FUJI WEB SIMULATION TOOL: PLECS BASED POWER ELECTRONIC APPLICATION SIMULATOR

USER MANUAL

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Contents

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How to Start

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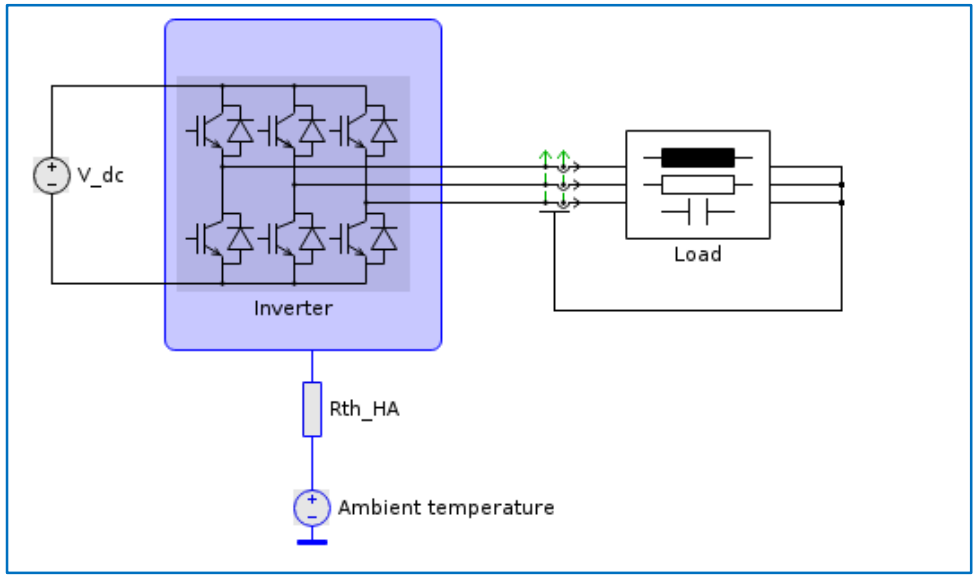
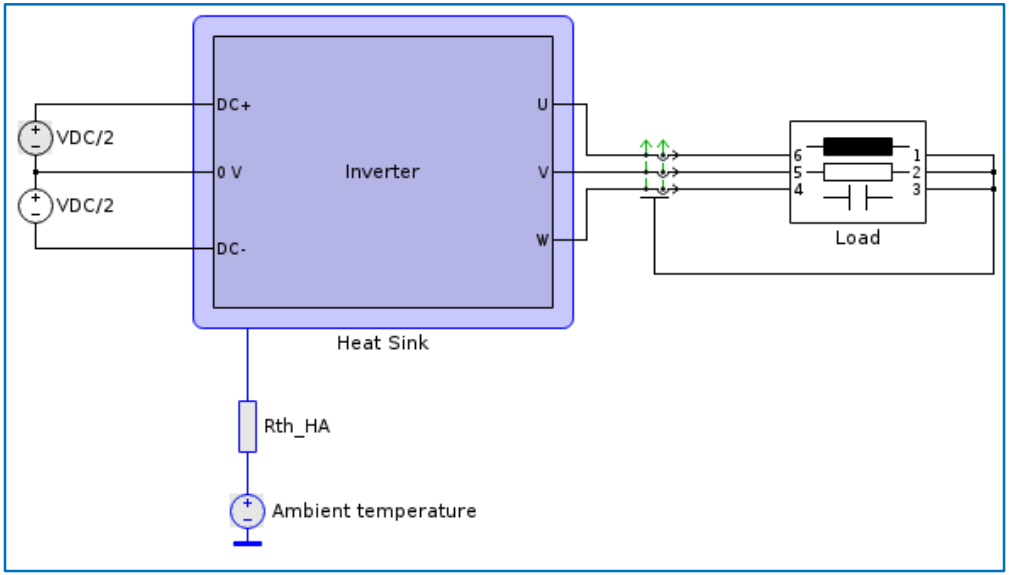
Choose between two different models:

3 Phases 2 Level Inverter



http://simu.fujielectric-europe.com/2_level_inverter.html

3 Level T type Inverter



http://simu.fujielectric-europe.com/3_level_inverter_t_type.html

3 Phases 2 Level Inverter

3 Phases 2 Level Inverter

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Explanation of start page

Variable Parameters for Simulation

Modulation rate:	1	
Modulation strategy:	Sinusoidal	
Inverter output current:	100	A
Inverter output frequency:	50	Hz
Switching frequency:	5000	Hz
Power factor:	0,9	

Module Selection

Module type: Single IGBT

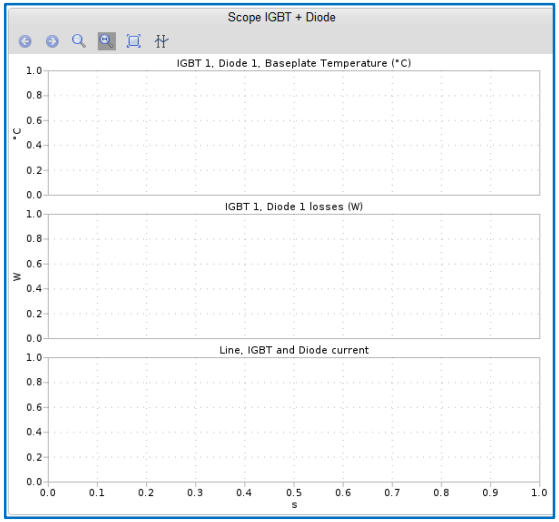
Blocking voltage: 1200 V

Package: High Power Module

IGBT Module:

- ○ 1MBI1200VC-120P V Series, 1200 A
- ○ 1MBI1600VC-120P V Series, 1600 A
- ○ 1MBI2400VC-120P V Series, 2400 A
- ○ 1MBI2400VD-120P V Series, 2400 A
- ○ 1MBI3600VD-120P V Series, 3600 A

Scope



Numerical results from Scope

Temperatures	Max temperature	Min temperature	Avg temperature
IGBT			
Diode			
Case			
Heat sink			

Losses	Cond. losses	Turn-on losses	Turn-off losses	Reverse recovery losses	Total losses
IGBT					
Diode					

Variables Parameters in the Circuit

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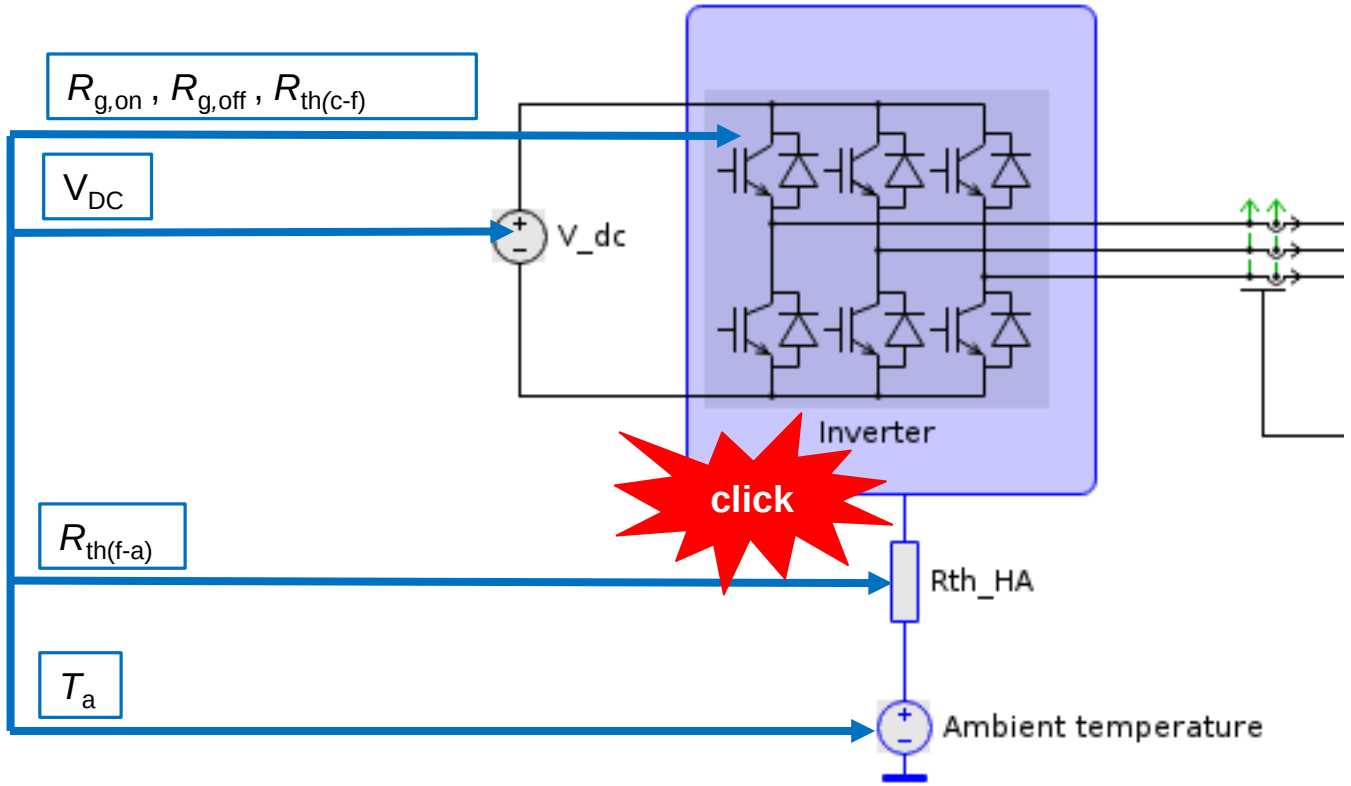
Components highlighted in **grey** contain adjustables parameters

Thermal Settings

- $R_{th(c\text{-}f)}$ case to heat sink
- $R_{th(f\text{-}a)}$ heat sink to ambient
- Ambient temperature T_a

Electrical Settings

- Rg,on and Rg,off
- Vdc



Thermal Conditions: Overview

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Different scenarios in the thermal calculation can be considered:

1) Calculate case temperature

- Input $R_{th(c\text{-}f)}$
- Input $R_{th(f\text{-}a)}$
- Set ambient temperature

Refer to next page how to input the values!

2) Fixed case temperature

- $R_{th(c\text{-}f)} = R_{th(f\text{-}a)} = 0$
- Set ambient temperature

3) Fixed heat sink temperature

- Set $R_{th(f\text{-}a)} = 0$
- Set heat sink temperature = ambient temperature
- Provide Rth_c-h

Thermal Conditions: Settings

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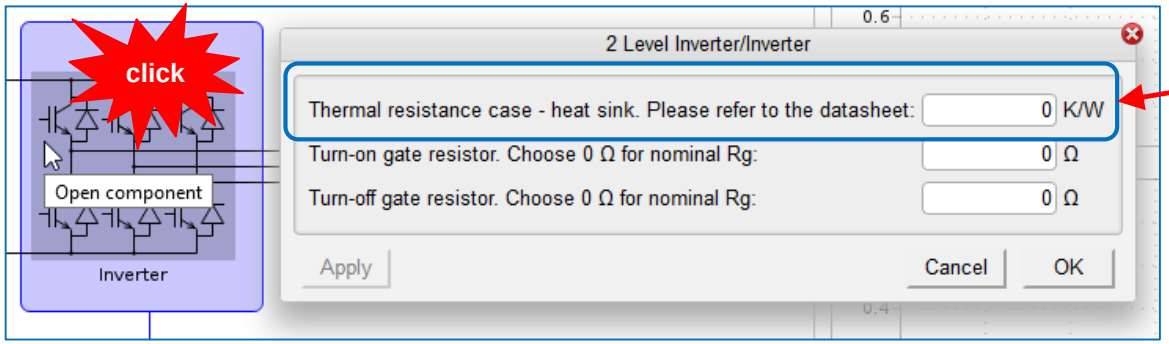
$R_{th(c-f)}$

Click on the grey box in the inverter model.

A drop down menu will open.

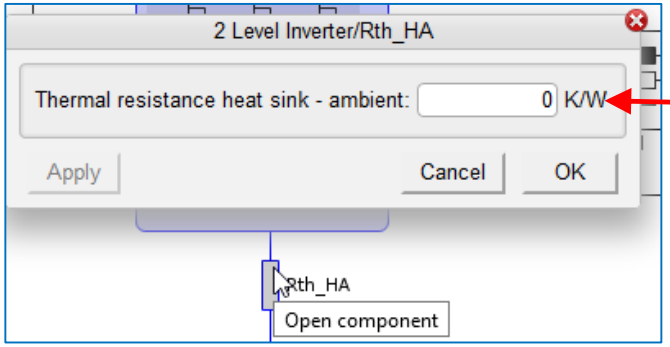


Input $R_{th(c-f)}$ here.

Please check the datasheet for the value.

$R_{th(h-a)}$

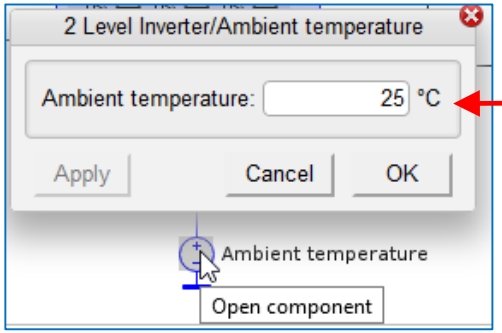
Click on the resistor "Rth_HA"



Input $R_{th(h-a)}$ here.

T_a

Click on the constant temperature symbol "Ambient temperature"



Input ambient temperature.

Electrical Conditions

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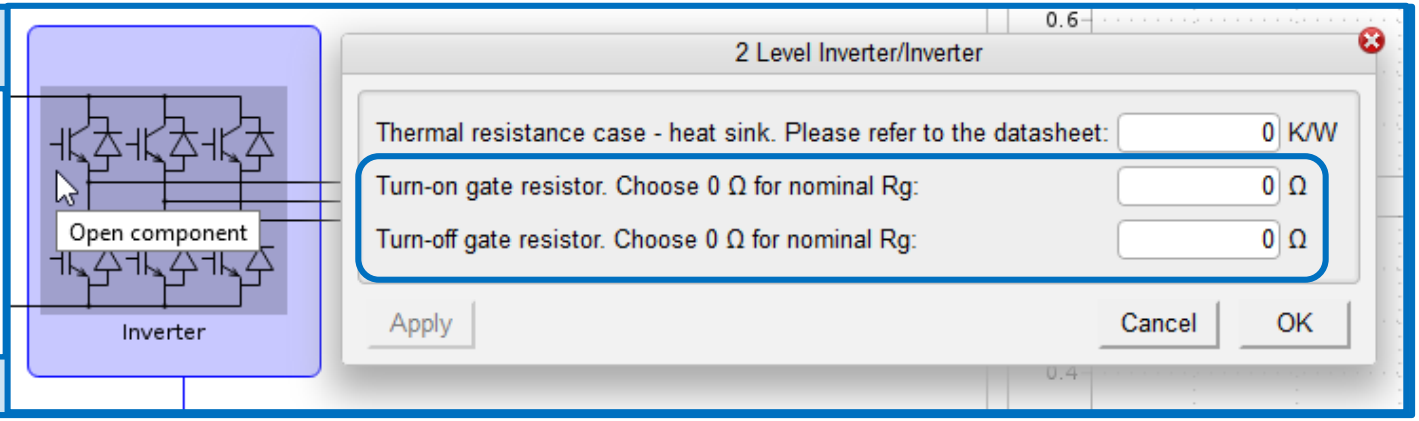
$R_{g,on}$ and $R_{g,off}$

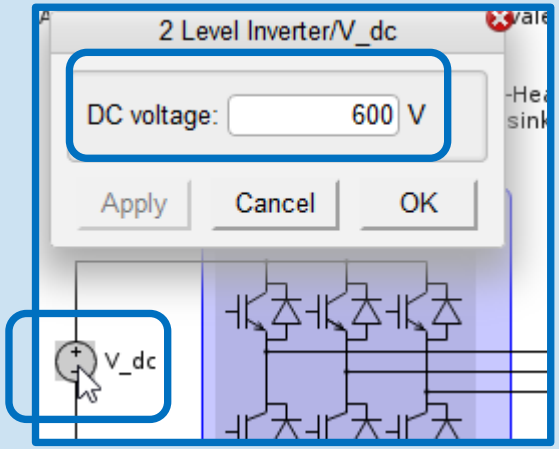
Click on the grey inverter part and the menu will open.

Input $R_{g,on}$ and $R_{g,off}$. Set them to 0 if you want to use the datasheet values.



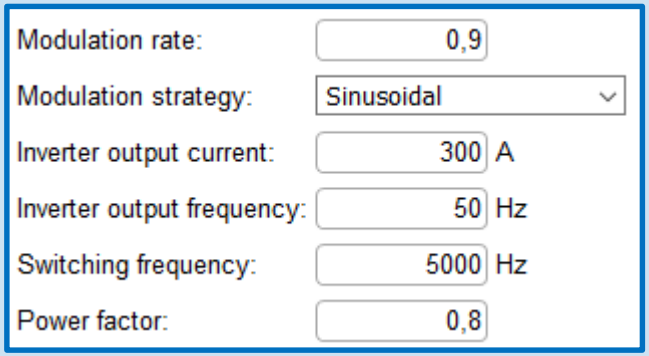
V_{DC}

Drop Down Menu when clicking on the voltage source "V_dc".



m, PWM, I_{out}, f_{out}, f_{sw}, pf

Input the simulation parameters.



3 Level T Type Inverter

Variables Parameters in the Circuit

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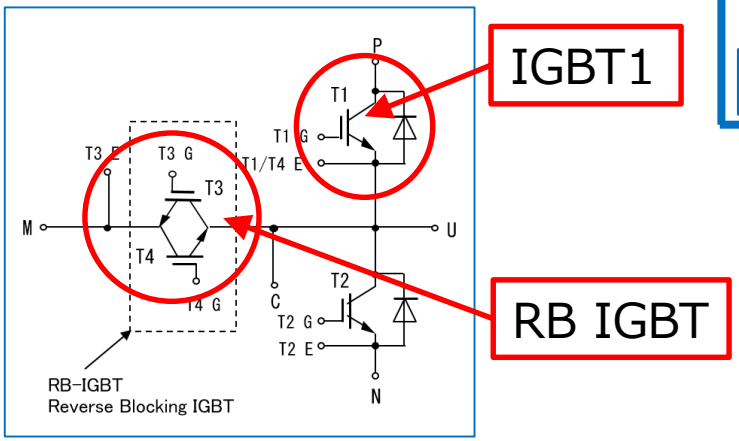
Components highlighted in **grey** contain adjustables parameters

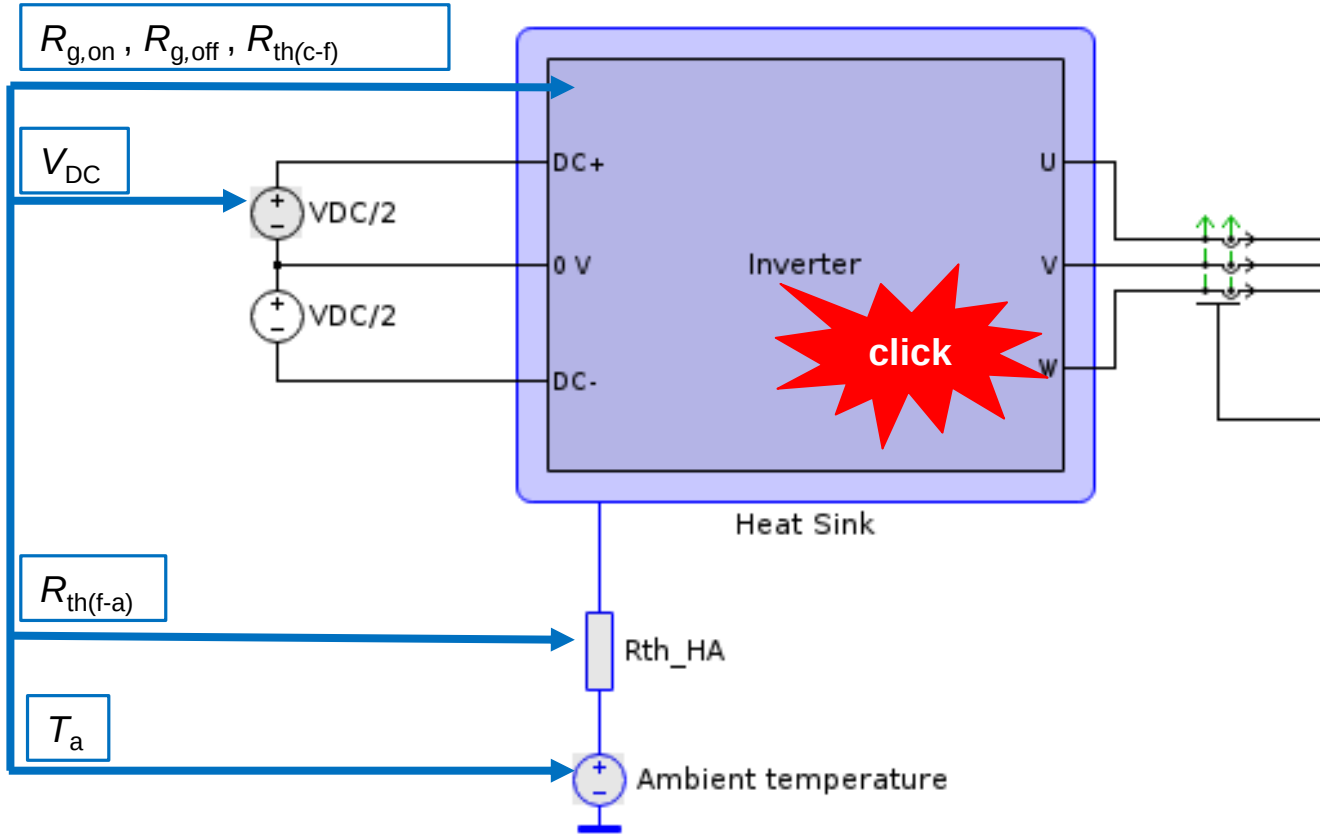
Thermal Settings

- $R_{th(c-f)}$ case to heat sink
- $R_{th(f-a)}$ heat sink to ambient
- Ambient temperature T_a

Electrical Settings

- IGBT1 $R_{g,on}$ and $R_{g,off}$
- RB IGBT $R_{g,on}$ and $R_{g,off}$
- V_{DC}





Electrical Conditions

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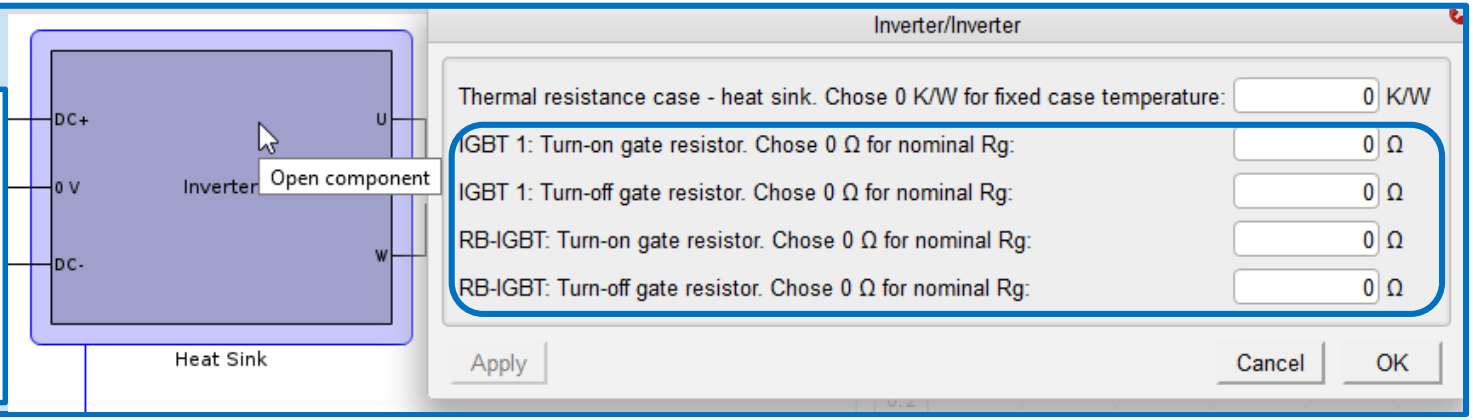
$R_{g,on}$ and $R_{g,off}$

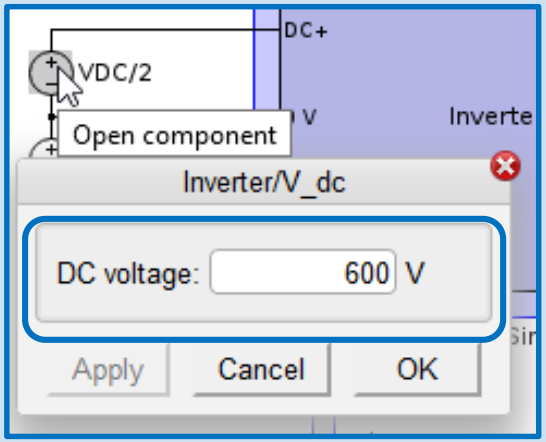
Click on the grey inverter part and the menu will open.

Input $R_{g,on}$ and $R_{g,off}$ for IGBT and RB IGBT. Set them to 0 if you want to use the datasheet values.



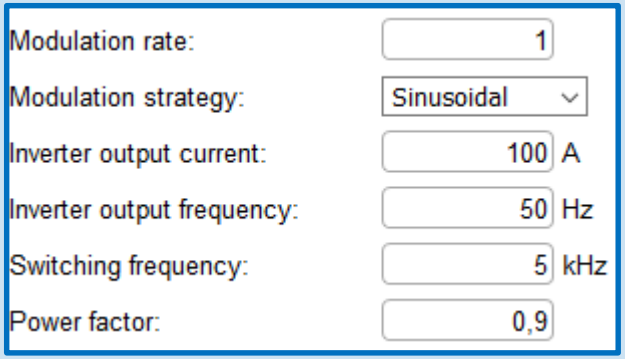
V_{DC}

Drop Down Menu when clicking on the voltage source "V_DC/2".



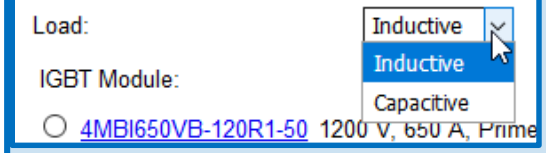
m, PWM, I_{out}, f_{out}, f_{sw}, pf

Input the simulation parameters.



load

Choose load type.



General Settings

Module Selection

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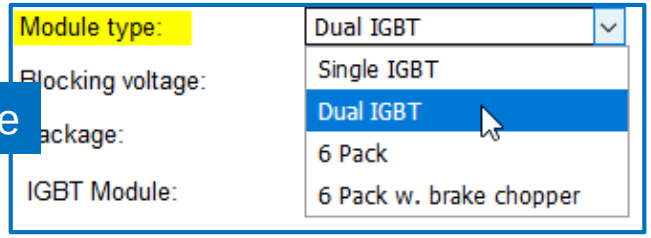
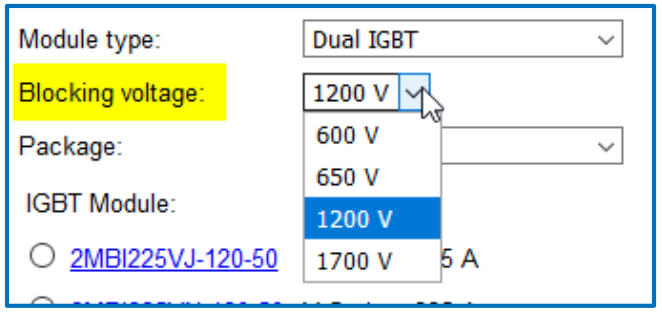
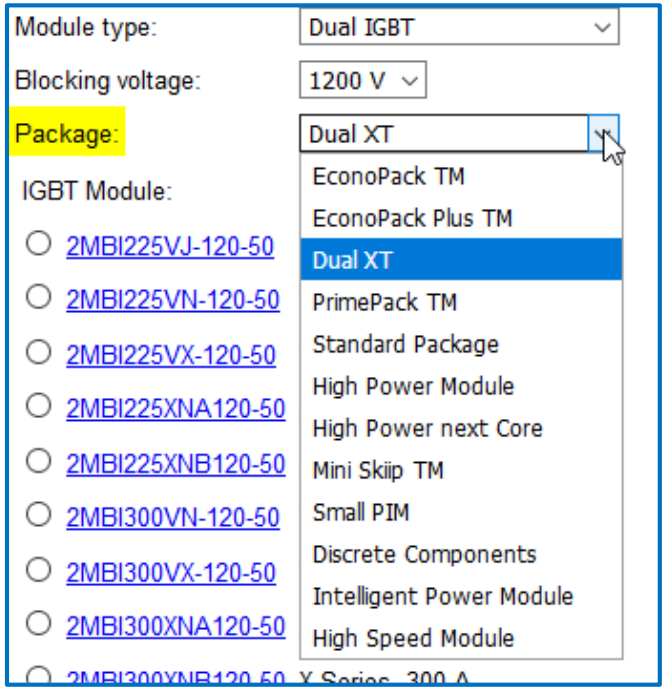
1 Module type



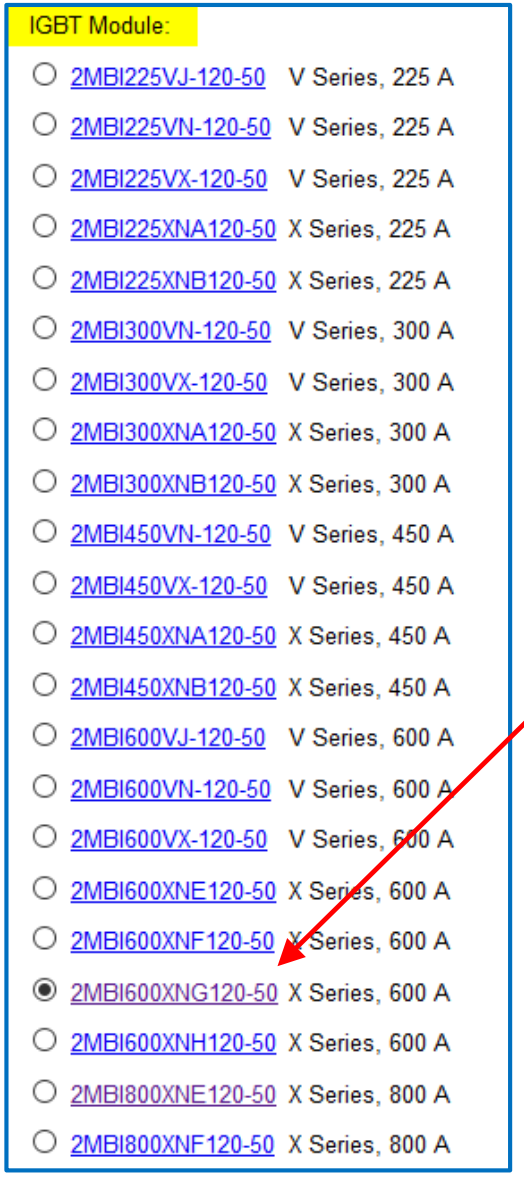
2 Blocking voltage



3 Package



4 Modules



Link to data sheet on www.fujielectric.com

MT5F39886

PWM Methods

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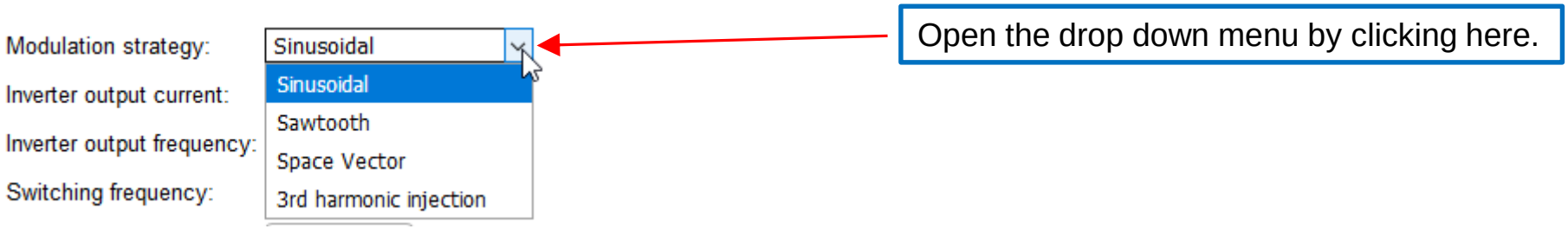
Currently the following modulation methods are available:

- Sinusoidal
- Sawtooth
- Space Vector
- 3rd harmonic injection



Run Simulation

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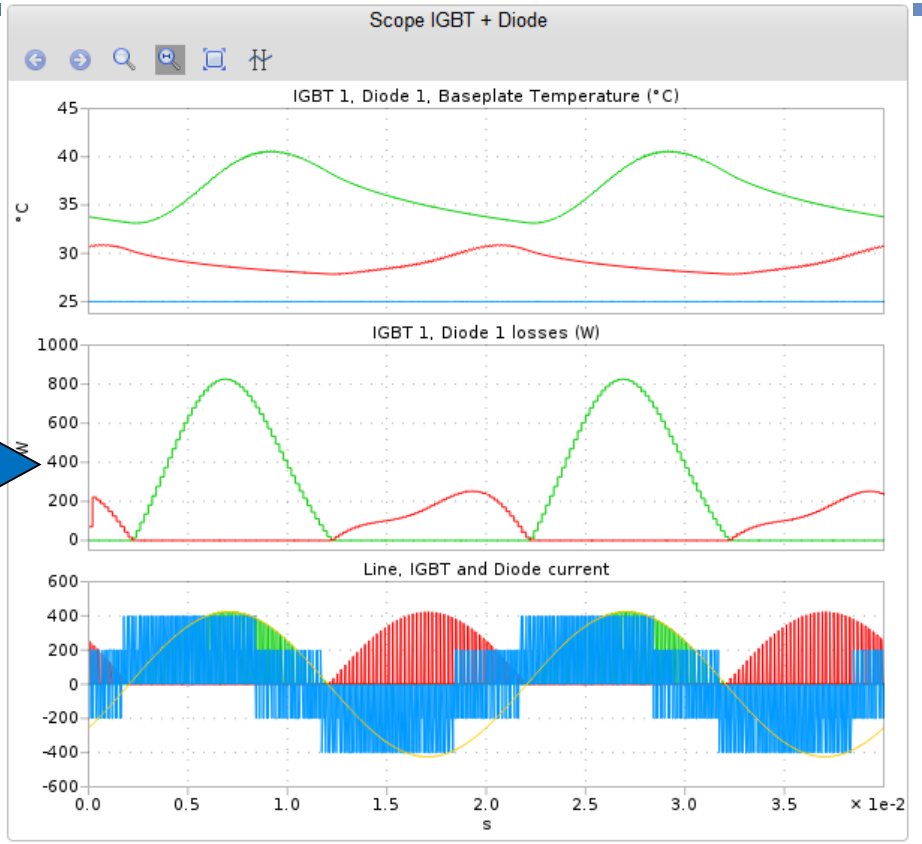
- 2MBI600XNE120-50 X Series, 600 A
- 2MBI600XNF120-50 X Series, 600 A
- (•) 2MBI600XNG120-50 X Series, 600 A
- 2MBI600XNH120-50 X Series, 600 A
- 2MBI800XNE120-50 X Series, 800 A
- 2MBI800XNF120-50 X Series, 800 A

Steady-State Analysis | Hold result

click

Simulation will start when you click the “Steady-State Analysis” button

Simulation Results



The resulting waveforms will be displayed in the screen of the scope.

Corresponding numerical values are shown in the Temperatures / Losses windows.

Temperatures	Max temperature	Min temperature	Avg temperature
IGBT	40.6 °C	33.1 °C	36.4 °C
Diode	30.9 °C	27.8 °C	29.0 °C
Case	25.0 °C		
Heat sink	25.0 °C		

Losses	Cond. losses	Turn-on losses	Turn-off losses	Reverse recovery losses	Total losses
IGBT	129.7 W	39.6 W	68.2 W		237.5 W
Diode	37.5 W			33.0 W	70.5 W

Simulation Results

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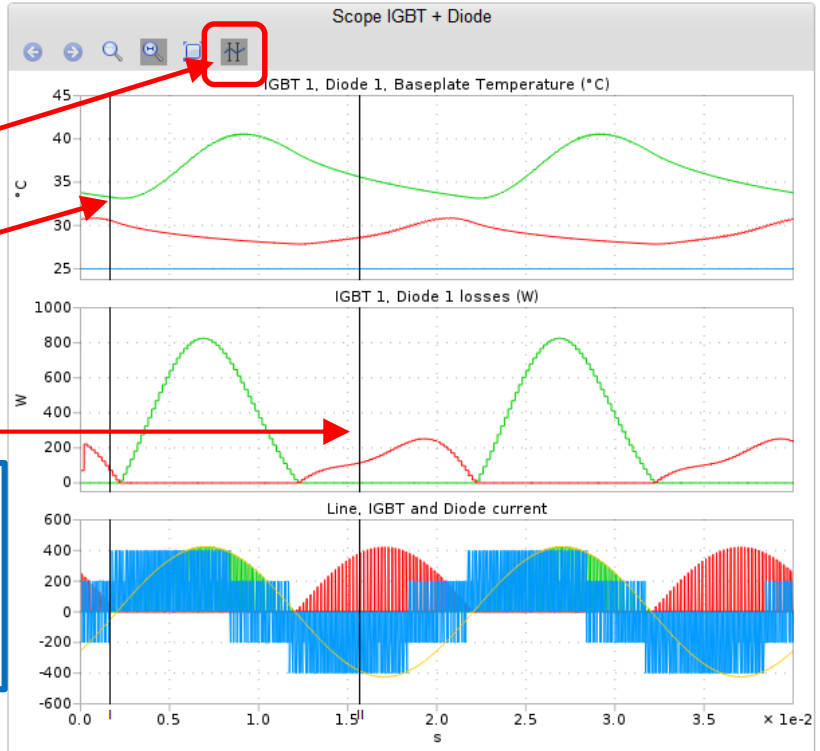
click

Using Cursors

Cursors will firstly appear at the edges. Use mouse cursor to move them to the right position.

New window will open



Name	Cursor 1	Cursor 2	Delta	Min	Max	Mean	
Time	0,001695	0,015712	0,014017				
IGBT 1, Diode 1, Baseplate Temperature (°C)							
IGBT 1 junction temperature	33.27	35.60	-2.326	33.12	40.65	37.29	3
Diode 1 junction temperature	30.56	28.68	1.881	27.84	30.56	28.63	2
Case temperature	25.00	25.00	0.000	25.00	25.00	25.00	2
IGBT 1, Diode 1 losses (W)							
IGBT losses	0.000	0.000	0.000	0.000	825.8	338.8	4
Diode losses	71.52	115.0	-43.50	0.000	115.0	19.77	4
Line, IGBT and Diode current							
IGBT 1 current	0.000	0.000	0.000	0.000	424.3	151.5	2
Diode 1 current	47.00	0.000	47.00	0.000	387.1	4.853	3
Output voltage	200.0	-400.0	600.0	-400.0	400.0	40.66	2
Output current	-47.00	-387.4	340.4	-387.4	424.3	135.0	2

Analysis window:

Characteristics

IGBT & Diode:
- Tj, losses, current

Module:
- Tc

Inverter:
- Iout, Vout

Values
- Delta, min, max, mean, rms

Simulation Results: Comparison

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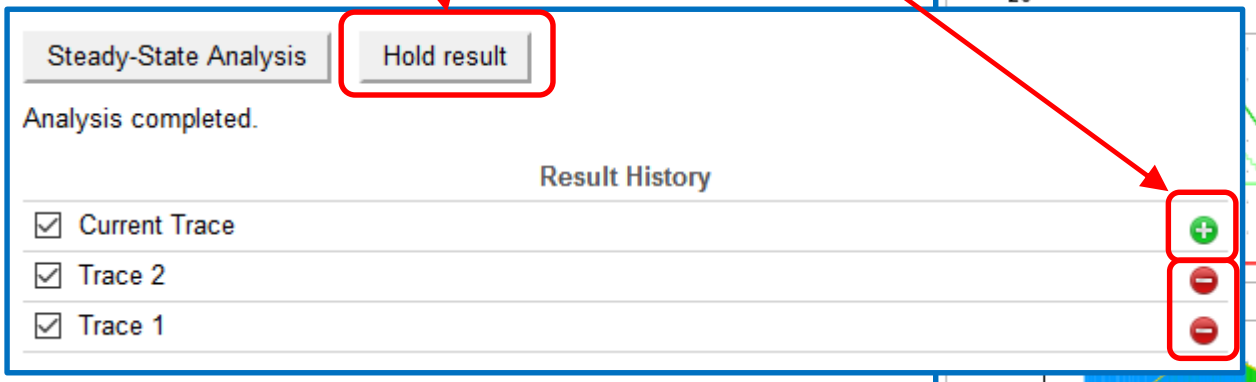
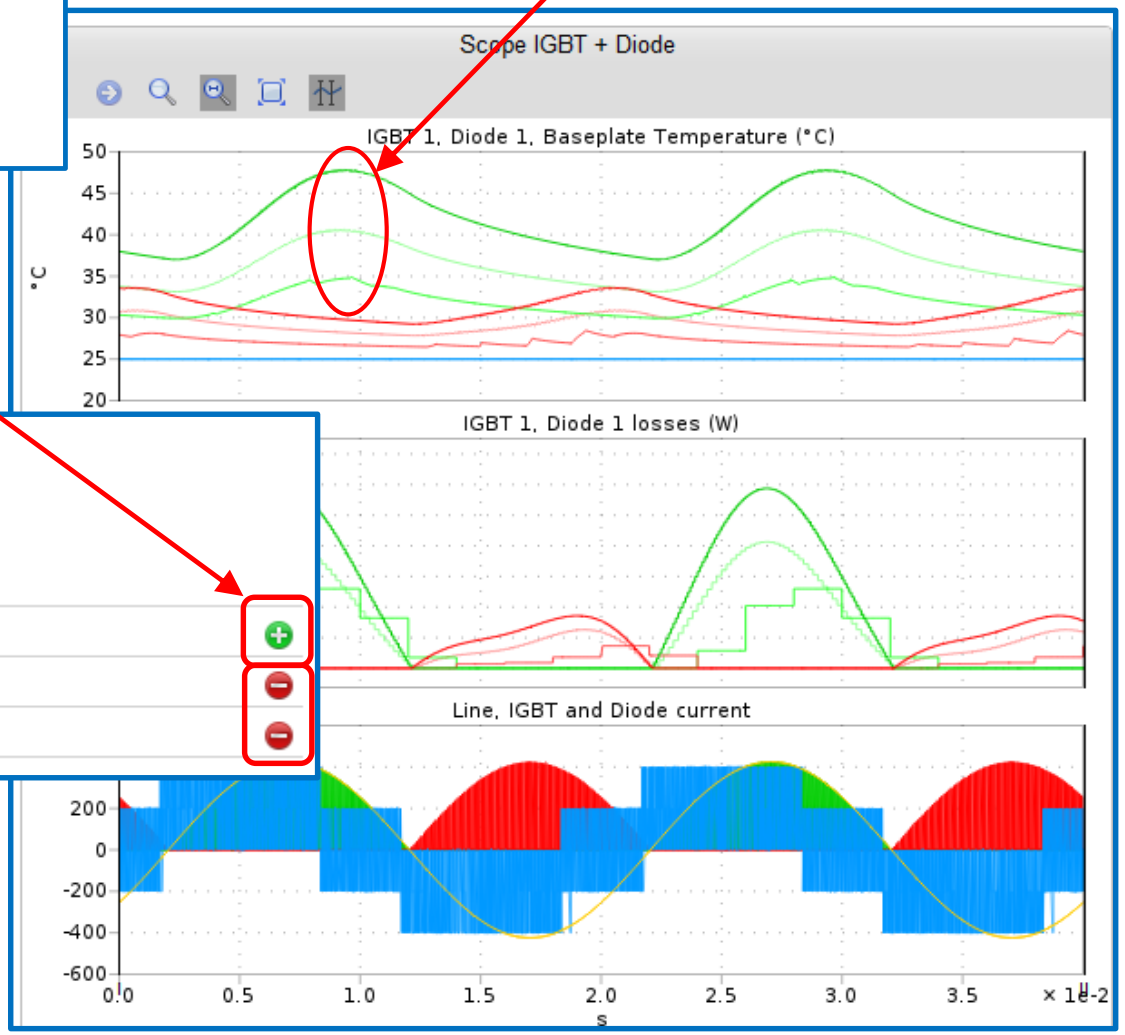
Use „hold result“ to easily compare different simulations:

The first result will be kept automatically. For more please use ⊕ when the simulation is finished.

To remove a result from the history, please click ⊖

3 different simulation results





Comparison: Multiple results

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Results of all 3 traces are displayed.

Scope values

Temperatures			
	Max temperature	Min temperature	Avg temperature
IGBT	47.8 °C 34.9 °C 40.6 °C	37.0 °C 29.9 °C 33.1 °C	41.8 °C 31.9 °C 36.4 °C
Diode	33.6 °C 28.5 °C 30.9 °C	29.2 °C 26.5 °C 27.8 °C	31.0 °C 27.1 °C 29.0 °C
Case	25.0 °C 25.0 °C 25.0 °C		
Heat sink	25.0 °C 25.0 °C 25.0 °C		

Losses					
	Cond. losses	Turn-on losses	Turn-off losses	Reverse recovery losses	Total losses
IGBT	130.5 W 133.6 W 129.7 W	82.1 W 3.6 W 39.6 W	137.4 W 7.1 W 68.2 W		350.0 W 144.3 W 237.5 W
Diode	37.8 W 33.5 W 37.5 W			67.8 W 3.1 W 33.0 W	105.7 W 36.6 W 70.5 W

Analysis result between the Cursors

Name	Cursor 1	Cursor 2	Delta	Min	Max	Mean	
Time	0,0054617	0,025726	0,020264				
IGBT 1, Diode 1, Baseplate Temperature (°C)							
IGBT 1 junction temperature	41.67	42.40	-0.7326	37.01	47.84	41.80	4
	31.90	32.20	-0.3025	29.92	34.91	31.93	3
	36.45	36.82	-0.3757	33.12	40.65	36.40	3
Diode 1 junction temperature	30.85	30.76	0.09595	29.23	33.62	31.02	3
	27.11	27.07	0.03669	26.47	28.46	27.08	2
	28.96	28.89	0.06622	27.84	30.90	29.02	2
Case temperature	25.00	25.00	0.000	25.00	25.00	25.00	2
	25.00	25.00	0.000	25.00	25.00	25.00	2
	25.00	25.00	0.000	25.00	25.00	25.00	2
IGBT 1, Diode 1 losses (W)							
IGBT losses	1019	1076	-57.23	0.000	1175	359.1	5
	114.7	114.7	3.965e-10	0.000	519.8	143.9	2
	712.4	741.9	-29.49	0.000	825.8	243.8	3
Diode losses	0.000	0.000	0.000	0.000	342.8	104.3	1
	0.000	0.000	0.000	0.000	146.2	36.09	5
	0.000	0.000	0.000	0.000	251.8	69.58	1
Line, IGBT and Diode current							
IGBT 1 current	372.6	388.2	-15.54	0.000	424.3	109.2	1
	372.6	388.2	-15.54	0.000	424.3	113.8	1
	372.6	388.2	-15.54	0.000	424.3	109.5	1
Diode 1 current	0.000	0.000	0.000	0.000	424.3	28.74	9
	0.000	0.000	0.000	0.000	424.3	25.80	8
	0.000	0.000	0.000	0.000	424.2	28.52	9
Output voltage	200.0	400.0	-200.0	-400.0	400.0	3.728	2
	400.0	400.0	1.128e-7	-400.0	400.0	5.218	2
	400.0	200.0	200.0	-400.0	400.0	2.899	2
Output current	372.6	388.2	-15.54	-424.3	424.3	4.965	3
	372.6	388.2	-15.54	-424.3	424.3	4.965	3
	372.6	388.2	-15.54	-424.3	424.3	4.965	3

More Scope Functions

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You can use different kind of zoom functions. Please note that (according to your hardware / internet connections etc.) the responding time might be slow.

Free zoom:

Zoom in x and y direction possible

1

Constrained zoom:

the whole y-axis range is fixed.
Zoom in x direction

2

Zoom to fit:

resets all zoom operations

3

Previous / next view

Thank you!

If you have any questions, please contact us.

http://www.fujielectric.com/products/semiconductor/contact/index.html