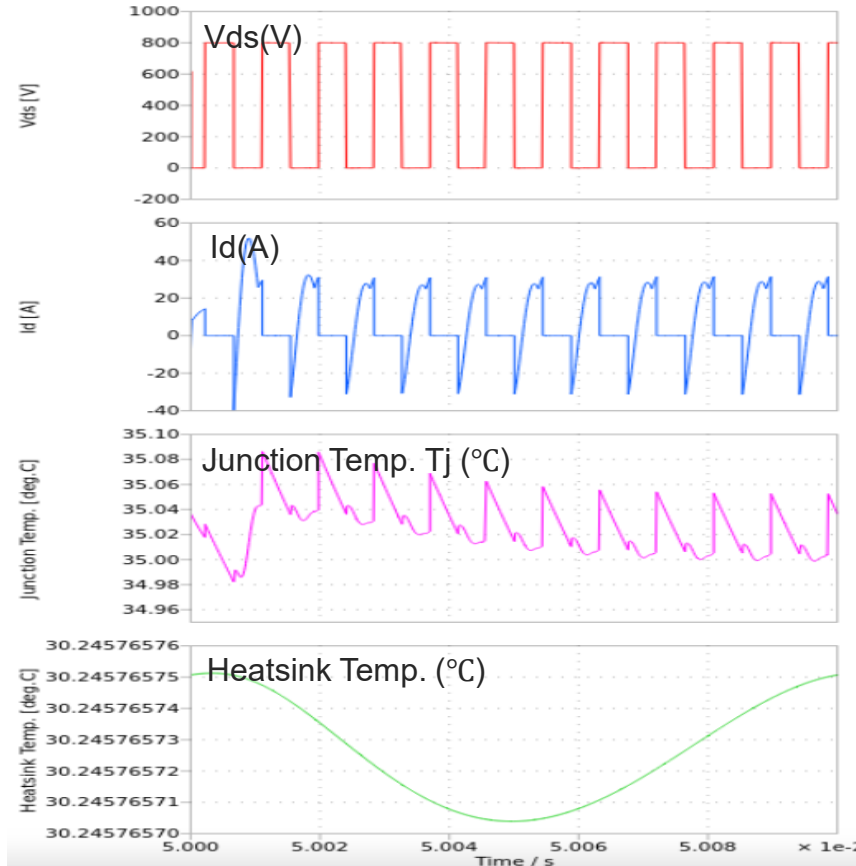
Simulation Mode: Steady State

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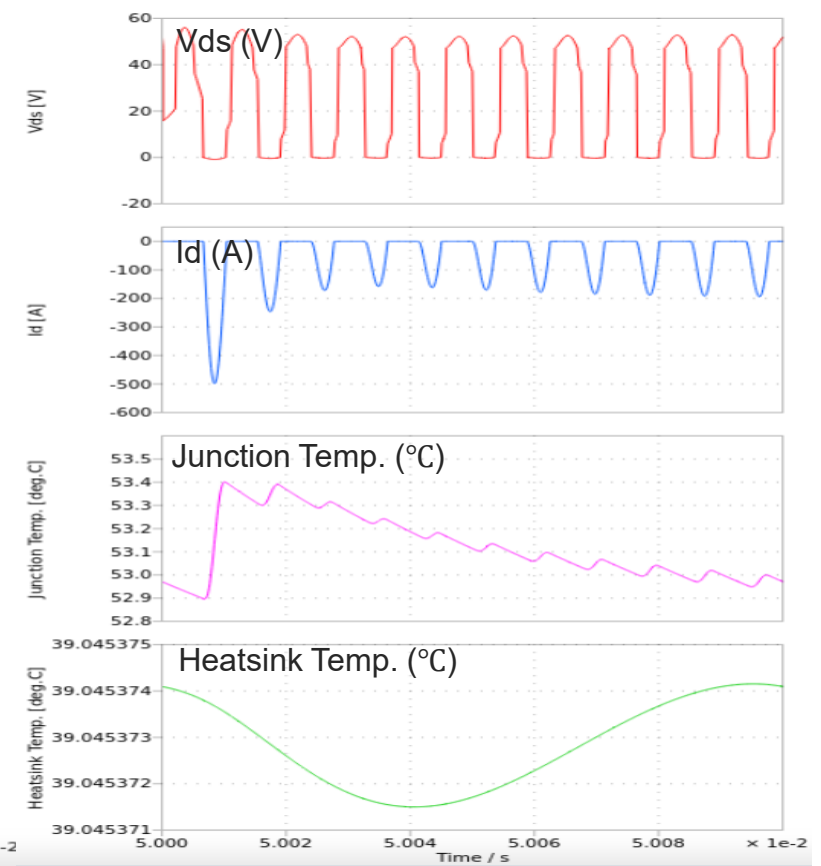
Input and Output



Primary side



Secondary side



Contents	Results
Input Power : Pin	10.195 (kW)
Output Power: Pout	9.920 (kW)
Efficiency: η	97.30 (%)

Contents	Results
Conduction Loss: Pcond (primary)	6.66 (W/device)
Switching Loss: Psw (primary)	6.26 (W/device)
Junction Temp. : Tj (primary)	35.02 (°C)
Heatsink Temp.: T_hs (primary)	30.25 (°C)
Total Loss: Ptot (primary)	51.65 (W)

Contents	Results
Conduction Loss: Pcond (secondary)	20.47 (W/device)
Junction Temp. : Tj (secondary)	52.98 (°C)
Heatsink Temp.: T_hs (secondary)	39.05 (°C)
Total Loss: Ptot (secondary)	163.76 (W)

How to change the devices

The figure of "(A-011-D) DC-AC Totem-Pole PFC Diode Rectification (Discrete)" is used as an example in this page.

You can select the simulation devices at "Step-2: Device Selection"

Step 2: Device Selection

Please check the checkboxes of the devices you want to simulate (Square checkboxes allow you to select up to three devices simultaneously.)

You can also select IDEAL devices (no-loss).

In addition, clicking PDF icon will allow you to view the datasheet of the certain device.

SIC-MOSFET Block

Selected: 1/3 SCS320AG

Select	Part Number	VDS [V]	Drain Current [A]	R _{DS(on)} [mΩ] (Typ.)	Package
<input type="checkbox"/>	SCT4090KWA	200	17	90.0	TO-263-7LA
<input type="checkbox"/>	SCT4090KR	200	19	90.0	TO-247-4L
<input type="checkbox"/>	SCT4090KE	200	19	90.0	TO-247N
<input type="checkbox"/>	SCT4065DWA	750	22	65.0	TO-263-7LA
<input checked="" type="checkbox"/>	SCT4065DR	750	25	65.0	TO-247-4L
<input type="checkbox"/>	SCT4065DLL	750	26	65.0	TOLL
<input type="checkbox"/>	SCT4065DE	750	25	65.0	TO-247N
<input type="checkbox"/>	SCT4065DK	200	24	62.0	TO-263-7LA

SIC-SBD Block

Selected: SCS320AG

Select	Part Number	Reverse Voltage [V]	Continuous Forward Current [A]	Package
<input type="radio"/>	SCS320KN	1000	20.0	TO-263-2L
<input type="radio"/>	SCS320KG	1000	20.0	TO-220AC
<input type="radio"/>	SCS320AM	600	20.0	TO-220FM
<input type="radio"/>	SCS320AJ	600	20.0	LPTL
<input checked="" type="radio"/>	SCS320AG	600	20.0	TO-220ACGE
<input type="radio"/>	SCS315KN	1000	15.0	TO-263-2L

Selected Products

- SIC-MOSFET SCT4065DR
- SIC-SBD SCS320AG

Selected device names are shown here.

SCT4065DR
N-channel SiC power MOSFET

V _{DSS}	750V
R _{DS(on)} (Typ.)	65mΩ
I _D ⁻¹	25A
P _D	88W

- Low on-resistance
- Fast switching speed
- Fast reverse recovery
- Easy to parallel
- Simple to drive
- Pb-free lead plating ; RoHS compliant

Inner circuit

Please note Driver Source and Power Source are not exchangeable. Their exchange might lead to malfunction.

How to change Dialog parameters

The figure of "(A-011-D) DC-AC Totem-Pole PFC Diode Rectification (Discrete)" is used as an example in this page.

ROHM PLECS Simulator
Simulation Example

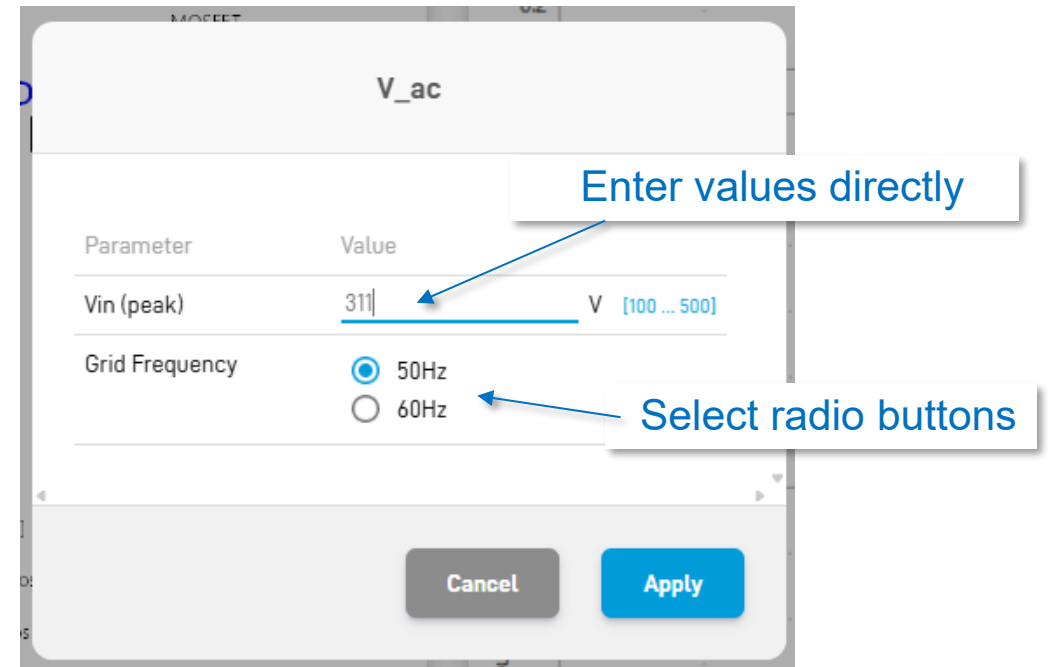


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- Symbols whose parameters can be changed are colored light-blue in the circuit diagram.
- Over your mouse cursor to the symbol that you want to change the parameter and the symbol color is turned to blue (e.g. "V_ac" symbol in the below).
- Click the mouse's left button.



- A new window like the below is opened.
- You can change the parameters by entering the value directly* or selecting radio buttons.
- Push "Apply" button after changing all parameters.



*Note: Parameters can be entered directly are limited by Min. and Max. values to avoid unexpected system errors.
(e.g. "Vin(peak)" is limited between 100 and 500V in the above.)

How to change Table parameters

The figure of "(A-011-D) DC-AC Totem-Pole PFC Diode Rectification (Discrete)" is used as an example in this page.

ROHM PLECS Simulator
Simulation Example



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Table parameters

The diagram illustrates the process of changing table parameters. It shows two screenshots of a parameter table. The top screenshot shows a table with 'Test_time' set to 1 sec and 'Switching Frequency' set to 60000 Hz. A hand cursor is pointing at the '60000' value. A yellow arrow points down to the second screenshot, which shows the same table but with 'Switching Frequency' set to 20000 Hz. The '20000' value is underlined in blue, and a blue range '[10000 ... 100000]' is visible to its right.

Parameter	Value
Test_time	1 sec
Switching Frequency	60000 Hz

Parameter	Value
Test_time	1 sec
Switching Frequency	<u>20000</u> Hz [10000 ... 100000]

Choose the parameter that you want change on the parameter tables (e.g. "60kHz" of Switching Frequency in the left figure.)

- A blue under-line and variable range of the parameter are appeared.
- Then, you can change the parameters by entering the value directly " (e.g. "60kHz" was changed to "20kHz").

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