ThermaSim™ On-Line Thermal Simulation for Vishay Siliconix Power MOSFETs

By Kandarp Pandya

Introduction

Vishay's new ThermaSim™ is a free on-line tool that helps designers speed time to market by allowing detailed thermal simulations of Vishay Siliconix power MOSFETs to be performed before prototyping. Useful for any power MOSFET application, ThermaSim is ideal for high-current, high-temperature, SMD (surface mount device) applications such as automotive, fixed telecom, desktop and laptop computers, and industrial systems. The tool is available at http://www.vishay.com/thermal-modelling.

This application note is a walk-through for each step in a ThermaSim simulation. For ease of understanding and comparing with on-line displays, this document uses the following style:

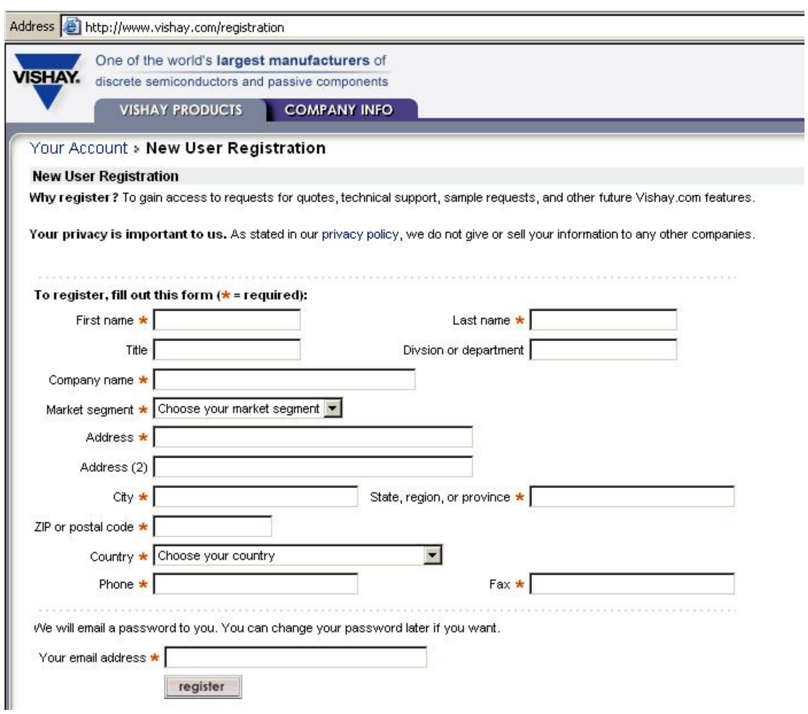
- Section headings and special notes are in ***Italic Bold***
- Sub-sections and item descriptions, as seen on screen displays, before actions are in **Bold**

Vishay recommends first reading through the entire document, then for an organized and efficient thermal analysis, using the "Appendix A" worksheet to collect all the necessary information for your specific analysis.

"Appendix B" through "Appendix E" cover various working examples. Starting with the worksheets for each case, the corresponding results follow, with detailed indexes for the examples given in the summary section.

Registration

First time users must register on Vishay's web site. Use the link http://www.vishay.com/registration to begin (see Figure 1). **Fill-in** the registration information, and a user password will be emailed to you. The "New Thermal Simulation" link under the MOSFET section on Vishay's web site (Figure 2 and 2A) also takes users to the log-on page (Figure 3).


Address http://www.vishay.com/registration

One of the world's **largest manufacturers** of discrete semiconductors and passive components

VISHAY PRODUCTS | COMPANY INFO

Your Account > **New User Registration**

New User Registration

Why register? To gain access to requests for quotes, technical support, sample requests, and other future Vishay.com features.

Your privacy is important to us. As stated in our privacy policy, we do not give or sell your information to any other companies.

To register, fill out this form (* = required):

First name *
Last name *
Title
Divsion or department
Company name *
Market segment * Choose your market segment
Address *
Address (2)
City *
State, region, or province *
ZIP or postal code *
Country * Choose your country
Phone *
Fax *

We will email a password to you. You can change your password later if you want.

Your email address *

register

Figure 1.

ThermaSim™ On-Line Thermal Simulation for Vishay Siliconix Power MOSFETs

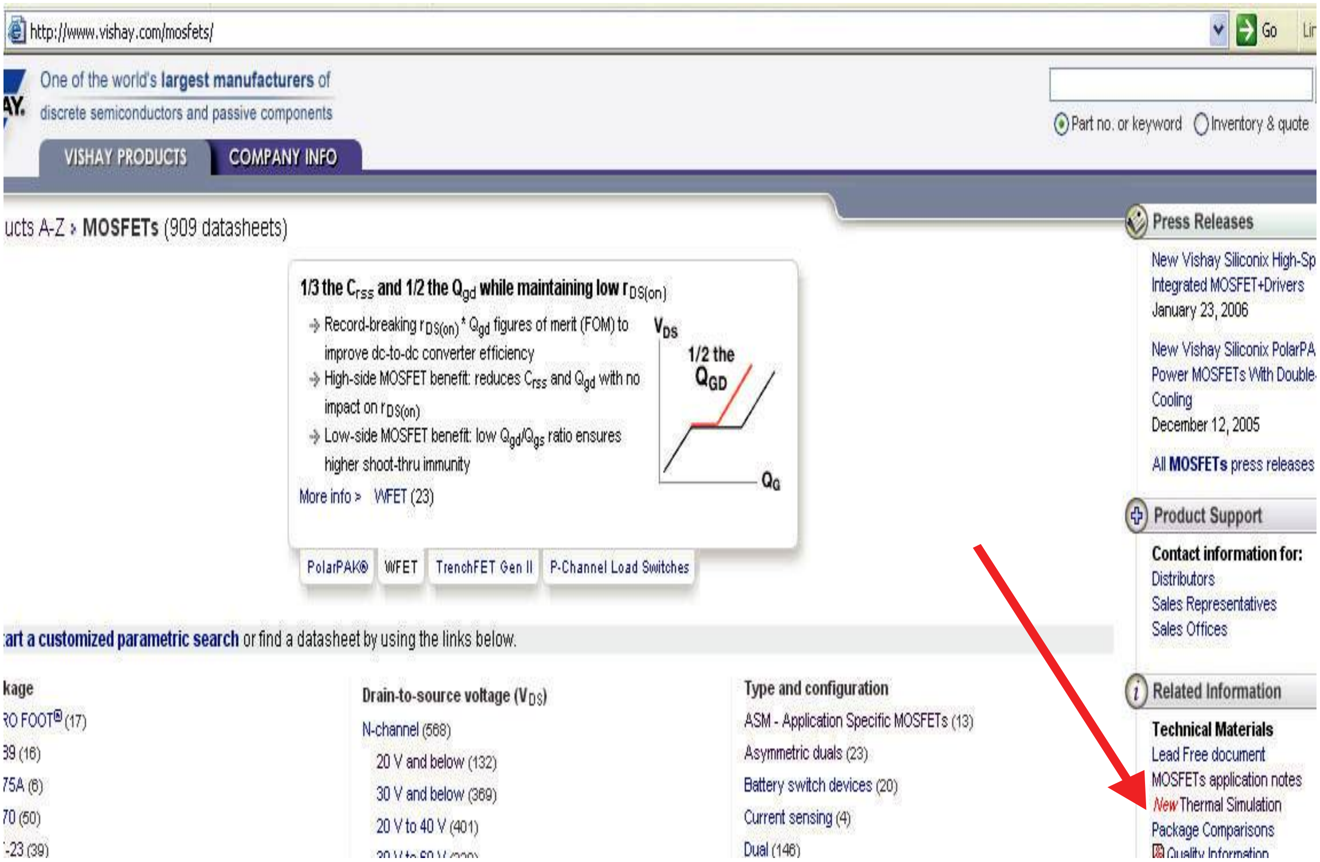


Figure 2.

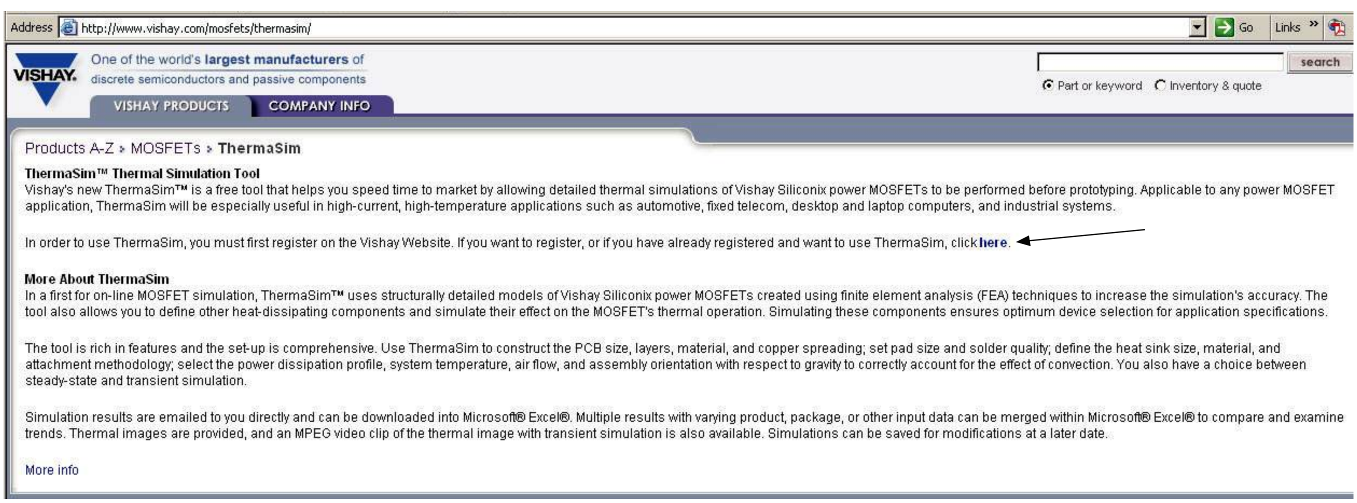


Figure 2a.

ThermaSim™ On-Line Thermal Simulation for Vishay Siliconix Power MOSFETs

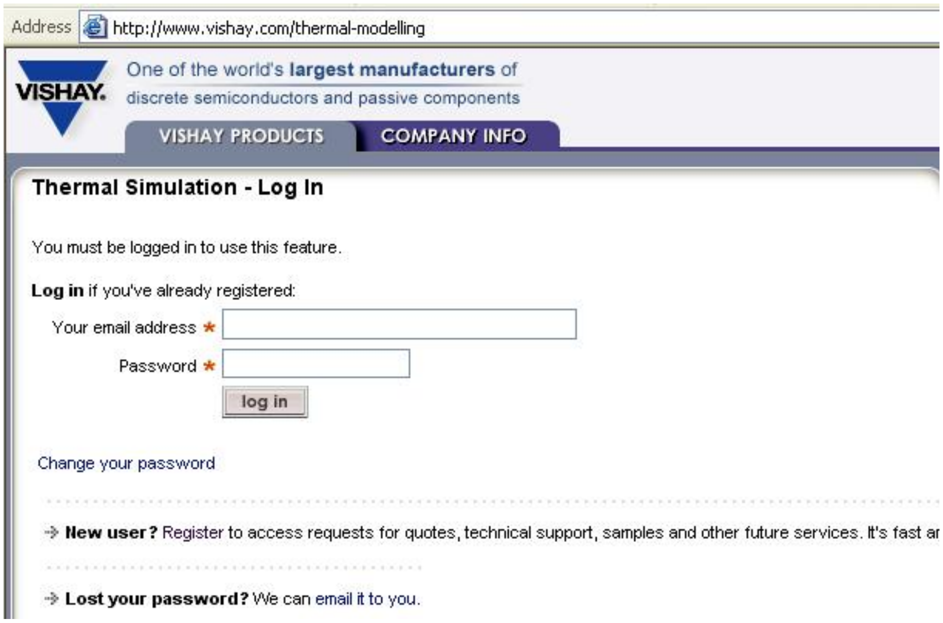


Figure 3.

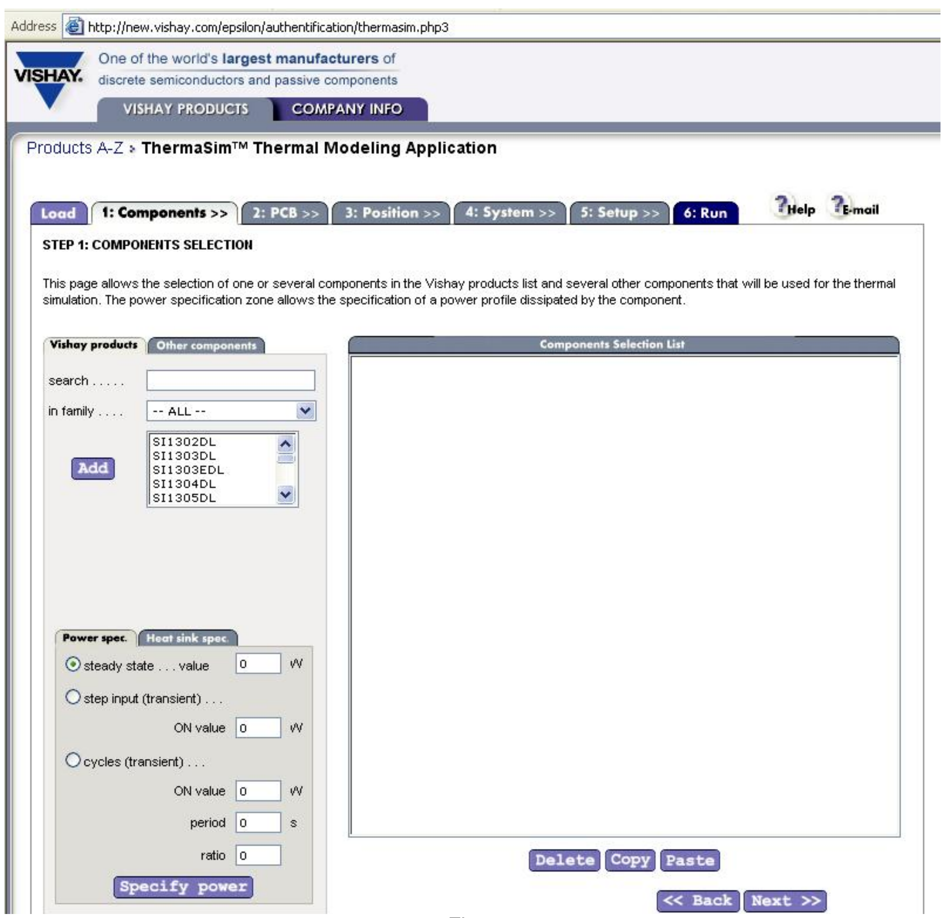


Figure 4.

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Log-In

Log-on using the link http://www.vishay.com/thermal-modelling (Figure 3) with your email address and password. The web tool should open as shown in Figure 4.

Tab 1: Components

This section enables the selection of thermal models for Vishay Siliconix power MOSFETs from a built-in library. If applicable, specify the MOSFET's power profile and heat sink. Also, define other heat dissipating components and specify its power.

Vishay Products: There are three options for selecting a Vishay component:

a) **Search Field:** Enter the part number in the search field.
Scroll down the list adjacent to the "Add" icon, the part will be ***highlighted*** (Figure 5).
If the thermal model is not available in the library, the part search will fail to display the highlighted part, as shown in Figure 6.

b) **By Family:** The pull down menu lists different packages (Figure 7).
Scroll down to the package.
Select package (For example, select **SO-8 S** for the SOIC single part family).
Scroll down the list that shows parts in the selected package family (Figure 8).
Select the part to ***highlight.***

c) **Pull-Down Menu:** Directly use the pull-down menu adjacent to the "Add" icon.
Scroll down to the part number.
Select the part as shown in Figure 9.

Using any one of the three methods listed above, ***select*** the part. ***Do not*** try to add the part to the design by clicking the "Add" icon. Doing so will result in an error window (Figure 10). However, before adding a part to the design, you must first define the power specifications (value and/or profile).

Power Specs: The "Power Spec" tab, located at the lower left of the page, enables the power profile definition for each component. Three options are available to set the power profile for either steady-state or one of the two transient simulation modes. **Select** the **"Power Specs"** tab to define power using any one of the three tabs:

a) **Steady-State Value:**
Click the **radio button** to select the **steady-state** mode.
Enter the steady-state value in the corresponding **box** (see Figure 11).
The simulation in this mode predicts the steady-state values of the component and PCB temperatures. The result provides maximum and minimum die (silicon) temperatures, top and bottom surface temperatures of both the component and the PCB, and the flux (power dissipated) through the PCB.

b) **Step Input (Transient) On Value:**
Click the **radio button** to select the **step input (transient)** mode.
Enter the step input (transient) on value in the corresponding **box** (see Figure 12).

This simulation mode predicts the transient thermal behavior of the component mounted on the defined PCB and with other system definitions. The results show the temperature excursion through a predefined period and time steps. The step transient simulation definition is completed in the "Systems" tab, "Simulation Settings" sub-menu.
Please note that in order to maintain a reasonable computational time with on-line access and operation of the FEA-based system, it is necessary to impose the following input value limitations for step transient simulation:
- ***Step Input Power Value in W: 0.1 ≤ Power Value ≤ 100.***

With incorrect values, an error message window will appear indicating value limits, as shown in Figure 13.

c) **Cycle Transient On Value:**
Click the **radio button** to select the **cycle transient** input mode (see Figure 14.
Enter cycle transient values:
- **On value** in the corresponding **box.**
- **Period** in the corresponding **box** (time of one cycle).
- **Ratio** in the corresponding **box** (ratio of on-time to off-time).

The results show the temperature excursion through a predefined time duration and time steps. The step transient simulation definition is completed in the "Systems" tab, "Simulation Settings" sub-menu.

Please note that in order to maintain a reasonable computational time with on-line access and operation of the FEA-based system, it is necessary to impose the following input value limitations for cyclic transient simulation:
- ***Power Value in W: 0.1 ≤ Power Value ≤ 1000.***
- ***Period in Seconds: 0.01 ≤ Period ≤ 2000.***
- ***Ratio: 0.01 ≤ Ratio ≤ 1.***

With incorrect values, an error message window will appear indicating value limits, as shown in Figures 15, 16, and 17.

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Add Vishay component (MOSFET part) to Design: After defining the power specs, click the **Add** icon to add the part to the design. The "Component Selection List" displays the part with its power specs, as shown in Figure 18.

Other Components (Heat Dissipating): This menu facilitates defining and adding other heat dissipating components, such as resistors and inductors, to the design. Thus, the simulation can take into account the effect of the heat dissipated by these components on the thermal performance of the Vishay Siliconix power MOSFET under study (refer to Figure 19).
Name: Enter a name for the heat-dissipating component. The default name for the component starts with **'Component1.'**
Enter the dimensions in mm:
- **Size (lx)** - Enter the value in the corresponding **box.**
- **Size (ly)** - Enter the value in the corresponding **box.**
- **Size (lz)** - Enter the value in the corresponding **box.**

The defaults values for thermal conductivity, density, and specific heat are good enough for first level of analysis. However, using the correct values, if known, can improve the accuracy of simulation results. Please note the units of each parameter while modifying the values:

- **Conductivity** - Modify the value in the corresponding **box.**
- **Density** - Modify the value in the corresponding **box.**
- **Specific Heat** - Modify the value in the corresponding **box.**

Next, define the average power dissipation for this component using the steady-state value icon as follows (see Figure 11):
Click the **radio button** to select the **steady-state** mode.
Enter the steady-state value in the corresponding **box.**

Click the "Add" icon to add the **other component1** to design.
The "Component Selection List" displays component1 with power specs, as shown in Figure 20.

To **add more than one Vishay component,** or **other heat-dissipating components,** follow the same procedure described in the preceding discussions. If there is more than one component with the same part number, it is possible to use editorial commands as shown below (refer to Figure 21).

Copy and Paste a Part in the Design:
Select ***(highlight)*** the part in the **"Component Selection List."**
Click the **"Copy"** icon to copy the part in the clipboard.
Click the **"Paste"** icon to add the copied part to the design.
The "Component Selection List" updates to add the part.

Edit a Part in the Design:
Select ***(highlight)*** the part in the **"Component Selection List."**
Select "Power Specs" to edit the power specification for the part.
Modify the information as required.

Click on the **"Specify Power"** icon.
The "Component Selection List" updates the selected part.

Delete a Part in the Design:
Select ***(highlight)*** the part in the **"Component Selection List."**

Click the **"Delete"** icon.
The "Component Selection List" will update to remove the part from the design.

Heat Sink Specs: The tab next to "Power Specs," located in the lower left of the page, enables the attachment of a heat sink on top of the MOSFET component selected from the "Component Selection List." In addition, it allows the removal or editing of the attached heat sink. ***Please note that at this time, the simulation can define only simple, plate heat sinks with X-Y-Z dimensions. (It is not possible to define heat sinks with fins).***

Specify Heat Sink:
Select a component from the "Component Selection List" as shown in Figure 22. The component will be **highlighted.**
Next, go to the "Specify Heat Sink" sub-tab.
Size (lx) - Enter the length in the corresponding **box** in mm.
Size (ly) - Enter the width in the corresponding **box** in mm.
Size (lz) - Enter the thickness in the corresponding **box** in mm.

Select Heat Sink Material: Aluminum or **copper** are the two options offered by the pull-down menu.
Select Heat Sink Attachment Method: Solder, glue, and **mica** are the three options under the pull-down menu.

Click on the **"Specify Heat Sink"** icon.
The "Component Selection List" will update to append the highlighted component with the heat sink information (see Figure 23).

Remove Heat Sink From Design:
Select a component with a heat sink from the "Component Selection List" as shown in Figure 23.
The component will be **highlighted.**

Click on the **"Remove Heat Sink"** icon. The ""Component Selection List"" will update to delete the heat sink information from the highlighted component.

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Edit Heat Sink Properties:
Select a component with a heat sink from the "Component Selection List" as shown in Figure 23.
The component will be **highlighted.**

Edit the parameter information in the **"Heat Sink Specs"** area.

Click on the **"Specify Heat Sink"** icon. The "Component Selection List" will update the highlighted component with the edited heat sink information.

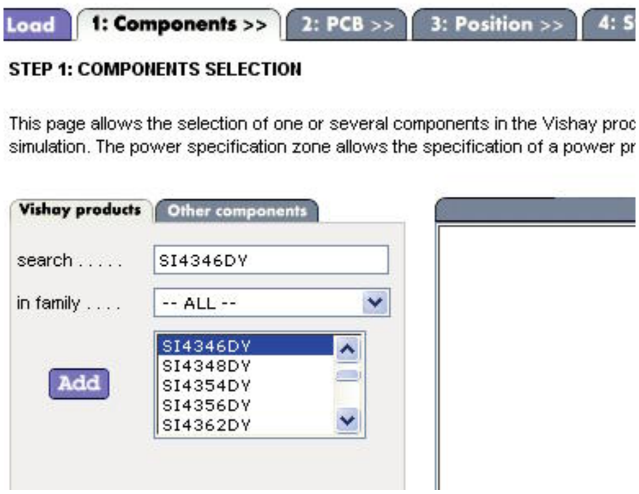

Figure 5.

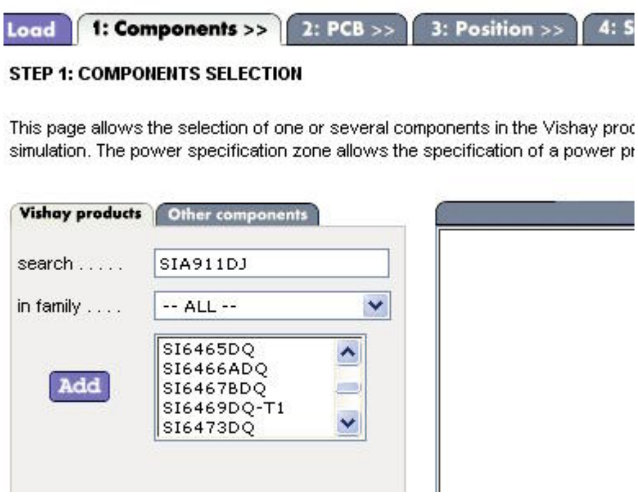

Figure 6.

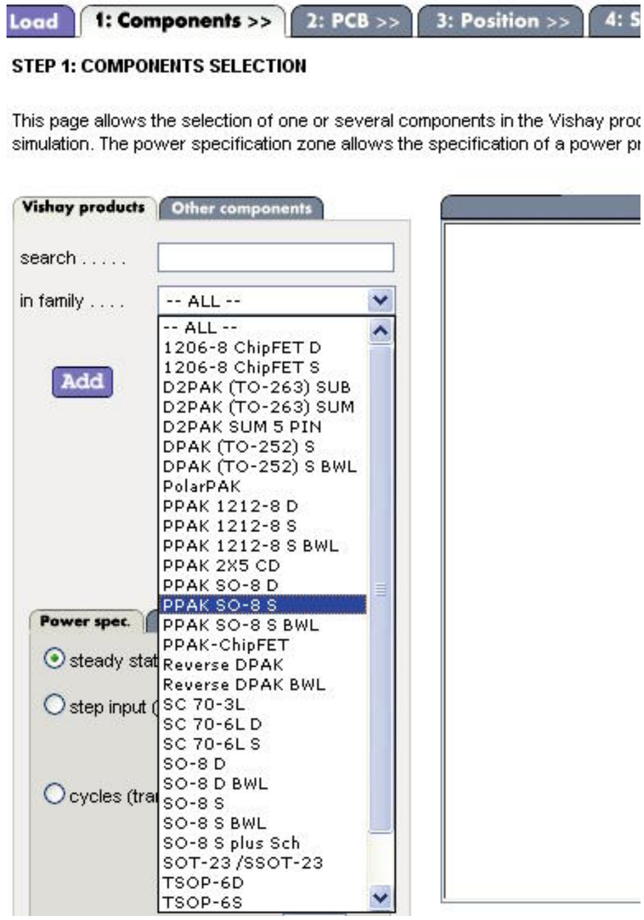

Figure 7.

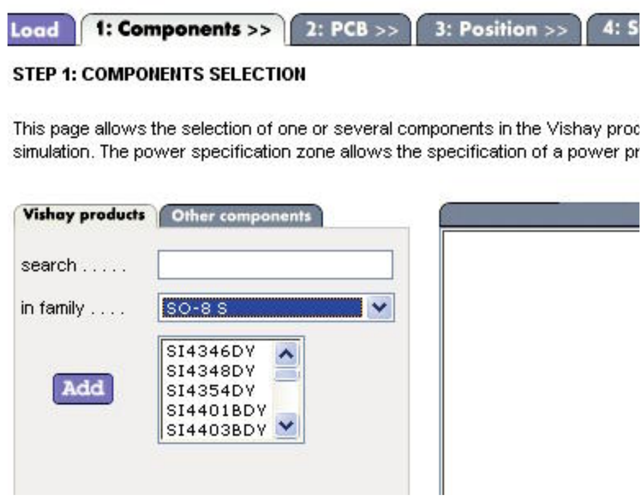

Figure 8.

ThermaSim™ On-Line Thermal Simulation for Vishay Siliconix Power MOSFETs

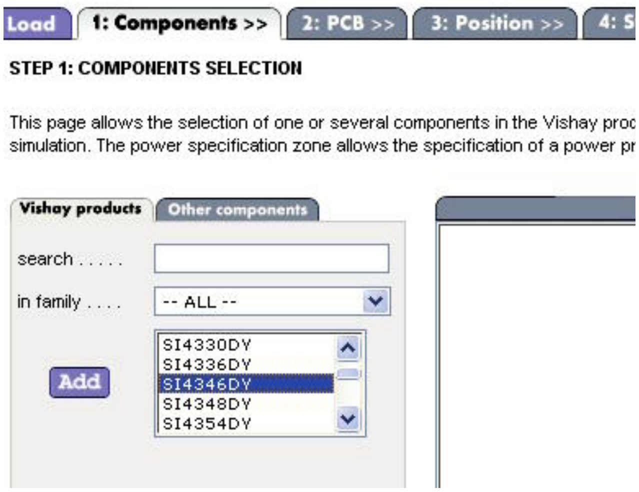

Figure 9.

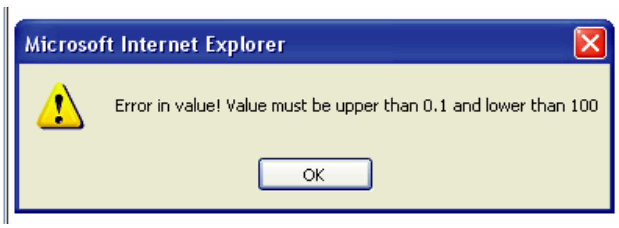

Figure 10.

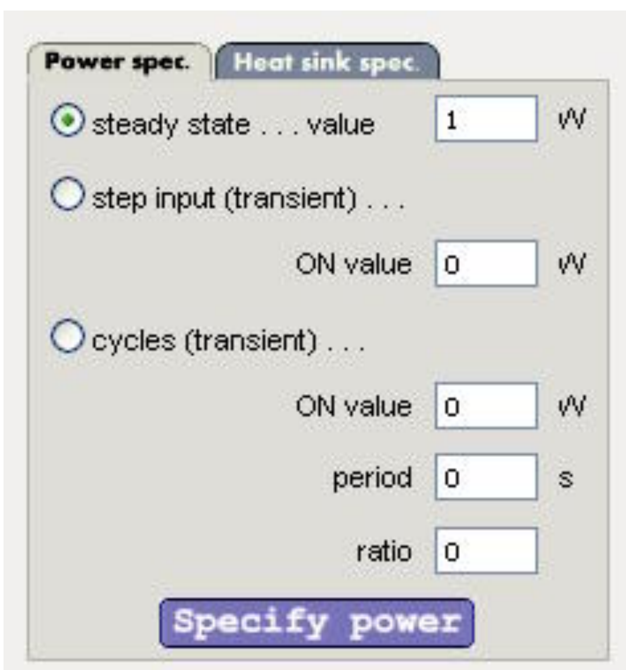

Figure 11.

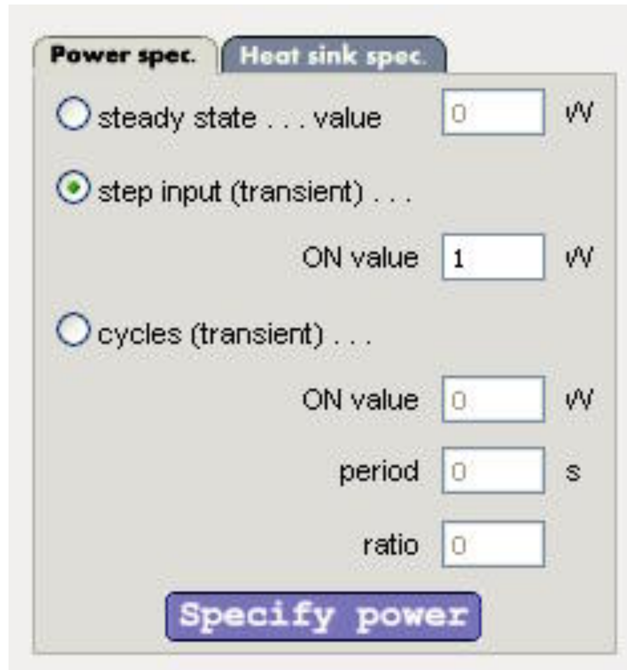

Figure 12.

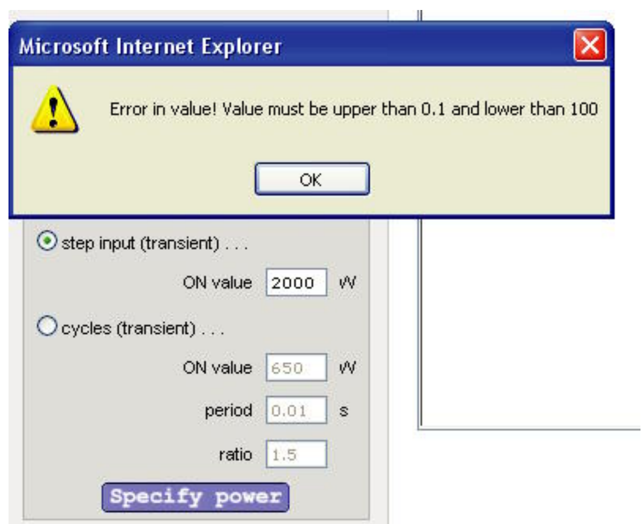

Figure 13.

ThermaSim™ On-Line Thermal Simulation for Vishay Siliconix Power MOSFETs

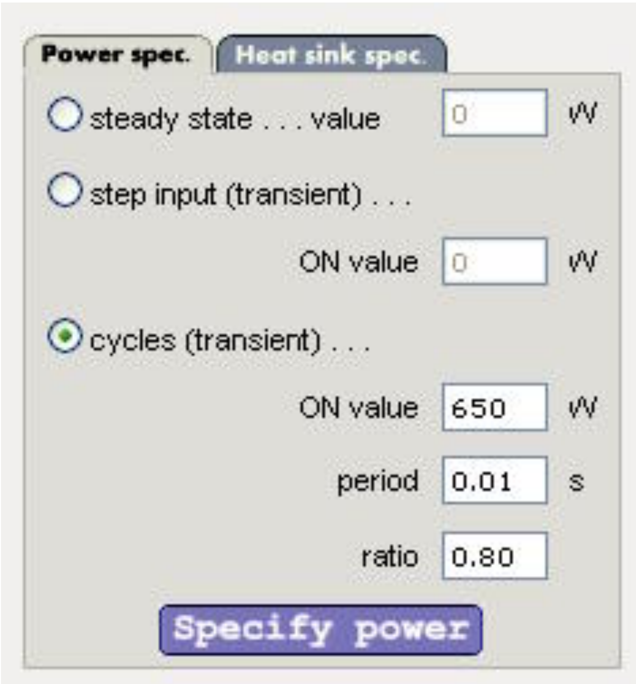

Figure 14.

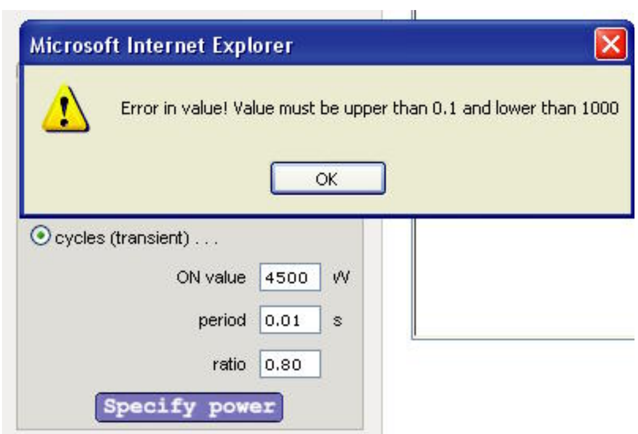

Figure 15.

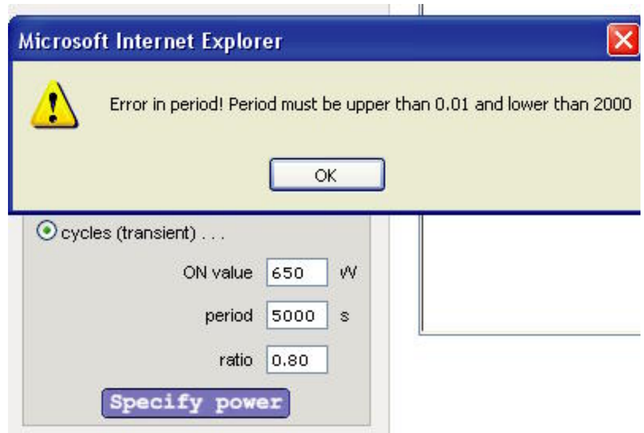

Figure 16.

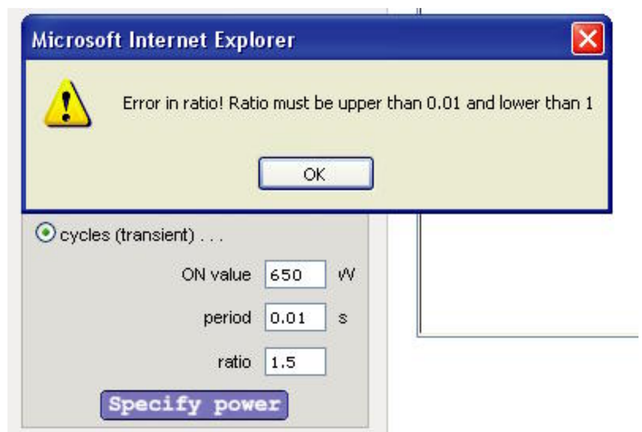

Figure 17.

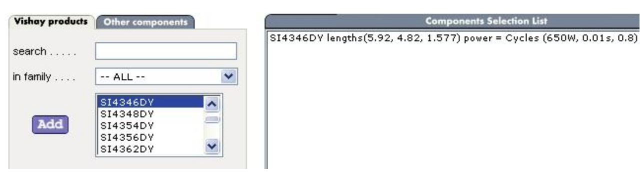

Figure 18.

ThermaSim™ On-Line Thermal Simulation for Vishay Siliconix Power MOSFETs

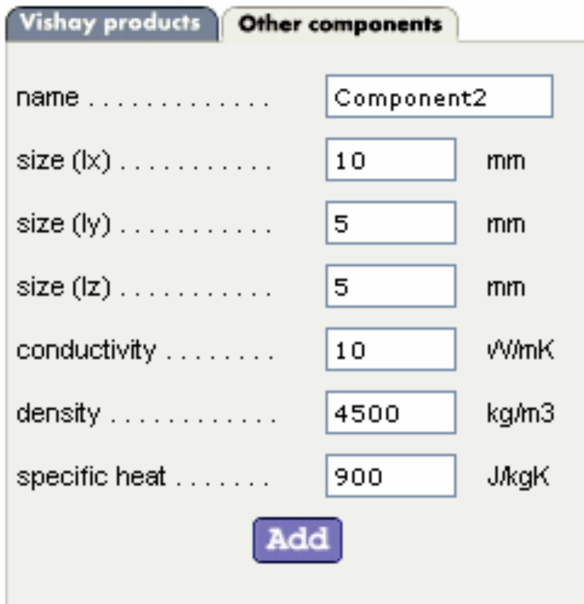

Figure 19.

Figure 20.

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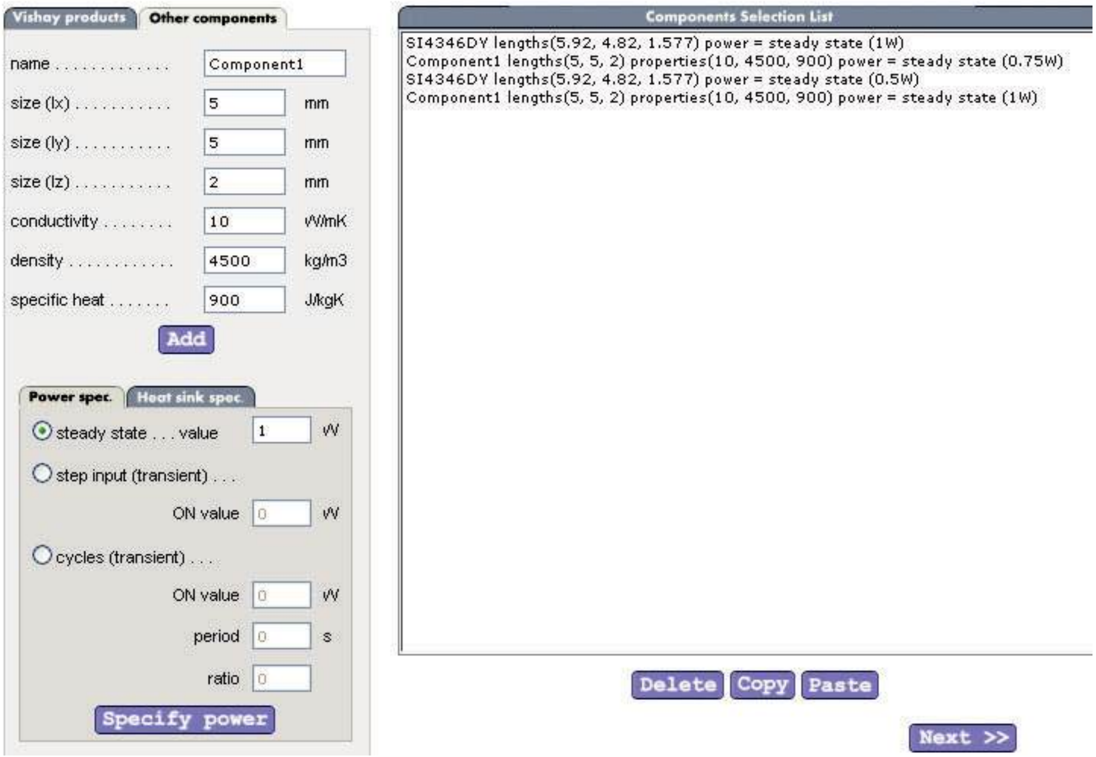

Figure 21.

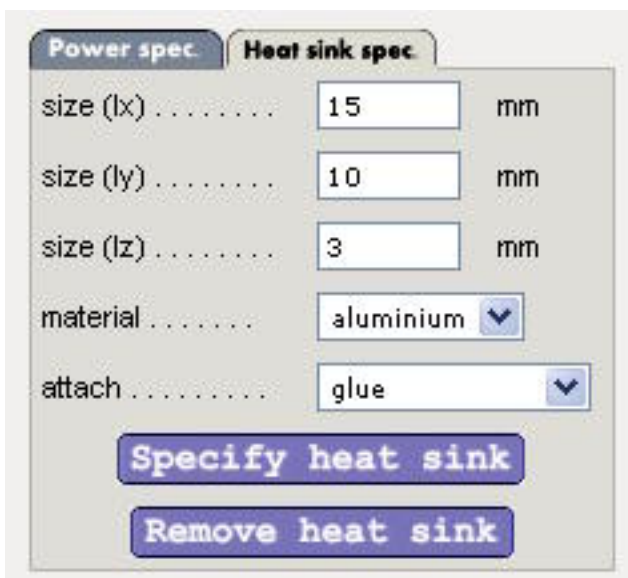

Figure 22.

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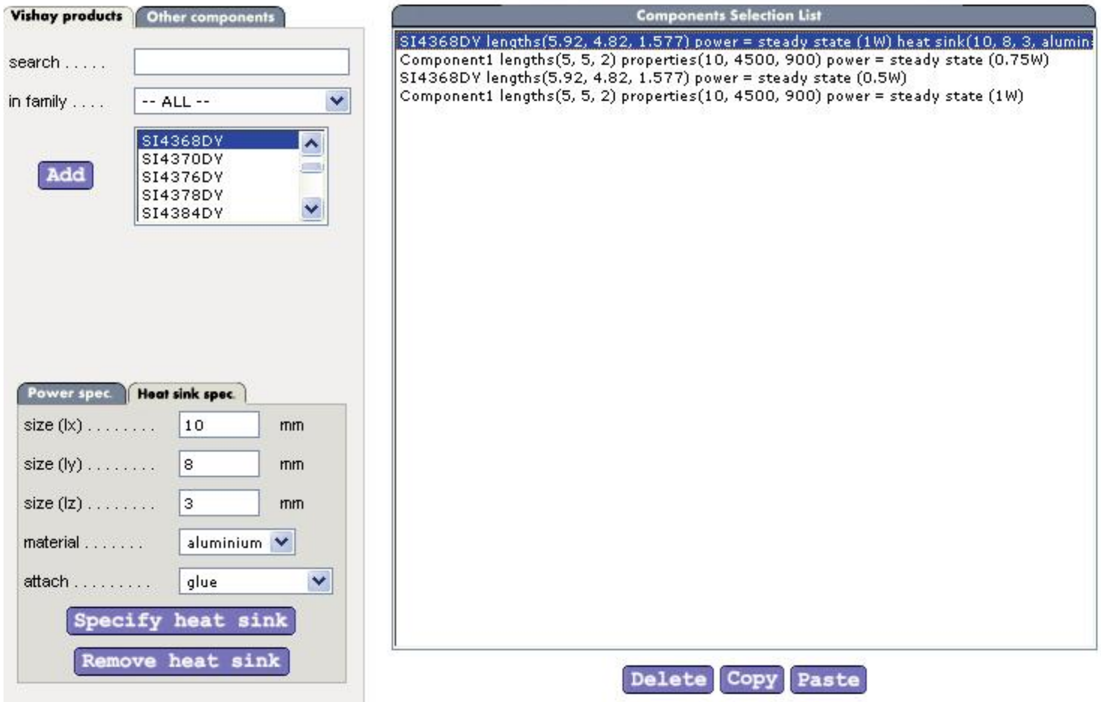

Figure 23.

Click on **"Tab 2: PCB"** at the top of the page to go to the next section.

Alternatively, **clicking** on the **"Next"** icon at the bottom of the page also takes you to **"Tab 2: PCB."**

Tab 2: PCB

In this section, the printed circuit board information relevant for thermal analysis is input. A visual aid dynamically displays a representative structure of the PCB. The information includes length and width, and the top, bottom, and internal layers' thickness in mm. The pull-down menu offers options for material and percentage coverage (for copper). In addition, include a via zone to specify thermal via information.

PCB Size:
Default values for **size X** and **size Y** are **100 mm** (refer to Figure 24).
Enter the length in the **size X** box.
Enter the width in the **size Y** box.
Click the **"Apply"** icon.
The board displays the changes proportionally.

Standard PCB: This pull-down menu allows you to choose available standard PCBs. This can be time saving if any of the available options meet the desired PCB specs.

Layer Definition:
Top Layer: The material for the top layer is either copper or none.
This sub-tab has a pull-down menu.

Select material from **none,** or **10 % copper through 100 % copper** with percentage coverage (see Figure 25).
Enter the top layer thickness in the corresponding **box** in mm (refer to Figure 24).

Click anywhere outside of the "Layer Definition" tab.
The PCB picture updates dynamically.

Refer to Table 1 for copper thickness in oz., and the corresponding measurements in mm, of the **external layer as per IPC 2201.** ***Please note that the thickness of the copper for the internal layer is different from external layers.***

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TABLE 1 - EXTERNAL CONDUCTOR THICKNESS AFTER PLATING	
BASE COPPER FOIL	MINIMUM
1/8 oz.	20 µm
1/4 oz.	20 µm
3/8 oz.	25 µm
1/2 oz.	33 µm
1 oz.	46 µm
2 oz.	76 µm
3 oz.	107 µm
4 oz.	137 µm
For each succeeding once of copper foil, increase minimum conductor thickness by 30 µm	

Internal Layer: The material for the internal layer is either FR-4 epoxy/glass or copper.
This sub-tab has a pull-down menu.
Select the material from FR-4 epoxy/glass, or 10 % copper through 100 % copper with percentage coverage (see Figure 26 and 27).

Enter the layer **thickness** in the corresponding **box** in mm.
Click anywhere outside of the "Layer Definition" tab.
The PCB picture updates dynamically.

Refer to Table 2 for copper thickness in oz., and the corresponding measurements in mm, of the **internal layer as per IPC 2201.**

TABLE 2 - INTERNAL LAYER FOIL THICKNESS AFTER PROCESSING	
COPPER FOIL	MINIMUM
1/8 oz	3.5 µm
1/4 oz	6.0 µm
3/8 oz	8.0 µm
1/2 oz	12.0 µm
1 oz	25.0 µm
2 oz	56.0 µm
3 oz	91.0 µm
4 oz	122.0 µm
Above 4 oz	13 µm below minimum thickness listed for that foil thickness in IPC-MF-150

Click on the **"Add"** icon to add the layer to the design.
The box will list the layer and the display will reflect the changes.
Click anywhere outside of the "Layer Definition" tab.
The PCB picture updates dynamically.

Edit Commands for Layers:
"Delete," "Copy," "Paste," and **"Modify"** icons remove, add, and edit a layer. Figure 28 shows internal layers for FR-4, 1.5-mm thick, 4-layer board.

Delete a Layer:
Select a layer from the selection list.
It will be **highlighted.**
Click on the **"Remove"** icon.
The selection list will update to delete the layer.

Copy and Paste a Layer/s:
Select a layer from the selection list.
It will be **highlighted.**
Click on the **"Copy"** icon.
Click on the **"Paste"** icon.
The selection list will update to add the layer.

Modify a Layer:
Select a layer from the selection list.
It will be **highlighted.**
Modify material or **layer thickness** as required.
Click on the **"Modify"** icon.
The selection list will update to modify the selected layer.

Bottom Layer: This is a duplication of the top layer. The material for the bottom layer is also copper or none.
This sub-tab has a pull down menu.

Select the material from none, or 10 % copper through 100 % copper with percentage coverage (see Figure 25).

Enter the bottom layer's thickness in the corresponding **box** in mm (refer to Figure 24).

Click anywhere outside of the "Layer Definition" tab.
The PCB picture updates dynamically.
Figure 29 is an example of a FR-4, 1.5-mm thick, 4-layer PCB.

Via Definition: Most practical designs use via arrays, under and/or around the part, to improve thermal efficiency of a PC board design. Use the **"Via"** tab to specify the **via zone**, and include via array information. The via zone is a rectangular area, which includes the via array.
Refer to Figure 30.

Select the **"Via"** tab.
The via menu page opens.

Via Zone Dimensions:
Enter size X (mm) in the corresponding **box.**
Enter size Y (mm) in the corresponding **box.**

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Via Zone Position (center location on the PCB):
Enter position X (mm) in the corresponding **box.**
Enter position Y (mm) in the corresponding **box.**

Diameter of One Via:
Enter internal diameter (mm) in the corresponding **box.**
Enter external diameter (mm) in the corresponding **box.**

Number of Via on:
X-axis - Enter number in the corresponding **box.**
Y-axis - Enter number in the corresponding **box.**

Select Material Inside Via: SnPb or **air** are the two choices in the pull-down menu.

Click on the **"Add Via Zone"** icon. The via zone information appears in the box below the **via list.** The graphical display also updates with the via zone (refer to Figure 30, a PCB picture updated with a 20-mm x 10-mm via zone located in the center.

Edit Commands for Via Zones:

Modify Position:
Select a **via zone** from the list.
Enter position X (mm) in the corresponding **box.**
Enter position Y (mm) in the corresponding **box.**
Click the **"Modify Position"** icon.
The PCB figure interactively changes to display the new position for the via zone.
Alternatively, **select** a **via zone** from the list.
Pick, drag, and drop the selected **via zone** to new position on the **PCB.**
Copy and Paste:
Select a **via zone** from the list to **highlight.**
Click on the **"Copy"** icon.
Click on the **"Paste"** icon.
The selection list will update to add the via zone.
Use **"Modify Position"** steps to reposition the via zone on the PCB.

Delete Via Zone:
Select a **via zone** from the selection list.
It will be **highlighted.**
Click on the **"Delete"** icon.
The selection list will update to delete the via zone.
The graphical display changes interactively.

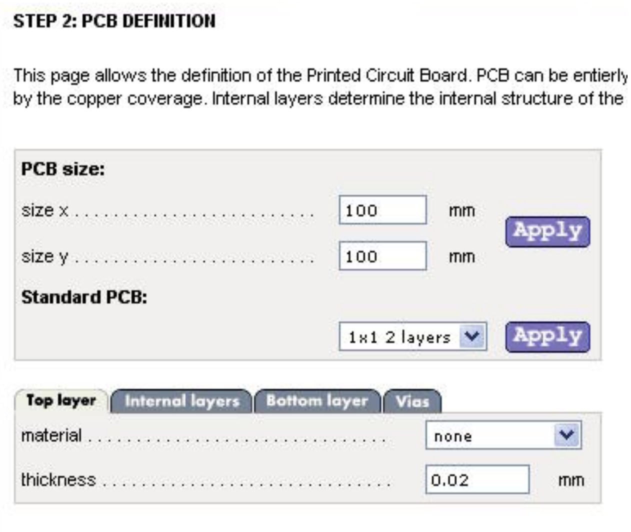

Figure 24.

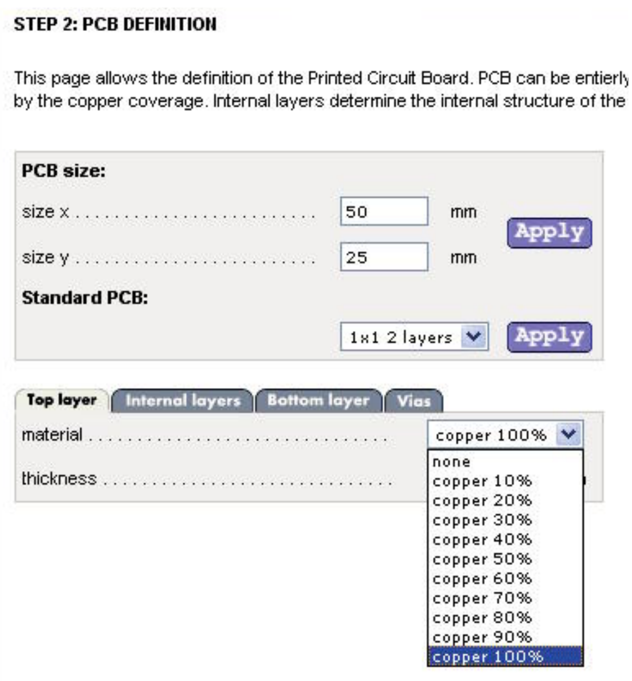

Figure 25.

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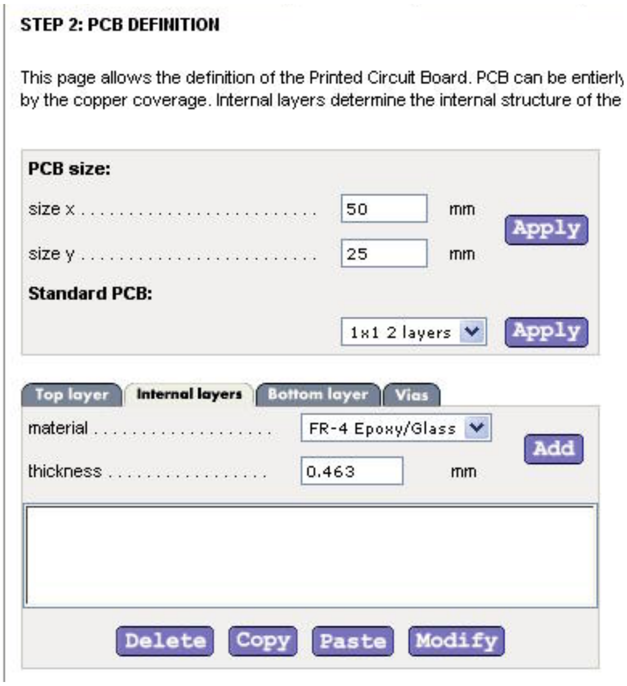

Figure 26.

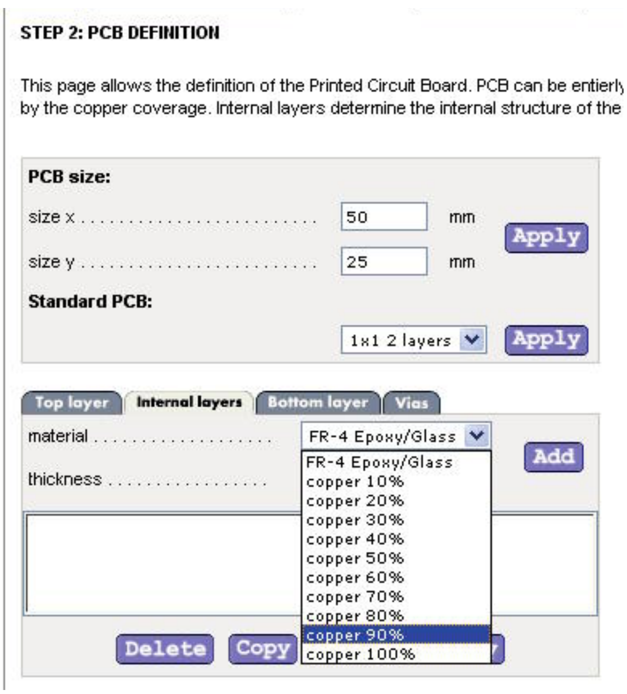

Figure 27.

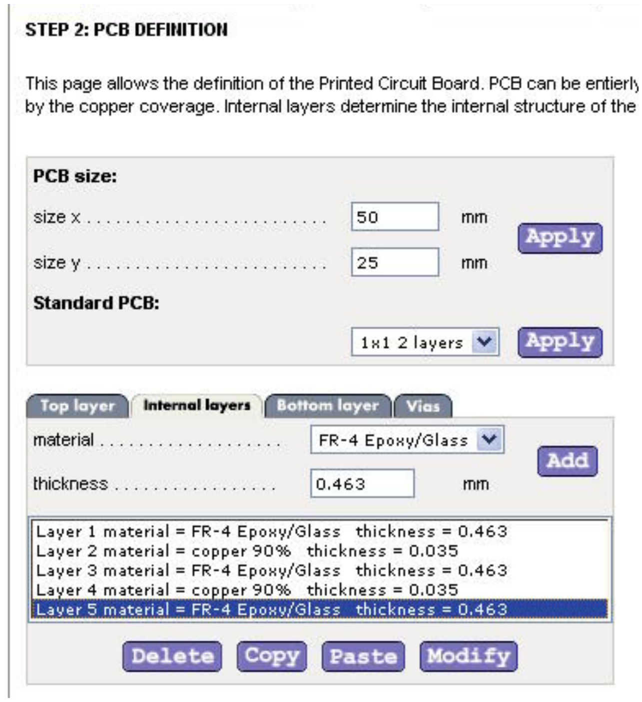

Figure 28.

ThermaSim™ On-Line Thermal Simulation for Vishay Siliconix Power MOSFETs

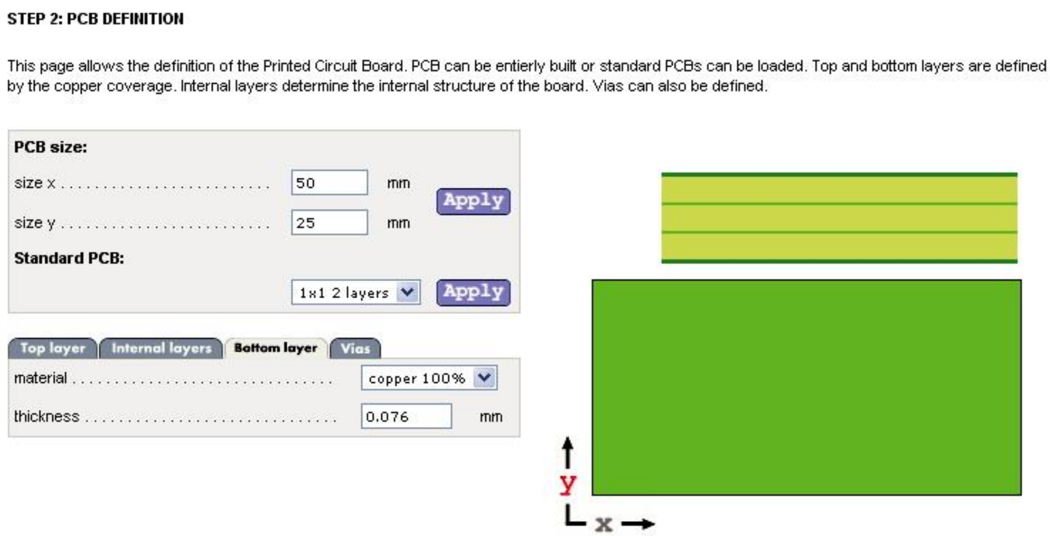

Figure 29.

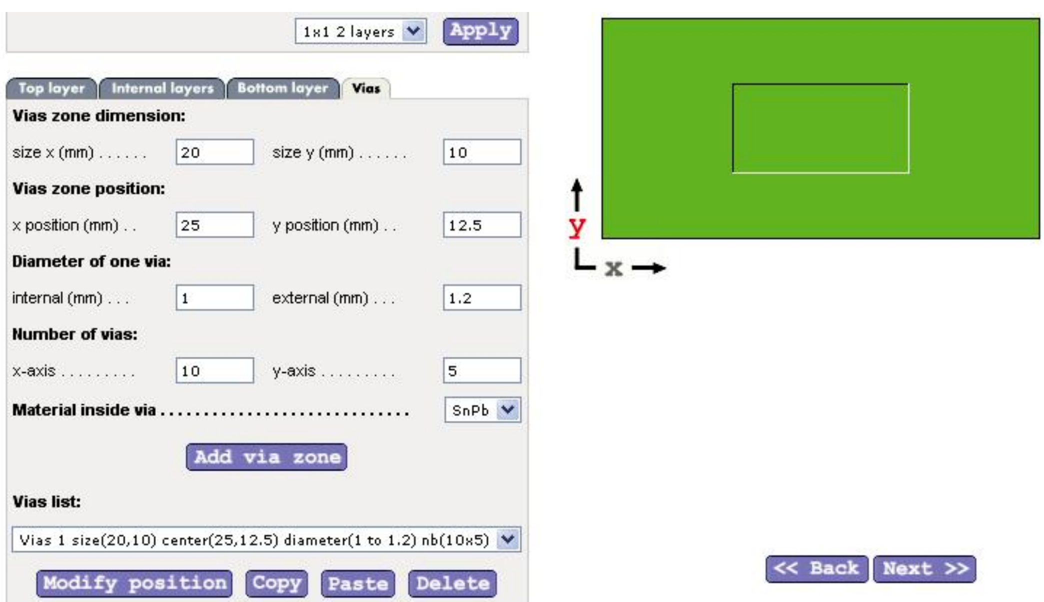

Figure 30.

Click on **"Tab 3: Position"** at the top of the page to go to the next section.
Clicking on the **"Next"** icon at the bottom of the page also takes you to "Tab 3: Position."

Tab 3: Position

This section allows for the placement of components on the PCB, the definition of the component's pad size, and PCB solder definition. The PCB solder definition facilitates evaluating the effect of solder voids.

Place a Component: Refer to Figure 31.
Select a component from the **"Component Selection List."**
Enter component positions X (center) in the corresponding **box** in mm.
Enter component positions Y (center) in the corresponding **box** in mm.
Click the **"Apply"** icon.

The PCB picture interactively updates to move the selected component to its new location.

ThermaSim™ On-Line Thermal Simulation for Vishay Siliconix Power MOSFETs

Pick, Drag, and Drop Command (Alternative):
Select a component from the **"Component Selection List."** The corresponding component will be highlighted in both list as well as on the PCB.
Pick, drag, and drop the highlighted component to the desired location with your mouse's left button.

Change Default Pad Sizes:
Select a component from the **"Component Selection List."**
Enter pad size (lx) in the corresponding **box** in mm.
Enter pad size (ly) in the corresponding **box** in mm.
Click the **"Apply"** icon.
The PCB picture interactively updates to include the new pad (centered around) for the selected component.

PCB Solder Definition: Define solder quality in this section to account for possible air pockets or voids in the solder joint. The default is 100 % solder, 0 % air.

Select a component from the **"Component Selection List."** **Select** one of the four solder definitions from pull-down menu (see Figure 32). The options are: (a) **100 % solder, 0 % air,** (b) **90 % solder, 10 % air,** (c) **80 % solder, 20 % air, and** (d) **70 % solder 30 % air.**

Click the **"Apply"** icon.
This applies property changes internally in the design database. ***There will not be any changes in the PCB graphics.***

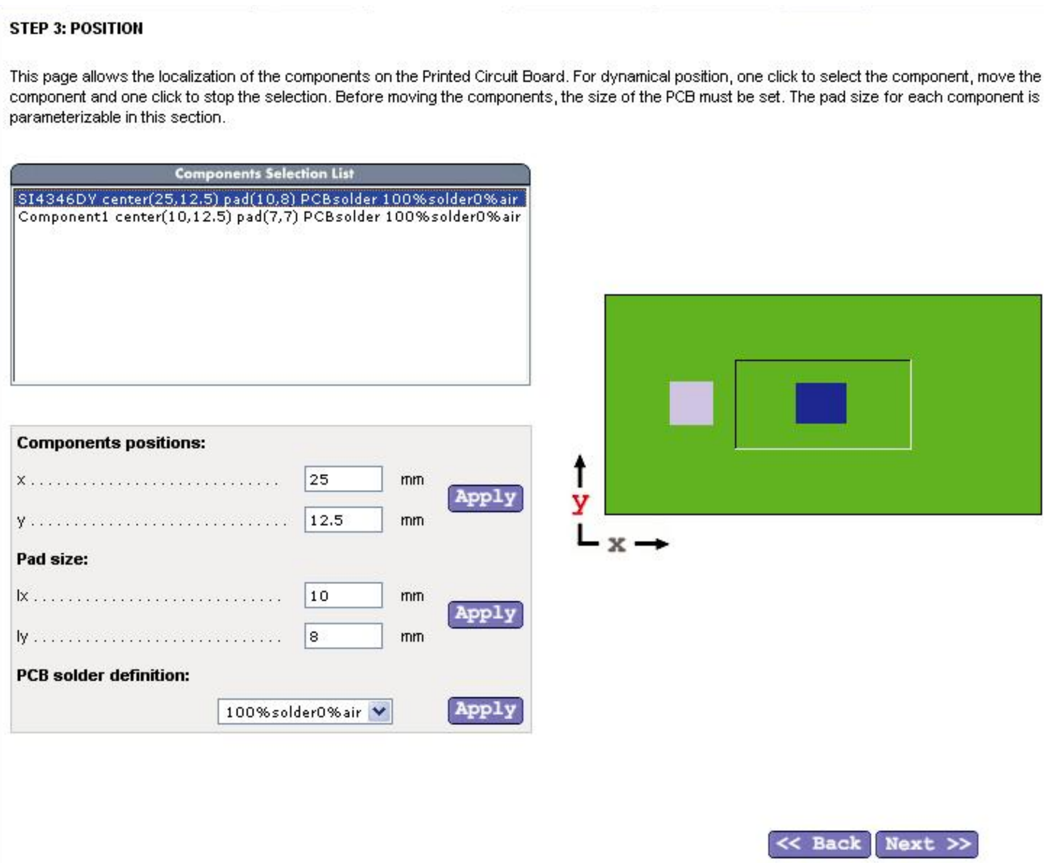

Figure 31.

ThermaSim™ On-Line Thermal Simulation for Vishay Siliconix Power MOSFETs

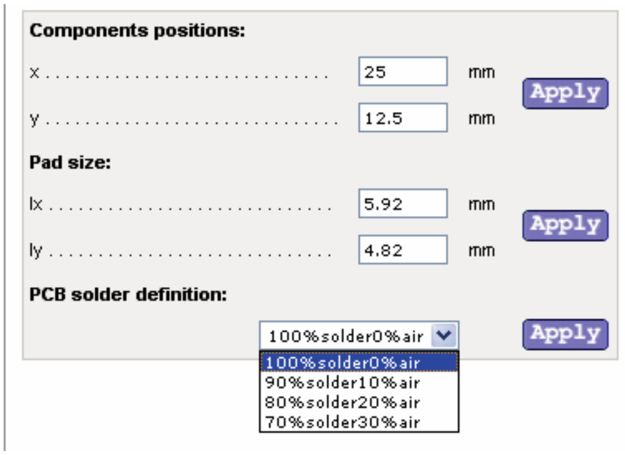

Figure 32.

Click on **"Tab 4: System"** at the top of the page to go to the next section.
Clicking on the **"Next"** icon at the bottom of the page also takes you to "Tab 4: System."

Tab 4: System

This section allows you to specify the ambient temperature and the orientation of the PCB and airflow if applicable. Also, you can specify additional simulation settings for transient simulation. ***The "Enclosed Environment" tab is inactive at this time;*** however, it is a provision for future features.

Infinite Environment: This tab covers convection definitions (refer to Figure 33).
Enter Ambient Temperature in the corresponding **box** in °C.
Click the **"Free Convection"** radio button.
The Adjacent pull-down menu on the right side offers three options for PCB orientation:

- **Z gravity** for a PCB with the component on the top side (see the interactive picture on the right side in Figure 33).
- **-Z gravity** for an upside down PCB with the component on the bottom side (see the interactive picture on the right side in Figure 34).
- **XY gravity** for a PCB with a vertical orientation (see the picture in Figure 35).

In a system with air flow, **select** the **"Air Flow"** radio button.
The adjacent pull-down menu offers six options for the direction of airflow:

- **Z to -Z direction** for air blowing on top of the component (see Figure 36).
- **-Z to Z direction** for air blowing from the bottom with the component on the top side (see Figure 37).
- **X to -X direction** for air blowing right to left over the PCB and component (See Figure 38).
- **-X to X direction** for air blowing left to right over the PCB and component (see Figure 39).
- **Y to -Y direction** for air blowing over the PCB in -Y direction over the component (see Figure 40).
- **-Y to Y direction** for air blowing over the PCB in +Y direction over the component (see Figure 41).

Enter the value of the airflow's **normal velocity** in the adjacent **box** in meters per second (refer to Figure 41).

Enclosed Environment: ***This is inactive at this time.*** It is a provision for a feature we intend to offer in the future.

Simulation Settings: Complete the definitions of steady-state or transient simulations settings in this section.
Select the **"Steady-State"** radio button as shown in Figure 42 for steady-state simulations.

There are four steps to complete for transient simulation settings (refer to Figure 43).
Select the **"Transient"** radio button.
Enter the value for **initial time** in the adjacent **box.** This helps to keep the file size smaller and speeds up the simulation process. Please note that the ***initial time value is always lower than final time.***
Enter the value for **final time** in the adjacent **box.**
Click the **"Next"** icon at the bottom of the page to check if the entry is correct.
An **error message window** will **pop up** for a wrong entry. Figure 44 is an example of an error message for the mismatch of final time and time step. The mistake here is ***final time/time step*** = 100/0.01 = 10000. This is more than ***2000 limit.***
Click "OK."
Correct the entry, and proceed.
Enter the value of the **time step** in the adjacent **box** (see Figure 43).
Click the **"Next"** icon at the bottom of the page to check if the entry is correct.
An **error message window** will **pop up** for a wrong entry, as shown in Figure 45. Here a value of 0.001 for the time step is lower than the ***minimum limit of 0.01.***
Click "OK."
Correct the **entry**, and **proceed.**

Please note that all of the above-mentioned limitations help to limit the simulation size and time, which is very important for an on-line simulation.

ThermaSim™ On-Line Thermal Simulation for Vishay Siliconix Power MOSFETs

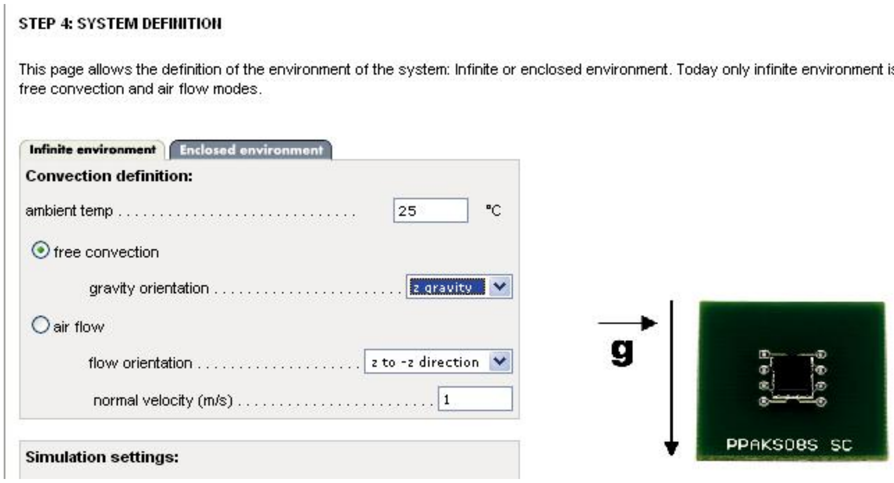

Figure 33.

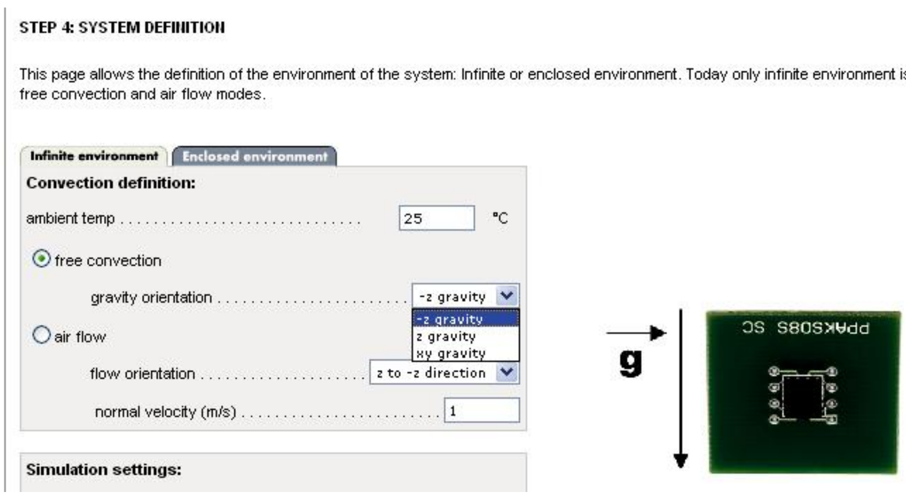

Figure 34.

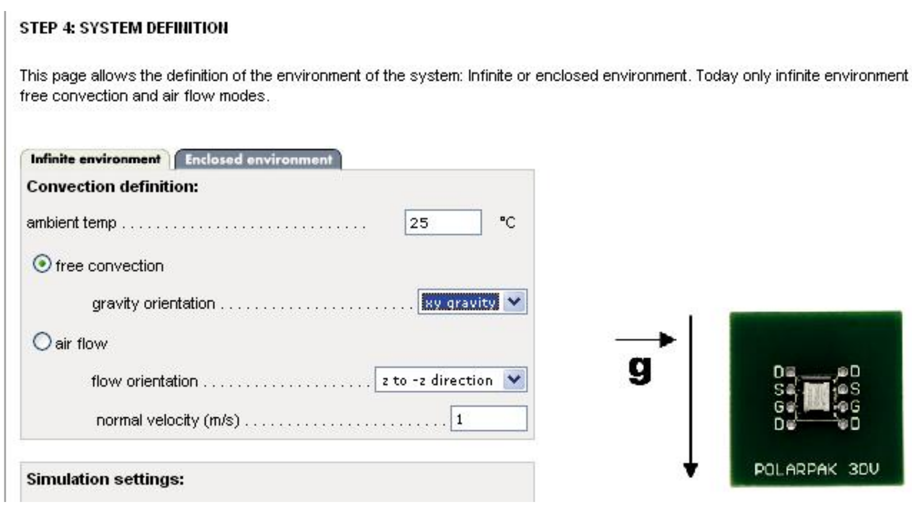

Figure 35.

APPLICATION NOTE

ThermaSim™ On-Line Thermal Simulation for Vishay Siliconix Power MOSFETs

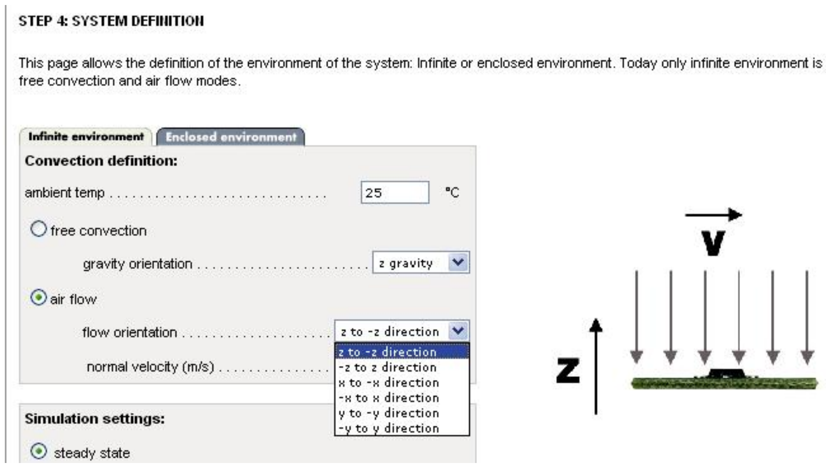

Figure 36.

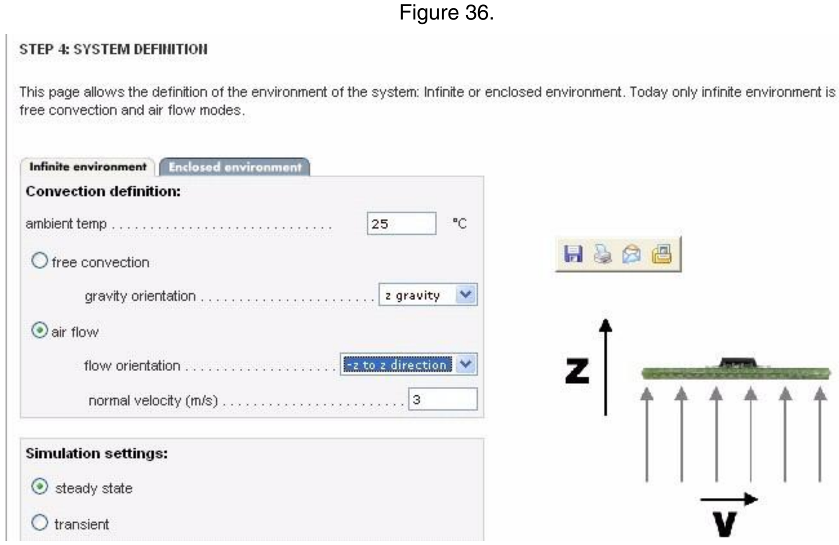

Figure 37.

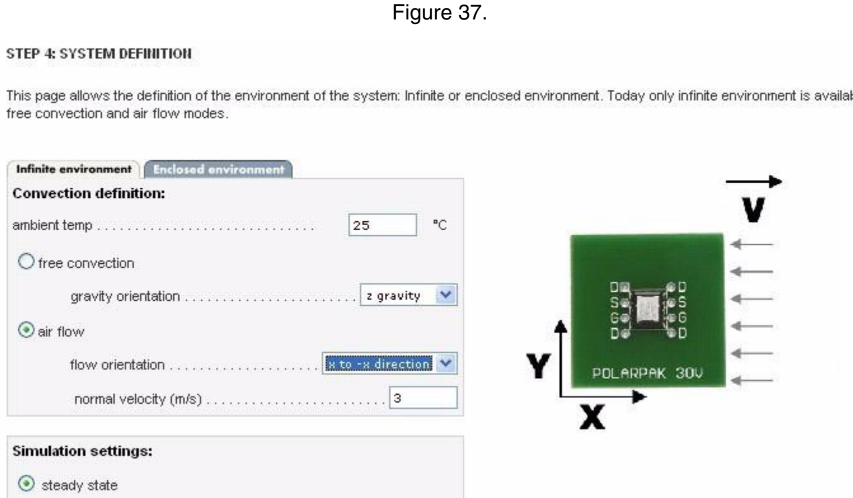

Figure 38.

APPLICATION NOTE

ThermaSim™ On-Line Thermal Simulation for Vishay Siliconix Power MOSFETs

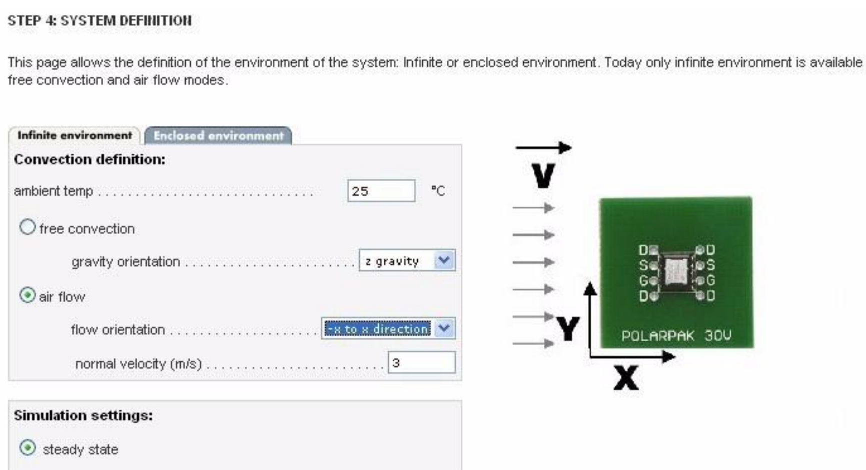

Figure 39.

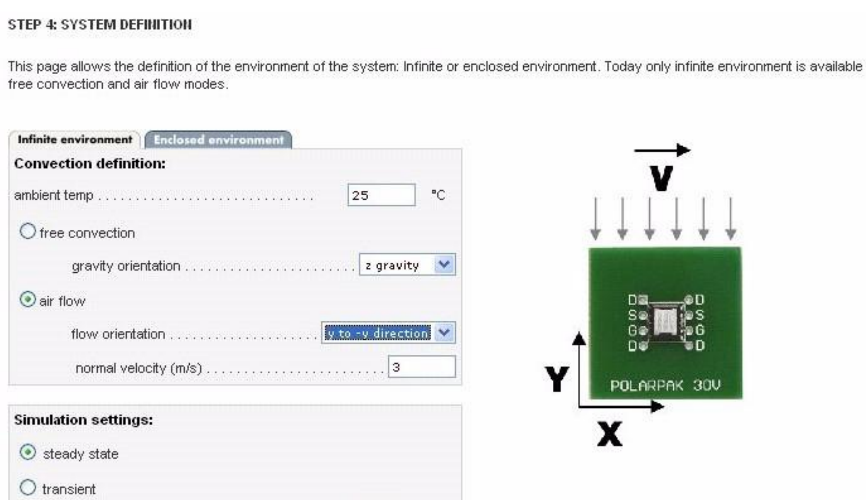

Figure 40.

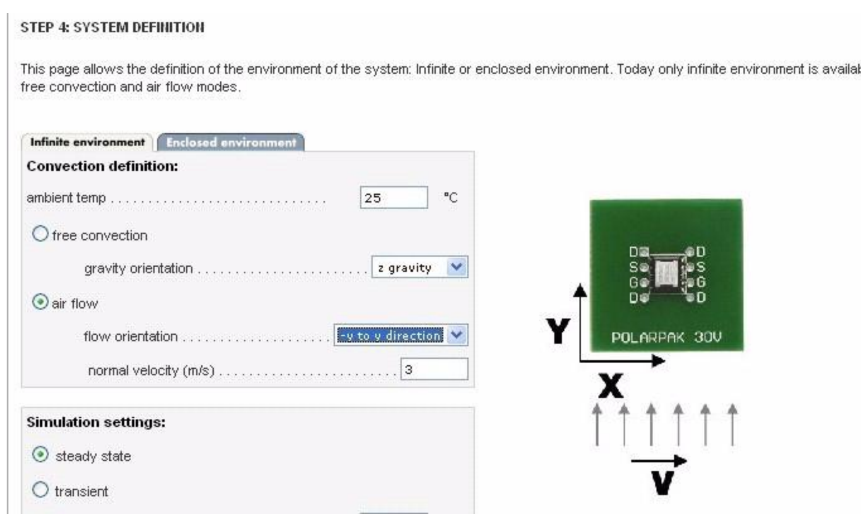

Figure 41.

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ThermaSim™ On-Line Thermal Simulation for Vishay Siliconix Power MOSFETs

Figure 42.

Figure 43.

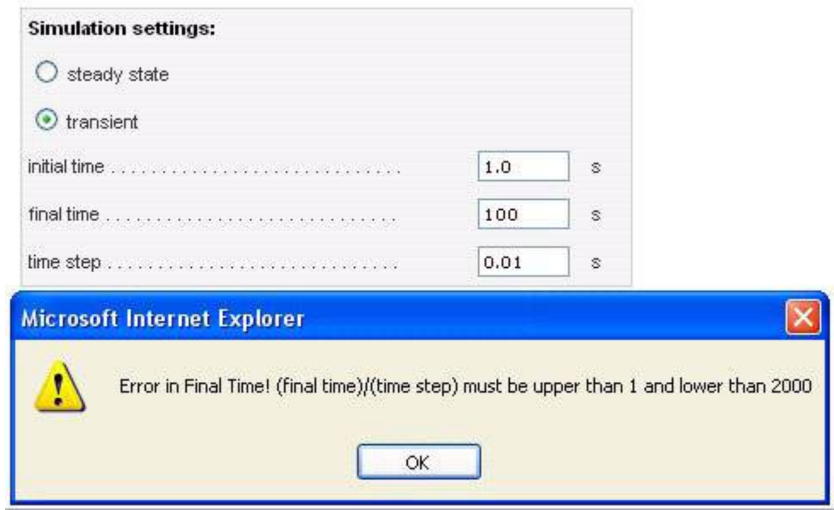

Figure 44.

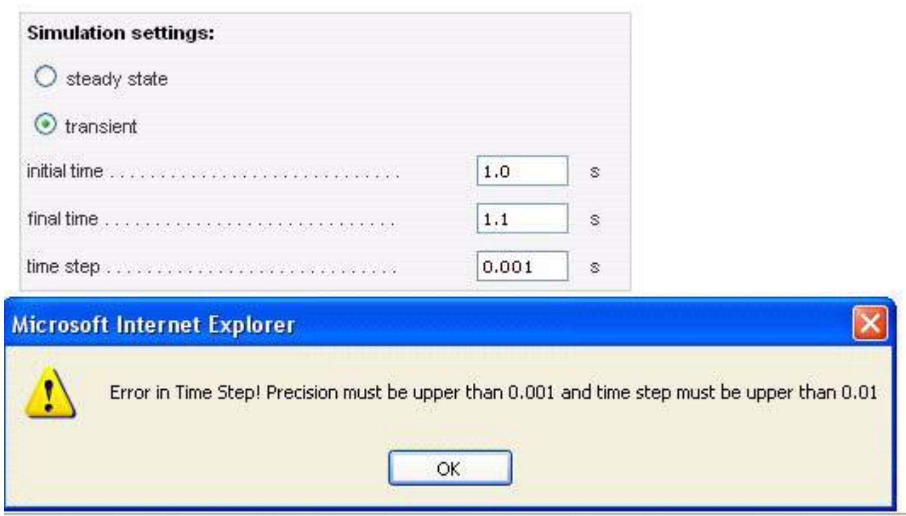

Figure 45.

Click on **"Tab 5: Simulation Setup"** at the top of the page to go to the next section.

Clicking the **"Next"** icon at the bottom of the page also takes you to "Tab 5: Simulation Setup."

ThermaSim™ On-Line Thermal Simulation for Vishay Siliconix Power MOSFETs

Tab 5: Simulation Setup

This section allows you to select the accuracy of simulation results, specify the email address of the recipient, save the configuration for future use, and to select the output data in a PDF format.

Simulation Settings:
Select Accuracy Level: The two pull-down menu options are **85 % or 95 %** (see Figure 46). Selecting 85 % accuracy gets simulation results within 5 °C to 10 °C while maintaining a reasonable file size and a quick turn around time for the results email. On the other hand, selecting 95 % accuracy gets simulation results up to 5 °C. However, this can take surprisingly long (even up to a day) to get the results email.

Enter recipient's **email** (address) in the adjacent **box** (see Figure 47).

Saving Configuration:
Enter a file name in the adjacent **box.**
Click the **"Save Configuration"** icon to save the work for future or repetitive use (refer to Figure 48). Later we will discuss how to load and use a saved configuration.

Output Data:
Select a **component** from the list to **highlight** (see Figure 49).
Check the **boxes** for the data you wish to receive.
Click the **"Apply"** icon.
Repeat all three steps for each component in the list.

Click the **"Start Simulation"** icon at the bottom of the page or **select "Tab 6: Run."**

The **"Simulation Checking"** window opens with list of all input data information for final review (refer to Figure 50).
Click "Send" to send the acceptable data for simulation after review.
Click "Cancel" to go back and edit data if necessary.
The pop-up message shown in Figure 51 confirms the successful submission of data.
Click "Close" to return the to design.

Clicking on the **"Back"** icon on any page takes you back to the previous page.
Also, **select any Tab in the top menu** to go to that section of the design.

Load a saved configuration:
Click on **"Load"** tab.
The load page opens as shown in Figure 52.
Click on the **"Load Configuration"** icon.
The system refreshes to "Tab 1: Components."

Click on **"Load"** again. This time the load window opens as shown in Figure 53, with one of the saved configuration's file names in the list window.

Click on **the pull down menu** to list all the saved configuration files, as shown in Figure 54. **Select** a file and click **"Open"** to load a file.
The design opens staring with "Tab 1: Components."
Modify the design as necessary on any page, save it with different name, and run the simulation.

Delete a Saved Configuration:
Select a file and **click "Delete"** to remove the unwanted configuration from the saved database.

?On-Line help
This menu is available on all pages of the design. A quick reference guide is available here.

?e-mail
This tab is available to send questions and comments for technical help. Include a snap shot of the screen to describe the problem. The latter helps generate prompt and accurate responses.

Simulation Results:
Refer to Figure 54, which is a snap shot of a simulation result email. The subject includes the name of the MOSFET component under study. The body of the email covers the simulation input data. There are two attachments: a result.pdf and a result.txt.

"result.pdf": The result.pdf document has three sections:
- **Input Data** (see Figure 55) - This section lists all relevant design data.
- **Global Results** (see Figure 56) -This section lists the minimum and maximum temperature values of the system, and the flux, or power dissipated, through the PCB.
- **Component Results** (see Figure 57) - This section lists the temperature values for the MOSFET component, such as minimum and maximum die temperatures, top and bottom temperatures of the package, and the flux to the PCB

"result.txt": The result.txt document lists output values in text format (see Figure 58). The latter facilitates data analysis while evaluating different scenarios.

ThermaSim™ On-Line Thermal Simulation for Vishay Siliconix Power MOSFETs

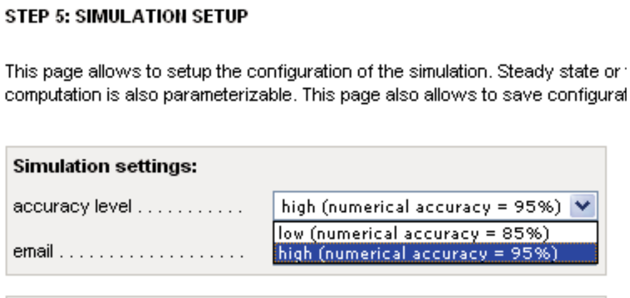

Figure 46.

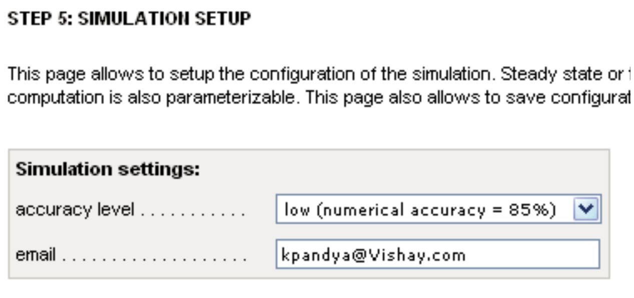

Figure 47.

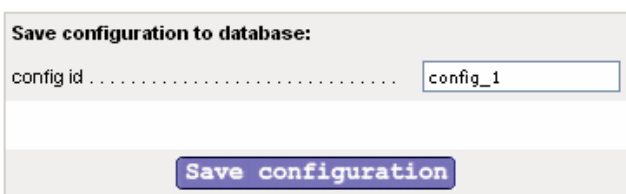

Figure 48.

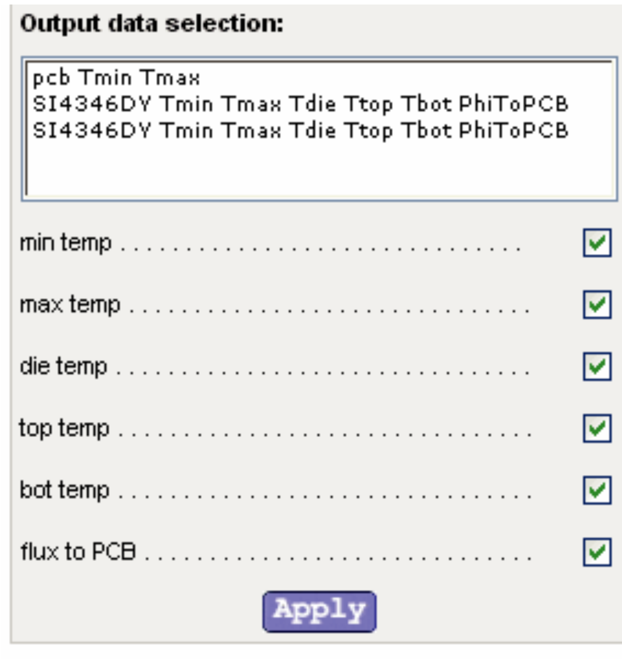

Figure 49.

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ThermaSim™ On-Line Thermal Simulation for Vishay Siliconix Power MOSFETs

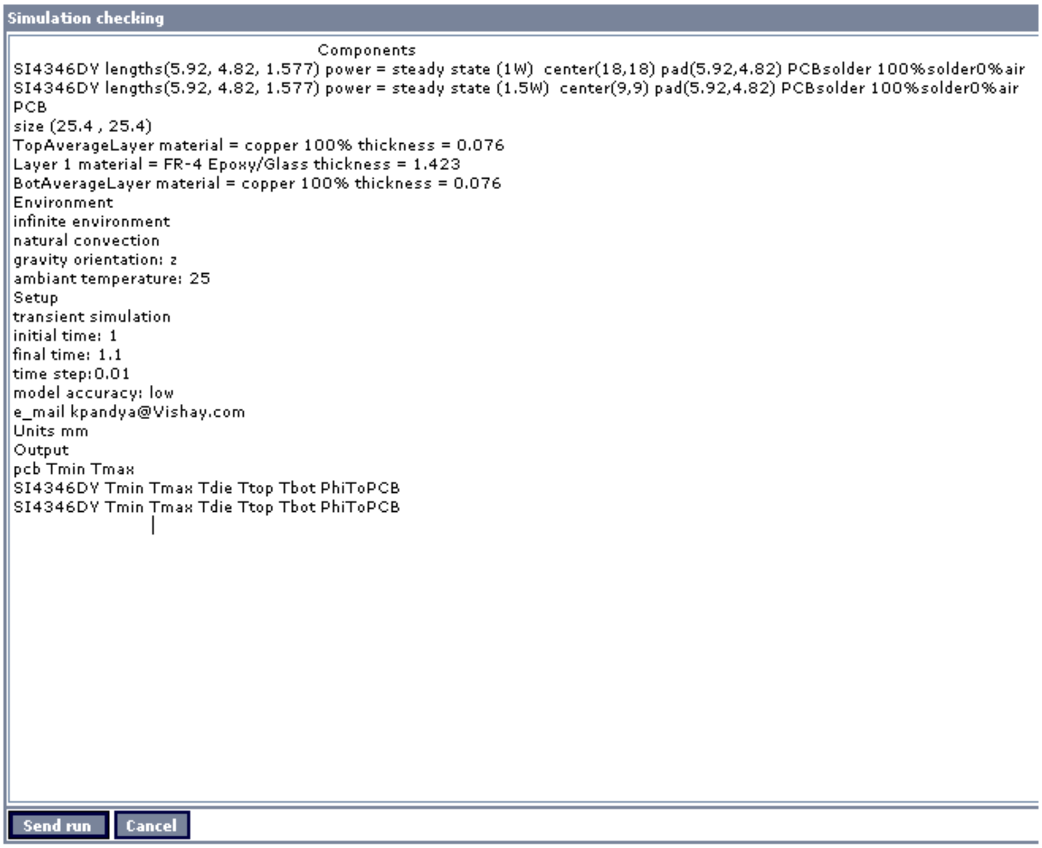

Figure 50.

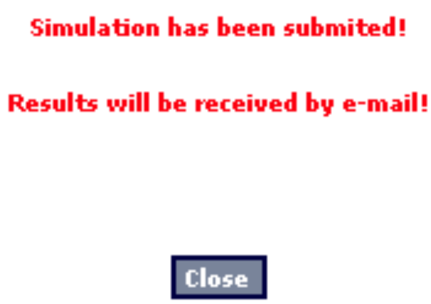

Figure 51.

Figure 52.

ThermaSim™ On-Line Thermal Simulation for Vishay Siliconix Power MOSFETs

Figure 53.

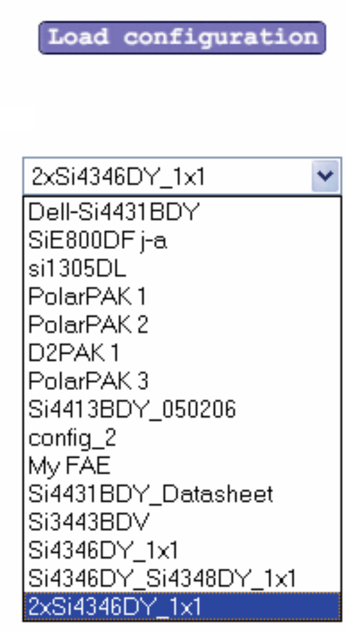

Figure 54.

ThermaSim™ On-Line Thermal Simulation for Vishay Siliconix Power MOSFETs

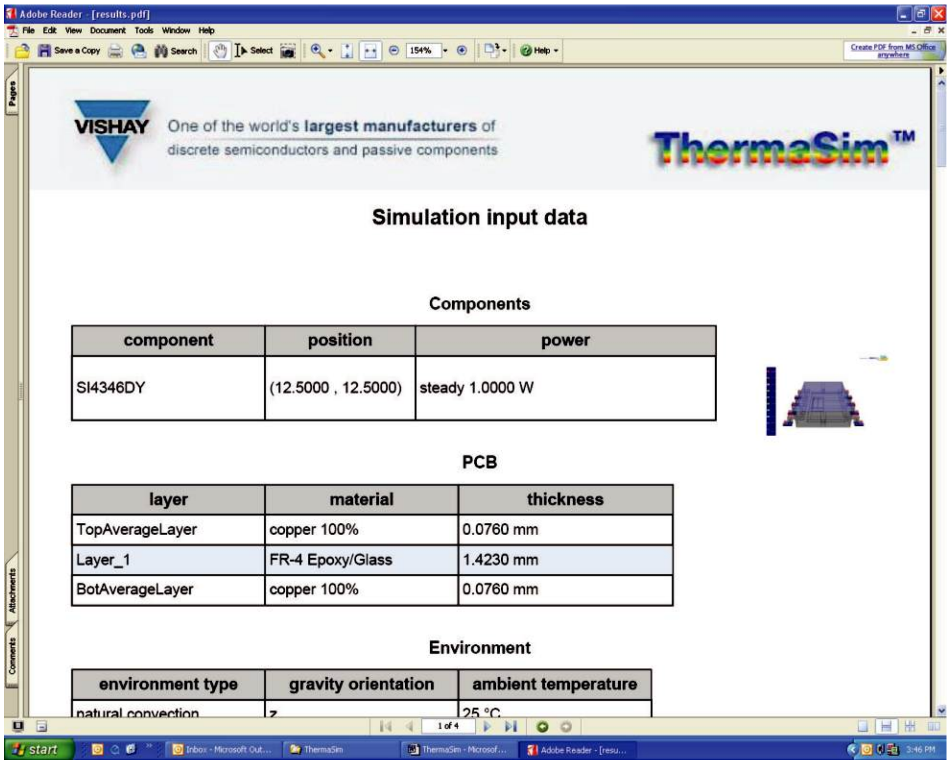

Figure 55.

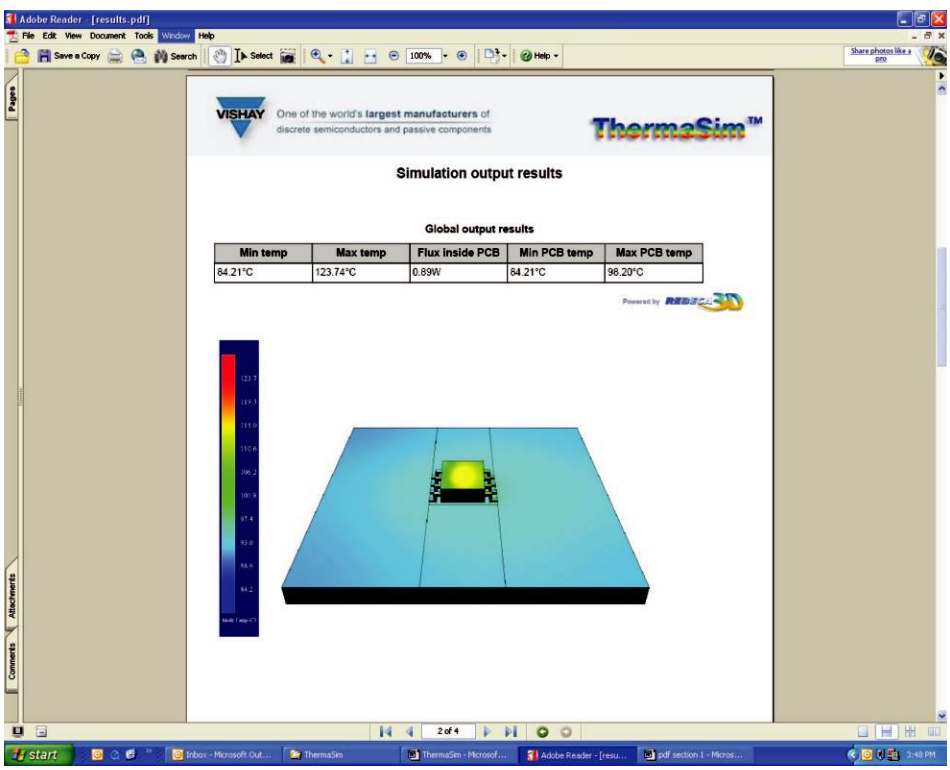

Figure 56.

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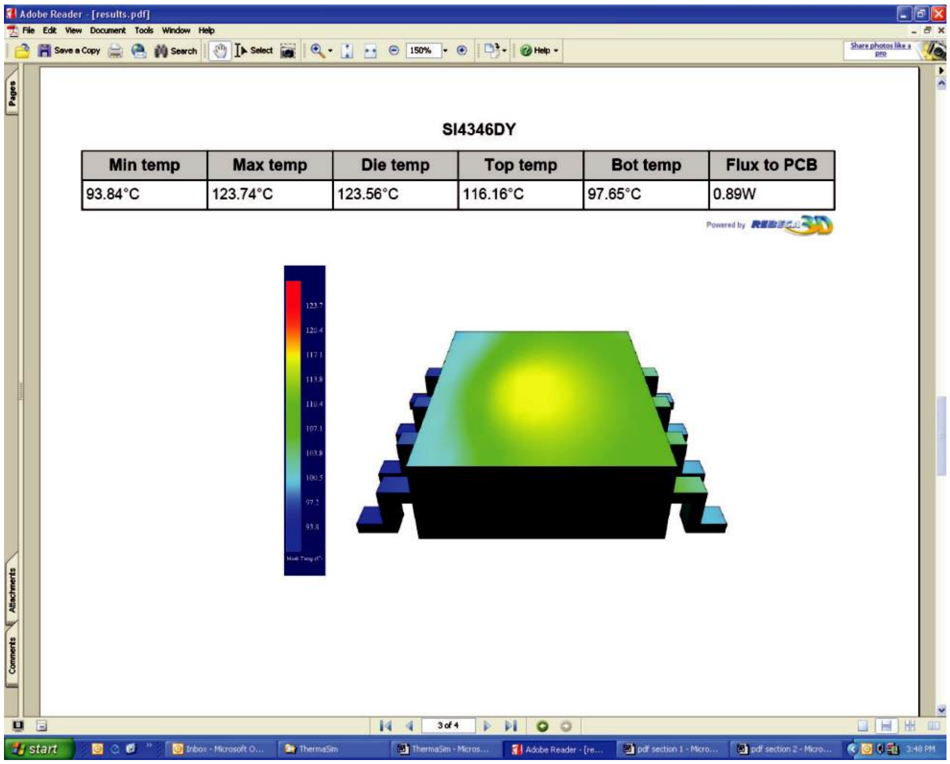

Figure 57.

Minimum system temperature = 84.21 °C
Maximum system temperature = 123.74 °C
Tot flux PCB = 0.89 W Tmin PCB = 84.21 °C Tmax PCB = 98.20 °C

Number of components = 1
SI4346DY Tmin = 93.84 °C
SI4346DY Tmax = 123.74 °C
SI4346DY Tdie = 123.56 °C
SI4346DY Ttop = 116.16 °C
SI4346DY Tbot = 97.65 °C
SI4346DY PhitoPCB = 0.89 W

Figure 58.

Summary of Simulation Examples:

Appendix B
Steady-state analysis for Si4368DY on FR4 1-in. x1-in., double-sided PCB with 2 oz. copper.

Appendix C
Step transient simulation for SOIC-8.

Appendix D
Cyclic transient simulation for DPAK, SUD.

Appendix E

Steady-state solution for D^2PAK, DPAK, PowerPAK, and PolarPAK with heat sink and air flow.

For the appendices please refer to the following link:

http://www.vishay.com/doc?69535

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