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Thermal Management Calculator Discussion

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Thermal Manangement Calculator

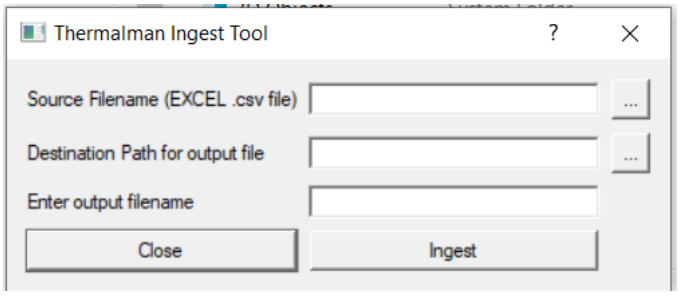
This "Calculator" is for sizing electrical conductors in printed circuit boards. The **Thermal Management Software** is a database of current carrying capacity data. Data from this software database were used to create "*Standard for Determining Conductor Current-Carrying Capacity In Printed Board Design*", IPC 2152. This design tool has more information than was published in the standard. It is for determining the size of electrical conductors based on the temperature rise of conductors as a function of PCB physical parameters and current.

As some people know and others are learning, the charts in IPC-2221 goes back to work performed by the National Bureau of Standards in 1955 and published in 1956. Their work only addressed external conductors. Those conductors were on Phenolic and Epoxy boards. In addition, their results were all compiled together to create a chart that was labeled "tentative". Their test results were a mix of variables that effect trace temperature, such as board thickness, board material, trace thickness and some of the test boards had copper planes on the back of them. All of these variables influence the temperature rise of the trace, some more significantly than others, which makes it difficult to ascertain the actual temperature change of a trace in various board configurations. That was for the external traces. The internal trace charts were not based on test data, they were simply based on half the current from the external trace chart. This has caused problems throughout the electronics design community due to increasing currents, high-density electronics and design standards that are not well understood.

Now with a fresh start, all of the variables are separated, so that design decisions can be made with a better understanding of conductor heating. The **Thermal Management Software** is a collection of years of research. The database contains test results that have been validated by a U.S. Air Force Independent Research group and a Navy test lab. The test data covers 1 and 2oz internal and 2oz external traces for FR4 and ½ oz, 1, 2, 3 oz internal and 2, 3 oz external traces for polyimide in Air and Vacuum.

Additional information is also included that shows the influence of copper planes on heat spreading and lowering trace temperatures. The software has the capability of importing new trace charts. A process of creating technology specific design charts is well defined.

As new charts are created they can be imported through an "Ingest Tool". The interface is simple and only requires data input through a comma separated variable format.



Figures 1-9 shows the initial graphical user interface for the calculator followed by other attributes.

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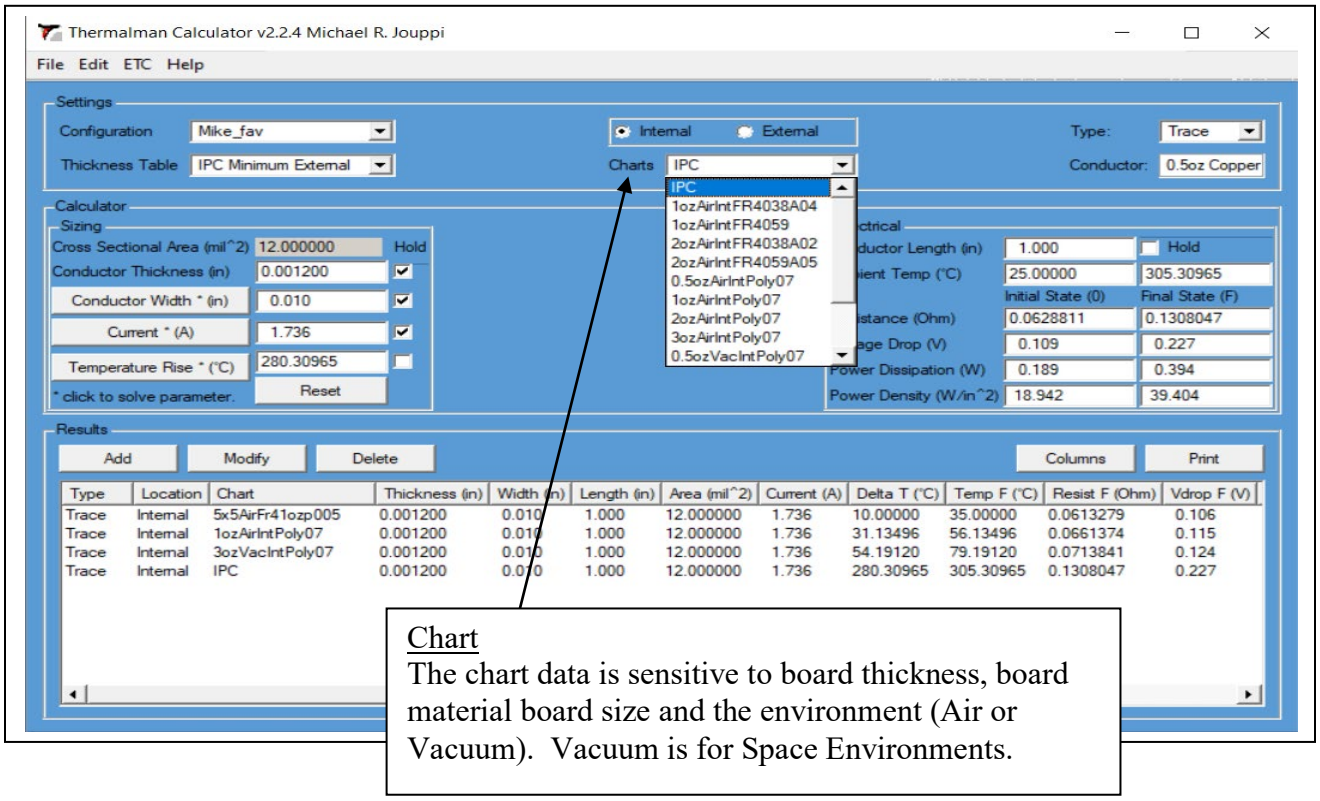

Figure 1. Charts

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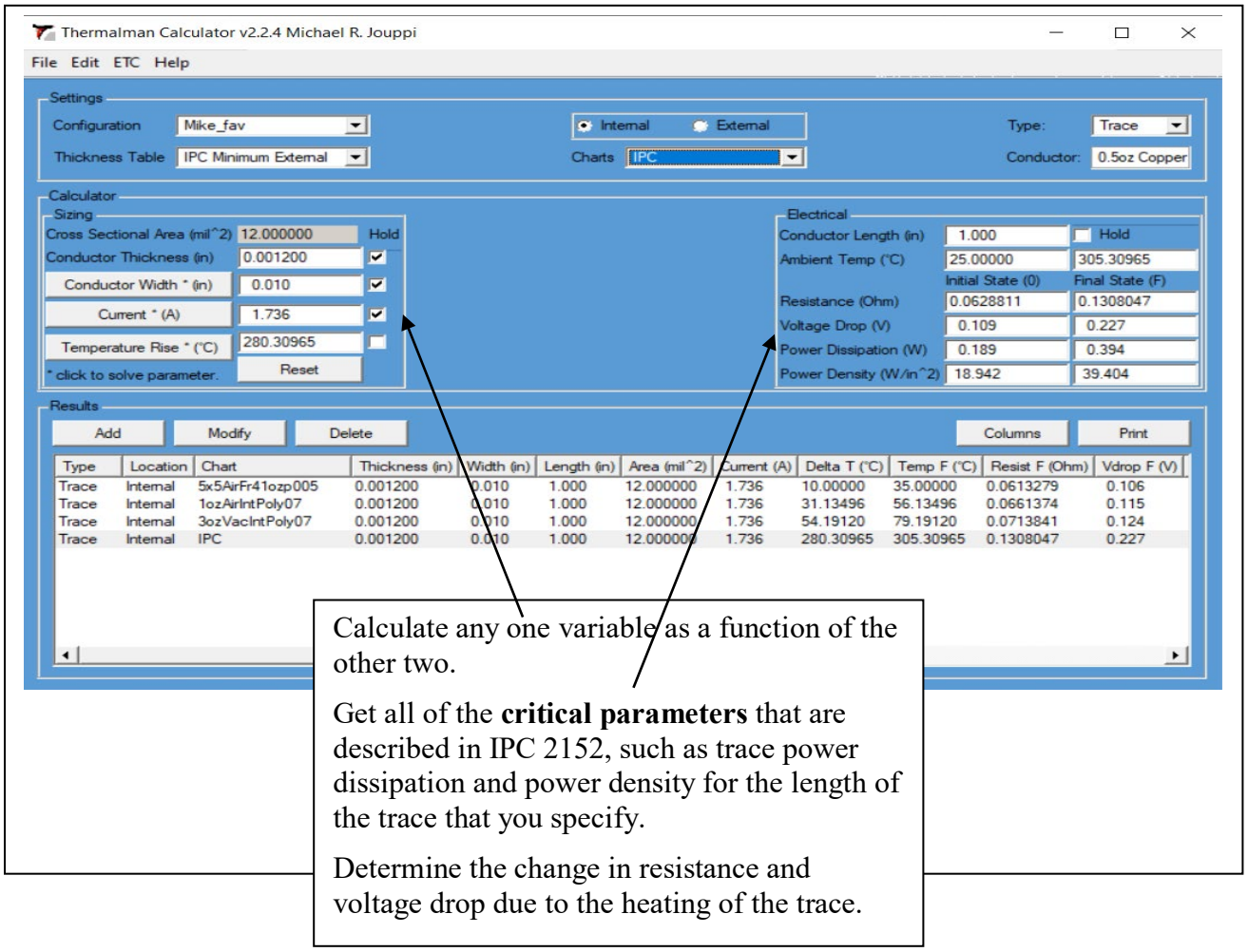

Figure 2. Calculations

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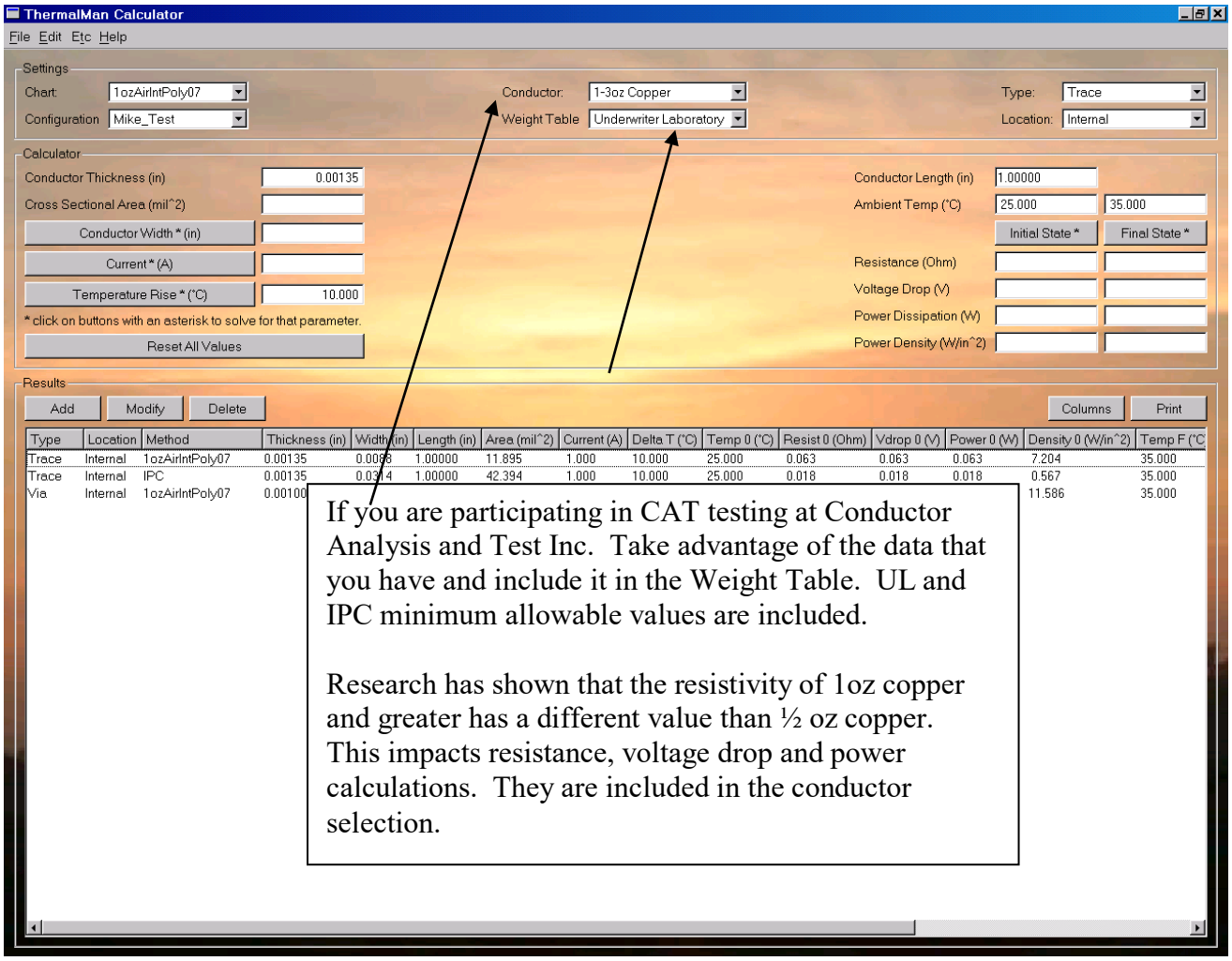

Figure 3. Conductor Analysis Test Data and Weight Table

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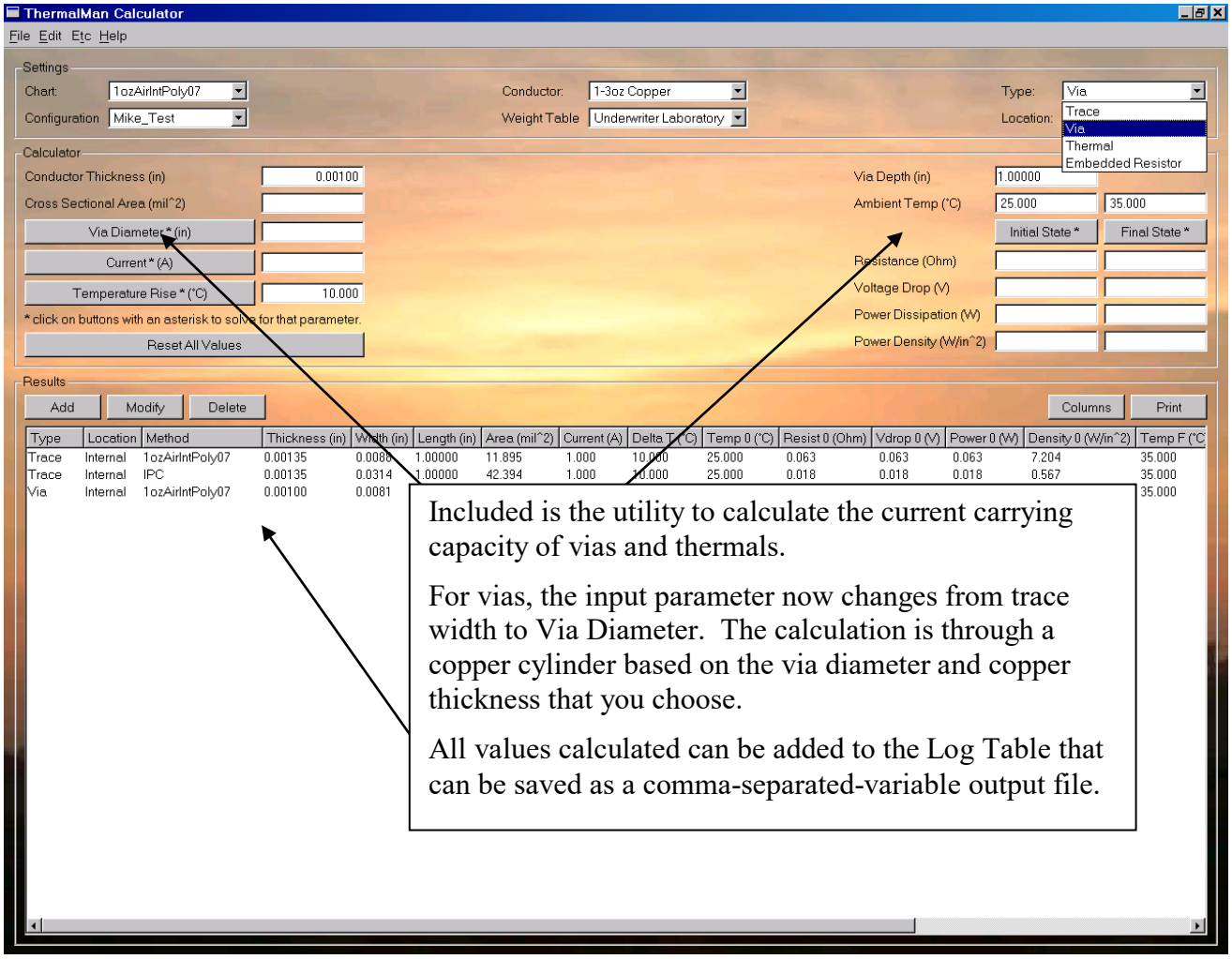

Figure 4. Vias and Thermals

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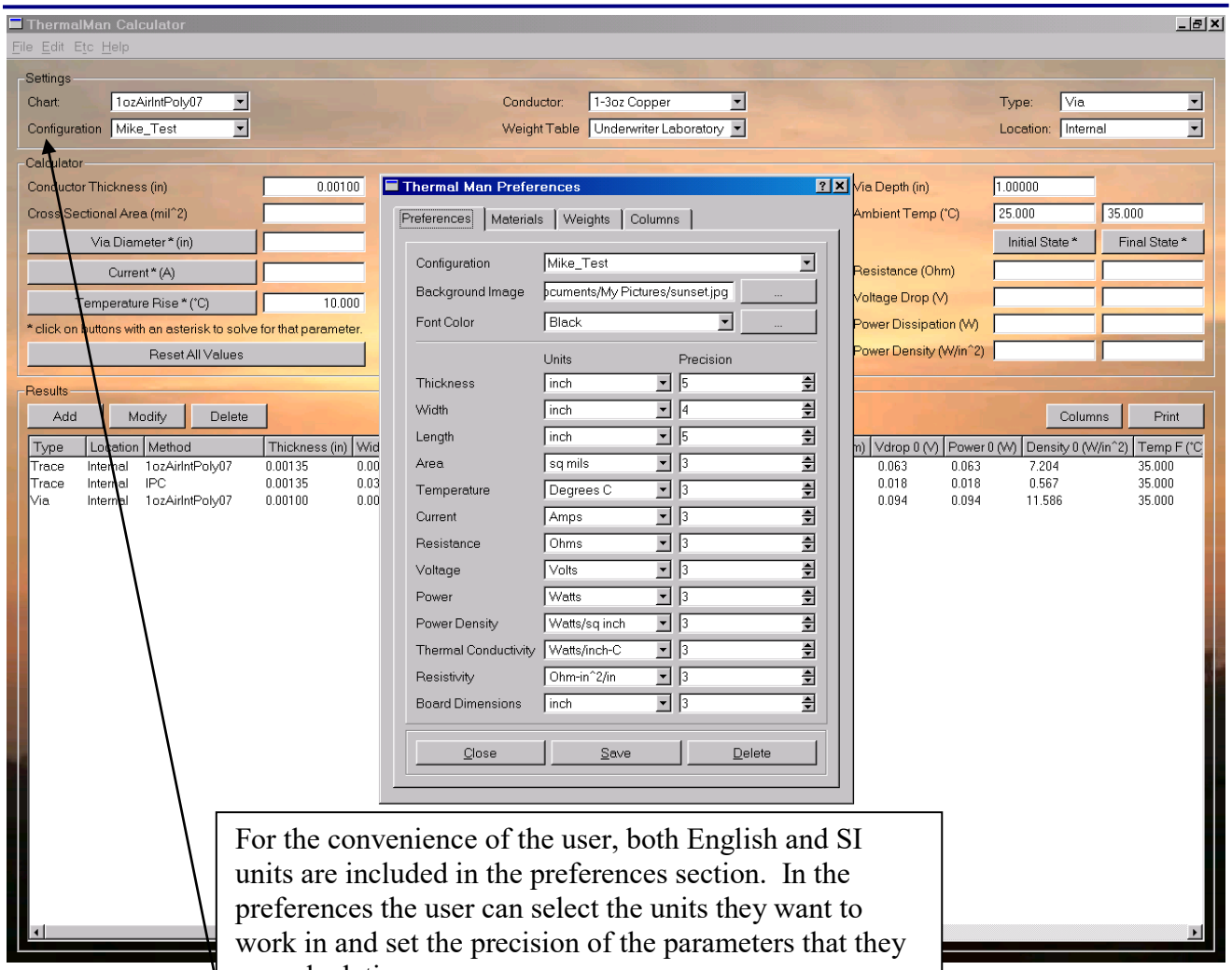

For the convenience of the user, both English and SI units are included in the preferences section. In the preferences the user can select the units they want to work in and set the precision of the parameters that they are calculating.

Then **Save** those parameters as a configuration.

Figure 5. Preferences

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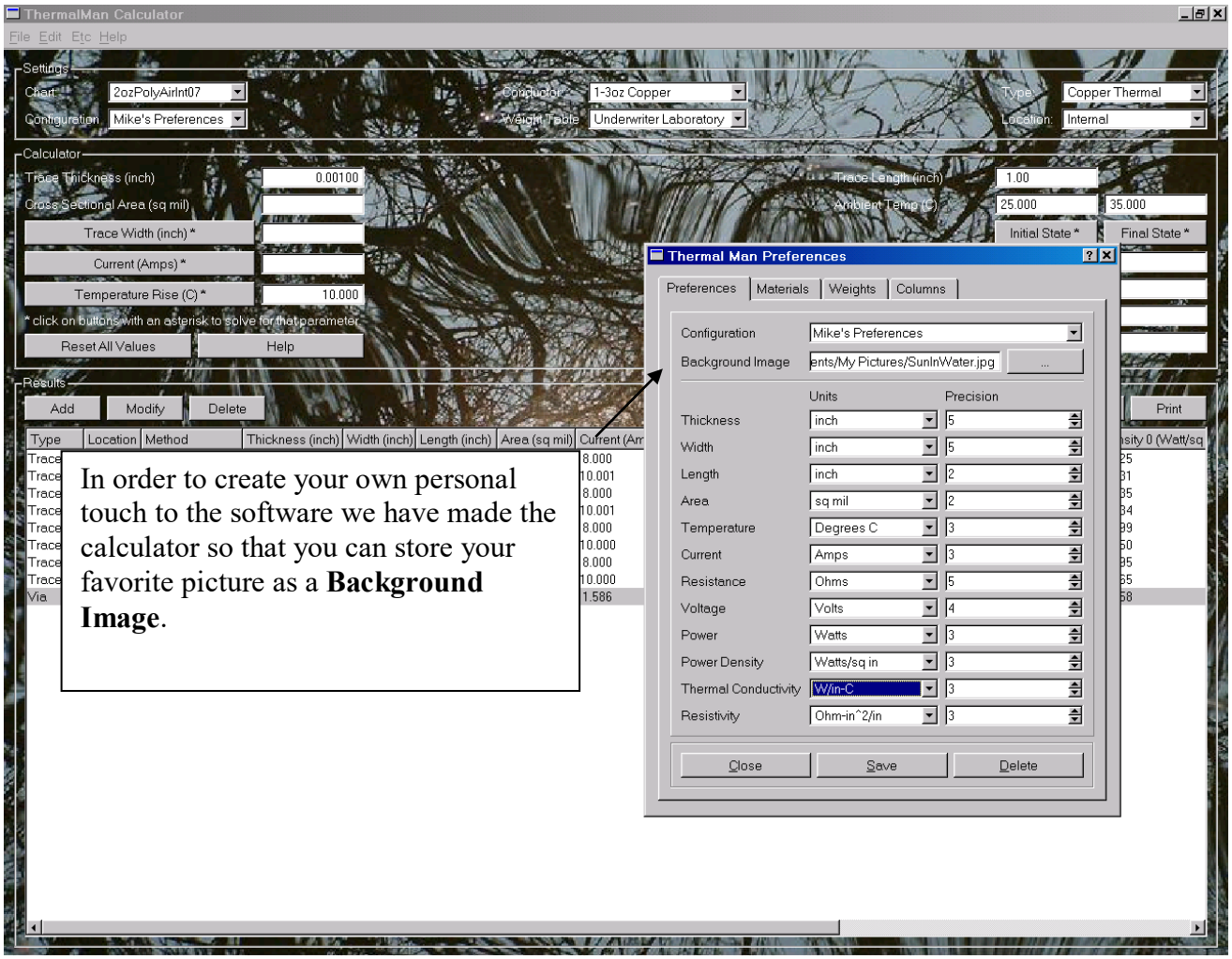

Figure 6. Features

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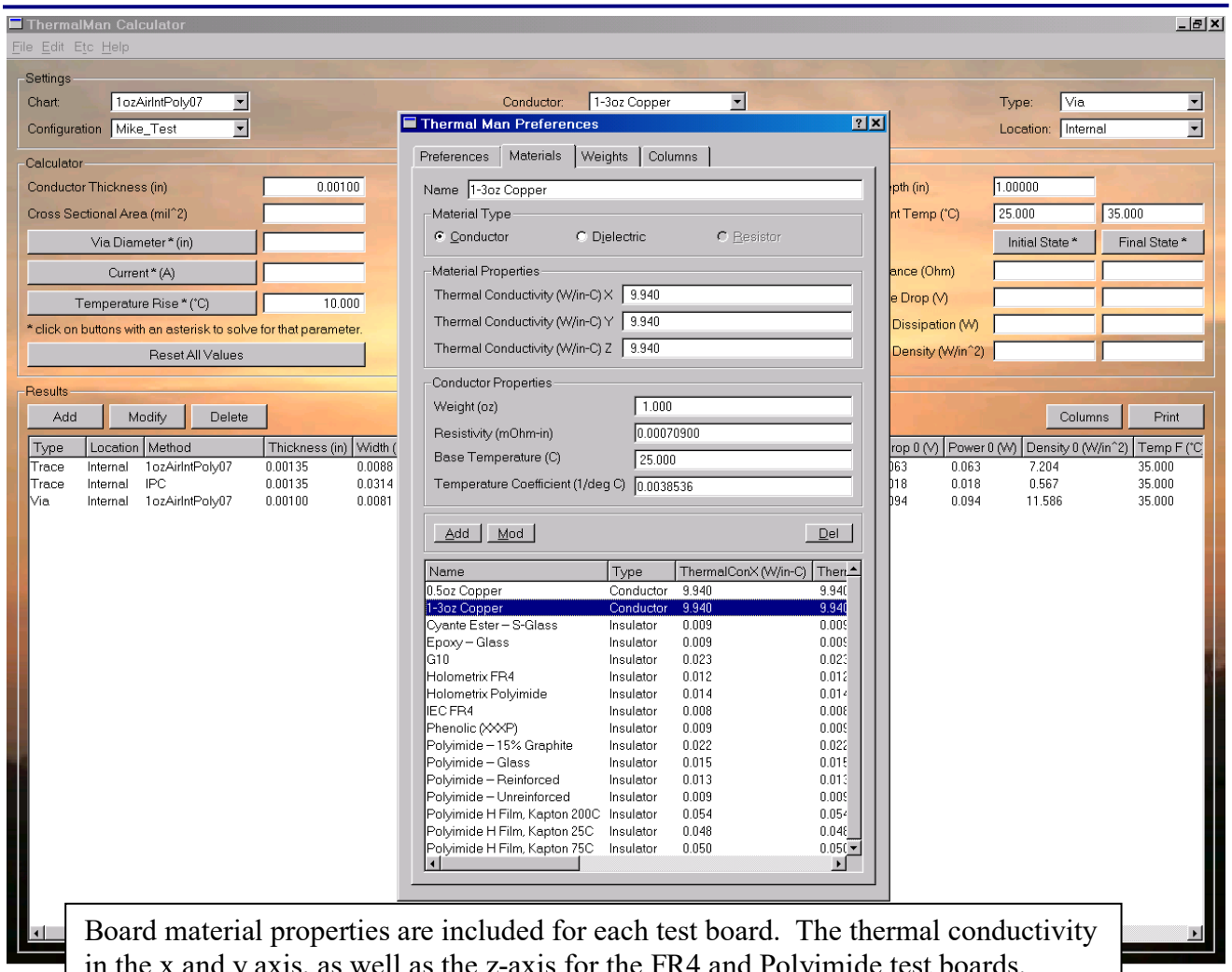

Board material properties are included for each test board. The thermal conductivity in the x and y axis, as well as the z-axis for the FR4 and Polyimide test boards. Other board materials and the properties for copper are in this database. This database is included for use with the **Equivalent Thermal Conductivity Calculator**.

Figure 7. Board Properties

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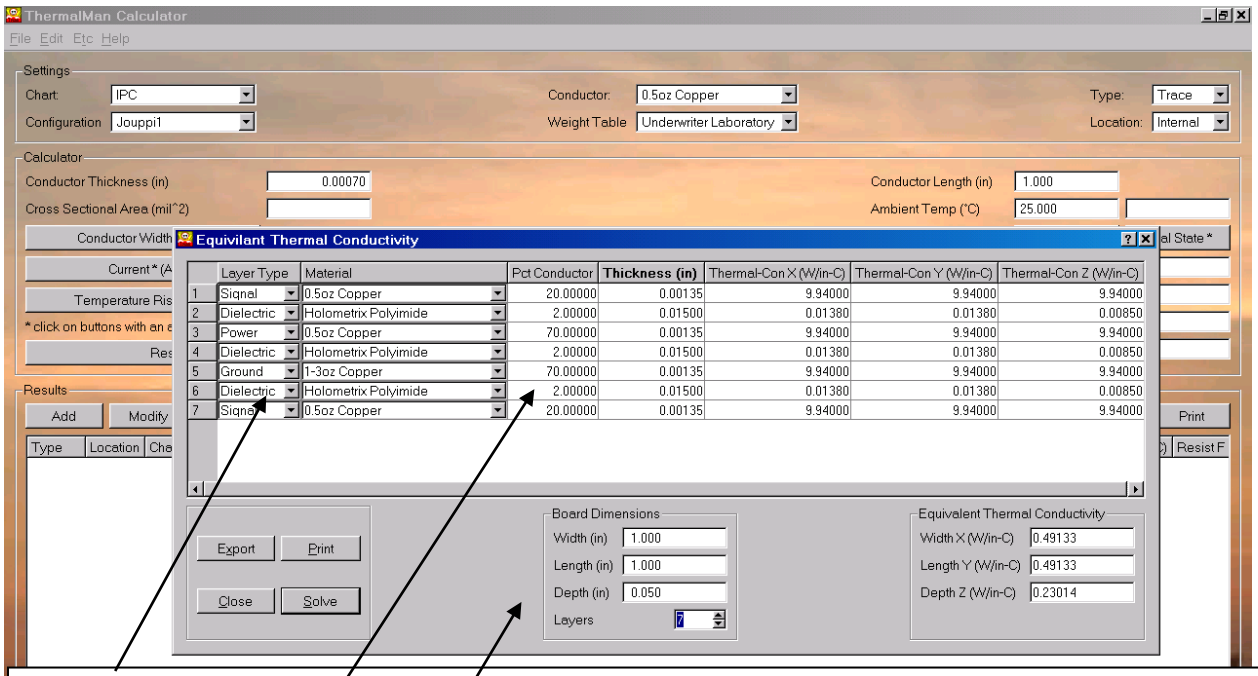

The Equivalent Thermal Conductivity Calculator is an aide for estimating the equivalent thermal conductivity of a board stack up. This accounts for external and internal copper planes and dielectric material.

Material properties in the database are available for the user or the user can input their own. Then the user defines the board dimensions, width, length, thickness and the number of layers. The user then defines the thickness of each layer and the percent copper on power, signal and ground layers.

This calculator is an aide for understanding what the trace heating will be in other board materials. If the effective thermal conductivity of the material is higher than the raw board material then the traces will run cooler. The important aspect to consider is that the traces dissipate power.

Figure 8. Equivalent Thermal Conductivity Calculator

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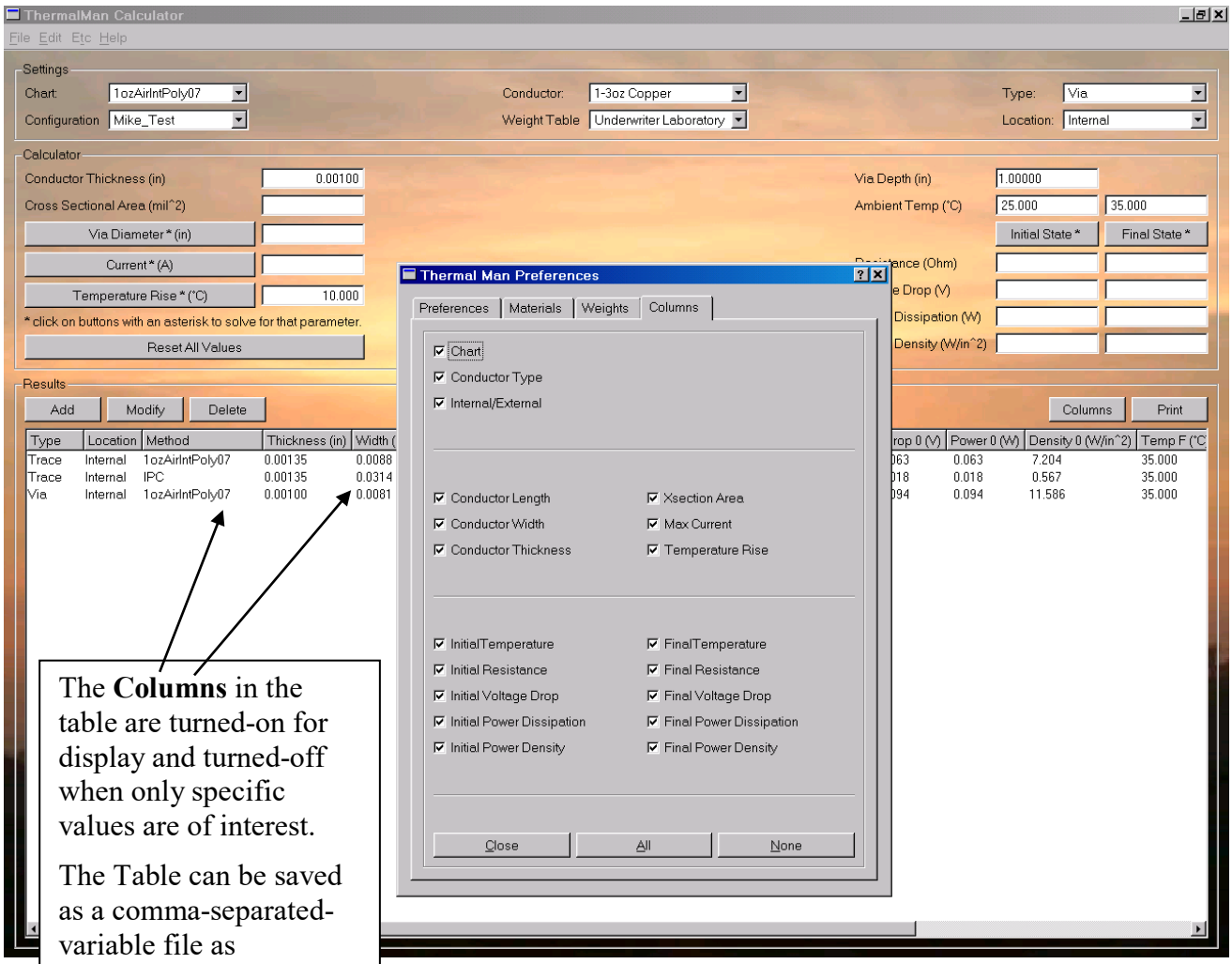

Figure 9. Table Preferences