# A COMSOL APP for thermal analysis of electronic devices

Petrone G.*, Barbagallo C., Scionti M.

BE CAE & Test S.r.l., Viale Africa 170 - Sc.A, 95129, Catania, ITALY.

*Corresponding author: Viale Africa 170 - Sc.A, 95129, Catania, ITALY; giuseppe.petrone@be-caetest.it

**Abstract:** Among the new features introduced by the last versions of COMSOL Multiphysics, the opportunity of building up customized model interfaces by exploiting the Application Builder is for sure one of the most promising. Arising from this concept, the Certified Consultant BE CAE & Test presents a COMSOL APP built-up to analyse the thermal behavior of an electronic Surface-Mount Device (SMD). The created APP was also run on the COMSOL Server platform for testing its remote use.

**Keywords:** Application Builder, Thermal analysis, Combo Box, Global material link, COMSOL Server.

## 1. Introduction

The Application Builder is a new feature that promises to revolutionize the concept of simulation. It allows engineers to create easy-to-use applications based on their simulations. The engineer creating the application customizes the interface and controls the inputs and outputs that the user of the app will be allowed to manipulate. Apps are built by experts who include only the parameters relevant to the design of a specific device or process. The apps then make the simulation engineer's expertise available to everyone involved in the design and manufacturing processes across all engineering disciplines of an organization. By enabling more people to access simulation in an organization, product designs and processes can be improved efficiently and effectively. Two tools are integral to the Application Builder: The Form Editor and the Method Editor. The Form Editor is the platform for building your apps and allows for easy creation of your app's user interface through drag-and-drop capabilities. The Method Editor is used to extend your app's simulation capabilities by providing a programming environment for use with Java code [1].

Moreover, apps can in turn be uploaded to COMSOL Server that is an intuitive and flexible platform that allows access to and management of your simulation applications locally or on a central or cloud-based machine to support multi-user operation. COMSOL Server can be accessed via any modern web browser, including those found on mobile devices [2]. On this base, a COMSOL APP for thermal analysis of electronic devices is presented.

## 2. Application building

The created GUI is shown in Fig.1. The APP allows to compute thermal distribution of a SMD device for several geometrical and functional configurations. Users can set solder layer thickness, materials properties and dissipated thermal power. As result, junction temperature and junction-to-case thermal resistance are available.

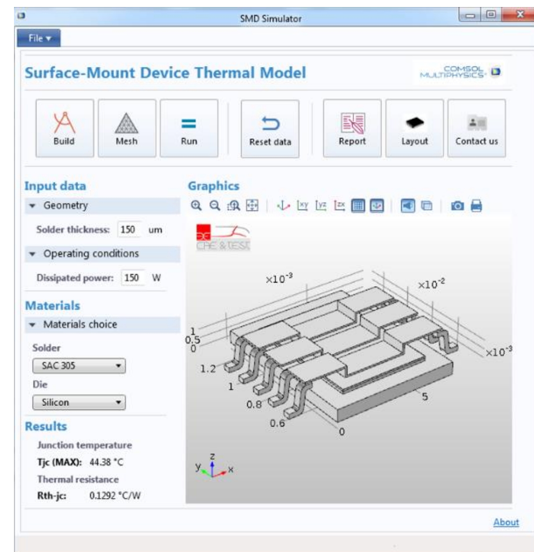


**Figure 1**. SMD Simulator.

The APP was built-up using the Application Builder of COMSOL Multiphysics version 5.1. The proposed tool exploits several functionalities of the Application Builder, such as Action Buttons, Input Fields, Combo Boxes, Graphics and Data Display. Some features were

implemented concerning global/local links for material definition, declarations, initial values and methods for manage strings in combo box application and global variable values assumed by specific probes. The steps of application building and implemented functionalities are presented in the following paragraphs.

## 2.1 Model layout

The layout of the studied SMD device is shown in Fig. 2. The device is mainly made by a copper frame, a lead-free solder layer (also called solder die) and a silicon die equipped with a front metal, which is connected to device pins by several ribbons.

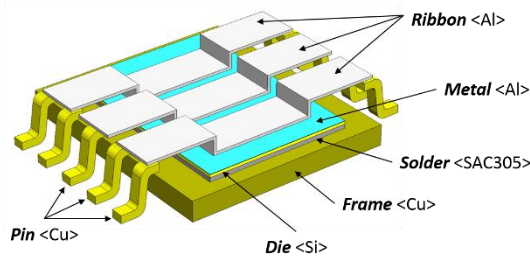


**Figure 2**. Layout of the numerical model.

## 2.2 Action buttons

The action buttons tab, that is shown in Fig.3, displays the model and application actions that can be run by clicking a button in the application user interface [3]. In particular, we implemented some action buttons: Build, Mesh, Run, Reset data, Report, Layout and Contact us.

Build button allows to show in the graphic window the updated geometry after setting solder thickness in the suitable input field. Mesh button permits to generate the mesh of the numerical model. Run button consents to compute the implemented study. Reset data button permits to return to the default settings. Report button shows a resume of the performed simulation. Layout button shows information about geometry and materials of the SMD device. Contact us button shows the contacts of our company.

**Figure 3**. Action buttons tab.

## 2.3 Input fields

Input fields allow to manually set geometrical and functional parametric data. In particular, users can set solder layer thickness, and dissipated thermal power, as shown in Fig.4.

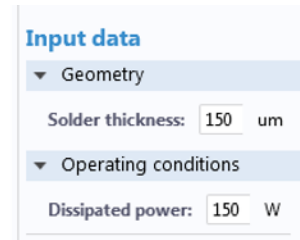


**Figure 4**. Input fields.

## 2.4 Combo boxes

Two combo boxes were implemented in order to change material for solder layer and die. The material choice is implemented in the embedded model using global materials and a material link, as shown in Fig.5. Each material is indexed with a string, where global variables are defined. For the global variables both an initial value and a choice list were associated. An event listens for changes to the value of the global variable, where the value is controlled by a combo box. When the value is changed, the local method implemented in the Application Builder permits to change materials in combo boxes [3].

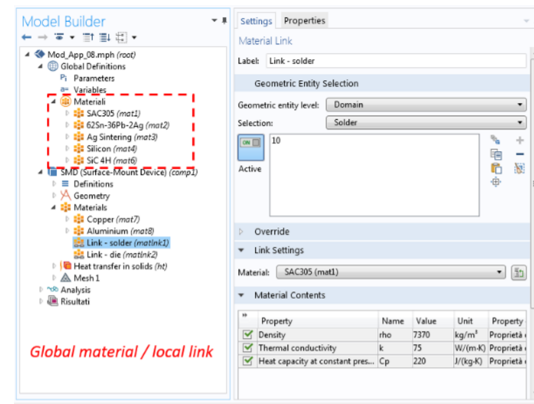


**Figure 5**. Global materials implementation.

### 2.5 Data display

A data display object is used to display the outputs of thermal model, that are maximum junction temperature ($T_{jc}(MAX)$) and junction-to-case thermal resistance ($R_{th-jc}$) of SMD. In particular, a probe was defined assuming a global variable value for junction-to-case thermal resistance, defined as shown in Fig.6. The thermal resistance value depends by another probe value, that is $T_{jc}(MAX)$, defined as shown in Fig.7.

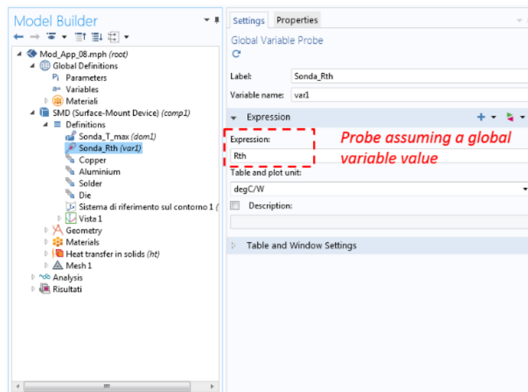


**Figure 6**. Junction-to-case thermal resistance probe implementation.

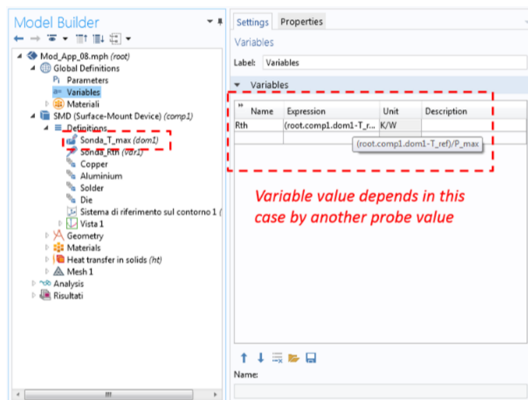


**Figure 7**. Maximum junction temperature probe implementation.

### 2.6 Graphics

The dynamic graphic window displays updated geometry, mesh and thermal map of SMD device as post-processing result. In Fig.8, a GUI snapshot of the APP is shown in one of the possible geometrical and functional configurations.

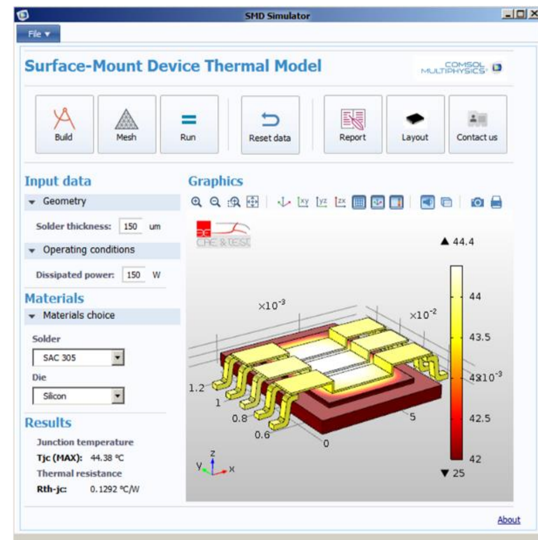


**Figure 8**. GUI snapshot of the APP.

### 3. Exploiting APP by COMSOL Server

The APP built-up by BE CAE & Test was also live tested on COMSOL Server platform () during a specific event [], showing the opportunity of exploiting it by a remote control through COMSOL Client and a web browser.

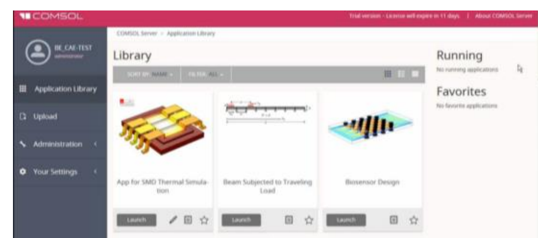


**Figure 9**. Snapshot taken by the live-event showing the APP running on COMSOL Server.

### 4. Conclusions

A COMSOL APP for thermal analysis was built-up in order to compute thermal distribution of a SMD device for several geometrical and functional configurations exploiting several available features of the COMSOL Application Builder. As result, junction temperature and junction-case thermal resistance are available. The presented APP well shows the opportunity of revolutionizing the concept of simulation for users, representing a competitive advantage in terms of organizational efficiency for companies.

## 5. References


1. COMSOL Multiphysics website, http://www.comsol.com/release/5.1/application-builder

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## 6. Nomenclature

| Symbol | Quantity | Unit |
|---|---|---|
| $R_{th\text{-}jc}$ | Junction-to-case thermal resistance | °C/W |
| $T_{jc}$(MAX) | Maximum junction temperature | °C |