The Future of Maximum CAD/CAM Automation for Ceramic Hybrids

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ABSTRACT

New concepts developed maximize CAD/CAM automation for all types of Ceramic Hybrids including Thick Film, Thin Film, LTCC and HTCC. Designs can go quickly from concept to manufactured product, which will fuel more progress to bring a largely manual process to maximum automation, to include automatic masks, panels and generation of 3D analysis models. Maximum automation results in expanded use of technologies that are now shrinking. Technologies that have complex and difficult to understand design and manufacturing steps have a hard time gaining wide acceptance.

CDS is tackling this complex challenge and is designing and implementing the following processes to solve the most difficult CAD/CAM problems:

1. Be a true CAM tool that reads in designs from any other EDA (layout) system. **Y**
2. Run all possible DRC checks necessary for high fabrication and assembly yield. **Y**
3. Make all manufacturing masks automatically from very basic designs by using settings in an automatically configurable table. **Y**
4. Panelize all types of Ceramic designs in preparation for manufacturing. **Y**
5. Generate documentation automatically through from stored configuration files. **D**
6. In LTCC and HTCC, place cavity punches (nibbles and rubs) automatically and feed correct machine data to the punch machine. **Y**
7. Export resistor trimming data directly to the laser trimming machine. **F**
8. Feed flying probe test data directly to the flying probe tester. **D**
9. Automatically make a 3D Image and export ACIS or STEP for thermal analysis. **D**
10. Export data directly to all electrical analysis and thermal analysis tools**. P**
11. Support circuit fabrication non-planar surfaces. **F**
12. Make full 3D analysis models of circuits non-planar surfaces. **F**

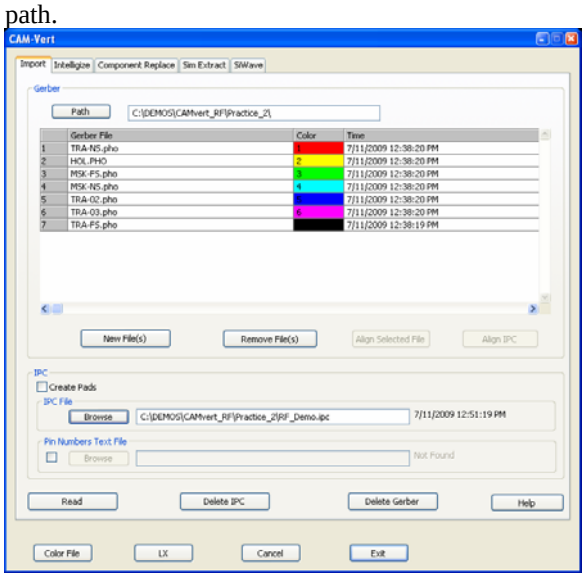
The purpose of this paper is to define what is required for the Ceramic Hybrid industry to realize full automation in design, checking and output to manufacturing. Your ideas are welcome.

Key to Bold Letters: **Y** = Covered in this paper, **D** = Done, fully implemented
F = Planned for Future Implementation, **P**= Partially implemented

View any dialogue box and diagrams at 200% Zoom

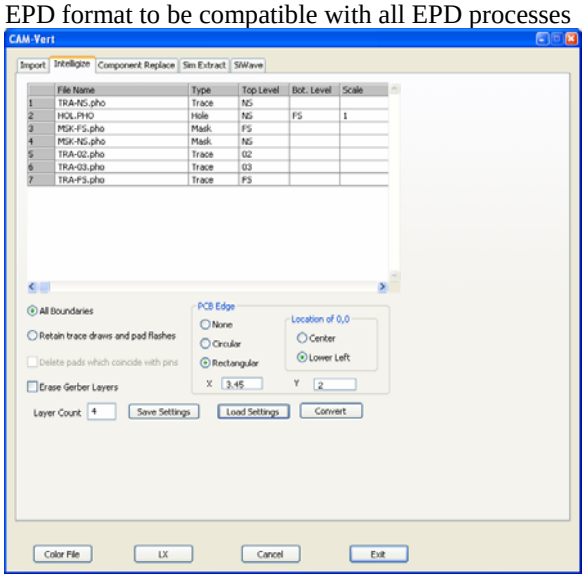
EDA Design Software Should Encompass Design and Manufacturing; and have the CAM Software Fully integrated

CAM-Vert reads in the Gerber 274X files and IPC-D-356A Netlist made by any Layout software using the import tab. Select the Path and it automatically locates the Gerber files in the current path.



In the IPC File area Browse to select the Path and file name of the appropriate IPC Netlist that matches the Gerber 274X data,

CAM-Vert automatically intelligizes this data into EPD format to be compatible with all EPD processes



The simple interface enables quick selection of the Gerber and IPC files, maps them to Traces, holes or masks and supports automatic configuration by loading pre-made configuration files for an easy fit into any process flow.

Advantages of having CAD and CAM in the same software

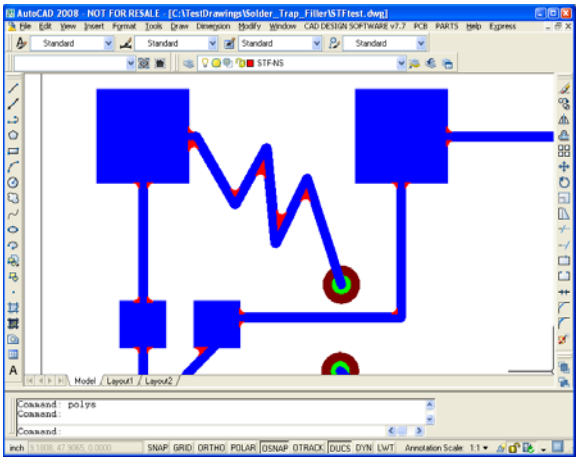
Verification of Gerber accuracy is possible because the Gerber image may be directly compared to the layout image. It may be compared automatically by making boundaries for both the Gerber and the layout and then doing a Boolean subtraction of the layout from the Gerber or visa-versa. Remainders after the subtraction are errors.

Or the layout and Gerber may be visually compared by the method shown on the next page,

Gerber cleanup features can be applied to the Gerber or the layout in the Layout Software. Solder taps may be filled and Solder Mask skivers removed,

Panelize in the Layout, one design or multiple different designs.

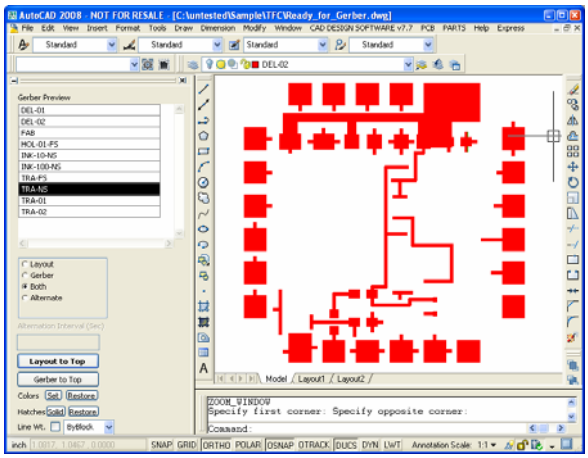
The image below is shown after the Solder Trap Filler is run. The Blue is the original metal and the red is the solder trap filler.



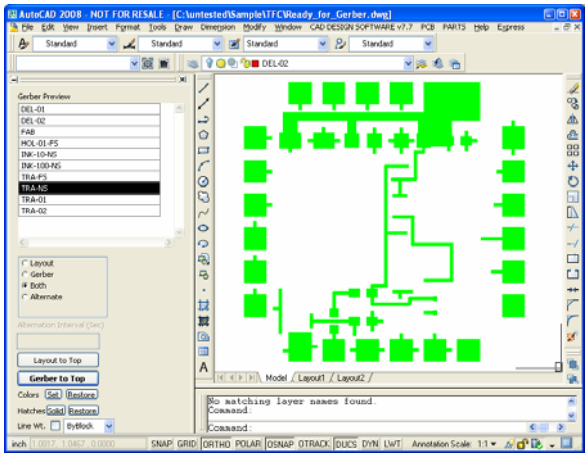
Gerber Verification Process

1. Read Gerber files into Layout
2. Set all Gerber layers to the color green
3. Set all Layout layers to the color red
4. The Gerber and Layout images are superimposed
5. When the Gerber layers are on Top of the Layout layers then no Red should be visible
6. When Layout layers are on Top of the Gerber layers no Green should be visible

Gerber Verification Process – Layout on top
Gerber is hidden underneath



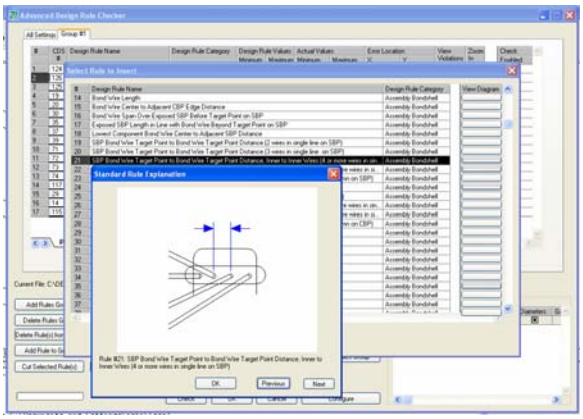
Gerber Verification Process – Gerber on top
Layout is hidden underneath



Design Software Should Check all Possible Design and Manufacturing Rules. The software should eliminate all possibilities of failure in manufacturing.

Advanced DRC (ADRC) – Main Dialog
Activate the ADRC command and pick the "Read Parameters from File" button to fill the grid with pre-configured rules.

ADRC – Special Library

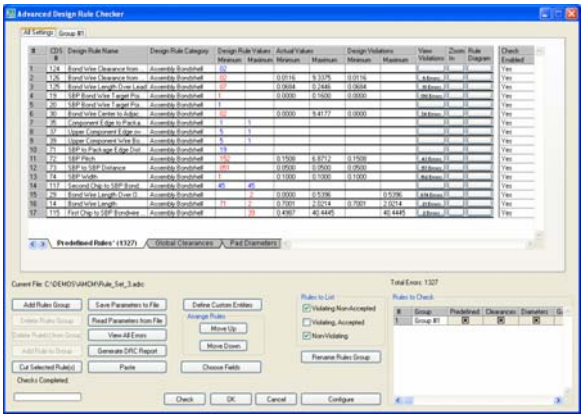


A Library of unique checks made especially for Ceramic MCM

Rule illustrations are viewed by selecting the buttons in the View Diagram column. Any new rule can be added quickly.

ADRC – After Checking with Errors shown in red.

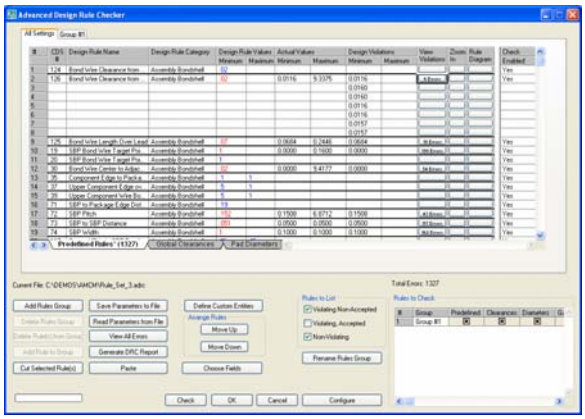
View any dialogue box at 200% Zoom



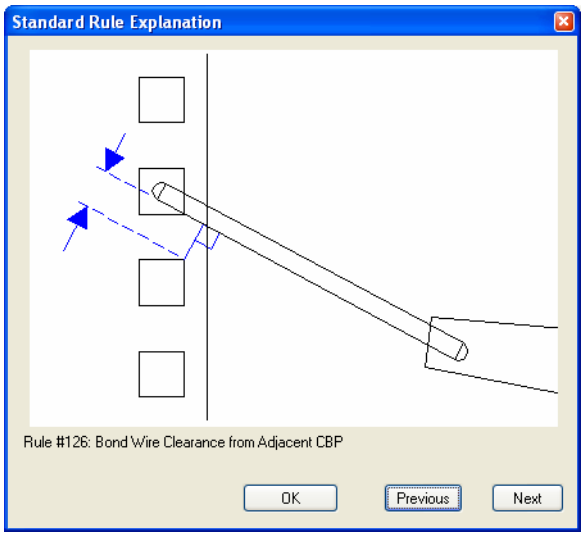
Pick the "**Check**" button and the main grid will indicate errors by putting error quantity numbers on the buttons in the "**View Violations**" column and turning the checking values red in the "**Design Rule Values (Minimum and Maximum)"** columns if they have errors.

ADRC – View Violations Button

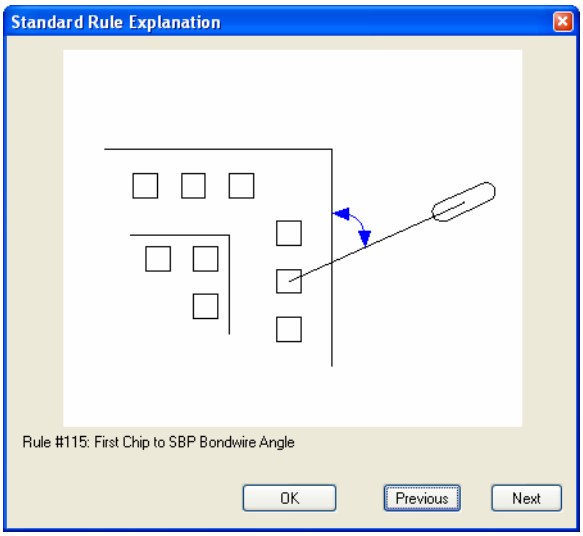
Pick a "View Violations" button that has a number on it and each error appears on its own line. Pick the "Zoom In "button for that error and the error will be zoomed to and a dimension placed at the error's location.



Sample Rule
Clearance from Bond Wire to Adjacent CBP



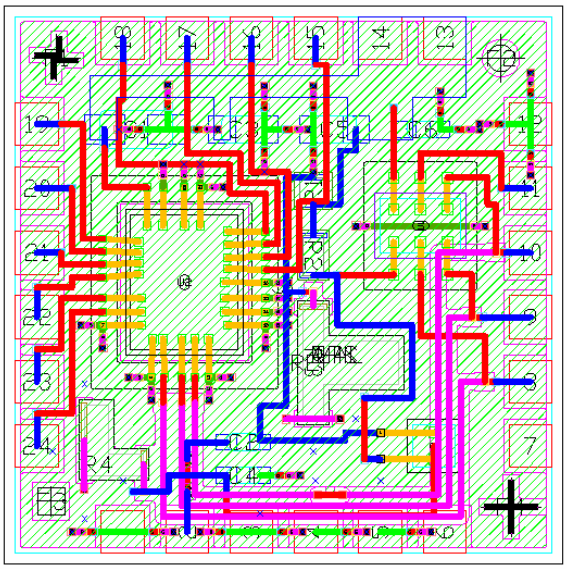
Sample Rule
Bond Wire Angle from First Chip to Bond Finger



All Manufacturing Masks Should be Auto-Generated from the Initial Simple Design

The difficult part of preparing for fabrication should be done automatically using technology knowledge stored in the software.

Basic Layout with All Layers On



The basic layout does not have the dielectric and other masks needed for Thick Film manufacturing.

That was the easy part of the design

To get a Thick Film Design into fabrication requires many more masks than there are layers in this design, such as:

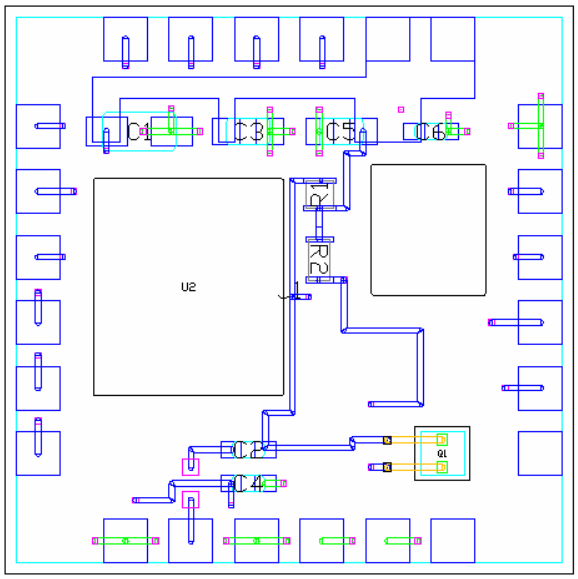
- Multiple prints of each dielectric to achieve the desired dielectric constant and for pin hole filling.
- Each upper layer of dielectric must be slightly smaller than the layer just below to compensate for registration tolerance.
- Slivers may be formed when the edges are drawn in and they must be trimmed,
- Another mask called Dielectric Glaze may be needed to seal the last upper and lower dielectric layers. A glaze mask is also placed on printed resistors.
- Multiple prints of conductive Silver or Gold paste may be needed.
- Each upper layer of the metal paste must be pulled back a small distance from the adjacent lower layer to compensate for registration tolerance.
- If there are many layers in a design, this can cause a large increase in the total number of masks.

Yet more Masks

Extra masks are required to build up metal on the solder terminals and, if a terminal needs to receive a wire bond it must be covered with gold or bondable silver

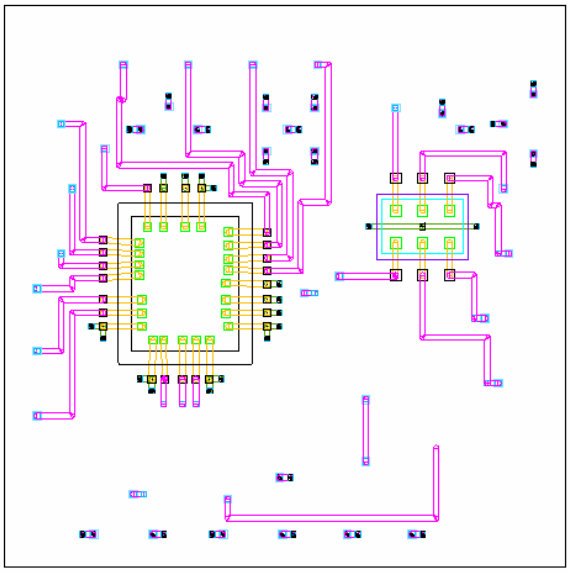
And yet more…

Basic Layout showing Top Level Only



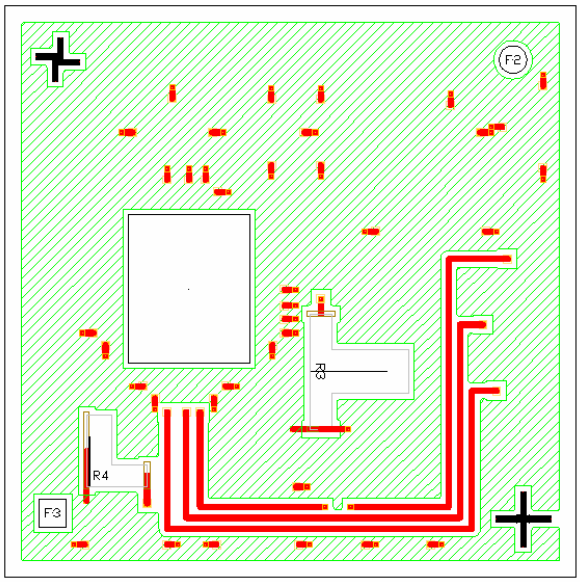
Top Metal with 2 Cavities, 2 Printed Resistors, 6 Chip Capacitors and a Die.

Basic Layout showing Level 2 Only



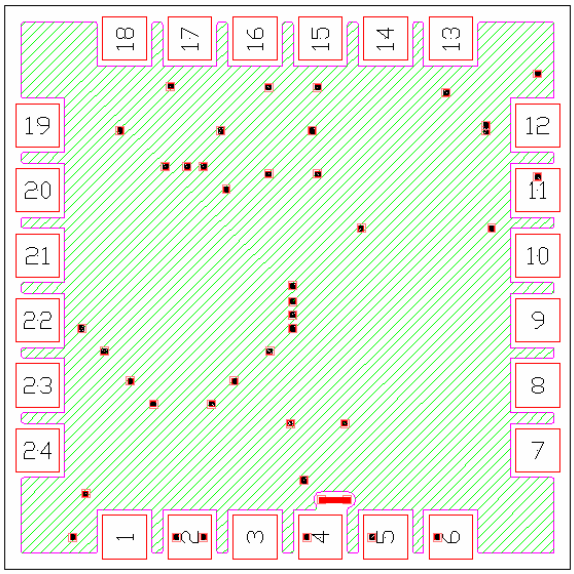
Metal Level 02 with 2 Wire Bonded Dies

Basic Layout showing Level1 Only



Metal on Level 1 with 2 Trimmable Resistors and a Plane

Basic Layout showing Bottom Only

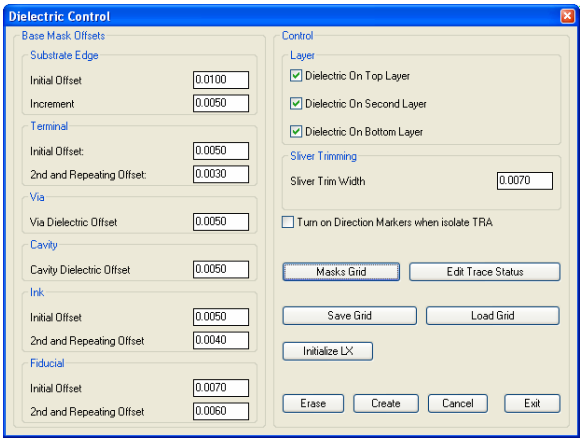


Bottom Metal with a Plane and Terminals around the edge

Printed Dielectric

- Multiple Prints may be required because the Capacitance Target may require more thickness.
- Dielectric Constant is known for standard materials
- Formula is based on the total thickness and the dielectric constant
- Edge Offsets are to compensate for screen placement tolerance.
- Substrate Edge has Initial Offset and Repeating Offsets.
- Terminal Edge has Initial Offset and Repeating Offsets.
- Via Edge has one offset only.

DMASKS - Automatic Masks Generation

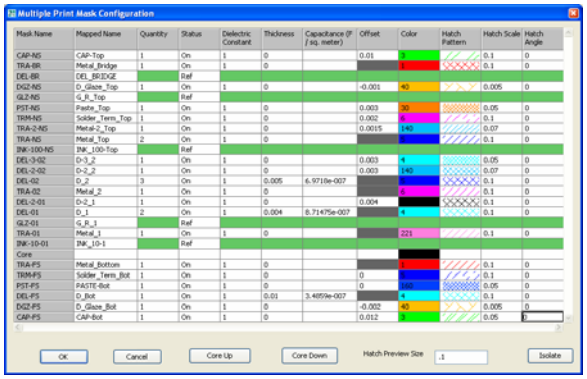


All necessary manufacturing masks are made automatically from basic layout data that can be read in from any PCB layout system. Initial and repeating mask offsets are made in this dialog

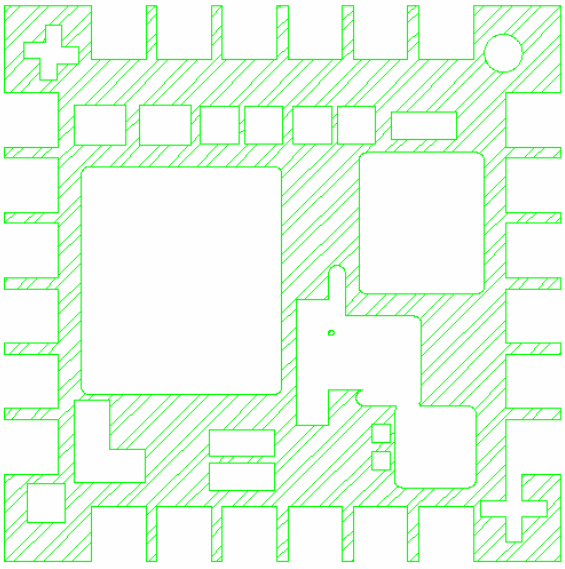
Masks Offset Control Grid

The grid lists all masks in their order of application and enables control of all secondary offsets and multiple prints and controls color and hatch parameters.

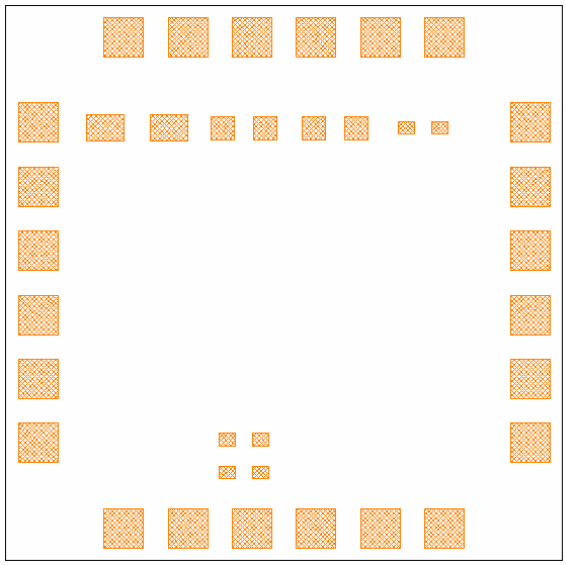
View any dialogue box and diagrams at 200%



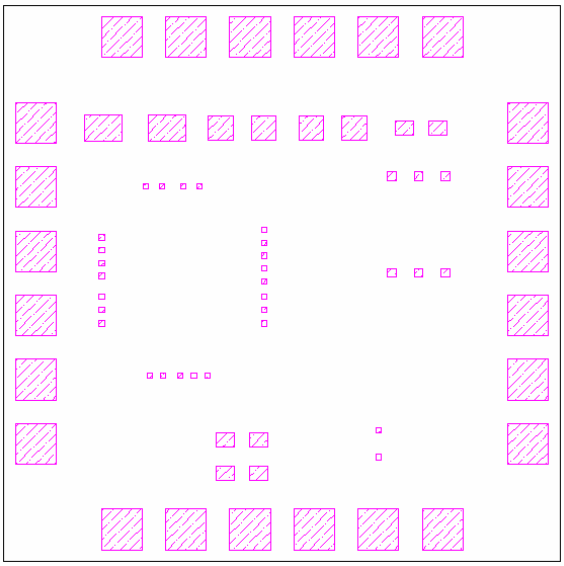
The grid lists all masks in their order of application and enables control of all secondary offsets and multiple prints and controls color and hatch parameters. The first column contains the **Mask Name** that is the standard mask name that is used by the software. The second column contains a **Mapped Name** that is user controllable. A viewing system turns masks on and off by selecting either name.



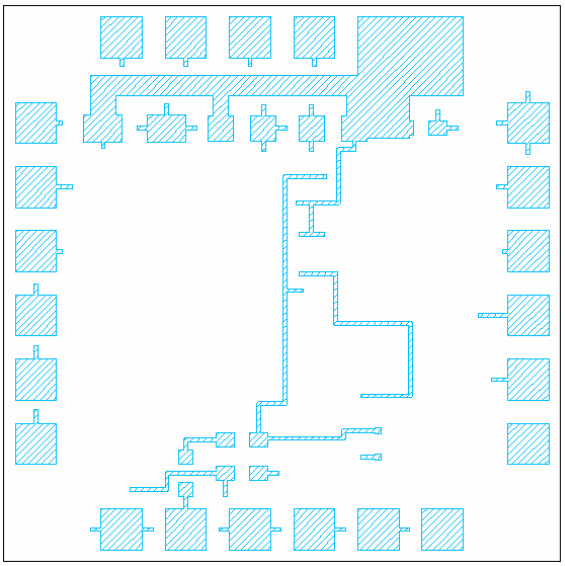
Top Cap



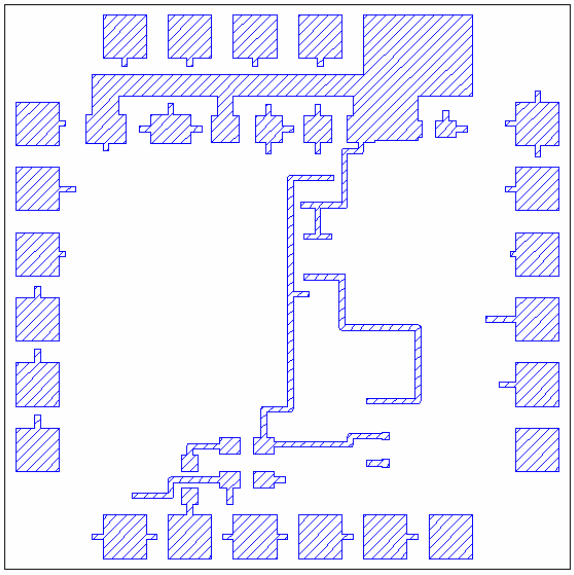
Top Solder Paste



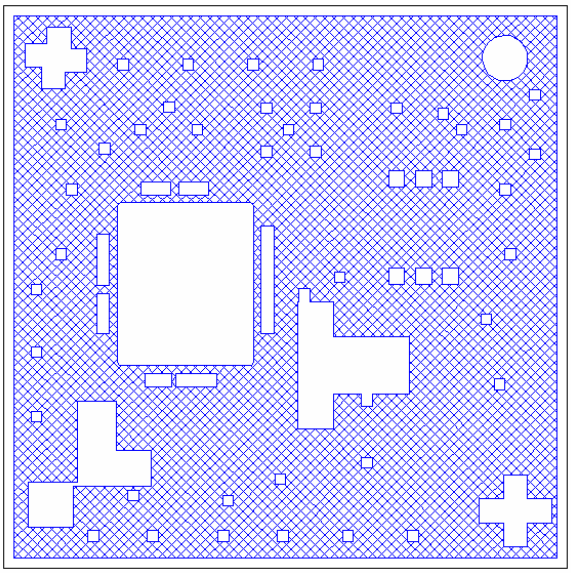
Top Solder Terminal Second Print



Top Metal Second Print

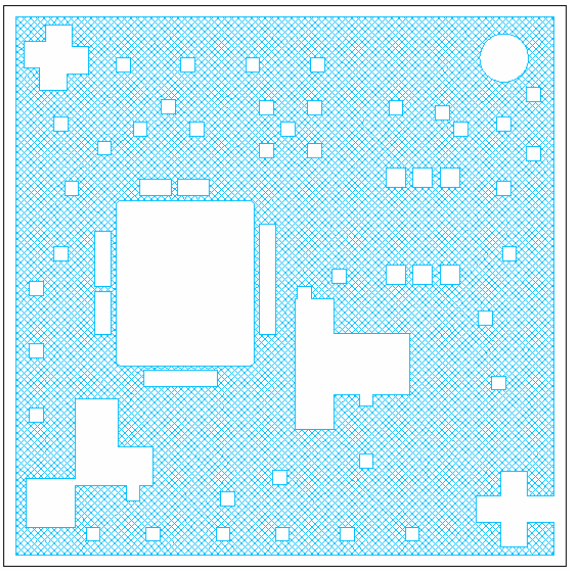


Top Metal First Print

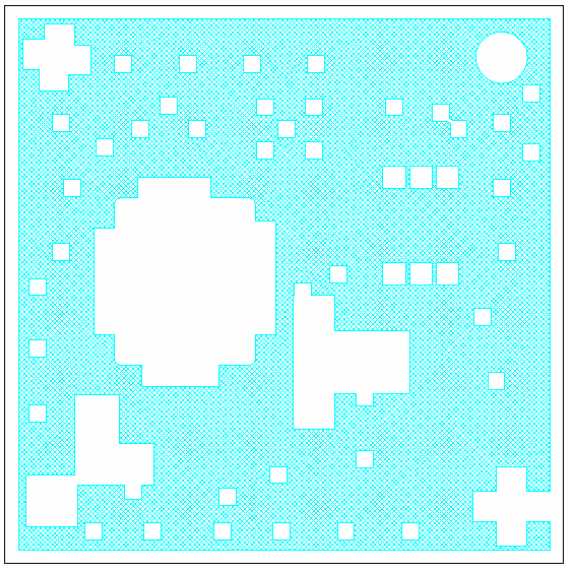


Dielectric 02 First Print

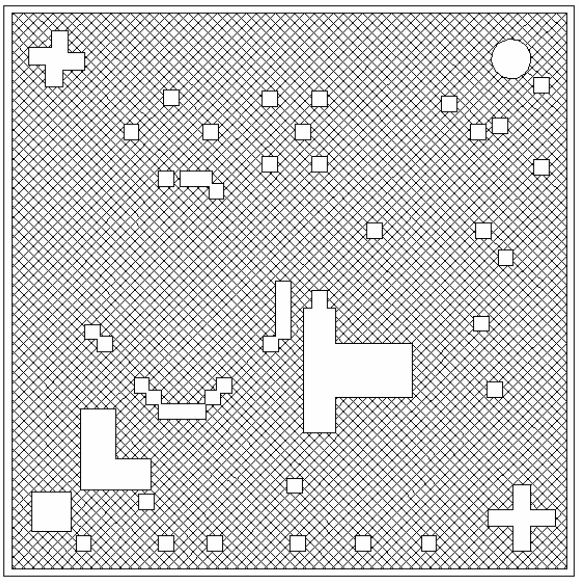
Multiple prints are for pin hole filling and controlling the dielectric constant. Sliver trimming and offsets cause the 3 masks to be different.



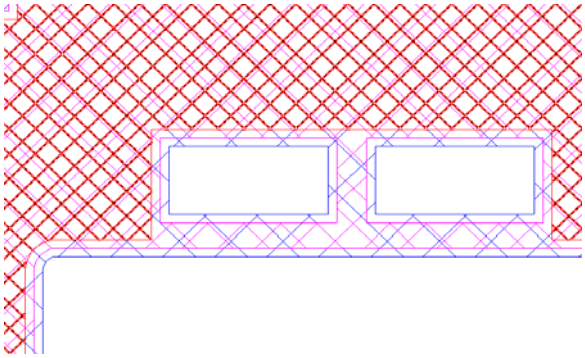
Dielectric 02 Second Print



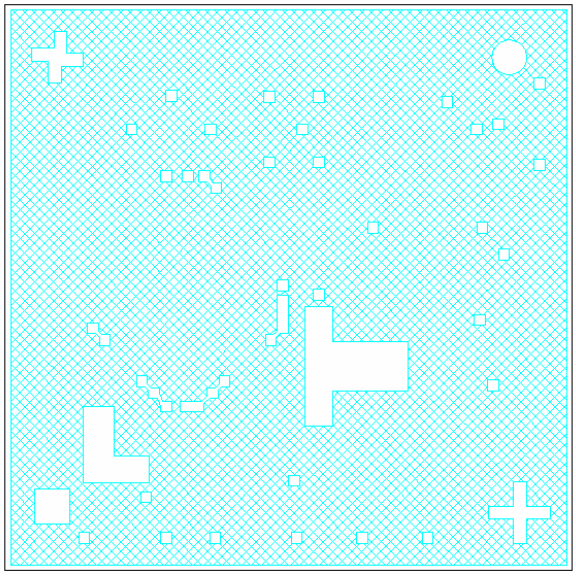
Dielectric 02, All 3 Prints



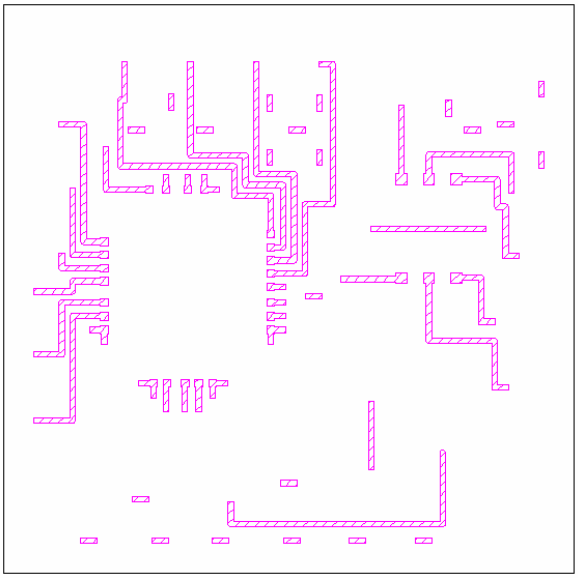
Dielectric 01 Second Print



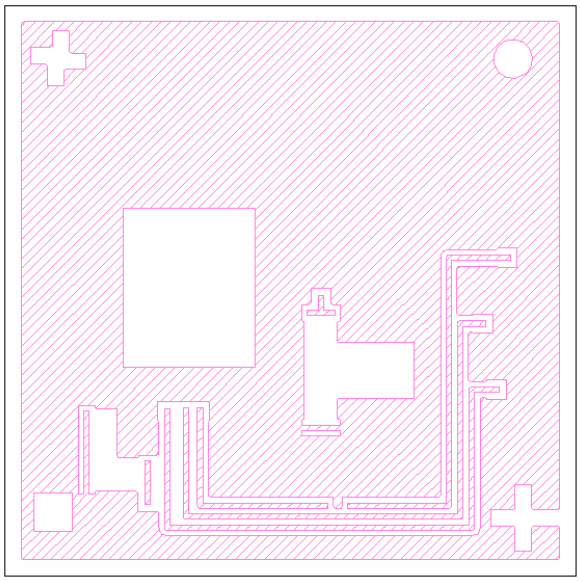
Three superimposed dialect are built up to make a 3D image due to the offsets and the silver trimming of narrow “peninsulas”



Dielectric 01 First Print



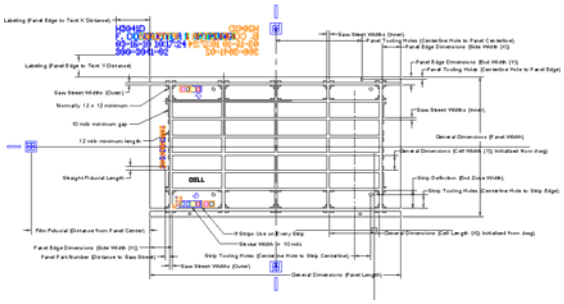
Metal Level 02



Metal Level 01

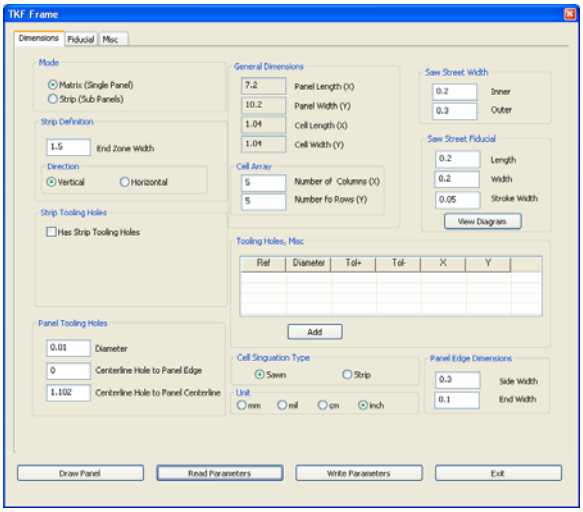
Panelizing all Types of Ceramics and Laminates - Full Manufacturing Output must Include Panelization

Thick Film Ceramic (TFC) Panelization Diagram

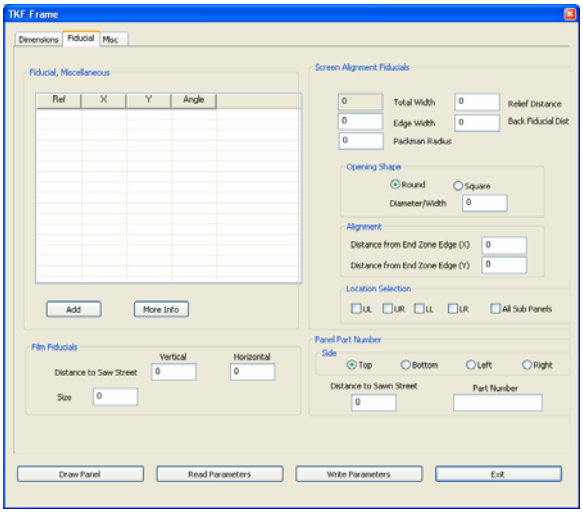


View this diagram at 200% Zoom

Thick Film Ceramic Panelization Dimensions Dialog



Thick Film Ceramic Panelization Fiducials Dialog



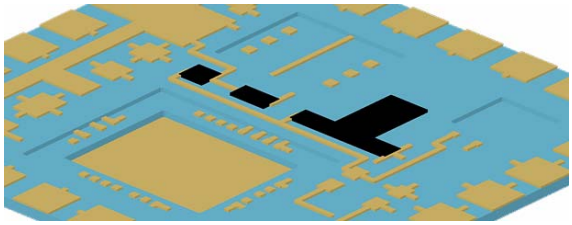
Cavities with Parametric Design and Automatic Link to Punching Machine

- **One of the most difficult tasks is now automatic.**

Cavities Design

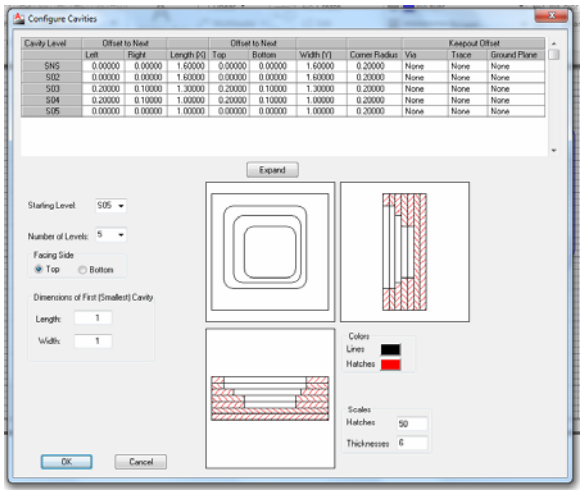
To enable connecting wire bonds from dies to inner layers without using vias the LTCC manufacturing system allows for the design of cavities. The following features are allowed in a cavity:

- Any number of levels deep from either side of the substrate
- Multiple offsets from the defined base cavity for stepped cavity creation with shelves

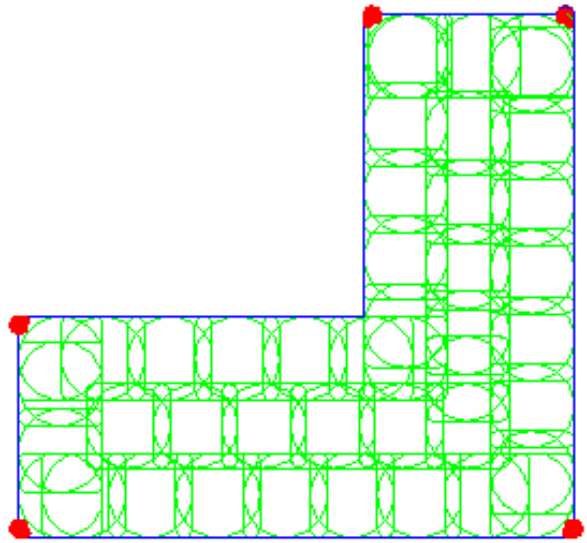


Creating cavities with multiple Shelves

Cavity Creation Dialog box



Rubs and Nibbles



LTCC – Nibble Details

Notes:

- 90% overlap is the typical overlap for round nibbles
- Corner Relief prevents cracking and enables a square opening
- The total opening in the Green Tape is punched at a larger size than the final fired product

Rubs and Nibbles are scaled up when the punch file is made to compensate for later shrinkage

CDS customizes its software to speed up the Design process

- Opportunities always exist to make more automation for various design and process steps
- Every type of design has some unique requirements missing from most software.
- We provide automatic application specific software instead of forcing the designer to use generic features and workarounds.
- New commands and processes are easily implemented to reduce laborious tasks
- Short development, test and release cycle
- This policy speeds up research and development since we are willing to develop software before the technology becomes main stream.
- Researchers can add their own code or CDS can provide programming support.

Future Goals.
The software should contain up to date technology and help the designer conform to the technology's rules.
The software should be capable of training a new designer; it should be a knowledge base that supports the design effort. Different foundries can have Design Rule Files. Automatic cross-sections of anything should be displayed when picking on entities. Process descriptions help the designer to understand why the rules exist.

About CDS
CAD Design Software (CDS) offers customizable Microelectronic Design Automation Software for all technologies from design layout through links to Analysis tools, including all types of Semiconductor Packages, PCBs, MCMs and Probe heads to meet your unique needs and time-to-market requirements. EPD supports all substrate technologies including Laminate, Flex, Ceramic (Thick Film, Thin Film and LTCC), Lead Frame and experimental types.
The problems we encountered that motivated us to start developing these unique automatic applications was that hybrid designers that used our software told us that they were confused about the rules for making fabrication masks, DRCing them, making fabrication panels and punching cavities.
We researched the problems over a period of a few years and were told by various hybrid foundries what the requirement were and that software did not exist to quickly solve these problems. The current software requires excessive manual labor and 10 to 50 times more time to accomplish the same tasks manually as can now be done automatically.
Utilize CDS' complete EDA layout and DFM solutions, or add automation features to your current design flow for CAM processing, automatic documentation, advanced DRC and links to Analysis; and gain high-value time and cost reductions.
CDS offers the only currently available solution for true 3D Semiconductor Packaging and Printed Electronics including stacked dies and stacked substrates with links to industry standard analysis tools.
CDS creates custom solutions to fit your design flow and delivers high-value custom software at a low cost of entry, the ability to read in designs from all other EDA layout tools, and true 3D links to simulation tools.

The process of identifying a serious problem and solving it.
We learned that the difficulty of deploying the proper CAM files for a design is stunting the expansion of that technologies deployment. Ease of use, efficiency and confidence in the deployment of the rules will lead to expansion of the technology.
It all means that the half way efforts of many other hybrid design software is turning away potential users. Thus, CDS has decided to write the needed software through contracts with major foundries when the opportunity exists or with our own funds if necessary. Our goal is to do more that what is necessary and create a new paradigm for EDA software. This level of automation provided in Hybrid Design paves the way for more and more automation as designers realize that they can get automation, if they ask for it.
References: Our Hybrid Design software (LTCC, Thick Film and Thin Film) is being used by some top foundries and many aerospace and commercial OEMs that express there needs to us. When they see the results of our latest
R & D effort, they will be encouraged to ask for more.

Biography.
John Sovinsky founded CAD Design Services (also known as CAD Design Software) in 1989 as a design service and EDA software company. He majored in electronic engineering as an honor student at California State Polytechnic College, and is an experienced PCB / semiconductor package / microelectronics packaging designer. After a brief illness, John Sovinsky passed away in early March, 2011.

CDS Technical Sales Engineer Geoff Sylvester is presenting the paper on behalf of John Sovinsky. Geoff joined CDS in 1995 when it was decided to market the EDA CAD Design Software, developed for in house use, to Designers of PCB's and Ceramic/Hybrid Components.

www.CAD-Design.com

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