
PCB Layer Calculation and Documentation Tool

User Guide

Speedstack

PCB Stackup Design and Documentation

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Speedstack User Guide

POLAR INSTRUMENTS LTD

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Speedstack specifications

| | |
|--|---|
| Maximum layer count | 128+ |
| Via rules | Conventional, blind and buried |
| Materials library | Foils, Cores, RCC foils, Non-copper cores, Prepregs, Solder masks, Flexible cores, Bondply, Adhesive, Coverlays, Ident inks, Peelable masks |
| Post press compensation | Yes (user defined) |
| Finished thickness compensation | Copper coverage/simple percentage |
| Stackup calculation | Copper thickness, stackup thickness, dielectric thickness, solder mask thickness |
| Drill types | Mechanical, Laser, Laser stacked, Through plated |
| Drill-via fill types | Copper, Resin, Solder Mask, Non-Conductive, Conductive, Sintering Paste, Copper Paste |
| Back drill types | Back Drill Must Cut Layer No, Back Drill Must Not Cut Layer No, Back Drill Minimum Distance From Cut Layer, Back Drill Maximum Distance From Cut Layer, Primary Drill Size |
| Design rules check | Design logic, symmetry, copper balance, board thickness, manufacturing tests, resin starvation |
| Si8000m/Si9000e integration | Bi-directional copy/paste structure parameters |
| Flex-rigid modelling | Mesh/crosshatch ground plane modelling in conjunction with Polar Si8000m/Si9000e |
| Controlled impedance structures | 100+ structures supported with impedance goal seeking and structure validation |
| Symmetrical stacks | Structure mirroring for symmetrical stacks |
| Loss/Frequency dependent modelling/graphing | Differential, Odd mode, Even mode graphed over a user-specifiable frequency range |
| Frequency dependent calculations (causal interpolation of dielectric constant) | Single frequency Er causal modelling using interpolation of Er v frequency employing Svensson-Djordjevic method |
| Result presentation | Length of line, Inches, Metres |
| Display series | All Losses, Impedance Magnitude, Inductance, Resistance, Capacitance, Conductance, Alpha, Beta |
| Surface roughness compensation | Smooth, Hammerstad, Grosse, Huray, Cannonball-Huray |
| Material library | On-line and on-premises |
| File import | IPC-2581 Rev B, Ucamco Job file, Ucamco Integr8tor and Ucam (.ssx), XML, Zuken CR-8000 |
| File export | CGen Coupon Generator, CITS File, DXF, Gerber, Stackup Image (JPEG, BMP, TIFF), Cadence Allegro (IPC-2581 Rev B), CSV, IPC-2581 Rev B, Mentor Graphics, XML file, Zuken CR-8000, Zuken DFM Center, Ucamco Integr8tor and Ucam (.ssx), |

Personal computer requirements

| | |
|--------------------------|---|
| Computer | IBM PC compatible |
| Processor | Pentium 1GHz or better |
| Operating system | Windows 10 or later |
| Environment | Requires .NET Framework v2.0 or above |
| System memory required | 2GB recommended |
| Hard disk space required | 200MB (min.) |
| Video standard | FHD (1920 x 1080*) 2 FHD (1920 x 1080*) monitors recommended * Note: refers to <i>effective resolution</i> (some systems automatically apply scaling to render text readable – i.e. <i>effective resolution</i> refers to the screen resolution after scaling.) |
| Licensing | Electronic: local FlexNet license Fixed: Parallel/USB key Floating FlexNet license (Windows servers only) |

Guide to the manual

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| Introduction | Introduces Polar Instruments Speedstack. |
| Getting started with Speedstack | Steps through the process of creating a simple stack from a set of manufacturer's data. |
| Configuring Speedstack | Setting up the Speedstack environment including license options, crosshatch and structure defaults, goal seeking parameters and file locations. |
| Using Speedstack | Discussion of the Speedstack user interface; creating and editing stackups. Using Virtual Material mode; using Material Library mode |
| Design rule checking | Using the Speedstack Design Rule Checker to correct stackup design errors. |
| Adding controlled impedance structures | Working with the Si8000m/Si9000e field solvers to add controlled impedance structures to the stackup model. Using the goal seeking facilities of the field solver to obtain the correct impedance for a structure. |
| Frequency dependent calculations (Speedstack Si) | Working with frequency dependent calculations to produce graphs and tables of insertion loss v frequency for each stack substrate. Using causal modelling Using surface roughness compensation |
| Si Projects | Working with Si Projects in Speedstack with Si8000m and Si9000e |
| CITS test files | Creating CITS test files for controlled impedance structures in the stack |
| Speedstack Flex | Working with flex-rigid stackups – using the Speedstack Flex navigator |
| Speedstack HDI | Working with HDI builds – sequential lamination |
| The Speedstack materials libraries | Using the Speedstack materials libraries, creating new libraries, adding material to the library. Accessing the online libraries |
| Printing stackup reports | Printing Speedstack technical reports; using the stack data tables, drill data tables, controlled impedance data tables, bill of materials tables and frequency dependent tables and loss graphs |

Contents

| | |
|--|-----------|
| Speedstack specifications | ii |
| Personal computer requirements | iii |
| Introduction to Speedstack | 1 |
| Speedstack PCB Stackup Builder | 1 |
| Speedstack PCB | 1 |
| Lossless calculations | 1 |
| Speedstack Si | 1 |
| Frequency dependent calculations | 2 |
| Causal modelling | 2 |
| Surface roughness modelling | 2 |
| Speedstack Flex | 2 |
| Speedstack HDI | 3 |
| Rapid stackup creation | 3 |
| Easy stackup editing | 3 |
| High quality documentation and file format | 4 |
| Integration with the Si8000m/Si9000e | 4 |
| Materials library | 5 |
| Online / on-premise materials libraries | 5 |
| Speedstack's Virtual Material mode | 5 |
| Preferred builds | 5 |
| Dimensional information | 6 |
| High layer count boards | 6 |
| Supplier management | 6 |
| Graphical interface | 6 |
| Interfacing with other systems | 6 |
| Importing and exporting stackup information | 6 |
| Converting imported electrical layers to cores | 7 |
| Structure net classes | 7 |
| Installing Speedstack | 8 |
| Installing and activating Speedstack | 8 |
| Obtaining a Speedstack license | 8 |
| Uninstalling the software | 8 |

| | |
|--|-----------|
| Getting started with Speedstack | 9 |
| Online tutorial guides | 9 |
| Stackup Templates | 9 |
| Using Speedstack Stackup Builder | 10 |
| Speedstack Stackup Builder | 10 |
| The Stack Editor | 10 |
| Controlled Impedance window | 11 |
| The Speedstack menu system | 12 |
| The File menu | 12 |
| Opening projects | 12 |
| Saving stackups | 12 |
| Saving projects | 12 |
| Searching for stackups and project files | 12 |
| Supplying search criteria | 13 |
| Importing Stackup information | 15 |
| IPC-2581 Rev B | 15 |
| Setting import options | 16 |
| Setting display options | 16 |
| Sorting layer information | 16 |
| Assigning layer functions | 16 |
| Setting loss values | 17 |
| Ucamco Job Files | 18 |
| Integr8torJob files | 19 |
| XML files | 20 |
| Zuken CR-8000 | 20 |
| Ucamco Integr8tor and Ucam format (.ssx) | 20 |
| Converting imported electrical layers to cores | 20 |
| Exporting stackup information | 21 |
| Exporting to Coupon Generator (CGen) | 21 |
| Export CITS File | 22 |
| Generating printed output | 22 |
| DXF, Gerber, CSV and XML files | 22 |
| Stackup images | 22 |
| Cadence Allegro (IPC-2581 Rev B) | 23 |
| Choosing export options | 23 |
| Mentor Graphics | 24 |
| Zuken CR-8000/DFM Centre | 24 |
| Ucamco Integr8tor and Ucam | 24 |
| Assigning properties to projects and stackups | 24 |
| Backing up stackups and libraries | 24 |
| Opening recent files | 24 |

| | |
|--|-----------|
| The Edit menu | 25 |
| Material Library and Virtual Material modes | 25 |
| The View menu | 26 |
| Proportional Stack Viewer | 26 |
| The Tools menu | 27 |
| The Units menu | 27 |
| External Utility | 27 |
| The Help menu | 27 |
| Configuring Speedstack | 28 |
| Environment and default settings | 28 |
| General Options | 28 |
| Structure Defaults | 29 |
| Licensing | 29 |
| Choosing default file locations | 30 |
| Specifying goal seeking parameters | 30 |
| Setting user defaults | 31 |
| Specifying default CITS test file parameters | 31 |
| CITS test methods | 31 |
| Choosing background and stackup layer colours | 32 |
| Miscellaneous Options | 32 |
| Hatch Defaults | 32 |
| Rebuild and Calculate Structures | 33 |
| Manufacturing Constraints | 33 |
| Editing and adding constraints | 34 |
| Set Target Stackup Thickness/Enable Finishing | 35 |
| Finishing Options | 36 |
| Simple Percentage Method | 36 |
| Copper Coverage method | 37 |
| Virtual Material mode | 38 |
| Working with external utilities | 38 |
| The Speedstack toolbar | 39 |
| File operations | 39 |
| Stack building operations | 39 |
| Editing the stackup | 40 |
| Copying and pasting materials | 40 |
| Changing plane types | 40 |
| Applying finishing | 41 |
| Changing the stackup view | 41 |
| Managing the materials library | 41 |
| Exchanging data with the Si8000m or Si9000e Field solver | 42 |

| | |
|--|-----------|
| Creating and editing stackups (Virtual Material mode) | 43 |
| Material Library and Virtual Material modes | 43 |
| Using the Stackup Wizard | 44 |
| Setting basic stack data | 45 |
| Adding drills | 45 |
| Adding microvias | 45 |
| Editing the stack | 48 |
| Changing material properties | 48 |
| Choosing Symmetrical mode | 48 |
| Changing the material description | 48 |
| Changing electrical layers | 49 |
| Setting hatched planes | 49 |
| Adding controlled impedance structures | 50 |
| Calculating the structure impedance | 51 |
| Goal Seeking the target impedance | 52 |
| Mirroring structures | 52 |
| Rebuilding the stack | 53 |
| Creating and editing stackups (Material Library mode) | 54 |
| Using the Stackup Wizard | 54 |
| Electrical layer count | 54 |
| Build type | 54 |
| Choosing stackup materials | 55 |
| Adding layers | 55 |
| Nominating power planes and mixed layers | 56 |
| Adding drill information | 56 |
| Changing the stackup view | 58 |
| Filtering Materials | 58 |
| Saving stackups | 58 |
| Creating stackups manually | 59 |
| Editing the stack | 59 |
| Adding layers to the stackup | 59 |
| Consistency of units | 60 |
| Adding a core layer | 60 |
| Editing the selected layer properties | 62 |
| Adding data file names | 62 |
| Changing a layer function | 63 |
| Exchanging layers | 63 |
| Adding prepreg layers | 63 |
| Choosing the Display Data fields | 64 |
| Adding a foil layer | 65 |
| Adding solder mask layers | 66 |

| | |
|---|------------|
| Adding the Ident layers | 66 |
| Adding a drill | 67 |
| Deleting drills | 68 |
| Adding stack vias | 69 |
| Via stub removal (controlled depth drilling / back drilling) | 70 |
| Specifying back drills | 71 |
| Deleting a layer | 72 |
| Copying a layer | 72 |
| Copying material properties | 72 |
| Moving materials | 74 |
| Applying finishing | 74 |
| Displaying the stackup in 2-dimensional view | 74 |
| Mirror Builds | 75 |
| Symmetrical Builds | 76 |
| Creating a new stack | 76 |
| Adding a prepreg layer in Symmetrical Mode | 76 |
| Adding a second prepreg layer | 77 |
| Adding foil, LPI Mask and Ident layers | 78 |
| Assigning ground planes | 79 |
| Design rule checking | 80 |
| Viewing design rule errors | 80 |
| Correcting design rule errors | 82 |
| Creating and using manufacturing constraints | 82 |
| Editing constraints | 83 |
| Adding controlled impedance structures | 84 |
| Adding a controlled impedance structure | 84 |
| Choosing reference planes | 86 |
| Controlled impedance toolbar | 88 |
| Changing parameter values | 89 |
| Goal seeking with Speedstack | 89 |
| Goal seeking with the Si8000m/9000e | 90 |
| Changing layer functionality | 91 |
| Switching layer types and reallocating structures | 92 |
| Increasing the layer count | 95 |
| Structure net classes | 97 |
| Working with Si Projects in Speedstack and Si8000m/Si9000e | 99 |
| Si Projects | 99 |
| Transferring structures from Speedstack to the field solver | 99 |
| Adding/deleting and modifying structures | 101 |
| Frequency dependent loss calculations (Speedstack Si only) | 102 |

| | |
|--|------------|
| Frequency dependent parameters | 103 |
| Presentation of results | 104 |
| Graph settings | 104 |
| Displaying the loss budget | 106 |
| Material and surface roughness properties | 106 |
| Dielectric loss | 106 |
| Conductor losses – surface roughness compensation | 107 |
| Surface roughness compensation methods | 108 |
| Hammerstad/Groisse methods | 108 |
| Huray method | 109 |
| Printing the technical report | 111 |
| Speedstack Si to Si9000e data transfer | 112 |
| Sharing structure properties | 112 |
| Transferring structures between Speedstack and Si9000e | 115 |
| Transferring a single structure | 115 |
| Solving for impedance | 116 |
| Running frequency dependent calculations | 116 |
| Transferring multiple structures via Si Projects | 117 |
| Modifying structures | 119 |
| Creating CITS test files | 120 |
| Exporting the CITS test file | 120 |
| Working with flex-rigid stackups | 121 |
| Speedstack Flex | 121 |
| The graphical stackup display | 121 |
| Mesh / Crosshatch ground planes | 122 |
| Internal Coverlays | 122 |
| Definable colours per material | 122 |
| Enabling Speedstack Flex/HDI | 122 |
| Adding a flexible core | 122 |
| Using the Navigator | 123 |
| Adding stacks | 124 |
| Adding a new stack | 125 |
| Defining new stacks | 126 |
| Copying and pasting stacks | 126 |
| Removing stacks | 127 |
| Aligning materials in the navigator | 127 |
| Displaying the stack in Proportional View | 129 |
| Using the Ruler within Proportional view | 130 |
| Working with HDI builds | 131 |

| | |
|--|------------|
| Speedstack HDI | 131 |
| Easy graphical stackup display | 131 |
| Sub-stack reordering | 131 |
| HDI builds | 131 |
| Sequential plan | 131 |
| Drill plan | 131 |
| Using the Sequential Plan | 137 |
| Using the Drill Plan | 139 |
| Exposing cores | 140 |
| Working with multiple press cycles | 141 |
| Printing the Navigator screen | 142 |
| Using Speedstack materials libraries | 143 |
| Working with the materials libraries | 143 |
| Materials library toolbar | 144 |
| Opening a library | 145 |
| Opening and appending a library | 145 |
| Creating a new library | 145 |
| Importing material to the Speedstack materials library | 145 |
| Importing from the Polar Online Library | 145 |
| Filtering libraries by frequency | 146 |
| On-Premise libraries | 146 |
| Downloadable mlbx files | 147 |
| Choosing material files | 147 |
| Importing from local material files | 147 |
| Replacing existing material tables | 148 |
| Adding material data to an existing library | 148 |
| Adding new material to the data tables | 149 |
| Importing material to the data tables | 150 |
| Library sample files | 150 |
| Creating a new materials library table | 150 |
| Adding material data to an existing library | 152 |
| Selecting Materials from the Library | 152 |
| Column Order (Materials Library) | 152 |
| Arranging Columns in Library Forms | 152 |
| Filtering Materials | 153 |
| Building the filter string | 153 |
| Using the Like operator | 153 |
| Locking the library | 154 |
| Printing stackup information | 155 |
| Speedstack Report Printer toolbar | 155 |

| | |
|---------------------------------------|-----|
| Speedstack Report Printer menu system | 157 |
| File menu | 157 |
| Options menu | 157 |
| Print Setup | 157 |
| Page Setup | 158 |
| Stack Data Table | 158 |
| Controlled Impedance Data Table | 160 |
| Grouping structures by layer | 160 |
| Sorting impedance structures by type | 161 |
| Frequency dependent loss graphs | 162 |
| Drill DataTable | 163 |
| Showing expanded drills | 163 |
| Bill of Materials Table | 164 |
| Choosing the bar code font | 166 |
| Choosing the start/stop character | 166 |
| Footer | 167 |
| Suppressing the footer | 167 |
| Using the expanded footer | 167 |
| Overriding the footer labels | 167 |
| Note Field Aliases | 168 |
| Print Order | 168 |
| General options | 169 |

Introduction to Speedstack

Speedstack PCB Stackup Builder

Polar Instruments Speedstack PCB Stackup Builder is designed to accelerate the PCB stack design process and deliver significant reductions in the amount of time consumed in PCB stackup documentation and control. Given designer specifications the PCB fabricator can use the Speedstack Stackup Builder to create in just a few steps the most cost effective stack for the range of available materials. Speedstack offers interconnect designers (PCB layout engineers), PCB front-end engineers and fabricators a fast and professional solution to layer stackup creation and documentation. Speedstack provides formal documentation for everyone involved in ensuring the correct materials are used in the build process.

Speedstack PCB

Speedstack PCB is a versatile PCB layer stackup design tool featuring powerful and easy to use graphical stackup editing capabilities. For PCB fabricators Speedstack PCB interfaces with the industry standard Polar Si8000m PCB Multiple Dielectric Controlled Impedance Field Solver.

Lossless calculations

It includes a link and license for the Si8000m, using the proven Si8000m to provide the impedance data for the stack. In addition, Speedstack PCB licence holders have full access to the stand alone Si8000m Quick Solver.

Speedstack PCB is especially tailored for PCB fabricators and PCB brokers – anyone with a requirement to design or communicate controlled impedance PCB stackups.

Speedstack PCB customers are able to share stackups and read impedance requirements from designers who are using Speedstack Si PCB Insertion Loss Field Solver.

Speedstack Si

For electronic engineers involved in stackup design Speedstack Si interfaces with the Polar Si9000e PCB Insertion Loss Field Solver. Both Speedstack Si and Speedstack PCB are able to directly output controlled impedance test files associated with each stackup. For the fabricator this is an ideal way to link the impedance test requirements to a particular job. For the OEM this offers a

clear method of sending impedance test specifications out to suppliers or brokers. Designers and fabricators can work together and select the best material combinations for minimising build costs. Fabricators can share their in house material libraries with OEMs and ensure the most effective material choice is employed in the build.

Frequency dependent calculations

Speedstack Si caters for frequency dependent calculations and adds comprehensive insertion loss calculation capability into Speedstack; insertion loss can be graphed over a user-specifiable frequency range. Frequency dependent structure properties allow for insertion loss calculation: trace conductivity, frequency range and result presentation mode. Loss results can be shown in dB/m, dB/inch or dB/LL (length of line.)

Causal modelling

Frequency dependent parameters include length of line, trace conductivity, dielectric constant and loss tangent, frequencies of interest and causal extrapolation points for each substrate and also support amalgamated dielectric structures. Frequency dependent calculations employ causal interpolation of dielectric constant using Svensson-Djordjevic modelling. Library materials tables include dielectric constant and loss tangent fields and substrate causal extrapolation reference points values may be set either manually or automatically from the library (virtual material mode supports loss tangent in laminates and soldermask.)

Surface roughness modelling

Speedstack includes surface roughness compensation in frequency dependent calculations, supporting Hammerstad, Grosse and Cannonball-Huray surface roughness modeling methods.

Bidirectional copy and paste between Speedstack and the Si9000e transmission line field solver allows for quick transfer of structure parameters.

Technical reports optionally include insertion loss graphs for user-nominated structures.

Speedstack Flex

Speedstack Flex allows OEM designers to create accurate and efficient flex-rigid PCB stackups in just a few minutes, with error-free documentation for tighter control over the finished board. For PCB fabricators, Speedstack Flex provides the flexibility to quickly calculate the impact of substituting alternative materials to improve manufacturability and reduce cost while maintaining the specified parameters

and performance of the board. Speedstack Flex can be used in conjunction with the Si8000m and Si9000e field solvers when modelling and documenting mesh/crosshatch ground. Structure data and mesh geometry can be readily shared between Speedstack and the field solvers. The Navigator provides a clear contextual view of the rigid and flexible stacks within a flex-rigid build and allows easy alignment of displayed materials between stacks. The associated technical report also supports different materials on the same dielectric layer, improving the clarity of documentation between the stackup designer and fabricator.

Speedstack HDI

Speedstack's Navigator quickly guides you through the sequential sub-stack lamination sequence and presents the complete assembly in a parsed graphical display that shows each phase of the multi-step lamination sequence of an HDI PCB. There is no limit to the number of press cycles that can be documented.

Resin check / excess resin algorithms determine the order in which the materials are pressed together and return useful resin percentage information that can be used to determine potential de-lamination problems.

User-definable settings within the navigator allow engineers to display layers in transparent, invisible or 3D mode. Speedstack HDI makes re-ordering and renaming sub-stacks quick and easy with the Navigator. This is especially useful for HDI constructions.

Rapid stackup creation

Users may specify the stackup semi-automatically with the powerful Stackup Wizard or alternatively build the stack manually, layer by layer. Speedstack is flexible and allows full manual editing of stacks created by the Stackup Wizard.

Easy stackup editing

The Speedstack allows the user to view stackup in 2D or 3D format. Layer and material annotation is clear and easy to read and each layer may be selected and queried to display the associated material type and properties, including the associated data file. Visible drill information ensures that designers instantly know which layers support conventional, blind and buried vias.

Speedstack allows you rapidly to build and share stacks and verify via aspect ratios and track spacing rules. The stack file contains base material information combined with layer description and a complete listing of transmission line structures deployed in the stack. Keeping all stack

information in one file ensures that manufacturing data is accurately shared between original designer and fabricator.

Speedstack's Stack Editor provides efficient and time-saving features such as Copy/Paste Material properties so the stack designer can copy all properties from a selected material and then paste user-selectable property groups to other materials.

Speedstack allows the designer to retain and re-allocate structures when changes are made to the electrical layers of the stackup. This enables reallocation of structures after the following stackup changes:

- Adding and deleting foils and/or cores – increasing or reducing the layer count

- Moving foils and cores – maintaining the layer count

- Exchanging two different thickness cores within the stack

- Copying and pasting foils or cores – increasing the layer count

High quality documentation and file format

Speedstack saves the stack in efficient electronic format and outputs stack graphics in a variety of formats to suit your requirements. Stack data may be output in GERBER, DXF, BMP, JPEG, TIFF and XML. In addition, the stack data can be exported in comma-separated form for inclusion in other systems. Speedstack's high quality customisable printouts make it easy to discuss alternate builds and pricing impacts with fabricators.

Applications engineers, front end and production engineers benefit from receiving stack information in an intuitive, easy to understand format. The Speedstack .sci file contains full details of the layer stackup of a particular job. If changes are necessary or preferred stacks are to be shared with customers, Speedstack can cut the time for documentation and information sharing to a fraction of the time taken when employing traditional methods such as spreadsheet, word processor or presentation software.

Integration with the Si8000m/Si9000e

Speedstack is fully integrated with the Polar Si8000m Controlled Impedance and the Si9000e PCB Transmission Line Field Solvers so the user can quickly add controlled impedance structures to layers in the stackup. The designer or board fabricator can use the Goal Seek facility of the Si8000m/Si9000e field solvers to arrive rapidly at the controlled impedance structure parameters to produce the target impedance.

Materials library

The Speedstack supports a flexible materials library. This allows the designer to use standard materials data and also provides the facility to create new material libraries. PCB fabricators can also build libraries of commonly stocked materials to give interconnect designers visibility of the materials held in stock. Speedstack thus supports three types of library – custom user libraries of materials, generic designer libraries of materials of given dielectric characteristics (for example, thicknesses) along with a comprehensive set of materials libraries from PCB base material suppliers who are members of the Polar Speedstack Material Partner program.

Online / on-premise materials libraries

The Speedstack Material Library includes an online library to allow users to download material library MLBX files from the Polar website. The online material libraries feature provides the user with a list of available library files; on selection the file is downloaded and is either appended to the existing data or replaces the existing data.

Speedstack also includes an on-premise option to allow for users who cannot connect to the online library due to network security restrictions

Speedstack's Virtual Material mode

Speedstack provides *Virtual Material* mode allowing you to build and experiment with stackups (for example to examine the effects on impedance structures of different trace widths or dielectric heights) without requiring real materials to be entered into a materials library.

In Virtual Material mode you will use the Stackup Wizard to enter a few details about the stack, the number of layers, overall board thickness, plane and mixed layers, etc., along with solder mask and copper thickness and build type (foil, core or HDI.) and drills Speedstack will then build a stack to the specified board thickness by equally distributing the dielectric regions. If a preferred core thickness is specified the software will maintain the dielectric thickness for core regions but then equally distribute prepreg regions to reach the target board thickness.

Preferred builds

PCB fabricators are able to create and share preferred builds and exchange the associated information with designers. Build data also includes blind and buried via specification. This simplifies the task of sharing stackup and drilling information between board shops and the design community.

Dimensional information

Finished board thickness is a critical dimension in many applications; Speedstack keeps track of the finished PCB thickness and tolerance and allows fabricators the flexibility of adding in-house post-press thickness for prepreg layers. Additionally, Speedstack takes into account plating thickness where appropriate.

High layer count boards

On boards with high layer counts it can be very easy to make a change that would produce a non-symmetrical stack. The Speedstack Design Rules Check monitors symmetry across the stack, and ensures that material symmetry is maintained. Speedstack also makes it easy to set the symmetrical build mode to ensure that any changes you make are applied equally across the stack.

Supplier management

When multiple-sourcing PCBs or when moving from prototype to volume production, the stack and fabrication design rule checks ensure that the manufacturing capabilities of your chosen suppliers are not overlooked. In addition the professional documentation output ensures that layer stack information is accurately conveyed to PCB suppliers.

Graphical interface

Speedstack offers an easy to interpret graphical interface. Clearly showing the layers supporting blind and buried vias, Speedstack also records the data file for each layer (including ident and peelable mask layers). The graphical interface is especially designed to simplify the process of communication between interconnect designer and fabricator. OEMs who need to manage boards sourced from multiple suppliers will also find this facility invaluable. In addition to physical layers Speedstack adds mask and notation for electrical layers.

Interfacing with other systems

Speedstack is able to load an XML file on launch. If an XML file (.stkx) filename parameter is specified on the command line it will import this file into Speedstack.

Speedstack can call an external program / utility / script via the External Utilities menu options. The menu items are configured within the Configuration option.

Importing and exporting stackup information

IPC-2581 Rev B

Speedstack incorporates Import from and Export to IPC-2581 Rev B option with interactive interface, supporting stack up material and structure information

Ucamco

Speedstack incorporates the facility to read in files in XML format and Ucamco Job File format, providing comprehensive integration with Ucamco and will import files from and export to both Ucam and Integr8tor.

Zuken

Speedstack integrates directly with the Zuken CR-8000 Design Force and Zuken Design Force DFM Center PCB manufacturing pre-processing and CAM system, simplifying material communication in the supply chain. Designers can define layers in DFM Center then export to Speedstack to define materials and provide a fully documented stackup in a format widely recognised by both PCB supply chain managers and fabricators.

Stacks may be exported to the Polar CGen Coupon Generator for subsequent processing into test coupons.

The Export CITS File option will create test files for Polar CITS controlled impedance test systems.

Speedstack can generate printed output in DXF, Gerber, CSV and XML, as well as graphic image formats JPEG, BMP and TIFF.

Export options also include Cadence Allegro, CSV, IPC-2581 Rev B and Mentor Graphics.

Import / export XML file formats support frequency dependent structure properties.

Converting imported electrical layers to cores

When importing stackup data from some CAD / CAM systems only the electrical layers are defined, so copper layers may appear adjacent each other. Speedstack allows conversion of two adjacent electrical layers into core or flexible core materials using the Convert to Core function.

Structure net classes

Speedstack is able to import and store up to five net class names with each structure. These net class names provide a link to the matching impedance nets inside the ECAD PCB layout system.

Installing Speedstack

Installing and activating Speedstack

It will be necessary to install and activate the product license and set operating options prior to building stacks or performing calculations with Speedstack. See *Configuring Speedstack|Licensing* to select the associated field solver and purchased options.

Obtaining a Speedstack license

Speedstack is license using the FlexNet Publisher licensing service. Contact Polarcare@polarinstruments.com for installation/activation directions.

Download the software from the supplied link. Unpack and save the installation file to a suitable folder then run Setup.

Uninstalling the software

Caution: Prior to uninstalling, make a copy of the Speedstack folder structure and data files and store in a safe place.

To uninstall the Speedstack software:

Windows 7/8/10

Choose Settings|Control Panel; select Programs and Features and right click Speedstack and choose Uninstall.

Getting started with Speedstack

Online tutorial guides

Polar's web site provides online downloadable quick start and version specific user guides to familiarize users with the operation and features of the software.

From the Help menu choose Speedstack Help to download the Getting Started guide, along with tutorials for stack editing, managing materials libraries, manufacturing constraints and controlled impedance structures:

<https://www.polarinstruments.com/help/speedstack/tutorials/>

Download the user guide for your Speedstack version:

<https://www.polarinstruments.com/help/speedstack/Nrmstart.htm>

Stackup Templates

Polar's web site provides online downloadable prebuilt sample templates and associated technical reports (suitable for Speedstack 2019 or higher) to familiarize users with the operation and features of the software.

<https://www.polarinstruments.com/support/stackup/templates.html>

The stackup templates listed include materials and drills are typical of standard stacks used in PCB construction and can be used as a starting point when building your own stacks. Stackup samples include core and foil build models in both material library and virtual library modes (see *Creating and editing stackups*) for rigid stackups, flex-rigid stackups and multiple press cycle HDI stackups.

Click on the link to the stackup template page and download the Speedstack template project (.sci) file; save to a convenient location and the use the Open Project command in Speedstack to view and edit the stackup. Note that the sample stackups are shown with dimensions in microns.

Using Speedstack Stackup Builder

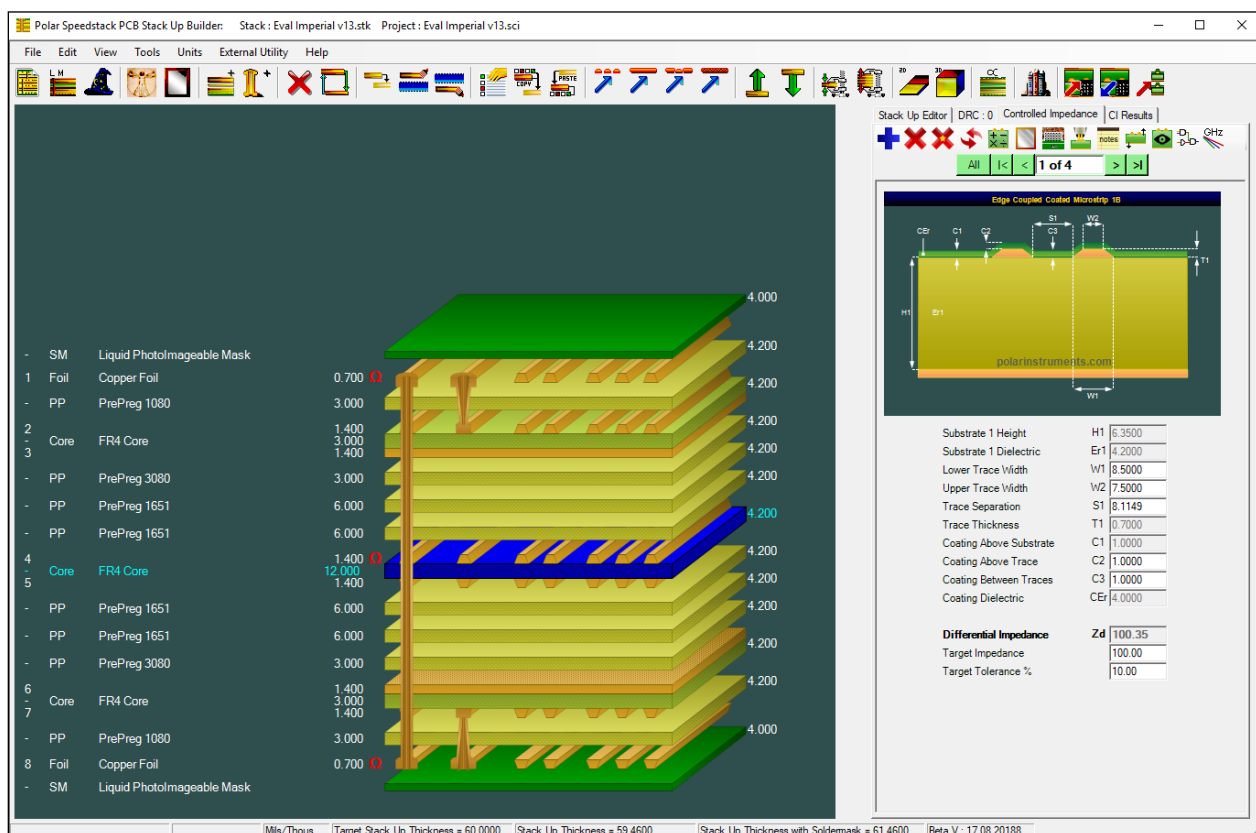
Speedstack Stackup Builder

Double-click the Speedstack icon to start the Speedstack program and display the Stack Editor.

The Stack Editor

The Stack Editor screen displays all details of the stack, including copper and prepreg materials, solder masks and ident layers, drilling information, controlled impedance structures and design rule check results.

Controlled impedance structure data may be transferred between Speedstack and the associated Polar Si8000m or Si9000e field solver to goal seek for the target structure dimensions.



The Stack Editor screen

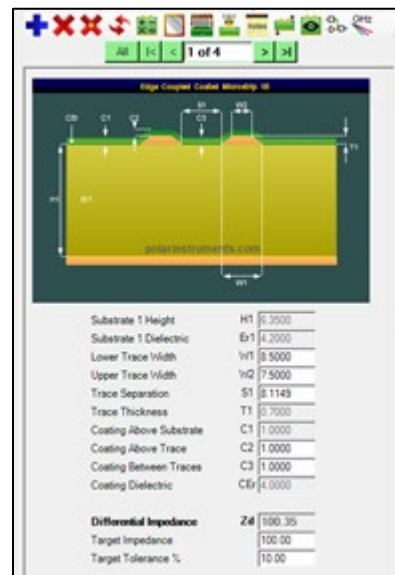
The Speedstack Stack Up Editor screen comprises:

- The Menu bar — drop-down context sensitive menus containing all the Speedstack Editor commands
- The Tool bar — incorporating short cut tool buttons to the most common menu commands

- The Stackup Build and Construction Window — where the board stackup is built and edited
- The Controlled Impedance window displaying the controlled impedance structures (if any) for the selected layer.
- Stack Up Editor/Notes tab— a free form text area for explanatory or commentary notes
- Design Rules Check (DRC) tab — allows design rules and manufacturing constraints to be specified and violations displayed
- Stack Up Information properties area — table containing information related to the whole stackup
- Selected Item Information area — properties table containing the attributes of the layer currently selected in the stackup
- The Controlled Impedance Results tab – summarizing the controlled impedance structures within the stack

Controlled Impedance window

The Controlled Impedance window displays all the controlled impedance structures and associated parameters for the selected layer.

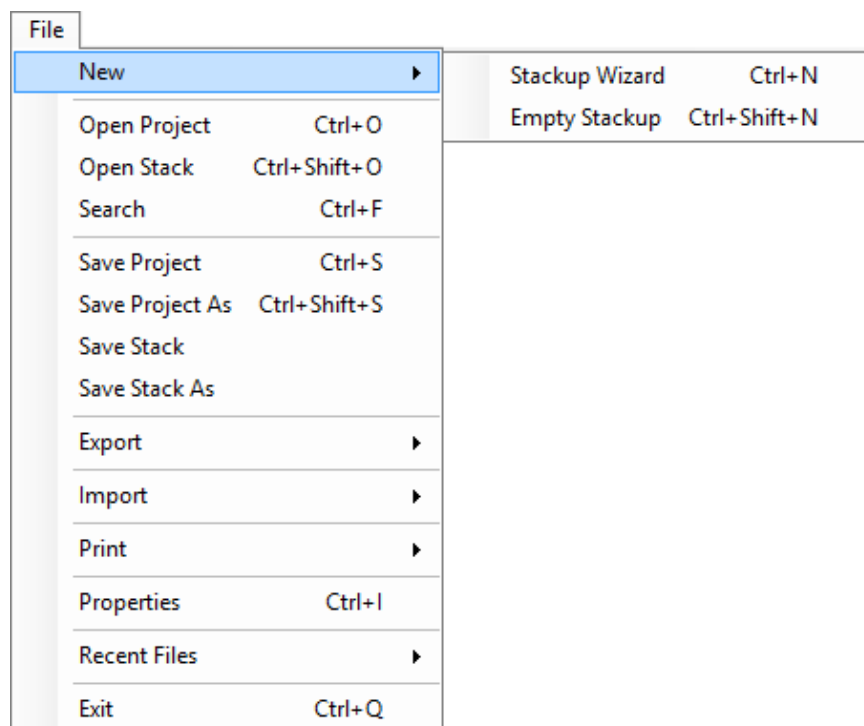


Step through the structures with the structure browse control – structures with the impedance within tolerance are shown in green, structures where the impedance is outside the specified tolerance range are shown in red.

The Speedstack menu system

The File menu

The File menu allows for creation of new stackups and projects and opening, saving, printing, importing and exporting existing stackups and projects and data files from companies providing data exchange with Speedstack.



Opening projects

Stackups that incorporate controlled impedance structures are saved as projects. Click Open Project and navigate to the project folder; projects are saved as .sci files. The stackup along with all its design rule checking settings and controlled impedance information is loaded.

Saving stackups

Click the Save button to save the stackup. Users are recommended to save the stackup frequently during the stackup creation process to avoid data loss; stackups are saved as .stk files.

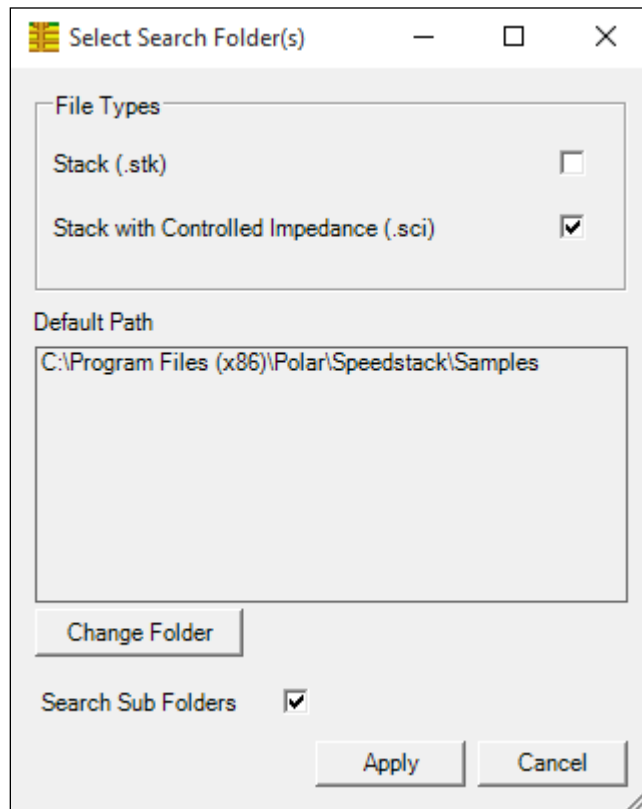
Saving projects

Use the Save Projects command to save a stackup and its controlled impedance structures.

Searching for stackups and project files

When creating new stackups and projects it will often be found convenient and timesaving to reuse an existing stack or project, modifying as required and the saving as a new

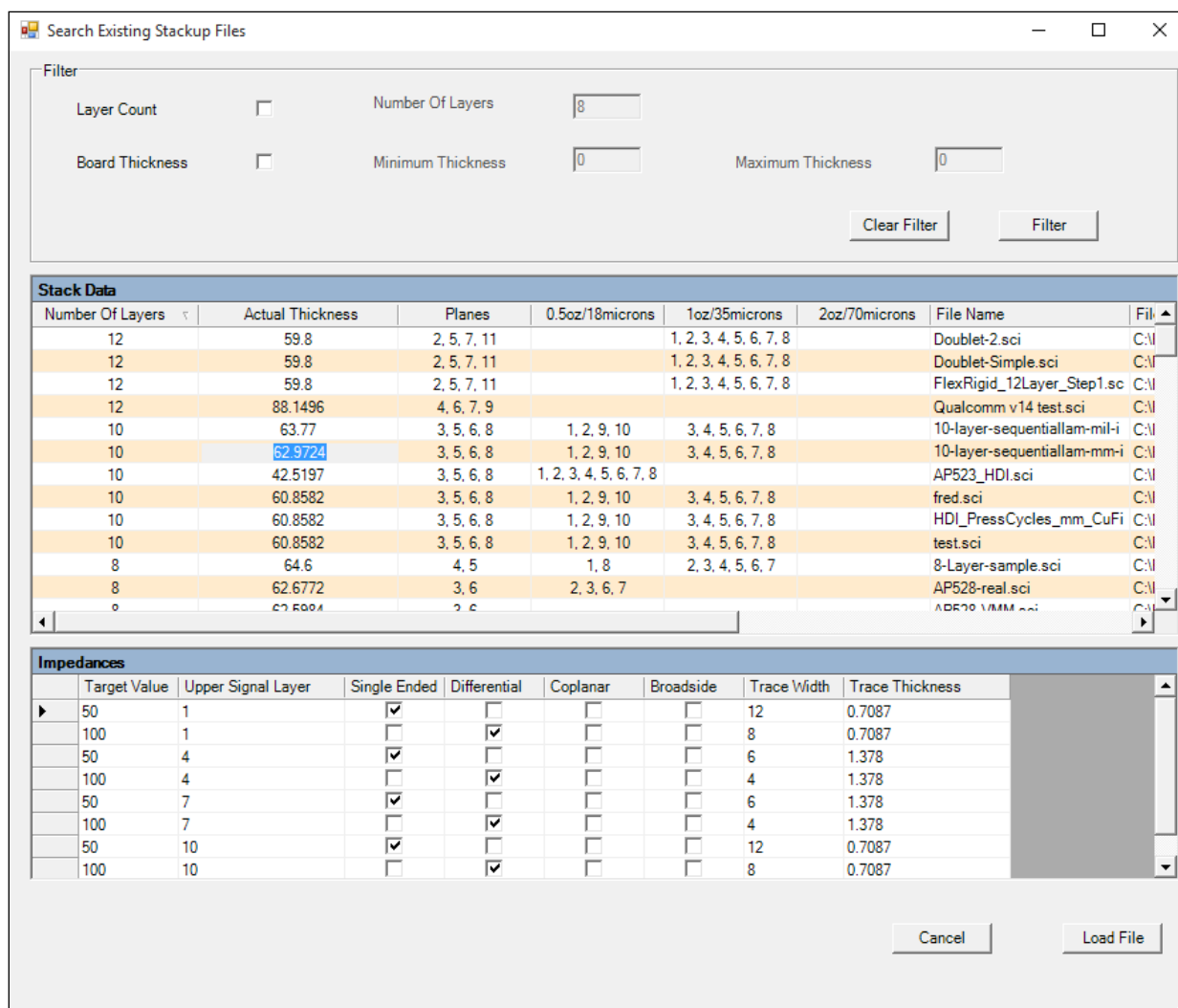
stack or project. From the File menu choose Search and click Change Folder to navigate to the collection of stacks.



Choose from stacks and/or projects (stacks with controlled impedance;) with the folder chosen, click Apply.

Supplying search criteria

The stackups and projects within the chosen folder structure are displayed. If appropriate supply criteria, layer count, board thickness, etc. and click Filter.



Importing Stackup information

Speedstack incorporates the facility to read in files in:

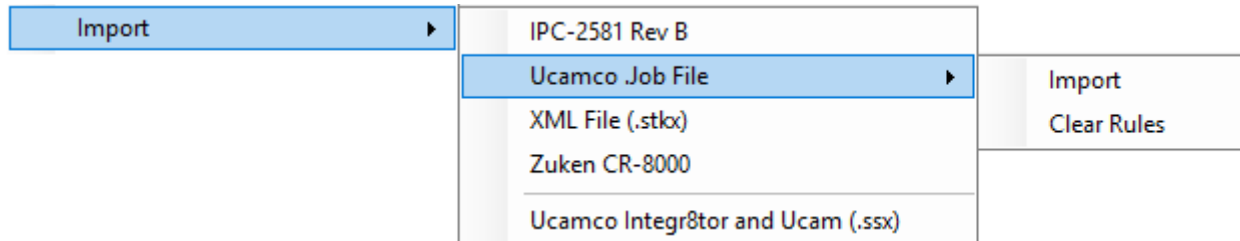
IPC-2581 Rev B format

Ucamco Job File format

XML format

Zuken CR-8000 format

Ucamco Integr8tor and Ucam format



IPC-2581 Rev B

Speedstack can import stack up and impedance structure data using the IPC-2581 Rev B XML file format. Use the IPC-2581 Rev B command to import IPC-2581 Rev B (XML) files using the interactive interface. The stack shown below displays both stackup material and structure information. The foil, prepreg, core and solder mask material data grid colours are determined by the Speedstack Configuration,

Import IPC-2581 Rev B

IPC-2581 File Information

Filename

C:\Program Files (x86)\Polar\Speedstack\Samples\AP517.xml

Revision

B

Units

INCH

Software Package (that generated the file)

Name

Polar Instruments Ltd Speedstack

Revision

17.1.21725

Vendor

Polar Instruments Ltd

Import

Cancel

Notes: 0

Import Options

☒ Assign IPC-2581 as Material Supplier

☒ Assign IPC-2581 Layer Name(s) as Material Type

☒ Calculate Upper Trace Widths (W2) using Default Etch Factor (3.000µm)

Assign imported Loss Tangent to Notes field :


None

Display Options

☐ All (Stack Up and Structure Data)

☒ Stack Up Data only

☐ Structure Data only

IPC-2581
CONSORTIUM

To edit the data displayed below select the row, right-click menu and choose the appropriate function

| Speedstack Layer Number | Layer Name | Specification Name | Layer Function | Side | Thickness | Sequence | Material Description | Resin Content | Dielectric Constant | Loss Tangent |
|-------------------------|-------------------|------------------------|----------------|----------|-----------|----------|----------------------------|---------------|---------------------|--------------|
| | STACKUP THICKNESS | | | | 0.068600 | | | | | |
| | LEGEND_TOP | LEGEND_TOP_SPEC | LEGEND | TOP | 0.002000 | 1 | Screened Ident | | | |
| | SOLDERMASK_TOP | SOLDERMASK_TOP_SPEC | SOLDERMASK | TOP | 0.001000 | 2 | Liquid PhotoImageable Mask | | 4.000 | |
| 1 | L1 | L1_SPEC | SIGNAL | TOP | 0.001400 | 3 | Copper Foil | | | |
| | DIELECTRIC_1 | DIELECTRIC_1_SPEC | DIELPREG | INTERNAL | 0.003400 | 4 | PrePreg 3113 | 53.00 | 4.200 | 0.0350 |
| | DIELECTRIC_2 | DIELECTRIC_2_SPEC | DIELPREG | INTERNAL | 0.003400 | 5 | PrePreg 3113 | 53.00 | 4.200 | 0.0350 |
| 2 | L2 | L2_SPEC | MIXED | INTERNAL | 0.002100 | 6 | FR4 Core | | | |
| | DIELECTRIC_3 | DIELECTRIC_3_SPEC | DIELCORE | INTERNAL | 0.008000 | 7 | FR4 Core | 45.00 | 4.200 | 0.0350 |
| 3 | L3 | L3_SPEC | SIGNAL | INTERNAL | 0.001400 | 8 | FR4 Core | | | |
| | DIELECTRIC_4 | DIELECTRIC_4_SPEC | DIELPREG | INTERNAL | 0.003600 | 9 | PrePreg 3113 | 53.00 | 4.200 | 0.0350 |
| | DIELECTRIC_5 | DIELECTRIC_5_SPEC | DIELPREG | INTERNAL | 0.003600 | 10 | PrePreg 3113 | 53.00 | 4.200 | 0.0350 |
| 4 | L4 | L4_SPEC | PLANE | INTERNAL | 0.001400 | 11 | FR4 Core | | | |
| | DIELECTRIC_6 | DIELECTRIC_6_SPEC | DIELCORE | INTERNAL | 0.008000 | 12 | FR4 Core | 45.00 | 4.200 | 0.0350 |
| 5 | L5 | L5_SPEC | PLANE | INTERNAL | 0.001400 | 13 | FR4 Core | | | |
| | DIELECTRIC_7 | DIELECTRIC_7_SPEC | DIELPREG | INTERNAL | 0.003600 | 14 | PrePreg 3113 | 53.00 | 4.200 | 0.0350 |
| | DIELECTRIC_8 | DIELECTRIC_8_SPEC | DIELPREG | INTERNAL | 0.003600 | 15 | PrePreg 3113 | 53.00 | 4.200 | 0.0350 |
| 6 | L6 | L6_SPEC | SIGNAL | INTERNAL | 0.001400 | 16 | FR4 Core | | | |
| | DIELECTRIC_9 | DIELECTRIC_9_SPEC | DIELCORE | INTERNAL | 0.008000 | 17 | FR4 Core | 45.00 | 4.200 | 0.0350 |
| 7 | L7 | L7_SPEC | MIXED | INTERNAL | 0.002100 | 18 | FR4 Core | | | |
| | DIELECTRIC_10 | DIELECTRIC_10_SPEC | DIELPREG | INTERNAL | 0.003400 | 19 | PrePreg 3113 | 53.00 | 4.200 | 0.0350 |
| | DIELECTRIC_11 | DIELECTRIC_11_SPEC | DIELPREG | INTERNAL | 0.003400 | 20 | PrePreg 3113 | 53.00 | 4.200 | 0.0350 |
| 8 | L8 | L8_SPEC | SIGNAL | BOTTOM | 0.001400 | 21 | Copper Foil | | | |
| | SOLDERMASK_BOTTOM | SOLDERMASK_BOTTOM_SPEC | SOLDERMASK | BOTTOM | 0.001000 | 22 | Liquid PhotoImageable Mask | | 4.000 | |

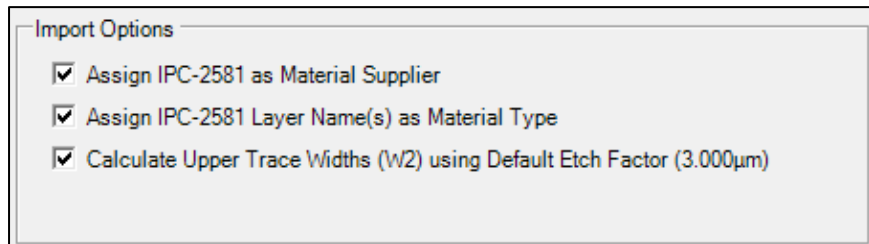
The dialog above provides user guidance through the import process.

The IPC-2581 File Information pane displays useful file data including the file name, revision and units. IPC-2581 supports inches, millimetres and microns.

The Software Package pane details the application (including the revision and vendor) that generated the IPC-2581 file.

Setting import options

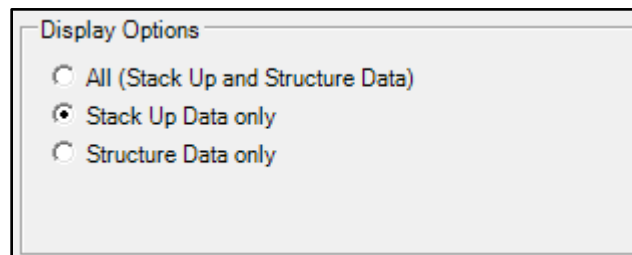
Set the import options to control how the IPC-2581 data is allocated in Speedstack:



The material type can optionally be derived from the layer name and the upper trace width can be derived from the given trace width and default etch factor.

Setting display options

From the Display Options dialog pane choose to display all data or stackup or structure data only



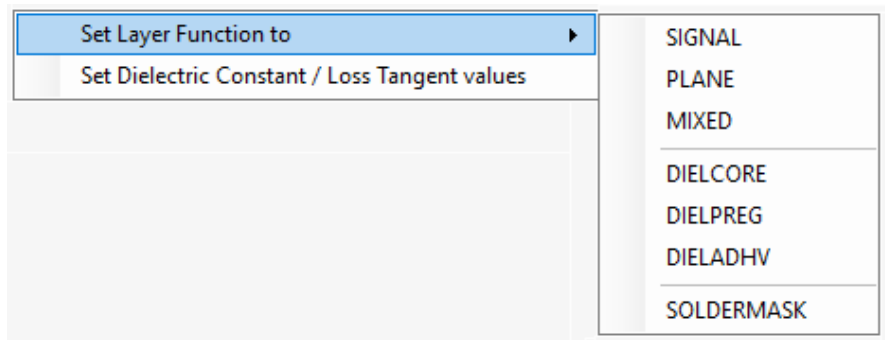
Sorting layer information

The stackup imported from the IPC-2581 file is shown in data grid form. Data can be sorted by column – click on each column header to sort in ascending or descending order by sequence, layer number, layer name, etc.

Assigning layer functions

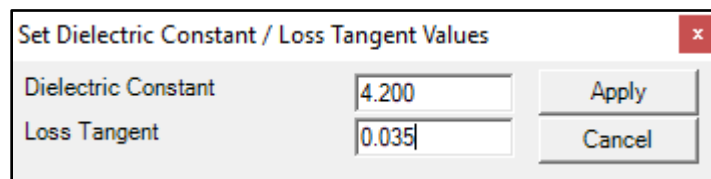
During the import process it may be necessary to consult the board authority or design documentation to ascertain the function of each layer, signal, plane, dielectric, core, etc.; the Layer Function determines the layer / material type.

Right click each layer and use the Set Layer Function to assign the layer its designated function.

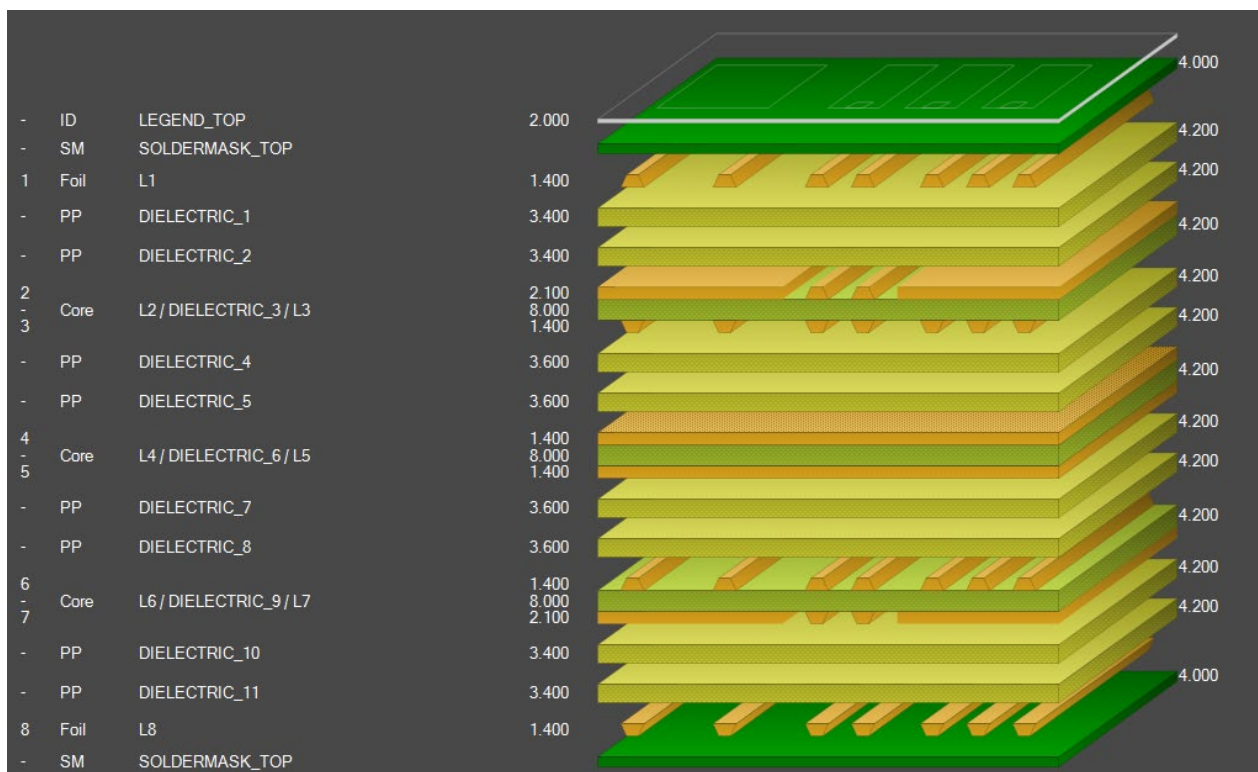


Setting loss values

Dielectric constant and loss tangent values can be set for each layer; select the layer (it will highlight in blue) and then right click the layer, the dialog should show the current values; enter each value and click Apply.



With all the editing completed, click Import to bring the file into the Speedstack Editor.



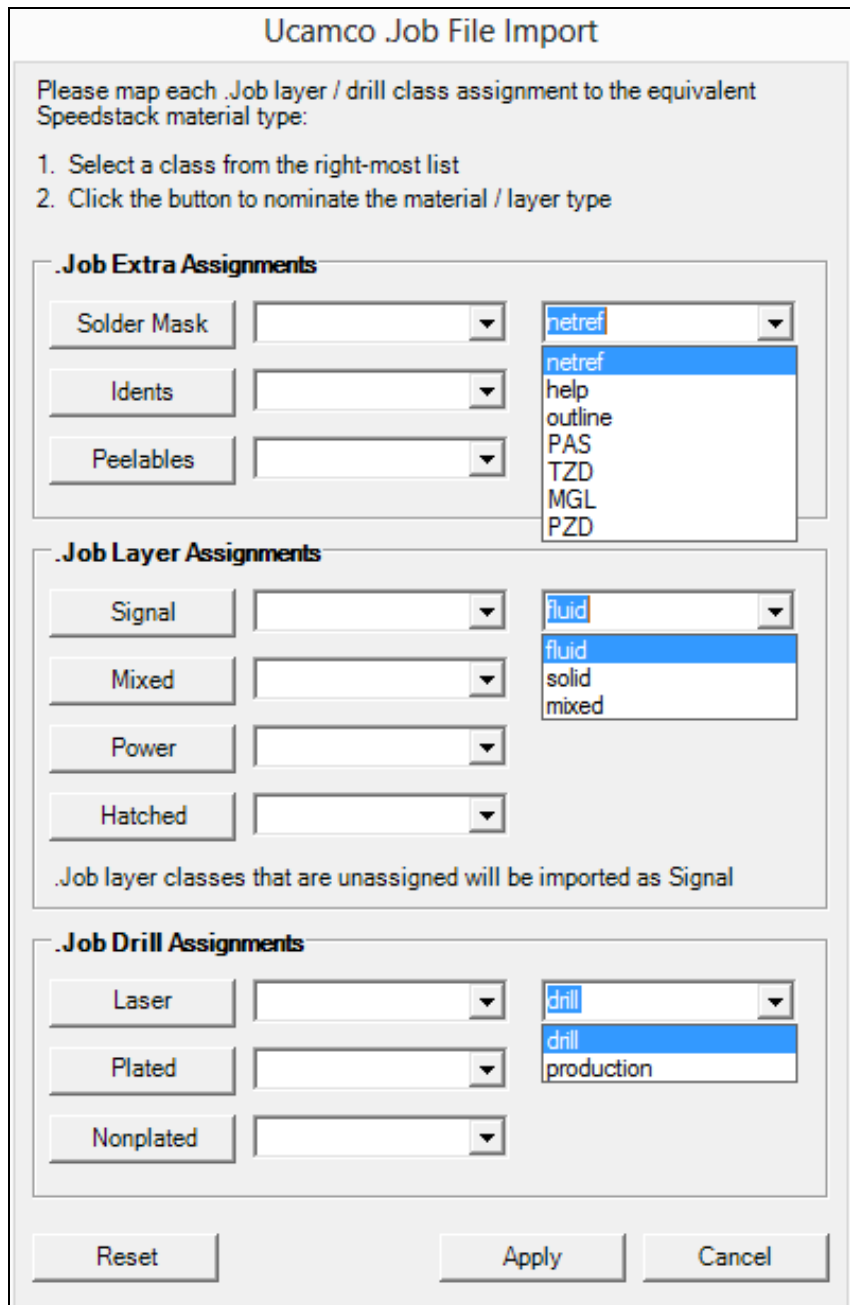
The imported stack can be processed using the Speedstack editing functions.

Ucamco Job Files

The .Job file format contains a varying amount of stackup information depending upon the how the system has been configured by the Ucam user.

Speedstack will import files from both Ucam and Integr8tor.

Choose File|Import|Ucamco Job File|Import and select the .job file and click Open. The Ucamco .Job File Import dialog is displayed:



The dialog box is titled "Ucamco Job File Import". It contains instructions: "Please map each .Job layer / drill class assignment to the equivalent Speedstack material type:" followed by two steps: "1. Select a class from the right-most list" and "2. Click the button to nominate the material / layer type".

The dialog is divided into three sections:

- .Job Extra Assignments:** Contains three buttons: "Solder Mask", "Idents", and "Peelables". Each button has a dropdown menu to its right. A separate dropdown menu is open to the right, showing a list of material types: "netref", "netref", "help", "outline", "PAS", "TZD", "MGL", and "PZD".
- .Job Layer Assignments:** Contains four buttons: "Signal", "Mixed", "Power", and "Hatched". Each button has a dropdown menu to its right. A separate dropdown menu is open to the right, showing a list of material types: "fluid", "fluid", "solid", and "mixed".
- .Job Drill Assignments:** Contains three buttons: "Laser", "Plated", and "Nonplated". Each button has a dropdown menu to its right. A separate dropdown menu is open to the right, showing a list of material types: "drill", "drill", and "production".

At the bottom of the dialog, there is a note: ".Job layer classes that are unassigned will be imported as Signal". At the very bottom, there are three buttons: "Reset", "Apply", and "Cancel".

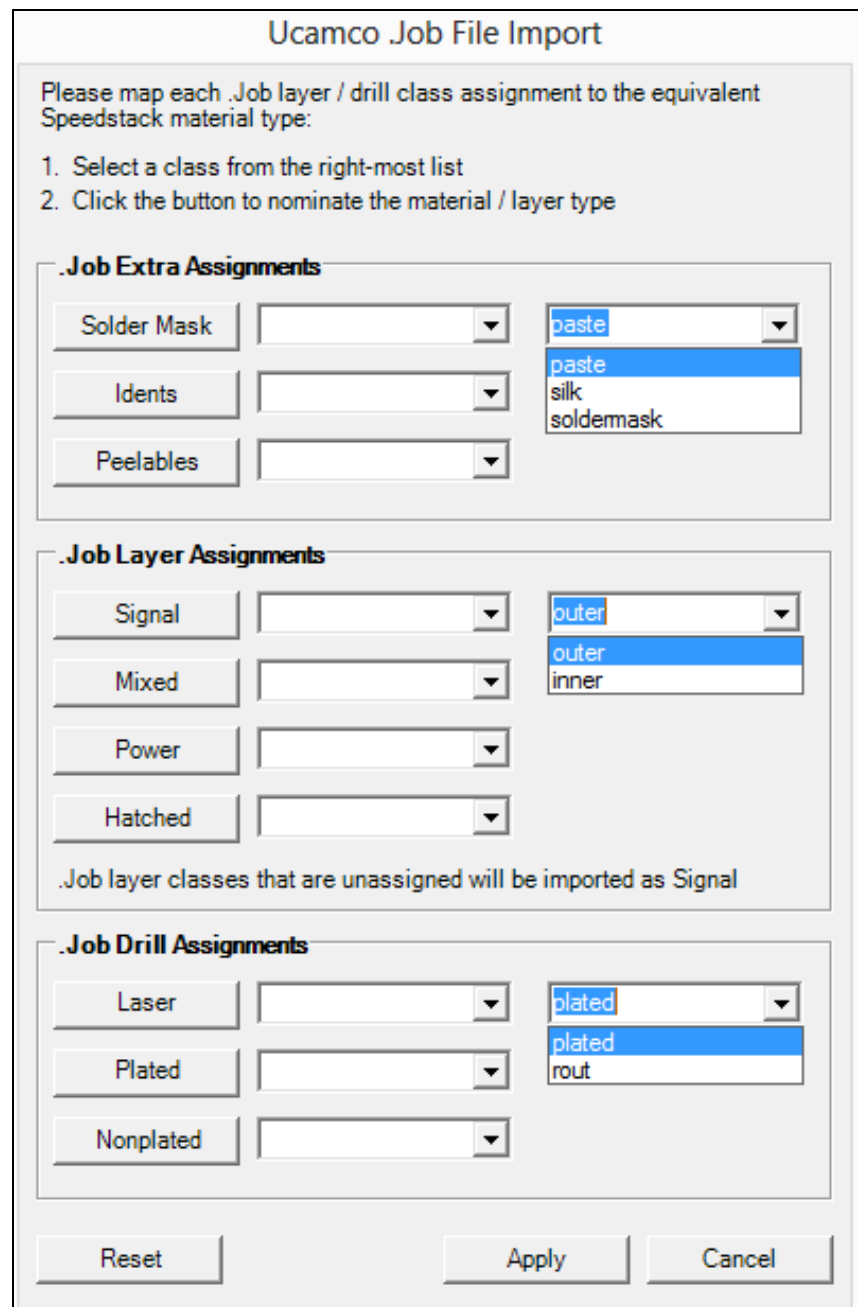
The .Job file contains user-definable material / drill class definitions so it will be necessary to map these definitions to the various Speedstack material and drill types.

To apply assignments select the class from the drop down list then click the associated button to nominate the material or layer type. Click Apply.

Note: Where stack data are not included in the .job file it will be necessary to include or update properties (for example, solder mask properties such as thickness and dielectric constant) before adding impedance structures.

Integr8torJob files

When Integr8tor files are imported the Ucamco .Job File Import dialog is displayed as shown below.



The dialog box is titled "Ucamco Job File Import". It contains instructions: "Please map each .Job layer / drill class assignment to the equivalent Speedstack material type:" followed by two steps: "1. Select a class from the right-most list" and "2. Click the button to nominate the material / layer type".

The dialog is divided into three sections:

- .Job Extra Assignments:** Contains three buttons: "Solder Mask", "Idents", and "Peelables". Each button has a dropdown menu to its right. A separate dropdown menu is open to the right, showing the list: "paste", "paste", "silk", "soldermask".
- .Job Layer Assignments:** Contains four buttons: "Signal", "Mixed", "Power", and "Hatched". Each button has a dropdown menu to its right. A separate dropdown menu is open to the right, showing the list: "outer", "outer", "inner". Below these buttons, it says ".Job layer classes that are unassigned will be imported as Signal".
- .Job Drill Assignments:** Contains three buttons: "Laser", "Plated", and "Nonplated". Each button has a dropdown menu to its right. A separate dropdown menu is open to the right, showing the list: "plated", "plated", "rout".

At the bottom of the dialog are three buttons: "Reset", "Apply", and "Cancel".

Select the assignment options as described above and click Apply. Click Reset to clear the assignments.

Clear Rules

The Clear Rules command will delete all previously learned rules.

XML files

Choose File|Import|XML File (.stx), select the .stx file for import and click Open.

Zuken CR-8000

Choose File|Import|Zuken CR-8000 format, select the .stkx file for import and click Open.

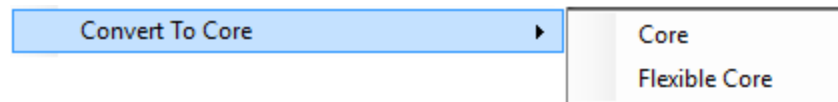
Ucamco Integr8tor and Ucam format (.ssx)

Choose File|Import|Ucamco Integr8tor and Ucam format, select the .ssx file for import and click Open.

Converting imported electrical layers to cores

When importing stack up data from some CAD / CAM systems only the electrical layers are defined. In this case copper layers may appear adjacent each other in the Stackup Editor. Speedstack allows the user to quickly convert two adjacent electrical layers into Core or Flexible Core materials using the Convert to Core function.

Select the adjacent layers within the stack – Speedstack adds the Convert to Core command to the Edit menu.



Select the Core type – Speedstack displays the core library; select the core – the layers are converted into the selected core; note that when converting two foils to a single core material the lower copper trace will be shown inverted.

Consider the stack below. Using ‘Convert to Core’ alongside other Speedstack editing functions, an electrical layer only stackup can be converted into a useful fully defined stackup containing full definitions of foils, prepreg and core materials.

| ID | Material | Length (mm) | Width (mm) | Height (mm) | Volume (mm³) | Weight (g) |
|----|----------|-------------|------------|-------------|--------------|------------|
| 1 | Foil | 1000 | 100 | 0.1 | 100000 | 0.0000 |
| 2 | Foil | 1000 | 100 | 0.1 | 100000 | 0.0000 |
| 3 | Foil | 1000 | 100 | 0.1 | 100000 | 0.0000 |
| 4 | Foil | 1000 | 100 | 0.1 | 100000 | 0.0000 |
| 5 | Foil | 1000 | 100 | 0.1 | 100000 | 0.0000 |
| 6 | Foil | 1000 | 100 | 0.1 | 100000 | 0.0000 |
| 7 | Foil | 1000 | 100 | 0.1 | 100000 | 0.0000 |
| 8 | Foil | 1000 | 100 | 0.1 | 100000 | 0.0000 |

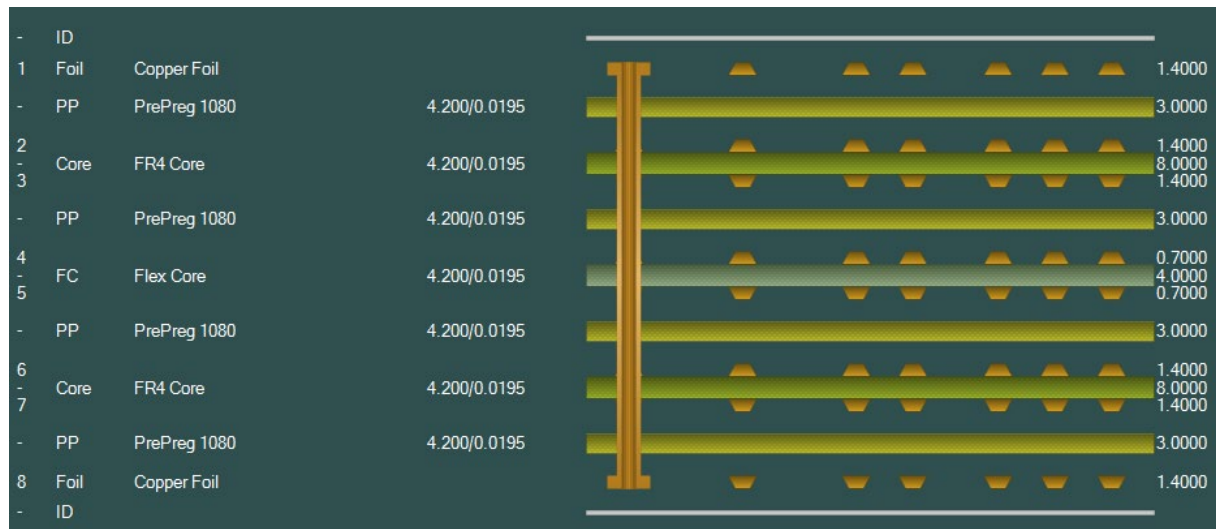
Add a prepreg layer between layers 1 and 2.

Repeat for layers 3 and 4, 5 and 6 and 7 and 8.

Select layers 2 and 3 and convert to a core.

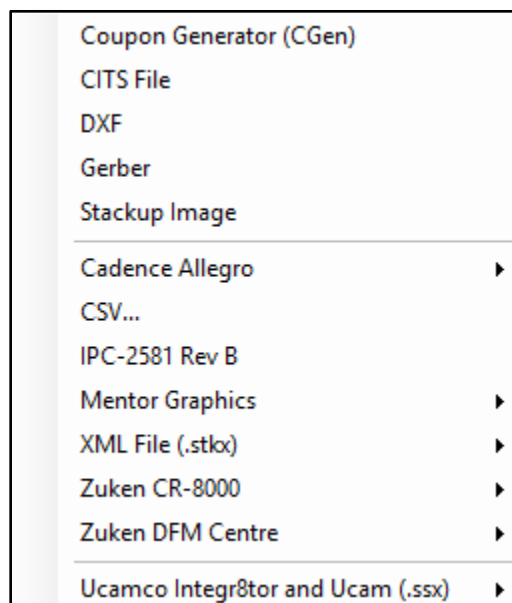
Repeat for layers 4 and 5, 6 and 7.

The resulting stack should appear similar to the stack below.



Exporting stackup information

Speedstack incorporates the facility to export stack data to external programs. From the File menu choose Export and choose the format from the Export sub-menu.

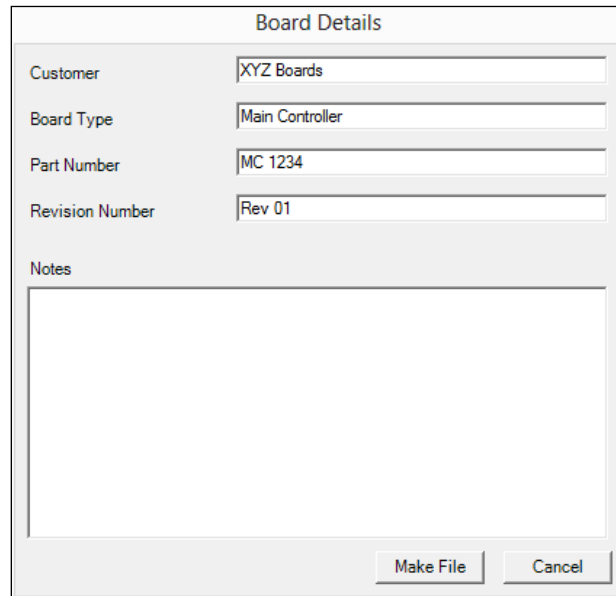


Exporting to Coupon Generator (CGen)

Stacks may be exported to the Polar CGen Coupon Generator for subsequent processing into test coupons. Click Export To | Coupon Generator – open the file in CGen.

Export CITS File

Use the Export CITS File to create test files for Polar CITS controlled impedance test systems. Supply board details via the Board Details dialog.



The 'Board Details' dialog box contains the following fields and controls:

- Customer:** Text field with 'XYZ Boards' entered.
- Board Type:** Text field with 'Main Controller' entered.
- Part Number:** Text field with 'MC 1234' entered.
- Revision Number:** Text field with 'Rev 01' entered.
- Notes:** A large empty text area for additional information.
- Buttons:** 'Make File' and 'Cancel' buttons at the bottom right.

Click Make File to generate .cif files (CITS test files).

Generating printed output

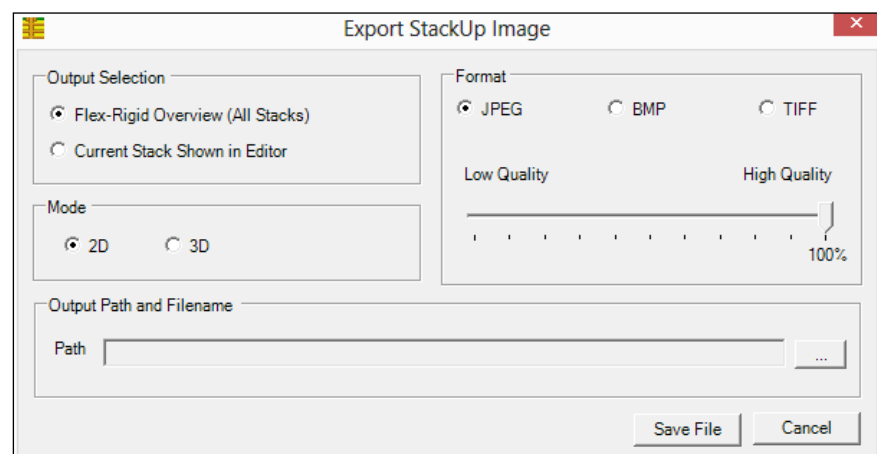
Speedstack can generate printed output in DXF, Gerber, CSV and XML, as well as graphic image formats.

DXF, Gerber, CSV and XML files

Choose DXF..., Gerber..., CSV... or XML File and navigate to a suitable folder, name the file as appropriate and save.

Stackup images

Speedstack can export stackup images in JPEG, BMP and TIFF file formats. Select from 2D or 3D displays.



The 'Export StackUp Image' dialog box contains the following sections and controls:

- Output Selection:** Radio buttons for 'Flex-Rigid Overview (All Stacks)' (selected) and 'Current Stack Shown in Editor'.
- Mode:** Radio buttons for '2D' (selected) and '3D'.
- Format:** Radio buttons for 'JPEG' (selected), 'BMP', and 'TIFF'.
- Quality Slider:** A slider ranging from 'Low Quality' to 'High Quality' (100%).
- Output Path and Filename:** A text field for the 'Path' with a browse button ('...').
- Buttons:** 'Save File' and 'Cancel' buttons at the bottom right.

The Low Quality – High Quality slider specifies JPG quality.

Choose the Flex-Rigid Overview (if appropriate) to display the master stack and associated sub-stacks or Current Stack Shown in Editor. Specify the destination folder and file name and save.

Cadence Allegro (IPC-2581 Rev B)

Speedstack supports reading/writing in IPC-2581 Rev B formatted data. Choose the Cadence Allegro/IPC-2581 Rev B option and supply the file name and destination folder: the Export IPC-2581 Rev B dialog is displayed.

Export IPC-2581 Rev B

IPC-2581 File Information

Filename: C:\Program Files (x86)\Polar\Speedstack\Samples\AP543.xml

Revision: B

Units: MICRON

Software Package (that generated the file)

Name: Speedstack

Revision: 20.5.16195

Vendor: Polar Instruments Ltd

Export

Cancel

Notes: 2

IPC-2581 CONSORTIUM

Export Options

☒ Export Target Impedance as the IPC-2581 Impedance data

☐ Export Calculated Impedance as the IPC-2581 Impedance data

Assign resin rich Dielectric Constant value: 3.5000

Apply

Display Options

☒ All (Stack Up and Structure Data)

☐ Stack Up Data only

☐ Structure Data only

To edit the data displayed below select the row, right-click menu and choose the appropriate function

| Speedstack Layer Number | Layer Name | Specification Name | Layer Function | Side | Thickness | TolPlus | TolMinus | Sequence | Material Description | Resin Content |
|-------------------------|----------------|---------------------|----------------|----------|-----------|---------|----------|----------|----------------------------|---------------|
| | SOLDERMASK_TOP | SOLDERMASK_TOP_SPEC | SOLDERMASK | TOP | 25.400 | 2.540 | 2.540 | 1 | Liquid PhotoImageable Mask | |
| 1 | L1 | L1_SPEC | SIGNAL | TOP | 35.560 | 0.000 | 0.000 | 2 | Copper Foil | |
| | DIELECTRIC_1 | DIELECTRIC_1_SPEC | DIELEPREG | INTERNAL | 76.200 | 7.620 | 7.620 | 3 | PrePreg 1080 | 60 |
| 2 | L2 | L2_SPEC | PLANE | INTERNAL | 35.560 | 0.000 | 0.000 | 4 | FR4 Core | |
| | DIELECTRIC_2 | DIELECTRIC_2_SPEC | DIELCORE | INTERNAL | 127.000 | 12.700 | 12.700 | 5 | FR4 Core | 50 |
| 3 | L3 | L3_SPEC | SIGNAL | INTERNAL | 35.560 | 0.000 | 0.000 | 6 | FR4 Core | |
| | DIELECTRIC_3 | DIELECTRIC_3_SPEC | DIELEPREG | INTERNAL | 76.200 | 7.620 | 7.620 | 7 | PrePreg 1080 | 60 |
| 4 | L4 | L4_SPEC | SIGNAL | INTERNAL | 35.560 | 0.000 | 0.000 | 8 | FR4 Core | |
| | DIELECTRIC_4 | DIELECTRIC_4_SPEC | DIELCORE | INTERNAL | 127.000 | 12.700 | 12.700 | 9 | FR4 Core | 50 |
| 5 | L5 | L5_SPEC | PLANE | INTERNAL | 35.560 | 0.000 | 0.000 | 10 | FR4 Core | |
| | DIELECTRIC_5 | DIELECTRIC_5_SPEC | DIELEPREG | INTERNAL | 76.200 | 7.620 | 7.620 | 11 | PrePreg 1080 NF | 60 |
| 6 | L6 | L6_SPEC | SIGNAL | INTERNAL | 35.560 | 0.000 | 0.000 | 12 | Polymide Film | |
| | DIELECTRIC_6 | DIELECTRIC_6_SPEC | DIELCORE | INTERNAL | 76.200 | 7.620 | 7.620 | 13 | Polymide Film | |
| 7 | L7 | L7_SPEC | PLANE | INTERNAL | 35.560 | 0.000 | 0.000 | 14 | Polymide Film | |
| 8 | L8 | L8_SPEC | PLANE | INTERNAL | 35.560 | 0.000 | 0.000 | 15 | FR4 Core | |
| | DIELECTRIC_7 | DIELECTRIC_7_SPEC | DIELCORE | INTERNAL | 127.000 | 12.700 | 12.700 | 16 | FR4 Core | 50 |
| 9 | L9 | L9_SPEC | SIGNAL | INTERNAL | 35.560 | 0.000 | 0.000 | 17 | FR4 Core | |
| | DIELECTRIC_8 | DIELECTRIC_8_SPEC | DIELEPREG | INTERNAL | 76.200 | 7.620 | 7.620 | 18 | PrePreg 1080 | 60 |
| 10 | L10 | L10_SPEC | SIGNAL | INTERNAL | 35.560 | 0.000 | 0.000 | 19 | FR4 Core | |
| | DIELECTRIC_9 | DIELECTRIC_9_SPEC | DIELCORE | INTERNAL | 127.000 | 12.700 | 12.700 | 20 | FR4 Core | 50 |
| 11 | L11 | L11_SPEC | PLANE | INTERNAL | 35.560 | 0.000 | 0.000 | 21 | FR4 Core | |
| | DIELECTRIC_10 | DIELECTRIC_10_SPEC | DIELEPREG | INTERNAL | 76.200 | 7.620 | 7.620 | 22 | PrePreg 1080 | 60 |
| 12 | L12 | L12_SPEC | SIGNAL | BOTTOM | 35.560 | 0.000 | 0.000 | 23 | Copper Foil | |

Choosing export options

Use the dialog to modify, if necessary, the file information details and choose the export options.

Export Options

☒ Export Target Impedance as the IPC-2581 Impedance data

☐ Export Calculated Impedance as the IPC-2581 Impedance data

Assign resin rich Dielectric Constant value: 3.5000

Apply

Specify whether Speedstack's target or calculated impedance is to be used to populate the IPC-2581 file.

Supply a value for dielectric constant and click Apply.

Click Export.

Mentor Graphics

Choose the Mentor Graphics option, choose the file version and supply the file name and destination folder. (Note the .ssx file extension.)

Zuken CR-8000/DFM Centre

The Zuken CR-8000 and DFM Center PCB manufacturing pre-processing and CAM systems integrate directly with Polar Instruments' Speedstack PCB system. Choose the file version, navigate to a suitable folder and save the file (XML format).

Ucamco Integr8tor and Ucam

Choose the Ucamco Integr8tor and Ucam option and file version and supply the file name and destination folder. (Note the .ssx file extension.)

Assigning properties to projects and stackups

The stack file Properties dialog may be displayed automatically each time a new stackup is created (see Tools|Options|General) and provides a range of text fields for descriptive information, e.g. stackup author, company name, file create date, stackup name, version, etc.

From the File menu choose the Properties command to add descriptive text fields — information contained in the Properties dialog will be displayed on stackup printouts.

To display the Properties dialog each time a new stackup or project is created, from the Tools menu choose Options and click the check box below on the General tab

☒ Display File Properties Dialog for New Stackups and Projects

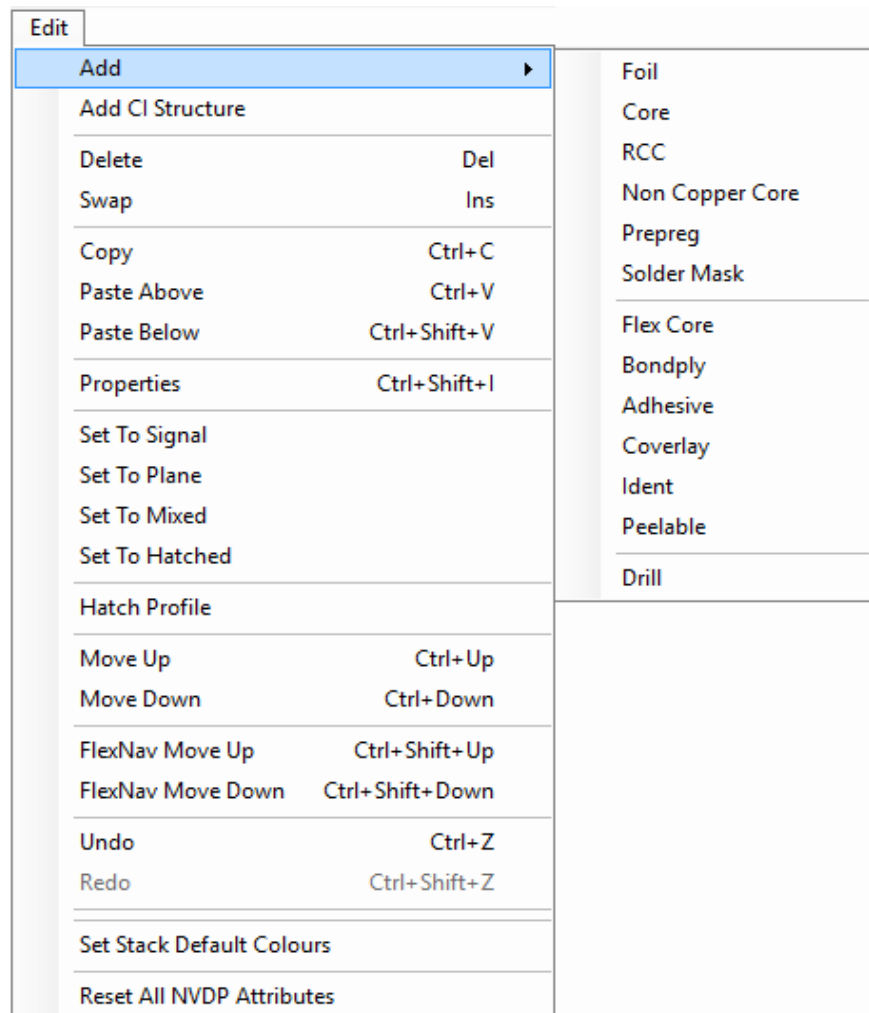
Backing up stackups and libraries

It is strongly recommended that stackup files (assigned the .stk extension), project files (assigned the .sci extension) and library files (assigned the .mlbx extension) be backed up to a secure location.

Opening recent files

Click Recent Files to select and open a file from the most recently used file list.

The Edit menu



The Edit menu contains the commands necessary to create and modify board stackups. The designer or fabricator works within the free-form stackup build and construction window and in Materials Library mode adds layers of foil, core, prepreg, etc., from the materials library.

Material Library and Virtual Material modes

Speedstack provides the option to switch easily between Material Library and Virtual Material modes allowing the stack designer to build and experiment with stackups (for example, to examine the effects on impedance structures of different trace widths or dielectric heights) without requiring real materials to be entered into a materials library.

Controlled impedance structures can be added to the stack. When Add CI Structure is selected Speedstack switches to the Controlled Impedance pane and allows the designer to add structures appropriate for the selected layer. The items that can be edited depend upon whether the Stack Up Editor or Controlled Impedance tab is selected.

Layers can be changed to signal, plane, mixed or hatched, moved up or down or copied and pasted, or assigned properties as required.

Use the Delete and Swap commands to delete materials or swap materials from the Materials Library.

The View menu

Use the View menu to change the Stack Editor display whilst adding or removing materials or modifying or refining the stack.

| View | |
|---------------------------|--------------|
| 2D View | Ctrl+Shift+2 |
| 3D View | Ctrl+Shift+3 |
| <hr/> | |
| Zoom In | Ctrl++ |
| Zoom Out | Ctrl+- |
| Zoom Extents | Ctrl+0 |
| Default View | Ctrl+9 |
| <hr/> | |
| Open Navigator | F4 |
| Restore Navigator | |
| <hr/> | |
| Proportional Stack Viewer | F5 |
| <hr/> | |
| Open Material Library | Ctrl+L |
| Open User AppData Folder | |

The View menu allows Speedstack to display the stackup in a 2-dimensional or 3-dimensional aspect.

Zoom In to get a close-up view of the stack or Zoom Out to see more of the stack at a reduced size. Zoom Extents will adjust the zoom level to display the whole stack.

Hint: Click the mouse centre button/wheel to Zoom Extents.

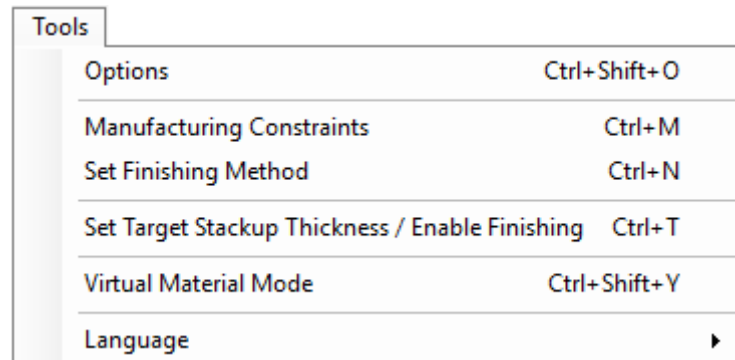
With the Flex / HDI option installed choose the Open Navigator command to view the master and associated sub-stacks. The floating Navigator window may get covered by other application windows when switching between programs; – use the Find Navigator to display a reduced Navigator window at the top left screen corner.

Proportional Stack Viewer

Use the Proportional Stack Viewer to display the stack currently selected in the Stack Editor so the material thicknesses are shown proportional to each other. This can be informative as a visual aid, especially when considering the dielectric thicknesses between electrical layers.

The Tools menu

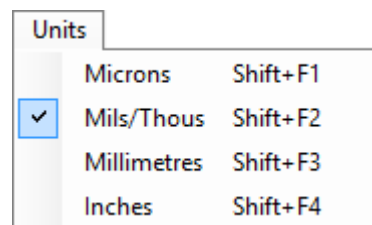
Use the Tools menu to configure Speedstack.



The Options command displays the configuration options, manufacturing constraints, target stack thickness and finishing options. See *Configuring Speedstack* for details.

The Units menu

Use the Units menu to select the stackup units, Microns, Mils/Thous, Millimetres or Inches



External Utility

Use the External Utility commands to start a program external to Speedstack. The programs are defined in the Configuration Options|External Utilities dialog.

The Help menu

Use the Help menu commands to access the User Guide for the current Speedstack version or tutorials relating to common Speedstack operations.

Review the licensing terms with the License and About Speedstack commands.

Configuring Speedstack

When first run, the Speedstack environment is initialised to its factory settings. These may require adjustment before outputting a finished stackup and/or project. Default settings are changed using Tools|Options, Tools|Manufacturing Constraints and Tool|Set Finishing Options.

Environment and default settings

From the Tools menu choose the Options command to display the Configurations Options dialog.

General Options

The screenshot shows the 'General Options' dialog box. It has three main sections: 'Default Stack Up View', 'Display Data', and 'Units'. The 'Default Stack Up View' section has two radio buttons: '2D' and '3D', with '3D' selected. The 'Display Data' section has a note: 'Display Fields 1 and 2 are reserved for Layer Numbers and Layer Types'. Below this note are three dropdown menus: 'Display Field 3' (set to 'Description'), 'Display Field 4' (set to 'None'), and 'Display Field 5' (set to 'Isolation Distance'). The 'Units' section has four radio buttons: 'Mils/Thous', 'Microns' (selected), 'Millimetres', and 'Inches'. At the bottom, there are two checked checkboxes: 'Open last used file on application start up' and 'Display File Properties Dialog for New Stackups and Projects'.

Choose the Default Stackup View – 2D or 3D; select the data fields that will appear alongside the stack in the Stack Editor

This screenshot shows the three dropdown menus from the 'Display Data' section of the dialog box, with their respective lists of options expanded. 'Display Field 3' shows a list with 'Description' selected. 'Display Field 4' shows a list with 'None' selected. 'Display Field 5' shows a list with 'Finished Thickness' selected.

| Display Field 3 | Display Field 4 | Display Field 5 |
|----------------------|---------------------|---------------------|
| Description | None | Base Thickness |
| Supplier | None | Finished Thickness |
| Supplier Description | Base Thickness | Copper Coverage |
| Description | Finished Thickness | Isolation Distance |
| Stock Number | Copper Coverage | Dielectric Constant |
| Type | Isolation Distance | Resin Content |
| | Dielectric Constant | Tg |
| | Resin Content | Colour |
| | Tg | Data Filenames |

Choose the stackup units; Speedstack supports Mils/Thou, Microns, Millimetres and Inches. Click the Open last used... check box to specify that Speedstack should open the last used file on start-up.

Note: Processed Thickness is the Finished Thickness for copper layers and Isolation Distance for dielectric layers.

Clicking the Display File Properties Dialog... will display the File Properties Dialog each time a new stackup or project is initiated.

Structure Defaults

| Structures | |
|-----------------------------|-------------------------------------|
| W1 Default Trace Width | <input type="text" value="150.00"/> |
| W2 Default Trace Width | <input type="text" value="125.00"/> |
| G1 Default Trace Width | <input type="text" value="150.00"/> |
| G2 Default Trace Width | <input type="text" value="125.00"/> |
| S1 Default Trace Separation | <input type="text" value="125.00"/> |
| D1 Default Trace Separation | <input type="text" value="125.00"/> |
| O1 Default Trace Offset | <input type="text" value="0.00"/> |
| REr Default Resin Puddle Er | <input type="text" value="4"/> |

| Board Thickness | |
|-----------------|--------------------------------------|
| Board Thickness | <input type="text" value="1600.00"/> |
| Plus % | <input type="text" value="10"/> |
| Minus % | <input type="text" value="10"/> |

| Drilling | |
|-------------------|-------------------------------------|
| Minimum Hole Size | <input type="text" value="508.00"/> |

When adding new controlled impedance structures default values are entered for the trace widths and separations. Use the Structure Defaults tab to specify the default structure parameters, board thickness and minimum drill hole size.

Licensing

Use the Licensing tab to tick the purchased licensing options.

| |
|--|
| <input type="radio"/> Speedstack License Only |
| <input type="radio"/> Enable Speedstack PCB and Si8000m link |
| <input checked="" type="radio"/> Enable Speedstack Si and Si9000e link |
| License Options: |
| <input checked="" type="checkbox"/> Speedstack Flex / HDI License (SF) |
| <input checked="" type="checkbox"/> Hatch Mode License (XFE) |
| <input checked="" type="checkbox"/> Speedstack Import / Export License (IO) |
| <input checked="" type="checkbox"/> Speedstack / Ucamco Integration License (UCAMCO) |

To activate the Speedstack controlled impedance function, ensure that the Si8000 or Si9000 is installed; from the Licensing tab choose either Use Polar Si8000m License or Use Polar Si9000e License option as appropriate.

Choosing default file locations

| | | |
|--|--|-----------|
| Select default materials library file | C:\Program Files (x86)\Polar\Speedstack\Samples\Speedstack Metric.mlbx | Browse... |
| Select default folder to store Stack Up (*.stk) files | C:\Program Files (x86)\Polar\Speedstack\Samples | Browse... |
| Select default folder to store Material Filter (*.mlf) files | C:\Program Files (x86)\Polar\Speedstack\Samples\Filters | Browse... |
| Select default folder to store custom print settings (*.prs) files | C:\Program Files (x86)\Polar\Speedstack\Samples\Filters | Browse... |

Use this dialog to choose which materials library the Speedstack uses at start-up. Click the File Locations tab and use the Browse button to navigate to the library (.mlbx) file.

The File Locations tab provides for default locations for stackup or project files, Material Filter (.mlf) files and custom print settings (.prs) files. Browse to the target folders and click OK to confirm (create new folders if necessary).

Specifying goal seeking parameters

Click the Goal Seeking tab to specify the default values for trace widths and separations used during goal seeking.

| | | | |
|-----------------------------|--------|--------------------|------|
| W1 Maximum Trace Width | 300.00 | Convergence | 0.50 |
| W1 Minimum Trace Width | 125.00 | Maximum Iterations | 10 |
| S1 Maximum Trace Separation | 300.00 | | |
| S1 Minimum Trace Separation | 125.00 | | |
| D1 Maximum Trace Separation | 300.00 | | |
| D1 Minimum Trace Separation | 125.00 | | |
| H Maximum Value | 200.00 | | |
| H Minimum Value | 50.00 | | |

During goal seeking the calculated value for impedance will progressively converge upon the target value.

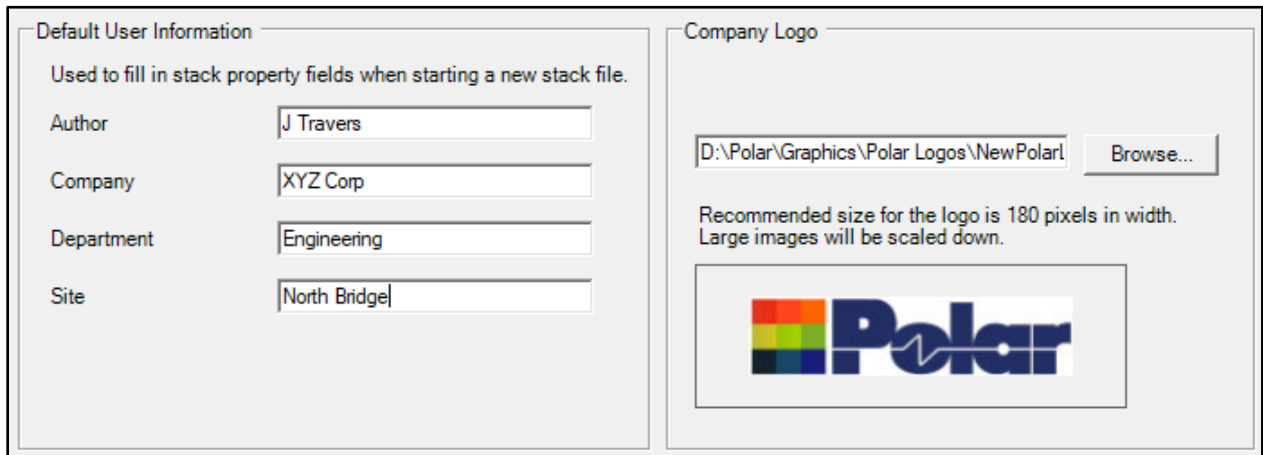
In the Convergence text box specify the difference between the target impedance and the actual impedance at which goal seeking will terminate.

Use the Maximum Iterations text box to limit the number of iterations used during goal seeking.

Setting user defaults

Information added to the User tab will be transferred to the File Properties dialog and used on printouts

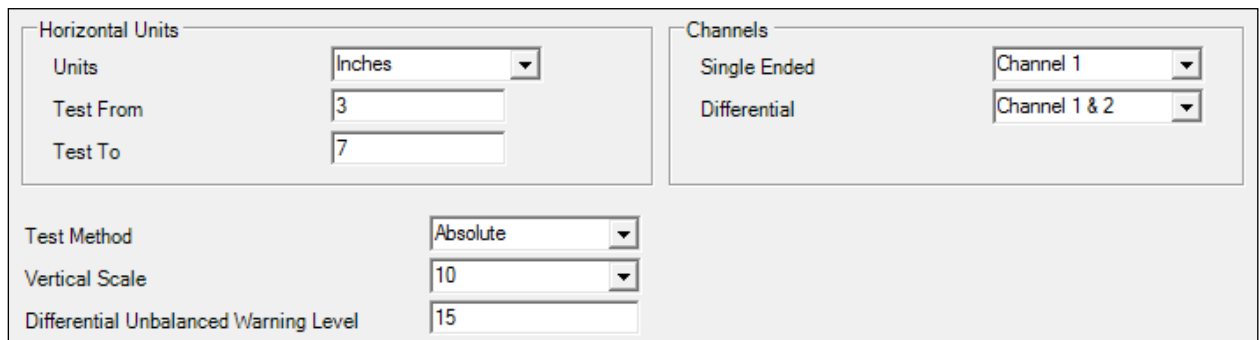
Enter information as appropriate into the associated text fields; optionally, select a graphic for use as the company logo — optimum graphic size is 180 x 32 pixels — the graphic is printed in the preview box.



Specifying default CITS test file parameters

Speedstack allows the user to generate a CITS test file for each controlled impedance structure within the stack.

Select the CITS Test tab to specify the default test parameters to be used when initiating a CITS test file.



Each test file contains the test parameters (test units, distance, number of channels, etc.) to be used when testing the stack's controlled impedance structures using a Polar CITS (Controlled Impedance Test System). The test file may be edited via the Edit Test Data dialog.

CITS test methods

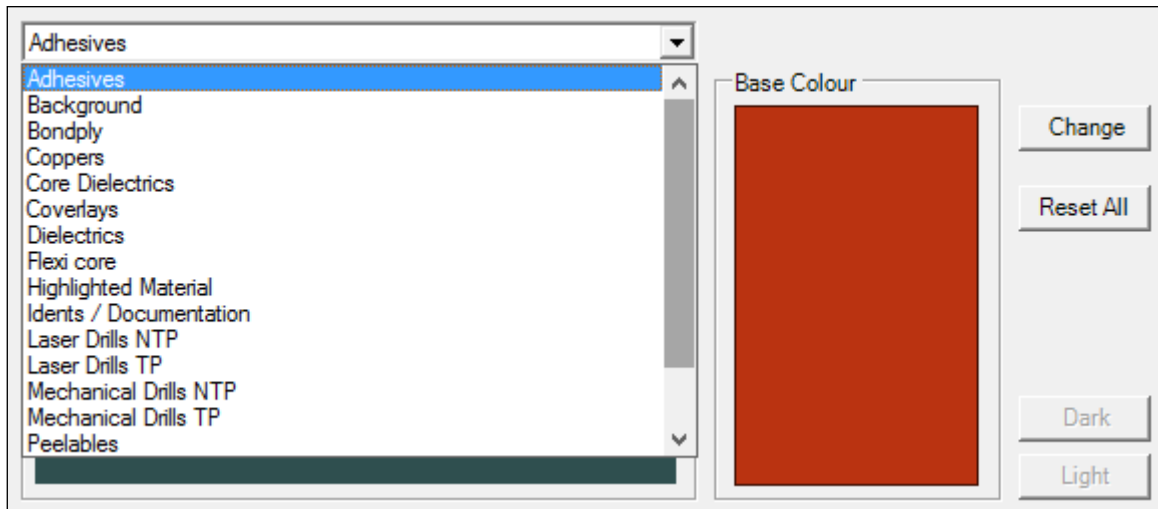
Note that the preferred test method is **Absolute**

*The **Average** method should only be used with the express approval of the specifying authority.*

See Polar Application Note AP8515 – *CITS Test Methods*

Choosing background and stackup layer colours

Choose the Colours tab to change stackup component colours from their factory defaults.



Click Reset All to return to cancel changes.

Miscellaneous Options

| | |
|------------------------------|--------------------------------|
| Number of Undo Levels | <input type="text" value="5"/> |
| Maximum Laser Drilled Layers | <input type="text" value="5"/> |

Use the Miscellaneous tab to specify the maximum Number of Undo for editing actions; choose the number of levels of editing Undo and the maximum number of layers a laser drill can span. (Exceeding this number will produce a Drill not Valid error message.)

Hatch Defaults

| | |
|-------------------|-------------------------------------|
| Hatch Pitch | <input type="text" value="433.58"/> |
| Hatch Width | <input type="text" value="127.00"/> |
| Copper Percentage | <input type="text" value="50.00"/> |

Use the Hatch Defaults tab to specify the default values for Hatch Pitch and Width and Copper Percentage when setting a plane to hatched (see Hatch Configuration.)

Rebuild and Calculate Structures

These options control the way that the Controlled Impedance structure parameters are updated from the stack up. When new structures are added or the Rebuild and Calculate option is selected, Speedstack will update all structures based on the selections below. Default : All options selected.

- ☒ Substrate Height (H n)
- ☒ Substrate Dielectric (Er n)
- ☒ Trace Thickness (T1)
- ☒ Coating Above Substrate (C1)
- ☒ Coating Dielectric (CEr)

The Rebuild and Calculate Structures tab allows the designer to specify which parameters are included when controlled impedance structures are recalculated after modifying the stack.

Manufacturing Constraints

The Manufacturing Constraints options consist of a collection of manufacturing capabilities, minimum gaps and trace widths, buried and blind via and trace aspect ratios, drill aspect ratios, etc. that can be applied during design rule checking (see the DRC tab detail below.)

☒ Manufacturing Tests

- ☒ Min. Trace Width
- ☒ Min. Gap Width
- Aspect Ratios
 - ☒ Mechanical Drill
 - ☒ Buried Laser Microvia
 - ☒ Blind Laser Microvia
 - ☒ Trace
- ☐ Resin Starvation

They will normally refer to differing levels of technology offered by one or more PCB manufacturers for a range of prices. The required information (shown in the example below) can normally be obtained from the manufacturer.

| Manufacturing Constraints | | | | | | | | |
|---------------------------|---------------------|-----------------------|---------------------|------------------------|-------------|---------------------|-------------|-------------|
| | Manufacturer's Name | Blind Laser Via A. R. | Buried Laser Via A. | Mechanical Drill A. R. | Minimum Gap | Minimum Trace Width | Trace A. R. | Units |
| ▶ | Polar Microns | 0.5 | 0.5 | 8.5 | 75 | 75 | 1 | Microns |
| | Polar Mils | 0.5 | 0.5 | 8.5 | 3 | 3 | 1 | Mils |
| | Polar Millimetres | 0.5 | 0.5 | 8.5 | 0.075 | 0.075 | 1 | Millimetres |
| | Polar Inches | 0.5 | 0.5 | 8.5 | 0.003 | 0.003 | 1 | Inches |

Current Active Constraint

Highlight

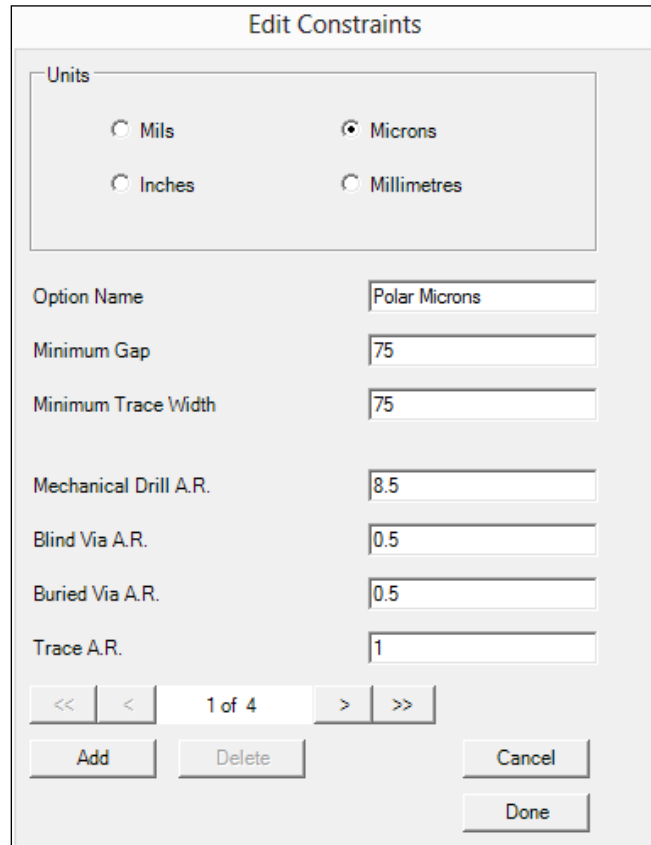
Set New

Close

Click the Highlight button to highlight the current active constraint; to apply a new constraint select the constraint row and click Set New.

Editing and adding constraints

To modify a constraint or add a new constraint, double click within the constraint row to be edited.



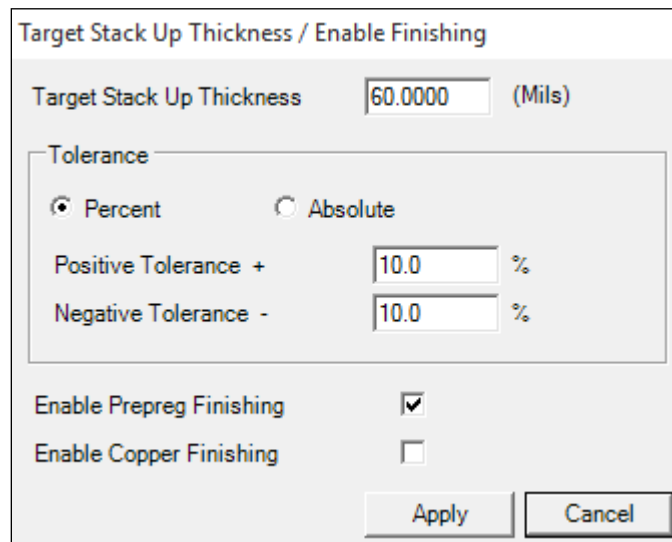
The 'Edit Constraints' dialog box is shown. It has a title bar 'Edit Constraints'. Inside, there is a 'Units' section with four radio buttons: 'Mils', 'Microns' (selected), 'Inches', and 'Millimetres'. Below this are several input fields with labels: 'Option Name' (Polar Microns), 'Minimum Gap' (75), 'Minimum Trace Width' (75), 'Mechanical Drill A.R.' (8.5), 'Blind Via A.R.' (0.5), 'Buried Via A.R.' (0.5), and 'Trace A.R.' (1). At the bottom, there are navigation buttons: '<<', '<', '1 of 4', '>', '>>'. Below these are 'Add', 'Delete', 'Cancel', and 'Done' buttons.

Modify each setting as required; click Done to confirm the settings and close the dialog.

To add a new constraint click the Add button, fill in the settings fields and click Done to finish. The new constraint will be added to the table of current constraints. Click the Delete button to remove the constraint from the list.

Set Target Stackup Thickness/Enable Finishing

Set the Target Stackup Thickness and tolerances via the dialog below.



Target Stack Up Thickness / Enable Finishing

Target Stack Up Thickness (Mils)

Tolerance

☒ Percent ☐ Absolute

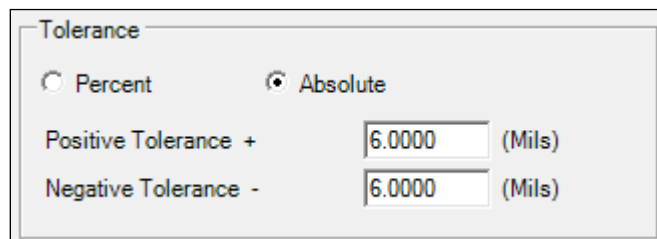
Positive Tolerance + %

Negative Tolerance - %

Enable Prepreg Finishing ☒

Enable Copper Finishing ☐

Tolerance may be set in terms of percentage or absolute values:



Tolerance

☐ Percent ☒ Absolute

Positive Tolerance + (Mils)

Negative Tolerance - (Mils)

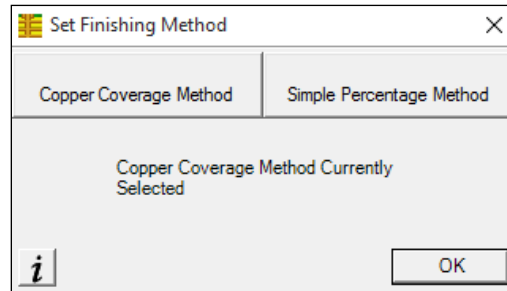
Note that positive and negative tolerance values can be set independently. The values should reflect the currently selected units.

To enable prepreg and/or copper finishing tick the associated check boxes. Click Apply.

Note: Unchecking the Enable Finishing options disables the Apply and Reset Finishing buttons. Note that these buttons are only available in Materials Library Mode – they are disabled in Virtual Material Mode.

Finishing Options

From the Tools menu choose the Set Finishing Method command to display the set finishing corrections dialog. Speedstack offers two methods: Copper Coverage Method and Simple Percentage Method.

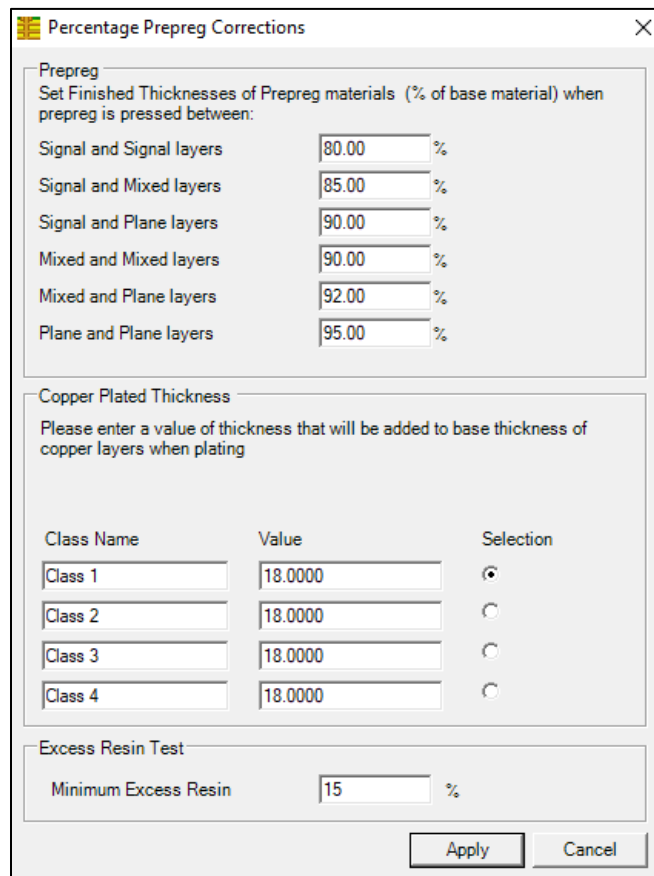


Each method requires that the amount of copper to be added where plating is required be set. In addition, where the Excess Resin design rule check is used the minimum acceptable value must be set.

Simple Percentage Method

Use the Simple Percentage Method to set the percentage of prepreg base height, which will be used to determine the isolation distance. The percentage is set for each electrical layer type pair.

Specify the IPC-6011 Class and plating thickness.

The image shows a dialog box titled "Percentage Prepreg Corrections". It has a "Prepreg" section with a description and a table of percentages for different layer pairs. Below this is a "Copper Plated Thickness" section with a description and a table for different class names. At the bottom is an "Excess Resin Test" section with a single input field. The "Apply" and "Cancel" buttons are at the bottom right.

| Layer Pair | Percentage (%) |
|--------------------------|----------------|
| Signal and Signal layers | 80.00 |
| Signal and Mixed layers | 85.00 |
| Signal and Plane layers | 90.00 |
| Mixed and Mixed layers | 90.00 |
| Mixed and Plane layers | 92.00 |
| Plane and Plane layers | 95.00 |

| Class Name | Value | Selection |
|------------|---------|----------------------------------|
| Class 1 | 18.0000 | <input checked="" type="radio"/> |
| Class 2 | 18.0000 | <input type="radio"/> |
| Class 3 | 18.0000 | <input type="radio"/> |
| Class 4 | 18.0000 | <input type="radio"/> |

Copper Coverage method

The Copper Coverage method allows the user to specify the amount of copper that will be embedded into the prepreg.

This can be set as a single value for each electrical layer type. Alternatively the amount of copper embedded will be calculated on an electrical layer by layer basis dependent upon the copper coverage for the layer set in the properties window. The greater the copper coverage the smaller the amount of copper that is embedded.

Specify the IPC-6011 Class and plating thickness.

Copper Coverage Based Prepreg Corrections

Percentage Copper To Be Embedded in Prepreg

☒ Set by Layer type

Signal Layer % 75

Mixed Layer % 15

Plane Layer % 5

☐ Proportional to Coverage

Copper Finishing

Enter values of thickness according to preference. The selected value will be the one added to the base thickness of copper layers when plating.

| Class Name | Value | Selection |
|------------|---------|----------------------------------|
| Class 1 | 18.0000 | <input checked="" type="radio"/> |
| Class 2 | 18.0000 | <input type="radio"/> |
| Class 3 | 18.0000 | <input type="radio"/> |
| Class 4 | 18.0000 | <input type="radio"/> |

Excess Resin Test

Minimum Excess Resin % 15

Apply Cancel

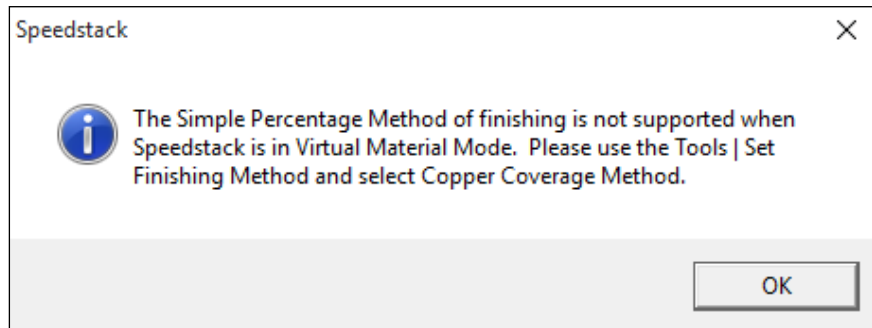
Note: The two methods of finishing are not compatible with each other. The Copper Coverage method requires that the finished thickness of prepreps be entered in the library; that value stays locked in the stack unless the Simple Percentage method is set up; if Reset Finishing is then clicked the finished thickness reverts to the base thickness.

Virtual Material mode

The Virtual Material Mode command toggles between Virtual Material and Material Library modes.

Note: Switching to Virtual Material Mode disables the Apply and Reset Finishing buttons.

Note: Virtual Material mode and the Simple Percentage method of finishing are not compatible. Speedstack displays the message below if the two are selected simultaneously.



Working with external utilities

Speedstack can call an external program / utility / script via the External Utilities menu options. The menu items are configured via Configuration Options|External Utilities.

| | | | |
|---|----------------------|---------------------------------------|--------------------------------------|
| 1 | <input type="text"/> | <input type="button" value="Choose"/> | <input type="button" value="Clear"/> |
| 2 | <input type="text"/> | <input type="button" value="Choose"/> | <input type="button" value="Clear"/> |
| 3 | <input type="text"/> | <input type="button" value="Choose"/> | <input type="button" value="Clear"/> |
| 4 | <input type="text"/> | <input type="button" value="Choose"/> | <input type="button" value="Clear"/> |
| 5 | <input type="text"/> | <input type="button" value="Choose"/> | <input type="button" value="Clear"/> |

To specify a program click Choose and navigate to the program and click Open. The program will be added to the External Utility menu.

The Speedstack toolbar

The Speedstack toolbar comprises shortcut links to the most popular commands.



Note: toolbar buttons will be enabled/disabled depending on whether Speedstack is performing stack editing or controlled impedance calculations. Pause the mouse over each tool button to display the tool's screen tip

File operations



Create new stackup



Library mode



Virtual Material mode



Stackup Wizard

Stack building operations



Symmetrical Mode off



Symmetrical Mode on



Mirroring Mode



Add layer to the stackup

Click to select the layer type. The list of layer types is displayed in the associated sub-menu.

Layers available include:

| | |
|-----------------|-------------------------------|
| Foil | Add foil layer to the stackup |
| Core | Add core layer |
| RCC | Add resin coated copper layer |
| Non-Copper Core | Add non-copper core |

| | |
|---------------|--------------------------|
| Prepreg | Add prepreg layer |
| Soldermask | Add solder mask |
| Flexible core | Add flexible core layer |
| Bondply | Add bond ply adhesive |
| Adhesive | Add Adhesive |
| Coverlay | Add coverlay layer |
| Ident | Add screened ident layer |
| Peelable | Add peelable mask |



Add mechanical/laser drill between layers

Editing the stackup



Delete selected stackup material or drill



Swap selected material

Note: the Copy and Paste buttons below are only enabled for the Stack Editor and DRC tabs – they are disabled for the Controlled Impedance and CI Results tabs.

Copying and pasting materials



Copy material of the selected layer



Paste material above selected layer



Paste material below selected layer



Copy material properties



Paste material properties

Changing plane types



Set the selected electrical layer as a signal layer



Set the selected electrical layer as a plane



Set the selected electrical layer as a mixed signal/plane layer



Set the selected electrical layer as a hatched plane

Note: the Move Selected Layer buttons below are only enabled for the Stack Editor and DRC tabs – they are disabled for the Controlled Impedance and CI Results tabs



Move selected layer up one layer



Move selected layer down one layer



Display properties dialog for the selected layer or drill

Note: the Apply and Reset Finishing buttons below are only enabled for the Materials Library Mode with the Prepreg and Copper Finishing Options checked (see Set Target Stack Up Thickness/Finishing Options) – they are disabled for the Virtual Materials Mode.

Applying finishing



Apply finished thickness



Reset finished thickness

Changing the stackup view



Display 2-dimensional view



Display 3-dimensional view



Proportional Graphics View

Managing the materials library



Go To/Display materials library

Exchanging data with the Si8000m or Si9000e Field solver



Copy controlled impedance data to field solver



Paste controlled impedance data from field solver



Copy to Si8000m or Si9000e Project

Creating and editing stackups (Virtual Material mode)

Material Library and Virtual Material modes

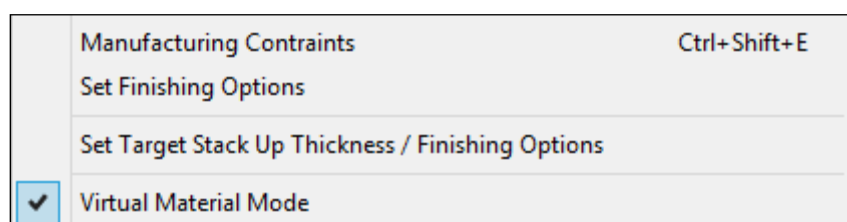
Speedstack provides the option of switching easily between Material Library and Virtual Material modes, allowing the stack designer to build and experiment with stackups without requiring real materials to be entered into a materials library.

In Virtual Material mode the Stackup Wizard allows rapid entry of stack details, the number of layers, overall board thickness, plane layers, solder mask and copper thickness. Speedstack will then build a stack to the specified board thickness by distributing the dielectric regions equally. If a preferred core thickness is specified Speedstack will maintain the dielectric thickness for core regions but equally distribute prepregs to reach the target board thickness.

This section will describe the steps to construct an 8-layer, symmetrical FR-4 stack to the specification below using Speedstack's Virtual material Mode.

| | |
|---------------------------|---|
| Thickness: | 60 mil |
| Signal layers: | 1, 3, 6, 8 |
| Plane layers: | 2, 4, 5, 7 |
| Er: | 4.2 |
| Preferred core thickness: | 8 mil |
| Copper (all layers): | 1 oz. / 1.4 mil |
| LPI Mask: | 1 mil |
| PTH drill passes: | Layers 1 – 8 |
| Laser microvia passes: | Layers 1 – 2, 8 – 7 |
| Impedance structures: | SE 50 Ohm Layer 1, Diff 100 Ohm Layer 1 |

From the Units menu choose Mils/Thou, from the Tools menu toggle Virtual Material Mode On.



Library/Virtual Material mode indicates Virtual Material mode.

Using the Stackup Wizard

From the File menu chose New|Stackup Wizard.

The Stackup Wizard supports up to 128 layers

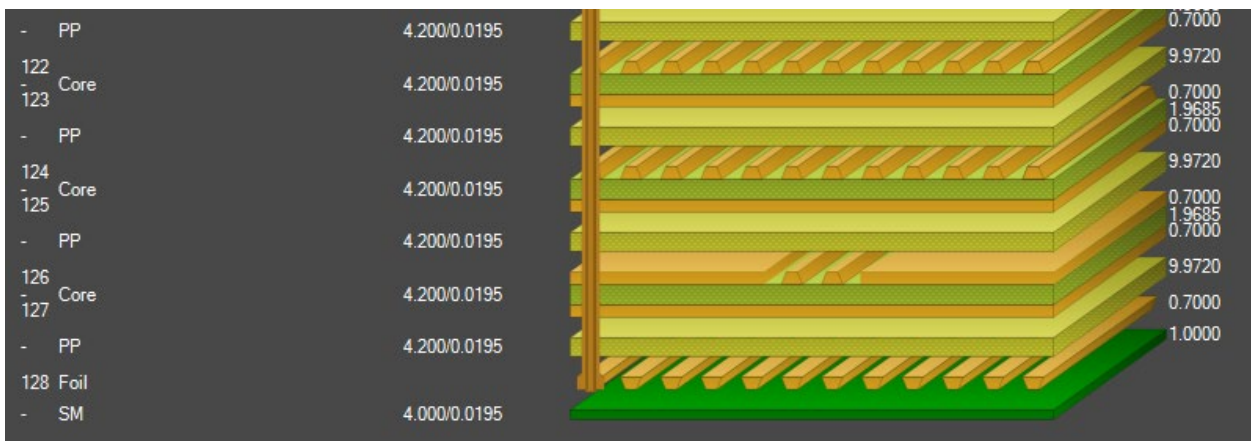
Stack Up Wizard (Virtual Material Mode)

| | | | | | |
|---------------------------|--|---------------------------------|-------------------------------------|--------------------|-------------------------------------|
| Number of Layers | 128 | Nominal Dielectric Constant | 4.2000 | | |
| Target Stack Up Thickness | 114 116 118 120 122 124 126 128 | Nominal Loss Tangent | 0.0195 | | |
| Positive Tolerance % | | Solder Mask Top | <input checked="" type="checkbox"/> | Solder Mask Bottom | <input checked="" type="checkbox"/> |
| Negative Tolerance % | | Solder Mask Dielectric Constant | 4.0000 | | |
| Symmetrical | <input type="checkbox"/> | Solder Mask Loss Tangent | 0.0195 | | |
| Plane Layers | 1 2 3 4 5 6 7 8 | Solder Mask Thickness | 1.0000 | | |
| Mixed Layers | 1 2 3 4 5 6 7 8 | Preferred Core Thickness | Select 12.0000 | | |
| | | Copper Thickness | 0.7000 | | |

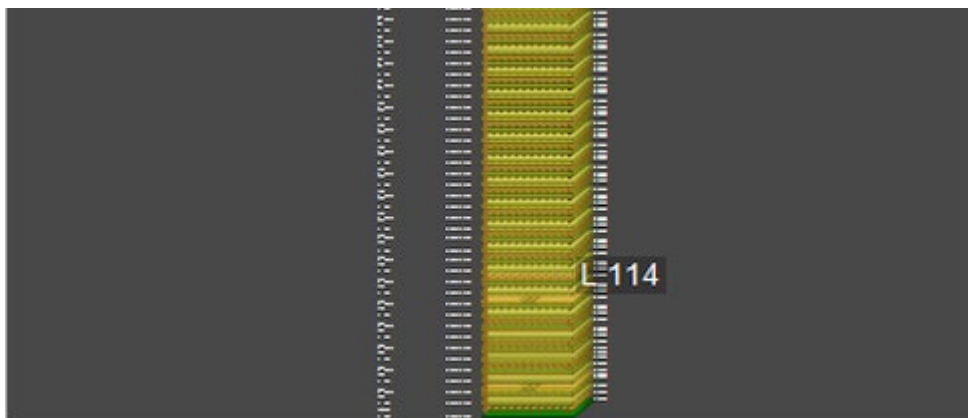
Build Type
☒ Foil ☐ Core ☐ Sequential/HDI

<Previous Next > Finish Cancel

In the example below the Stack Editor displays the last few layers of a 128 layer stack

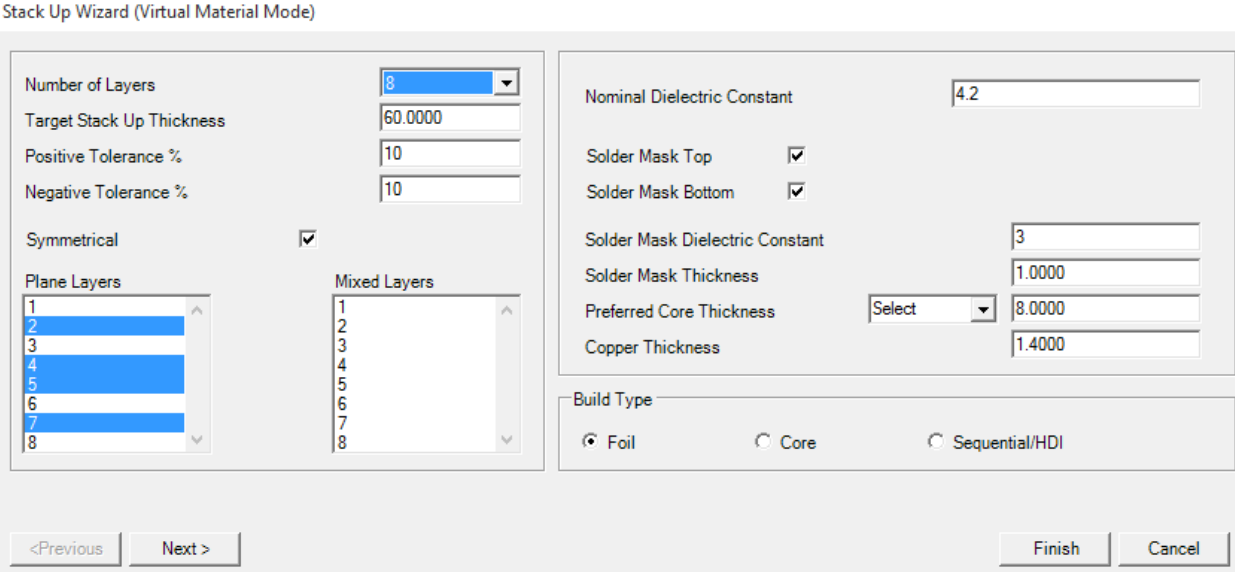


Use the Zoom Extents command to view the entire stack; navigate quickly to the layer to be edited with the mouse wheel zoom.



Setting basic stack data

Fill in the dialog as shown below.



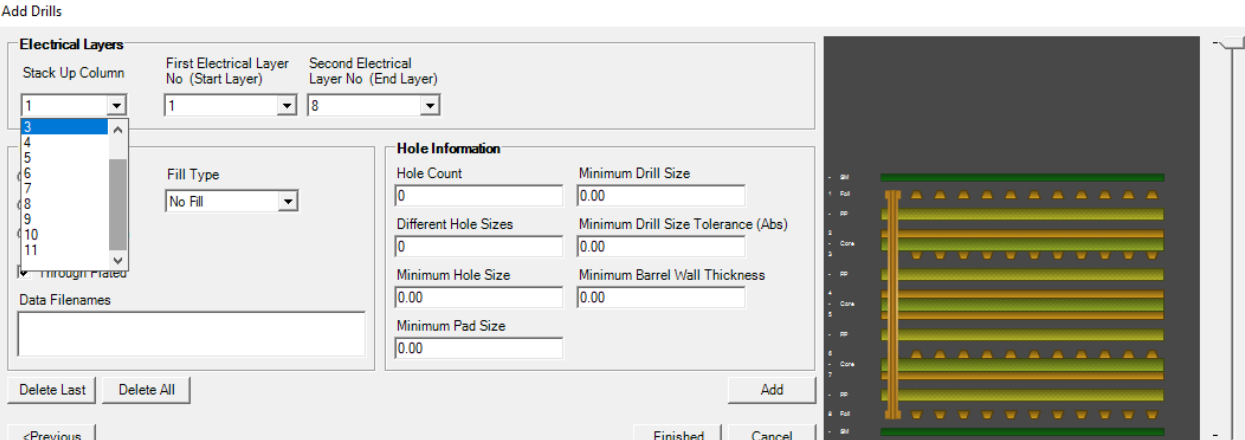
The Stack Up Wizard (Virtual Material Mode) dialog box is shown. It contains the following fields and options:

- Number of Layers: 8
- Target Stack Up Thickness: 60.0000
- Positive Tolerance %: 10
- Negative Tolerance %: 10
- Symmetrical: ☒
- Plane Layers: 1, 2, 3, 4, 5, 6, 7, 8
- Mixed Layers: 1, 2, 3, 4, 5, 6, 7, 8
- Nominal Dielectric Constant: 4.2
- Solder Mask Top: ☒
- Solder Mask Bottom: ☒
- Solder Mask Dielectric Constant: 3
- Solder Mask Thickness: 1.0000
- Preferred Core Thickness: Select
- Copper Thickness: 1.4000
- Build Type: ☒ Foil, ☐ Core, ☐ Sequential/HDI
- Buttons: <Previous, Next >, Finish, Cancel

Click Next to add drills.

Adding drills

Drill information is assigned to drill columns (up to 11 columns are available) Select Column 1 and specify the First Electrical Layer as Layer 1 and the Second Electrical Layer as Layer 8; choose Mechanical, Through Plated with No Fill and click Add to add the first drill to the stack.

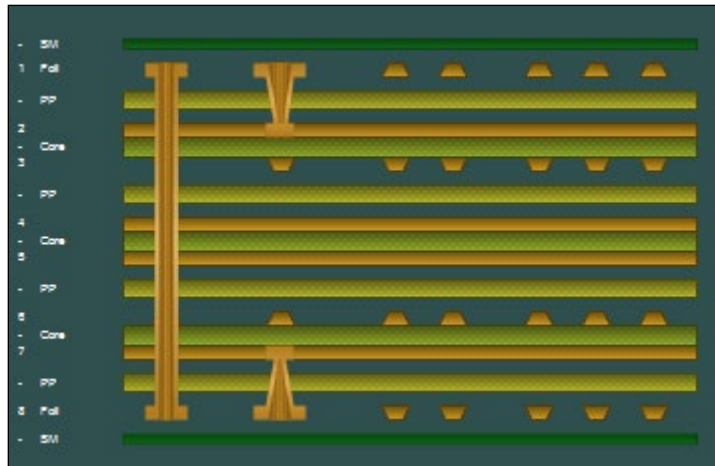


The Add Drills dialog box is shown. It contains the following fields and options:

- Electrical Layers: Stack Up Column: 1, First Electrical Layer No (Start Layer): 1, Second Electrical Layer No (End Layer): 8
- Fill Type: No Fill
- Hole Information: Hole Count: 0, Minimum Drill Size: 0.00, Different Hole Sizes: 0, Minimum Drill Size Tolerance (Abs): 0.00, Minimum Hole Size: 0.00, Minimum Barrel Wall Thickness: 0.00, Minimum Pad Size: 0.00
- Buttons: Delete Last, Delete All, Add, <Previous, Finished, Cancel

Adding microvias

Choose Column 2, specify the First Electrical Layer as 1 and the Second Electrical layer as 2; choose Laser with No Fill and click Add. Repeat the process to add another microvia to Column 2 between electrical layers 8 and 7 (shown below.)

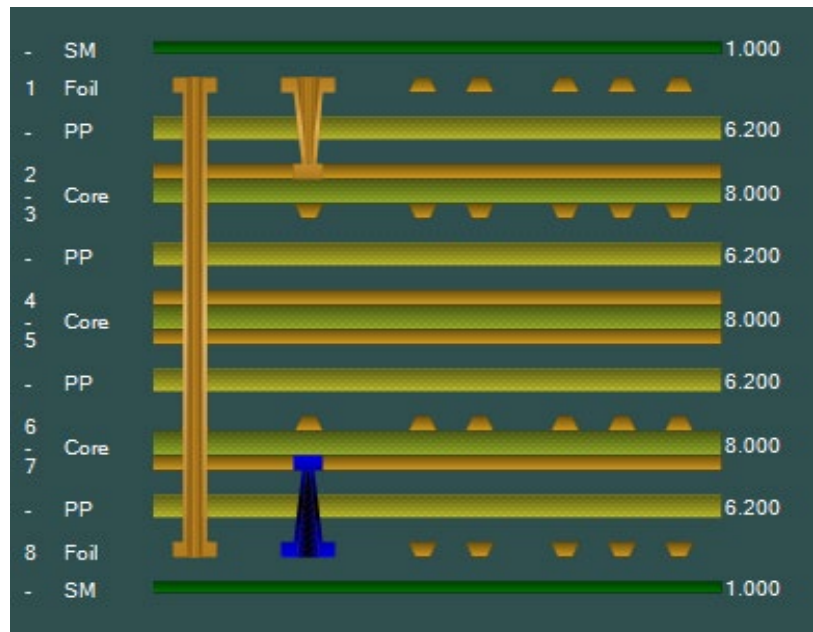


Click Finished.

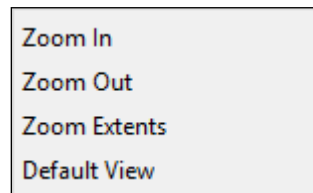
The Stackup Wizard displays the New Stackup File Properties dialog; enter the (optional) stackup properties.

Click OK to close the dialog and edit the stack. Speedstack builds the stack to achieve the specified board thickness.

Click the 2D button to assist in visualisation while editing the stack.



Use the View menu to zoom in and out of the stack.



Hint: Click the mouse wheel in the Stack Editor (Zoom Extents) to view the entire stack.

The Stackup Editor displays summary information for the whole stack and for items within the stack as they are selected.

| Stack Up Information | |
|------------------------------------|---------|
| Field | Value |
| Electrical Layer Count | 8 |
| Stack Up Cost | 0.00 |
| Copper Thickness | 11.0236 |
| Dielectric Thickness | 51.9685 |
| Solder Mask Thickness | 1.9685 |
| ===== | ===== |
| Target Stack Up Thickness | 62.9921 |
| Stack Up Thickness | 62.9921 |
| Stack Up Thickness with Soldermask | 64.9606 |
| ===== | ===== |

| Selected Item Information : Drill | |
|-----------------------------------|---------|
| Field | Value |
| First Electrical Layer No | 8 |
| Second Electrical Layer No | 7 |
| Mechanical Drill | False |
| Laser Drill | True |
| Fill Type | No Fill |
| Data Filenames | |
| Hole Count | 0 |
| Different Hole Sizes | 0 |
| Minimum Hole Size | 0.001 |
| Minimum Allowable Hole Size | 15.2000 |

Editing the stack

With the “virtual” stack in the Stack Editor the stack can be changed as required.

Changing material properties

To change the properties of a material, right click the material in the stack and choose Properties; fill in the text fields with the associated information and click Apply. Most material properties can be changed, including the material descriptions, base and finished thickness, dielectric constants, drill parameters along with the graphical colours.

Choosing Symmetrical mode

Stackups are often designed symmetrically to prevent warping and twisting – using similar materials in the top and bottom halves of the stack.



Symmetrical OFF



Symmetrical ON

Clicking the Symmetrical button will toggle the Symmetrical mode on or off. In Symmetrical mode the stack editing functions will process materials in the upper and lower halves of the stack simultaneously.

Changing the material description

In this example stack, ensure symmetrical mode is selected then right click the solder mask material in the stack to display the Solder Mask Properties dialog.


Solder Mask Properties

Main | Notes | Attributes

General Information

| | | | |
|----------------------|----------------------------|-----------|------|
| Supplier | Polar Samples | | |
| Supplier Description | SM/001 | | |
| Description | Liquid PhotoImageable Mask | Cost | 0.50 |
| Stock Number | 500-001 | | |
| Type | SolderMask | Lead Time | 0.00 |

Solder Mask

| | | | |
|---------------------|-------|------------------|---|
| Thickness | 25.00 | Mask Colour | Green |
| Dielectric Constant | 4.00 | Graphical Colour |  |
| Loss Tangent | 0.02 | | |
| Data Filename | | | |

Apply
Close

Change the Solder Mask Description to Liquid Photo Imageable (LPI).

Description Liquid Photo Imageable (LPI)

The change on the Description in both solder masks is reflected in the Editor window.



Changing electrical layers

Electrical layer types may be changed from plane to signal, mixed and hatched. Right click the layer to be changed and choose from Signal, Plane, Mixed or Hatched.

Set to Signal
Set to Plane
Set to Mixed
Set to Hatched

Speedstack will take the designated layer type into consideration when adding controlled impedance structures.

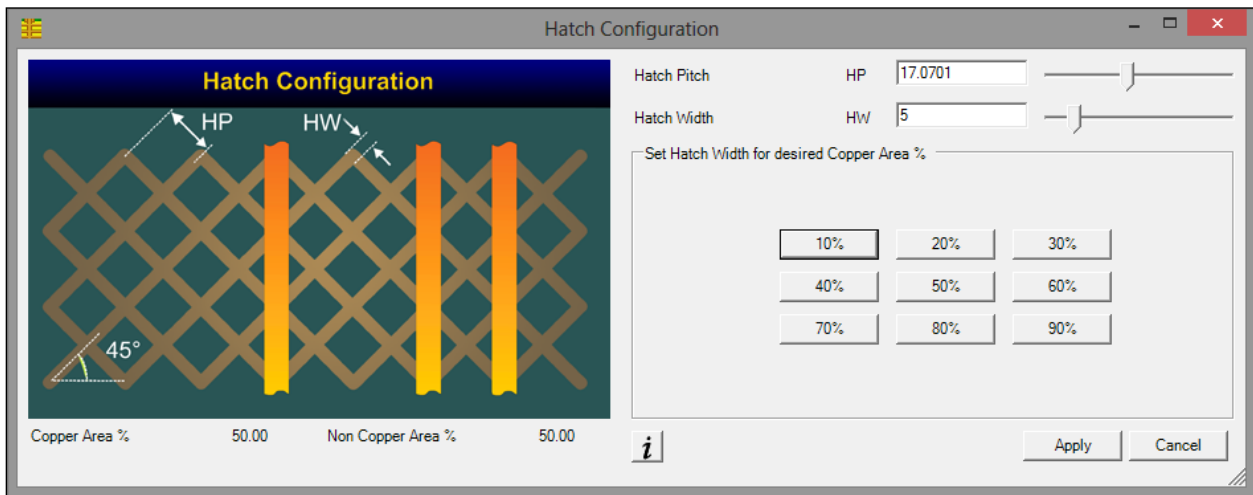
Setting hatched planes



Set Layer to Hatched Plane

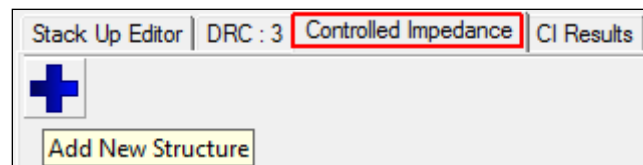
With the XFE option Speedstack supports hatched planes, implementing the same crosshatch calculation technique used in the Si8000m / Si9000e. If a crosshatch plane is required click Set Layer to Hatched Plane –use the Hatch

Configuration dialog to set hatch pitch and width or set the hatch width by percentage copper area. Click Apply.

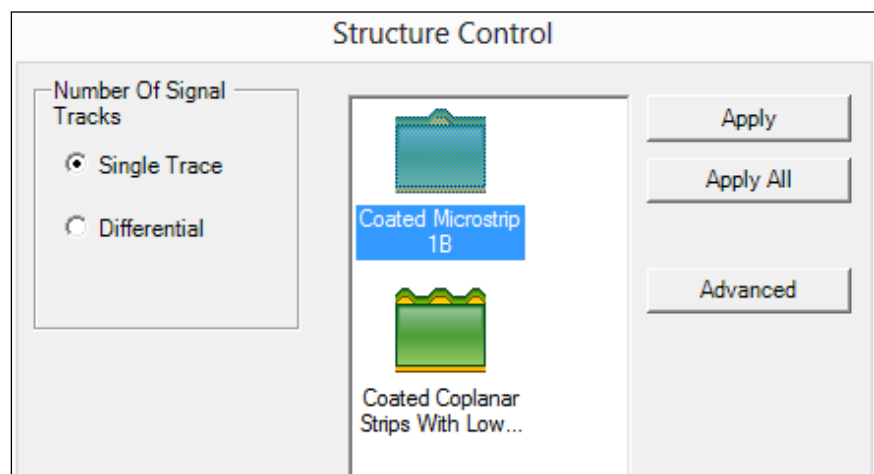


Adding controlled impedance structures

To add controlled impedance structures, click the Controlled Impedance tab, select the copper layer (in this example, Layer 1) and click the Add New Structure button.



Speedstack suggests structures valid for the layer based on the plane layer types.



For this example, choose a 50 Ohm single ended coated microstrip; leave the tolerance at 10%; click Apply then Done.

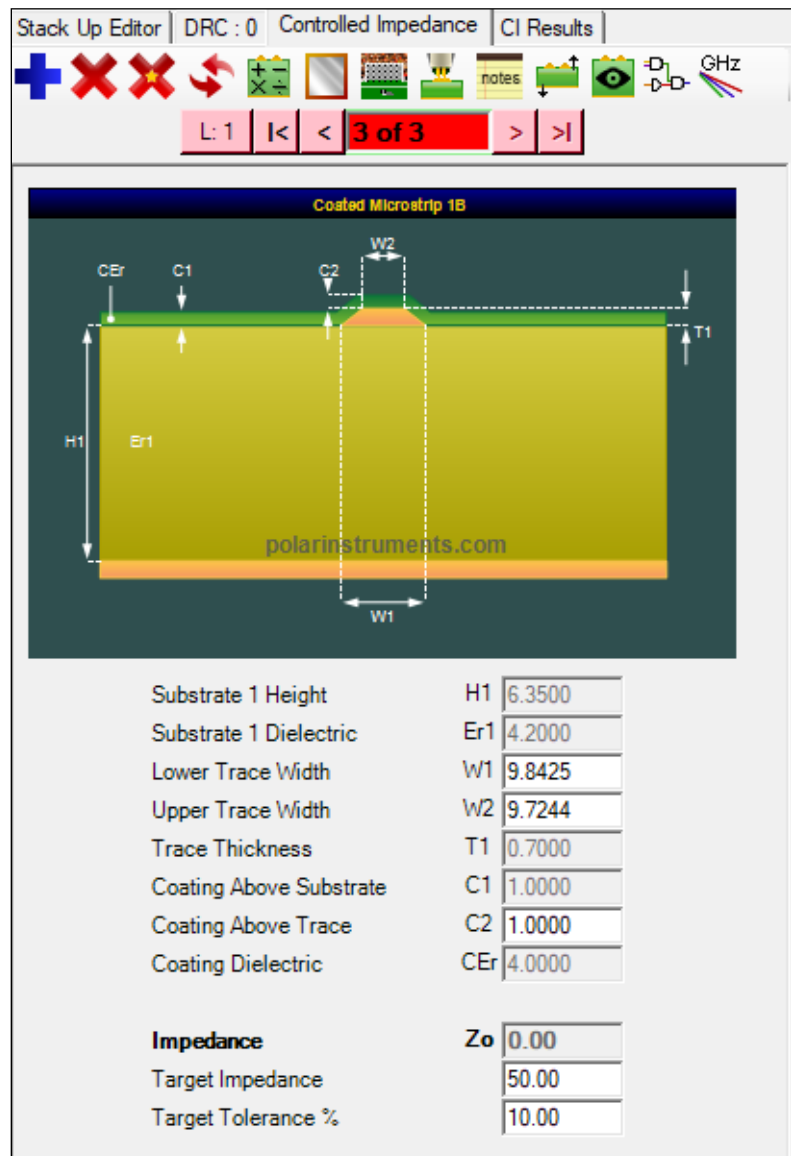


Structure on Layer

The new structure is shown in the stack, highlighting the materials employed by the structure.



The structure also appears in the Controlled Impedance panel, along with its parameters.



Calculating the structure impedance

Parameters calculated from the stack materials, such as the substrate height and dielectric are read only and shown greyed out; other parameters may be edited. If the editable parameters are known they may be entered directly.

For example, modify W1 to read 10.5 and W2 to read 9.5 and click the Rebuild and Calculate All Structures.

The impedance is calculated as 51.94 Ohms

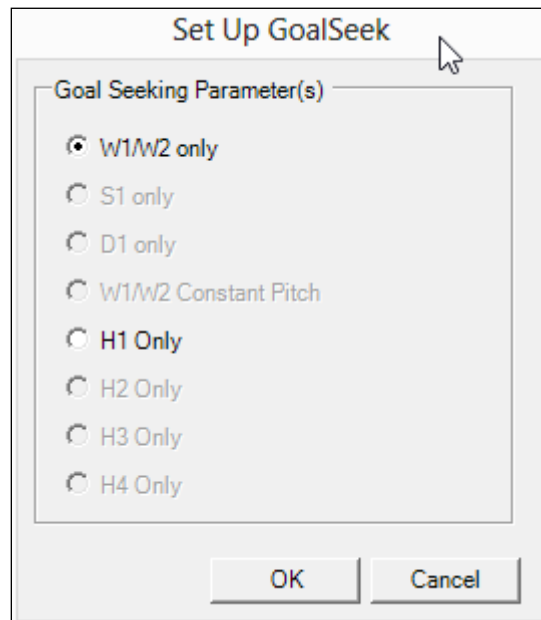


Goal Seek button

Goal Seeking the target impedance

Speedstack can adjust one or more structure parameters to achieve a specified target impedance. Leave the Target Impedance at 50 Ohms and click the Goal Seek button

From the Set Up Goal Seek dialog choose W1/W2 only



Click OK – Speedstack adjusts trace width (below) to achieve the target 50 Ohm impedance.

| | | |
|-------------------------|-----------|--------------|
| Substrate 1 Height | H1 | 6.2000 |
| Substrate 1 Dielectric | Er1 | 4.2000 |
| Lower Trace Width | W1 | 10.7037 |
| Upper Trace Width | W2 | 9.7037 |
| Trace Thickness | T1 | 1.4000 |
| Coating Above Substrate | C1 | 1.0000 |
| Coating Above Trace | C2 | 1.0000 |
| Coating Dielectric | CEr | 3.0000 |
| Impedance | Zo | 50.02 |
| Target Impedance | | 50.00 |
| Target Tolerance % | | 10.00 |

With the impedance in tolerance the navigation buttons display green.

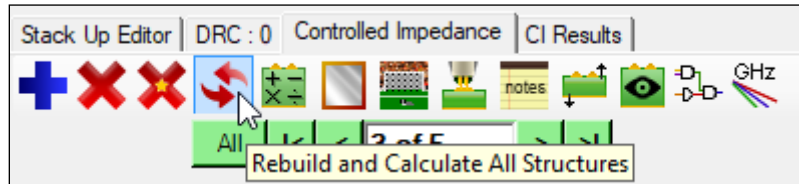
Mirroring structures

This example stack is symmetrical so structures may be copied to the lower half of the stack (i.e. on the lower outer layer.) Click Mirror Structures if Stack Symmetrical.

The impedance structure on Layer 1 is copied to Layer 8.

Rebuilding the stack

During stack editing changes to the stack (for example, inserting prepreg materials into a layer or altering the existing material thickness) will affect the impedance value of one or more structures. If Speedstack senses that an impedance structure has changed it issues a Rebuild alert.



Click Rebuild and Calculate All Structures – Speedstack recalculates the impedance for the new parameters. If the impedance value is out of tolerance the structure browse control changes colour to red.

Virtual Material mode allows the designer to experiment with material properties to examine the effects on impedance structures of different trace widths or dielectric heights, etc. Materials may be added, moved, copied, pasted or removed and the properties of materials changed – Speedstack will sense the changes and allow the “generic” stack to be rebuilt and recalculated.

Creating and editing stackups (Material Library mode)

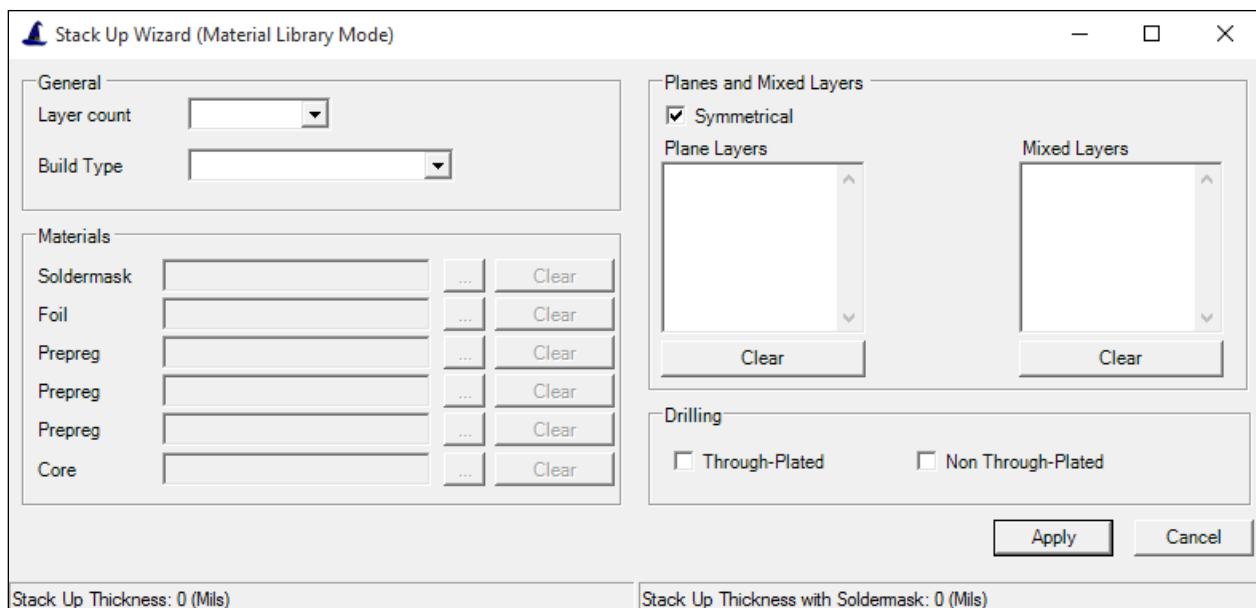
This section describes creating stackups using the Material Library mode. Stackups may be created manually using the Stackup Wizard or using the editing window. Ensure Tools|Virtual Material Mode is toggled Off.

Using the Stackup Wizard



Stackup Wizard button

The Stackup Wizard guides the user through the process of creating complex stackups in only a few steps. Click the Stackup Wizard button or choose Stackup Wizard from the File|New sub menu. The stackup editing window is cleared and the Stackup Wizard displayed.



Using the Wizard the user can specify the layer count and build type, stackup materials, planes and drill types in a single operation.

Electrical layer count

Begin by specifying the electrical layer count — up to 64 electrical layers may be specified. Choose the number of layers from the drop down list box.

Build type

Choose the build type (Foil or Core) from the drop down list box. Core builds contain only core materials; most builds will be foil builds — containing internal layers of cores with two outer foils.

General

Layer count: 8

Build Type: Foil

Choosing stackup materials

Note; if Core build type has been specified the Foil material control will be disabled.

The Wizard allows for a stack comprising solder mask, foil, and cores with up to three prepreg materials between.

Stack Up Wizard (Material Library Mode)

General

Layer count: 8

Build Type: Foil

Materials

Soldermask: Liquid PhotoImageable Mask SM/ ... Clear

Foil: Copper Foil FO/002 ... Clear

Prepreg: PrePreg 1080 PP/001 ... Clear

Prepreg: PrePreg 1080 PP/001 ... Clear

Prepreg: ... Clear

Core: FR4 Core CO/017 ... Clear

Planes and Mixed Layers

☒ Symmetrical

Plane Layers: 1, 2, 3, 4, 5, 6, 7, 8

Mixed Layers: 1, 2, 3, 4, 5, 6, 7, 8

Drilling

☒ Through-Plated ☐ Non Through-Plated

Apply Cancel

Stack Up Thickness: 59.2 (Mils) Stack Up Thickness with Soldermask: 61.2 (Mils)

The Wizard displays a running total of the stackup thickness in the Wizard's status bar.

Adding layers



To include a layer (in this example a foil layer) click the Foil Add Material button; the library of foil materials is displayed. Choose the foil material from the list and click the Add Material Above button; the material is added as a foil layer to the stackup.

| | Supplier | Supplier Description | Description | Stock Number | Cu Base Thickness | Type |
|---|---------------|----------------------|-----------------|--------------|-------------------|--------|
| ▶ | Polar Samples | FO/004 | Copper Foil 0.7 | 100-004 | 0.7 | Copper |
| | Polar Samples | FO/002 | Copper Foil 1.4 | 100-002 | 1.4 | Copper |
| | Polar Samples | FO/003 | Copper Foil 2.8 | 100-003 | 2.8 | Copper |
| | Polar Samples | FO/005 | Copper Foil 0.7 | 100-005 | 0.7 | Copper |
| | Polar Samples | FO/006 | Copper Foil 1.4 | 100-006 | 1.4 | Copper |
| | Polar Samples | FO/006 | Copper Foil 2.8 | 100-006 | 2.8 | Copper |

Repeat the procedure for prepreg and core materials and the (optional) solder mask layers. Use the Clear button to remove a layer from the stackup.

| Materials | | | |
|------------|--------------------------------|-----|-------|
| Soldermask | Liquid PhotoImageable Mask SM/ | ... | Clear |
| Foil | Copper Foil FO/002 | ... | Clear |
| Prepreg | PrePreg 1080 PP/001 | ... | Clear |
| Prepreg | PrePreg 1080 PP/001 | ... | Clear |
| Prepreg | | ... | Clear |
| Core | FR4 Core CO/017 | ... | Clear |

Nominating power planes and mixed layers

Use the list boxes to specify planes as power planes or layers as mixed layers. Select all planes as required. To remove a plane from the list select the plane number from the list and click Clear.

| Planes and Mixed Layers | |
|---|--------------|
| <input checked="" type="checkbox"/> Symmetrical | |
| Plane Layers | Mixed Layers |
| 1 | 1 |
| 2 | 2 |
| 3 | 3 |
| 4 | 4 |
| 5 | 5 |
| 6 | 6 |
| 7 | 7 |
| 8 | 8 |
| Clear | Clear |

The dialog above shows Layers 2, 4, 5 and 7 specified as power planes

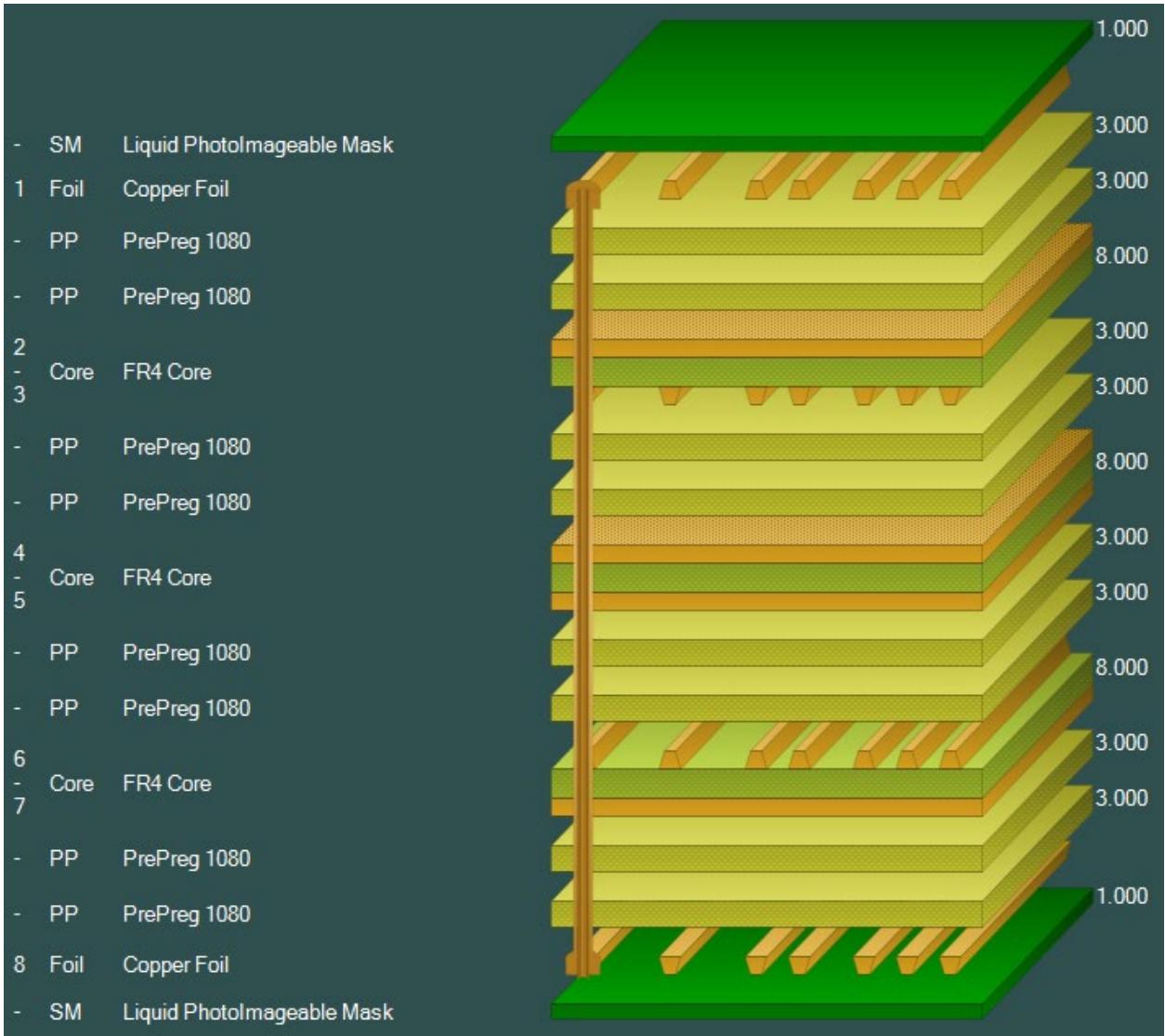
Adding drill information

To add a drill between electrical layer 1 and the last layer click the Through-Plated and Non-Through-Plated check boxes as required.

| Drilling | |
|--|---|
| <input checked="" type="checkbox"/> Through-Plated | <input type="checkbox"/> Non Through-Plated |
| ? | |

With all build options specified click Apply to complete the stackup. The finished stackup appears in the Editor window.

The example stack below includes two prepreg materials between layers.



Summary information is shown in the Status Bar and includes the units in use, the target stackup thickness and the stackup thickness without and with soldermask.

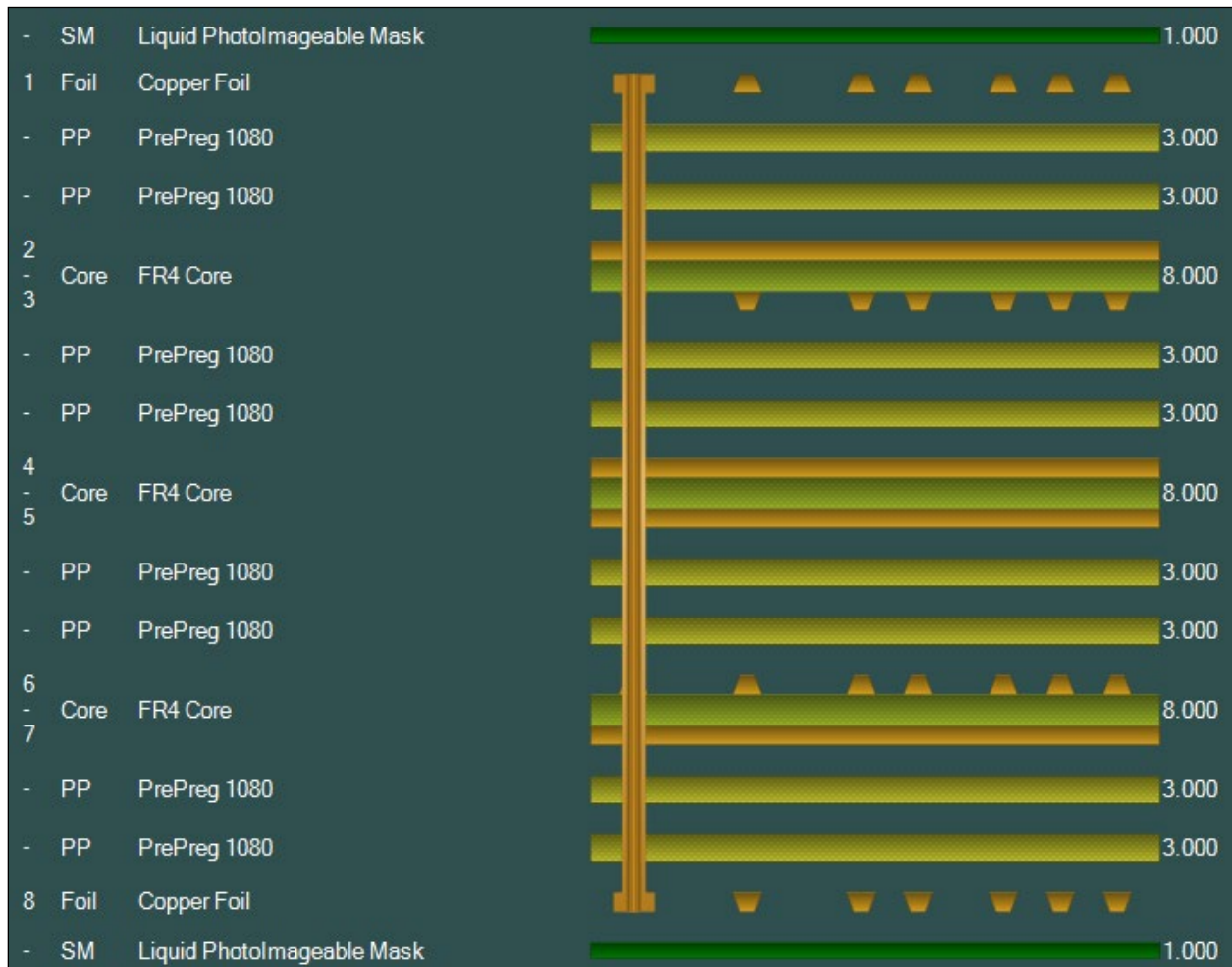
| | | | |
|------------|-------------------------------------|------------------------------|--|
| Mils/Thous | Target Stack Up Thickness = 60.0000 | Stack Up Thickness = 59.2000 | Stack Up Thickness with Soldermask = 61.2000 |
|------------|-------------------------------------|------------------------------|--|



See 2D View

Changing the stackup view

For many editing operations changes to the stack may be easier to visualize when shown two-dimensionally. Click the See 2D View button



Filtering Materials

When adding or swapping materials, available materials (foils, prepregs, etc.) are listed in the associated material library dialog.

Lists can be filtered for materials matching desired parameters (dielectric thickness, Er, etc.) See *Using Speedstack Materials Libraries*.

Saving stackups

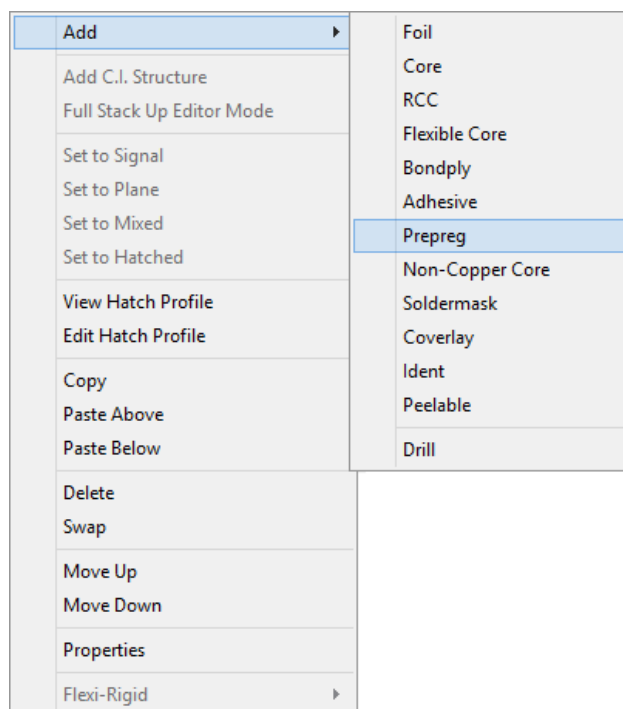
It is strongly recommended that users save work frequently and maintain safe backups of stackups and projects.

Creating stackups manually

Speedstack allows the designer to add or edit stackup layers in any order, from top to bottom, bottom to top or from the centre layer outwards. This example will create a four-layer stackup, starting at the centre core layer and adding layers above and below.

Editing the stack

When editing the stack it will probably be most convenient to right click an object in the stack and select the associated command from the context menu. The menu will reflect the commands available for the selected object — commands that are not appropriate for the object are greyed out.



Alternatively, select the object (copper, prepreg, core, etc.) with the left mouse button and choose the command from the Speedstack toolbar.

Adding layers to the stackup



Go To Materials Library

Items added to the stackup are added from the currently open materials library. Speedstack opens Program Files\Polar\Speedstack\default.mlbx if it exists; if a different library is required, open it via Go To Materials Library.

Note: Speedstack does not ship with the default.mlbx library.

For this discussion open one of the two sample library files, Speedstack Imperial.mlbx or Speedstack Metric.mlbx (stored in the Program Files\Polar\Speedstack\Samples folder at installation time for a default installation.)

Consistency of units

When defining dimensions for a stackup (for example, layer thicknesses) ensure that all measurements are defined using the same units (mils, mm, etc.) throughout the structure and its libraries.

Note: the libraries supplied for these examples are preloaded with sample data only.

Click the File|New command to clear the stackup screen and notes and information text areas.

Click the File|Save Stackup or Save Project command to save the stackup or project. Users are recommended to save stackups or projects frequently during the stackup creation process to avoid data loss. Stackup files, project files and library files should be backed up to a secure location.

Adding a core layer



Add Layer Material

Click the Add Layer Material button and choose Core...the Core library is displayed

The Core library contains full details of the core material, including base and finished thicknesses, dielectric constant, and upper and lower copper thicknesses.

| Supplier Description | Description | Stock Number | Dielectric Base Thickness | Dielectric Finished Thickness | Dielectric Constant | Upper Cu Base Thickness | Lower Cu Base Thickness |
|----------------------|-------------|--------------|---------------------------|-------------------------------|---------------------|-------------------------|-------------------------|
| CO/001 | FR4 Core 2 | 400-001 | 2 | 2 | 4.2 | 0.7 | 0.7 |
| CO/002 | FR4 Core 2 | 400-002 | 2 | 2 | 4.2 | 1.4 | 1.4 |
| CO/003 | FR4 Core 2 | 400-003 | 2 | 2 | 4.2 | 2.8 | 2.8 |
| CO/004 | FR4 Core 3 | 400-004 | 3 | 3 | 4.2 | 0.7 | 0.7 |
| CO/005 | FR4 Core 3 | 400-005 | 3 | 3 | 4.2 | 1.4 | 1.4 |

Click on any of the column buttons to sort the library list by the selected column.



Add Material above

Choose a core type from the list of cores and click the Add Material Above button. The core is added to the stackup screen. When editing a stack this button adds a core above the selected layer.



Stackup core layer



Add Material below

Layers may also be added below the selected layer. The Add Material below button adds a core below the selected layer.

As each layer is added the stackup information table is updated to reflect the current status of the stackup.

| Stack Up Information | |
|------------------------------------|---------|
| Field | Value |
| Electrical Layer Count | 8 |
| Stack Up Cost | 0.00 |
| Copper Thickness | 11.0236 |
| Dielectric Thickness | 51.9685 |
| Solder Mask Thickness | 1.9685 |
| ===== | ===== |
| Target Stack Up Thickness | 62.9921 |
| Stack Up Thickness | 62.9921 |
| Stack Up Thickness with Soldermask | 64.9606 |
| ===== | ===== |

Stackup information table

Note: The Stackup Information is printed in red when the stack thickness is outside its tolerance.

With the core selected, the Selected Item table displays the properties of the core.

| Selected Item Information : Core | |
|----------------------------------|--------|
| Field | Value |
| Upper Cu Base Thickness | 35.00 |
| Upper Cu Finished Thickness | 35.00 |
| Upper Copper Coverage | 0 |
| Minimum Trace Width | 75.00 |
| Data Filenames | |
| Dielectric Base Thickness | 100.00 |
| Dielectric Finished Thickness | 100.00 |
| Dielectric Constant | 4.2 |
| Loss Tangent | 0.0195 |
| Resin Content | 53 |
| Tg | 180 |
| Td | 0 |
| CAF Resistance | 0 |
| Z Axis Expansion | 0 |
| Excess Resin | 0.00 |
| Isolation Distance | 100.00 |
| Lower Cu Base Thickness | 35.00 |
| Lower Cu Finished Thickness | 35.00 |
| Lower Copper Coverage | 0 |
| Minimum Trace Width | 75.00 |

Core layer information

To observe the properties of any material, click the material in the stack and read off the properties in the Selected Item Information panel.

Editing the selected layer properties

To change the properties of the selected object (for example, to modify the dielectric constant or the value for the finished thickness of the dielectric), right click the object in the stackup and choose Properties from the shortcut menu; in this example the Core Properties dialog is displayed.

Note that the Enable Finishing setting in the Tools|Set Stackup Thickness/Finishing Options dialog must be unchecked to enable the Finishing Thickness to be specified manually.

Change the value to the corrected value and click Apply.

The image shows the 'Core Properties' dialog box with four tabs: Main, Notes, and Attributes. The 'Main' tab is active. The dialog is divided into four main sections: General Information, Upper Copper, Dielectric, and Lower Copper. Each section contains various input fields and checkboxes.

| General Information | |
|----------------------|--------------------------|
| Supplier | Polar Samples |
| Supplier Description | CO/008 |
| Description | FR4 Core |
| Stock Number | 400-008 |
| Type | FR4 |
| Exchange Copper | <input type="checkbox"/> |
| Cost | 8.00 |
| Tolerance | 10.00 |
| Lead Time | 0.00 |

| Upper Copper | |
|--|--------------------------|
| Base Thickness | 35.00 |
| Finished Thickness | 35.00 |
| Data Filename | |
| Trace Inverted | <input type="checkbox"/> |
| Finishing Applied | <input type="checkbox"/> |
| Copper Coverage % | 0.00 |
| Graphical Colour | |
| Remove Copper (disabled if structures or sub-stacks exist) | <input type="checkbox"/> |

| Dielectric | |
|---------------------|--------|
| Base Thickness | 100.00 |
| Finished Thickness | 100.00 |
| Dielectric Constant | 4.2000 |
| Loss Tangent | 0.0195 |
| Resin Content % | 53.00 |
| Tg | 180.0 |
| Td | 0.0 |
| CAF Resistance | 0.0 |
| Z Axis Expansion | 0.0 |
| Excess Resin | 0.00 |
| Isolation Distance | 100.00 |
| Graphical Colour | |

| Lower Copper | |
|--|-------------------------------------|
| Base Thickness | 35.00 |
| Finished Thickness | 35.00 |
| Data Filename | |
| Trace Inverted | <input checked="" type="checkbox"/> |
| Finishing Applied | <input type="checkbox"/> |
| Copper Coverage % | 0.00 |
| Graphical Colour | |
| Remove Copper (disabled if structures or sub-stacks exist) | <input type="checkbox"/> |

Buttons: Apply, Close

Adding data file names

If available, add the data file name(s) to the upper and lower copper layers and click Apply.

Close the dialog when all changes are completed.

Changes will be reflected in the Stackup Information table.

Changing a layer function

In this example both the signal layers above and below the core dielectric are changed to planes.



Set Layer to Plane

Click the lower signal layer and click the Set Layer Plane button. Repeat for the upper signal layer.

The changes are reflected in the stackup window

| | | | |
|---|------|----------|-------|
| 1 | Core | FR4 Core | 8.000 |
| 2 | | | |

Exchanging layers

To change just the core dielectric (leaving the copper layers unaffected), right click the core material (for example the FR4 in the graphic above) and choose Swap from the context menu or left click the core material and click the Swap Selected Material button. Choose the new core type from the library and click the Swap button. The layer properties will change to reflect the new material and changes appear in the Stackup Information table.



Swap Selected Material

Adding prepreg layers

With the core selected, click the Add Material button and choose Prepreg...; the Add Prepreg library is displayed.



Add Material

| Supplier | Supplier Description | Description | z | Stock Number | Dielectric Base Thickness | Dielectric Finished Thickness | Dielectric Constant | Loss Tangent | Resin Content |
|--------------|----------------------|--------------|---|--------------|---------------------------|-------------------------------|---------------------|--------------|---------------|
| PolarSamples | PP/006 | PrePreg 106 | | 300-006 | 50 | 50 | 4.2 | 0.0195 | 60 |
| PolarSamples | PP/001 | PrePreg 1080 | | 300-001 | 75 | 75 | 4.2 | 0.0195 | 60 |
| PolarSamples | PP/004 | PrePreg 1651 | | 300-004 | 150 | 150 | 4.2 | 0.0195 | 47 |
| PolarSamples | PP/002 | PrePreg 3080 | | 300-002 | 75 | 75 | 4.2 | 0.0195 | 60 |
| PolarSamples | PP/003 | PrePreg 3113 | | 300-003 | 100 | 100 | 4.2 | 0.0195 | 53 |
| PolarSamples | PP/005 | PrePreg 7628 | | 300-005 | 200 | 200 | 4.2 | 0.0195 | 45 |

The Prepreg library contains details of the prepreg material, including base and finished thickness, dielectric constant and loss tangent, resin content and excess resin.



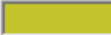
Add Material Above

Choose the Prepreg material from the database and click the Add Material Above button.

| | | | |
|---|------|--------------|-------|
| - | PP | PrePreg 1080 | 3.000 |
| 1 | | | |
| - | Core | FR4 Core | 8.000 |
| 2 | | | |

The prepreg layer is added above the core.




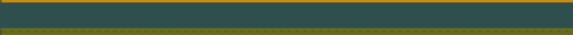
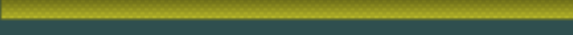
To change the properties of the prepreg material right-click the layer and choose Properties from the short cut menu. Items with a white background can be modified.

| Dielectric | | | |
|---------------------|--------|--------------------|---|
| Base Thickness | 125.00 | Td | 0.0 |
| Finished Thickness | 125.00 | CAF Resistance | 0.0 |
| Dielectric Constant | 4.2000 | Z Axis Expansion | 0.0 |
| Loss Tangent | 0.0195 | Excess Resin | 0.00 |
| Resin Content % | 47.00 | Isolation Distance | 125.00 |
| Tg | 180.0 | Graphical Colour |  |



Add Prepreg Below

Select the Core material and click Add Material|Prepreg to display the prepreg library and click the Add Below button. The layer of prepreg is added below the core.

| | | | | | |
|---|------|--------------|-------|--|-------|
| - | PP | PrePreg 1080 | 3.000 |  | 3.000 |
| 1 | | | 2.800 |  | |
| - | Core | FR4 Core | 8.000 |  | 8.000 |
| 2 | | | 2.800 |  | |
| - | PP | PrePreg 1080 | 3.000 |  | 3.000 |

Modify the properties as necessary.

Choosing the Display Data fields

The Speedstack Stack Editor provides a range of useful data fields for optional display alongside each material. Base and Finish (Display Field 4) refer to thicknesses and weights and appear to the left of the stackup graphic.

| Hatch Defaults External Utilities Rebuild and Calculate Structures | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|--|---|---------------------|-----------------|-----------------|-------------|----------------|--------------------|--|----------------|--------------------|--|--------------------|-----------------|--|-----------------|--------------------|--|--------------------|---------------------|--|---------------------|---------------|--|---------------|----|--|----|--------|--|---------------------|----------------|
| General Structure Defaults Licensing File Locations Goal Seeking Auto Stack User CITS Test Colours Passwords Miscellaneous | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <p>Default Stack Up View</p> <p><input type="radio"/> 2D</p> <p><input checked="" type="radio"/> 3D</p> | <p>Display Data</p> <p>Display Fields 1 and 2 are reserved for Layer Numbers and Layer Types</p> <table border="1"> <thead> <tr> <th>Display Field 3</th> <th>Display Field 4</th> <th>Display Field 5</th> </tr> </thead> <tbody> <tr> <td>Description</td> <td>Base Thickness</td> <td>Finished Thickness</td> </tr> <tr> <td></td> <td>Base Thickness</td> <td>Finished Thickness</td> </tr> <tr> <td></td> <td>Finished Thickness</td> <td>Copper Coverage</td> </tr> <tr> <td></td> <td>Copper Coverage</td> <td>Isolation Distance</td> </tr> <tr> <td></td> <td>Isolation Distance</td> <td>Dielectric Constant</td> </tr> <tr> <td></td> <td>Dielectric Constant</td> <td>Resin Content</td> </tr> <tr> <td></td> <td>Resin Content</td> <td>Tg</td> </tr> <tr> <td></td> <td>Tg</td> <td>Colour</td> </tr> <tr> <td></td> <td>Processed Thickness</td> <td>Data Filenames</td> </tr> </tbody> </table> | Display Field 3 | Display Field 4 | Display Field 5 | Description | Base Thickness | Finished Thickness | | Base Thickness | Finished Thickness | | Finished Thickness | Copper Coverage | | Copper Coverage | Isolation Distance | | Isolation Distance | Dielectric Constant | | Dielectric Constant | Resin Content | | Resin Content | Tg | | Tg | Colour | | Processed Thickness | Data Filenames |
| Display Field 3 | Display Field 4 | Display Field 5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Description | Base Thickness | Finished Thickness | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Base Thickness | Finished Thickness | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Finished Thickness | Copper Coverage | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Copper Coverage | Isolation Distance | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Isolation Distance | Dielectric Constant | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Dielectric Constant | Resin Content | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Resin Content | Tg | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Tg | Colour | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Processed Thickness | Data Filenames | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <p>Units</p> <p><input checked="" type="radio"/> Mils/Thous <input type="radio"/> Microns <input type="radio"/> Millimetres</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <p><input checked="" type="checkbox"/> Open last used file on application start up</p> <p><input checked="" type="checkbox"/> Display File Properties Dialog for New Stackups and Projects</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <p>Apply Cancel</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Display Field 5 appears to the right of the stackup graphic. Choose the data of interest from the drop down lists.

Note: Processed Thickness is the Finished Thickness for copper layers and Isolation Thickness for dielectric layers.

Adding a foil layer

Select the upper layer of prepreg and click the Add Layer Material button and choose Foil to display the copper foil library.

| Supplier Description | Description | Stock Number | Cu Base Thickness | Type | Cost | Lead Time |
|----------------------|-------------|--------------|-------------------|--------|------|-----------|
| FO/001 | Copper Foil | 100-001 | 0.7 | Copper | 1 | 0 |
| FO/002 | Copper Foil | 100-002 | 1.4 | Copper | 2 | 0 |
| FO/003 | Copper Foil | 100-003 | 2.8 | Copper | 3 | 0 |

Choose the foil type and click Add Above, the copper foil layer is added above the selected prepreg layer.

| | | | | | | | | | | |
|---|------|--------------|-------|--|--|--|--|--|--|-------|
| 1 | Foil | Copper Foil | 1.400 | | | | | | | |
| - | PP | PrePreg 1080 | 3.000 | | | | | | | 3.000 |
| 2 | | | 2.800 | | | | | | | |
| - | Core | FR4 Core | 8.000 | | | | | | | 8.000 |
| 3 | | | 2.800 | | | | | | | |
| - | PP | PrePreg 1080 | 3.000 | | | | | | | 3.000 |

Repeat the procedure for the lower prepreg layer: select the lower prepreg layer and add a layer of copper foil below the layer (shown below as layer 4 in the 3D view).

| | | | | | | | | | | |
|---|------|--------------|-------|--|--|--|--|--|--|-------|
| 1 | Foil | Copper Foil | 1.400 | | | | | | | |
| - | PP | PrePreg 1080 | 3.000 | | | | | | | 3.000 |
| 2 | | | 2.800 | | | | | | | |
| - | Core | FR4 Core | 8.000 | | | | | | | 8.000 |
| 3 | | | 2.800 | | | | | | | |
| - | PP | PrePreg 1080 | 3.000 | | | | | | | 3.000 |
| 4 | Foil | Copper Foil | 1.400 | | | | | | | |

To alter the foil properties, right-click the foil layer and choose Properties. Using the Properties dialog the user can, for example, specify that the trace is shown inverted.

| | | | |
|--------------------|-------------------------------------|---|-----------------------------------|
| Copper | | | |
| Base Thickness | <input type="text" value="17.78"/> | Copper Coverage % | <input type="text" value="0.00"/> |
| Finished Thickness | <input type="text" value="35.56"/> | Graphical Colour | <input type="text" value=""/> |
| Data Filename | <input type="text" value=""/> | | |
| Trace Inverted | <input checked="" type="checkbox"/> | Remove Copper (disabled if structures or sub-stacks exist) | <input type="checkbox"/> |
| Finishing Applied | <input checked="" type="checkbox"/> | | |

Note that the stackup is being built symmetrically about the centre layer.

Adding solder mask layers

With the upper layer of foil selected, click the Add Layer Material button and choose Soldermask to add a layer of LPI solder mask above the foil.

| Supplier Description | Description | Stock Number | Mask Thickness | Dielectric Constant | Colour | Type | Cost |
|----------------------|----------------------------|--------------|----------------|---------------------|--------|------------|------|
| SM001 | Liquid PhotoImageable Mask | 500-001 | 1 | 4 | Green | SolderMask | 0.5 |
| SM002 | Liquid PhotoImageable Mask | 500-002 | 1 | 4 | Green | SolderMask | 0.6 |
| SM003 | Liquid PhotoImageable Mask | 500-003 | 1 | 4 | Blue | SolderMask | 0.6 |
| SM004 | Liquid PhotoImageable Mask | 500-004 | 1 | 4 | Red | SolderMask | 1 |

Repeat the process for the solder mask material below the lower foil layer.



Adding the Ident layers

Select the lower LPI Soldermask layer and click the Add Layer Material button and choose Ident to add a layer of Screened Ident below the layer. The sample Ident library includes ink thickness and colour

| Supplier Description | Description | Stock Number | Ink Thickness | Colour | Type | Cost |
|----------------------|----------------|--------------|---------------|--------|-------|------|
| ID/001 | Screened Ident | 600-001 | 2 | White | Ident | 0.1 |
| ID/002 | Screened Ident | 600-002 | 2 | Yellow | Ident | 0.1 |
| ID/003 | Screened Ident | 600-003 | 2 | Black | Ident | 0.1 |

Repeat for the upper layer.

Specify the drill type, mechanical or laser and whether through plated.

Note that with laser drills the order of drill layers is important, e.g. layer 1 and 4 is different from layer 4 and 1.

Choose the Fill Type from the dropdown list of fills.

Optionally, add the NC drill data filenames.

Optionally, add the hole count, number of different hole sizes and the minimum hole size. Click Add and close the dialog.

The drill information is added to the stackup. The example below contains through plated and laser drill information.

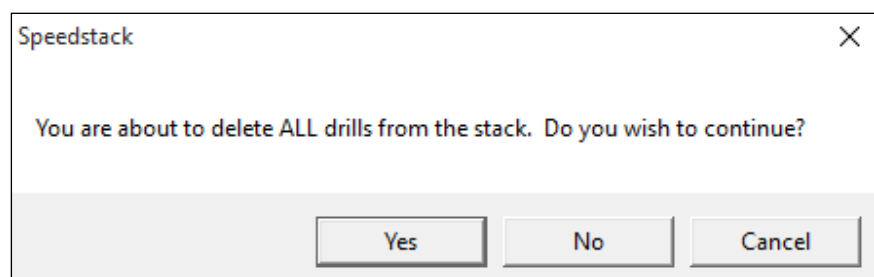
Note: The drill properties (i.e. Drill Information and Hole Information) are retained between each Add Drill operation. This can speed up the process of adding drills, especially when multiple drills of the same type are being added to the stackup.

The finished stackup is shown below



Deleting drills

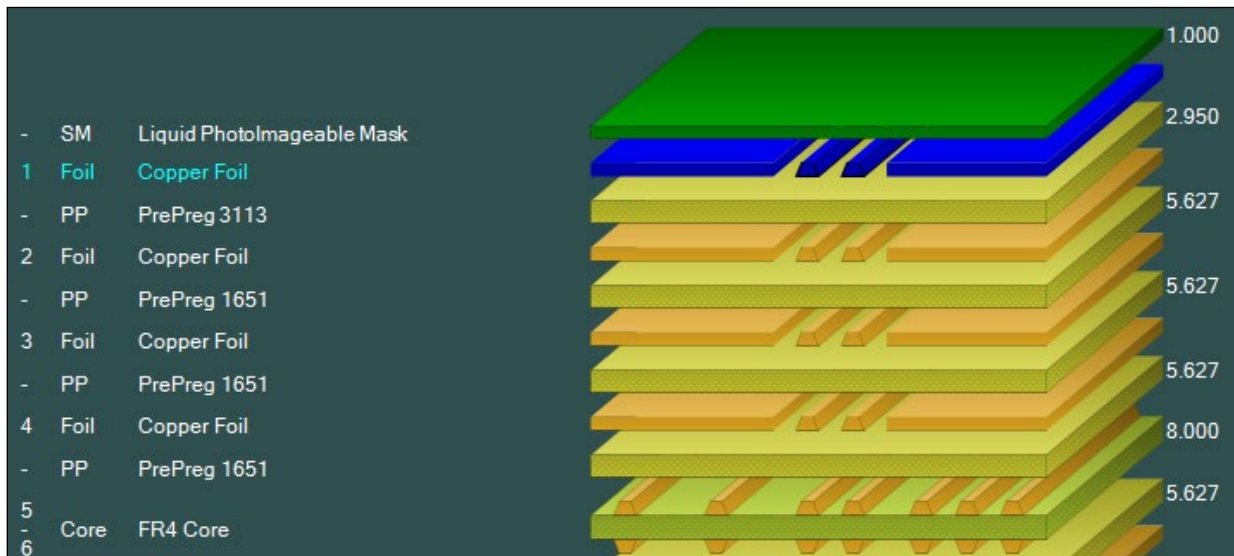
To delete a drill right click the drill and from the context menu choose Delete. To delete all drills choose Delete all Drills – confirm via the dialog below.



All drills will be cleared from the stack.

Adding stack vias

Speedstack can add stack vias to the stackup in a single operation. To add stack vias between layers 1 and 5 in the stackup below, select layer 1 and click Add Drill.



Specify the column number and electrical layers 1 and 5 and choose Laser (Stacked) – from the Fill Type drop down list choose Copper. Click Add.

Add Drill

Main | Notes

Electrical Layers

| Stack Up Column | First Electrical Layer No (Start Layer) | Second Electrical Layer No (End Layer) | Back Drill Must Cut Layer No | Back Drill Must Not Cut Layer No |
|-----------------|---|--|------------------------------|----------------------------------|
| 1 | 1 | 5 | 1 | 1 |

Drill Information

☐ Mechanical ☐ Laser ☒ Laser (Stacked) ☐ Back Drill

Fill Type: Copper

☒ Through Plated

Data Filenames:

Hole Information

| Hole Count | Minimum Drill Size |
|------------|--------------------|
| 0 | 0.00 |

| Different Hole Sizes | Minimum Drill Size Tolerance (Abs) |
|----------------------|------------------------------------|
| 0 | 0.00 |

| Minimum Hole Size | Minimum Barrel Wall Thickness |
|-------------------|-------------------------------|
| 0.00 | 0.00 |

| Minimum Pad Size |
|------------------|
| 0.00 |

Back Drill Information

| Minimum Distance From Cut Layer |
|---------------------------------|
| 0.00 |

| Maximum Distance From Cut Layer |
|---------------------------------|
| 0.00 |

| Primary Drill Size |
|--------------------|
| 0.00 |

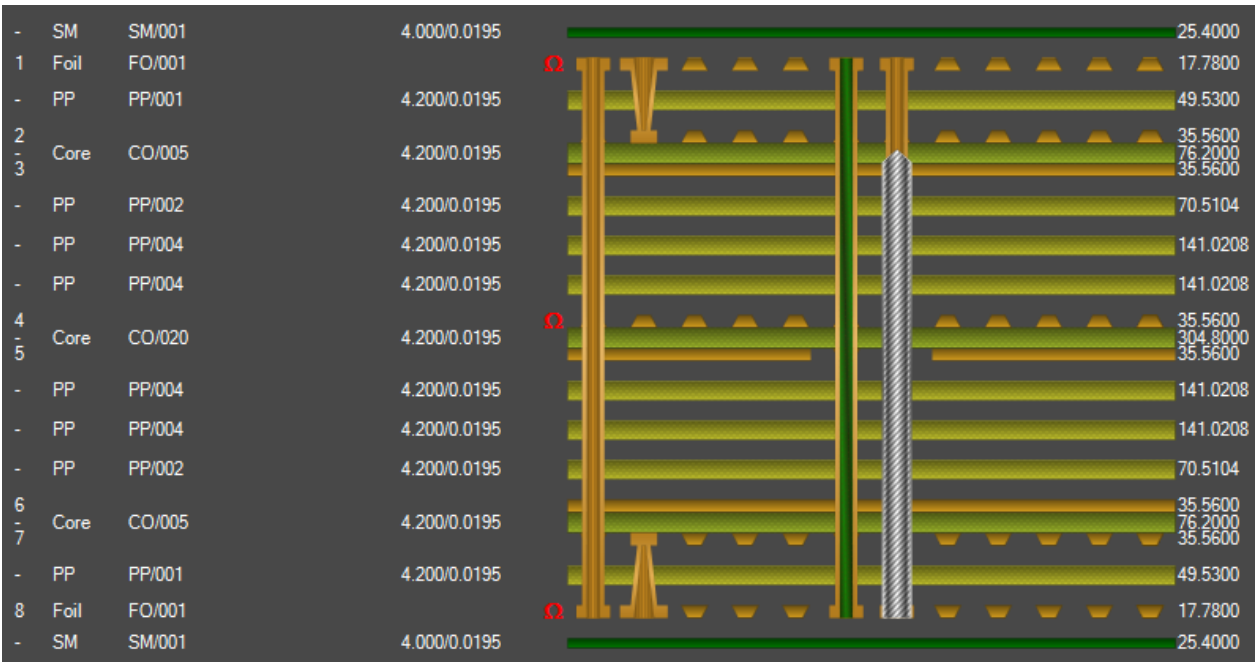
Add **Close**

The stack vias are added to the stack (below.)



Via stub removal (controlled depth drilling / back drilling)

PCB vias provide a conductive path to allow the transition of electrical signals between circuit layers through the walls of plated holes. The most common method of connecting two signal layers is to create a plated through hole through the entire board and then remove the unwanted portion of the plated through hole (the stub – the unused portions of via extending further than the last connected inner layer) by back drilling. Stubs can lead to reflections, discontinuity errors that become critical with increasing propagation speed.) The stackup below shows a plated through hole back drilled, resulting in a via between layers 1 and 2.



Specifying back drills

To add a back drill click Add Drill to display the Add Drill dialog.

Add Drill

Main | Notes

Electrical Layers

Stack Up Column: 7 | First Electrical Layer No (Start Layer): 8 | Second Electrical Layer No (End Layer): 1 | Back Drill Must Cut Layer No: 3 | Back Drill Must Not Cut Layer No: 2

Drill Information

☐ Mechanical | Fill Type: No Fill
☐ Laser
☐ Laser (Stacked)
☒ Back Drill
☐ Through Plated
Data Filenames:

Hole Information

Hole Count: 0 | Minimum Drill Size: 0.00
Different Hole Sizes: 0 | Minimum Drill Size Tolerance (Abs): 0.00
Minimum Hole Size: 0.00 | Minimum Barrel Wall Thickness: 0.00
Minimum Pad Size: 0.00

Back Drill Information

Minimum Distance From Cut Layer: 0.00
Maximum Distance From Cut Layer: 0.00
Primary Drill Size: 0.00

Add | Close

To specify the controlled drilling depth, from the Add Drill dialog:

Choose Back Drill from the Drill Information

Choose the drill column and specify the start layer.

Choose the layer number from the Back Drill Must Cut Layer No.

Choose the layer number from Back drill Must Not Cut Layer No.

Electrical Layers

Stack Up Column: 7 | First Electrical Layer No (Start Layer): 8 | Second Electrical Layer No (End Layer): 1 | Back Drill Must Cut Layer No: 3 | Back Drill Must Not Cut Layer No: 2

Specify other Back Drill and Hole Information

Click the Notes tab and click Add.



Delete Selected
Material

Deleting a layer

To remove a layer from the stackup select the layer and click the Delete button.



Copy Selected
Material

Copying a layer

With layers defined it will often be found more convenient to copy an existing layer and paste it into the stackup than to create a new layer “from scratch”. Select the layer to be copied and click the Copy Selected Material button. Click the layer nearest the destination location and choose Paste Above or Paste Below as appropriate

Note: when modifying the stackup it may be necessary to redefine the drill information to reflect the changes.

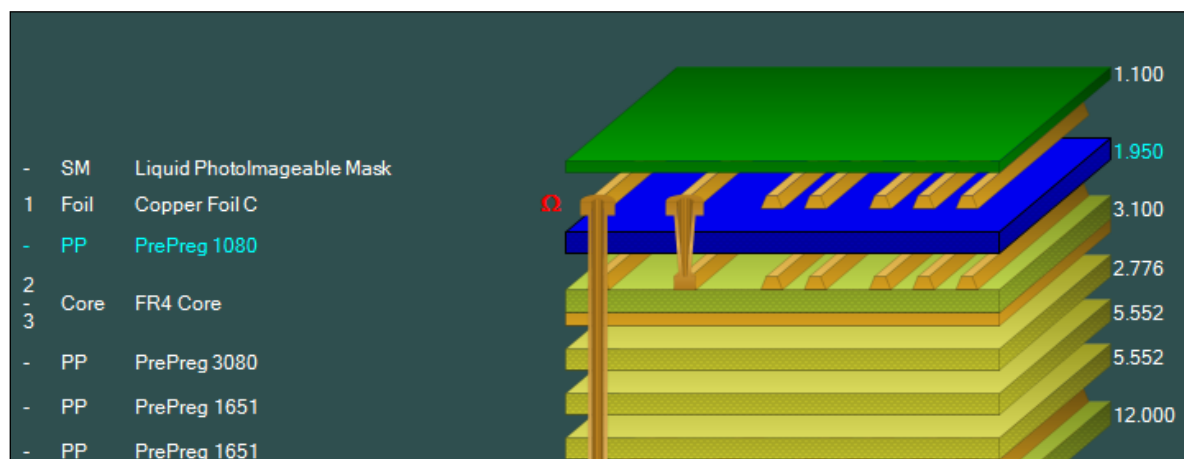
Copying material properties

Speedstack can copy material properties from one material in the stackup and paste them onto multiple materials simultaneously.

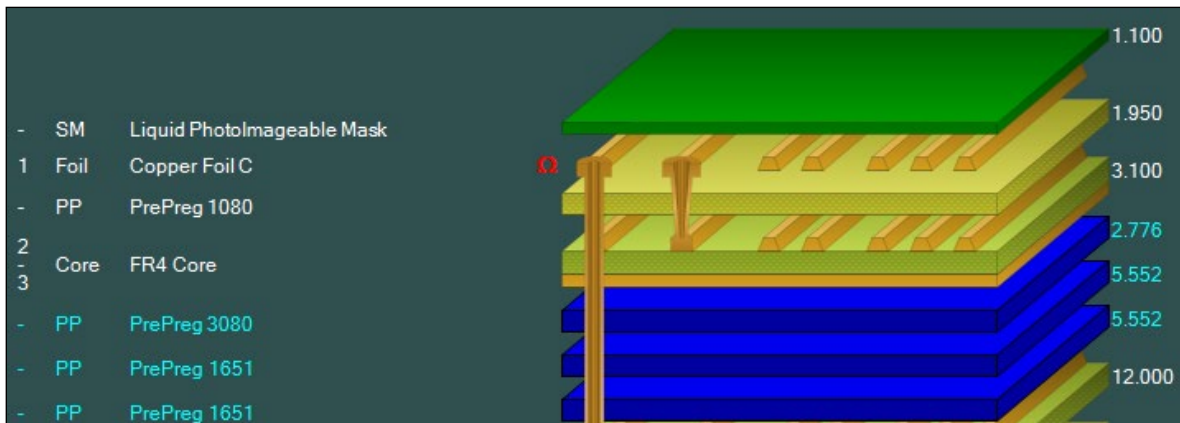


Copy Material
Properties

For example, to replace the three prepreg materials below Layer 3 in the stackup below with the Layer 1 material, PrePreg 1080, select the source material (shown highlighted below) and click Copy Material Properties



Select the three target layers



Paste Material Properties

Click Paste Material Properties – the Paste Material Properties dialog is displayed.

Paste Material Properties

Please select the Property Groups that you wish to paste to the selected materials:

General Properties (All Materials)

☒ General Information (Supplier, Description, Stock Number etc)

☒ Notes (5 x Note properties)

☒ Colour (Draw colour)

Conductor Properties (Foil, Core, RCC, Flex Core)

☒ Copper (Base and Finished Thickness, Copper Coverage etc See Note 1)

Note 1: Layer Numbers and Layer Types assigned to Copper layers are not copied.

Dielectric Properties (Core, RCC, Prepreg, Flex Core, Bondply, Adhesive)

☒ Dielectric (Base and Finished Thickness, Isolation Distance, Dielectric Constant etc)

Solder Mask Properties (Solder Mask)

☒ Solder Mask (Thickness, Dielectric Constant etc)

Coverlay Properties (Coverlay)

☒ Coverlay (Base and Finished Thickness, Dielectric Constant etc)

Ident Properties (Ident)

☒ Ident (Thickness etc)

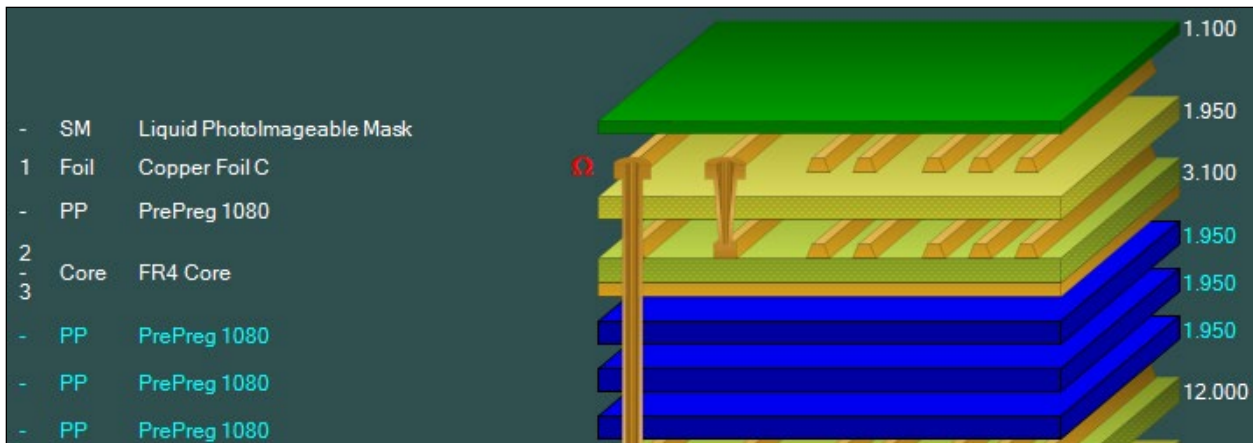
Peelable Properties (Peelable)

☒ Peelable (Thickness etc)

☒ Select / Deselect All

Apply Cancel

Select the property groups that are to be applied to the target materials and click Apply. Properties that do not apply for a material type are ignored.



In this example all material properties have been applied to the three target materials.

Note: When changing multiple materials simultaneously it is important to review the resulting stackup. It will probably be necessary to recalculate any associated controlled impedance structures, especially if dielectric height and copper thickness parameters have changed.

Moving materials

To move materials within the stackup click Move Selected Material Up and Move Selected Material Down.

When a material is moved it is exchanged with the layer above or below, respectively.



Move Selected
Material Up



Move Selected
Material Down



Apply Finishing



Reset Finishing

Applying finishing

To apply the finished thickness factor throughout the board, click the Apply Finishing button with no material selected.

To reset the finished thickness back to the original base thickness of the materials throughout the board, click the Reset Finishing button with no material selected.

Note: when applying or resetting finishing, if a material is selected it will be necessary to specify whether finishing is to be applied to the selected material only or the whole stack.

Displaying the stackup in 2-dimensional view

To change the view of the stackup from its default 3-dimensional aspect, click the See 2D View button. The stackup is displayed in 2-dimensional view.



See 2D View

| | | | | | |
|---|------|----------------------------|-------|--|-------|
| - | ID | Screened Ident | 2.000 | | 2.000 |
| - | SM | Liquid PhotoImageable Mask | 1.000 | | 1.000 |
| 1 | Foil | Copper Foil | 1.400 | | |
| - | PP | PrePreg 1080 | 3.000 | | 3.000 |
| 2 | | | 2.800 | | |
| - | Core | FR4 Core | 8.000 | | 8.000 |
| 3 | | | 2.800 | | |
| - | PP | PrePreg 1080 | 3.000 | | 3.000 |
| 4 | Foil | Copper Foil | 1.400 | | |
| - | SM | Liquid PhotoImageable Mask | 1.000 | | 1.000 |
| - | ID | Screened Ident | 2.000 | | 2.000 |



See 3D View

Click the View 3D button to restore the 3 dimensional view.

Mirror Builds

Mirror Build allows the designer to consider the stack in two halves, designing and building, for example, just the top half and mirroring the structure into the lower half.

Build the top half of the stack, including any controlled impedance structures and click the Mirror Build button; specify whether the current set of layers is the upper or lower half of the stack. To maintain symmetry, Speedstack will add a layer of material as appropriate to the stack;

Mirror Build

Which half of the new stack is this?

Top

Bottom

It will be necessary to add another prepreg to complete the Mirrored stack.

Cancel

the stack is reflected symmetrically into the lower half.

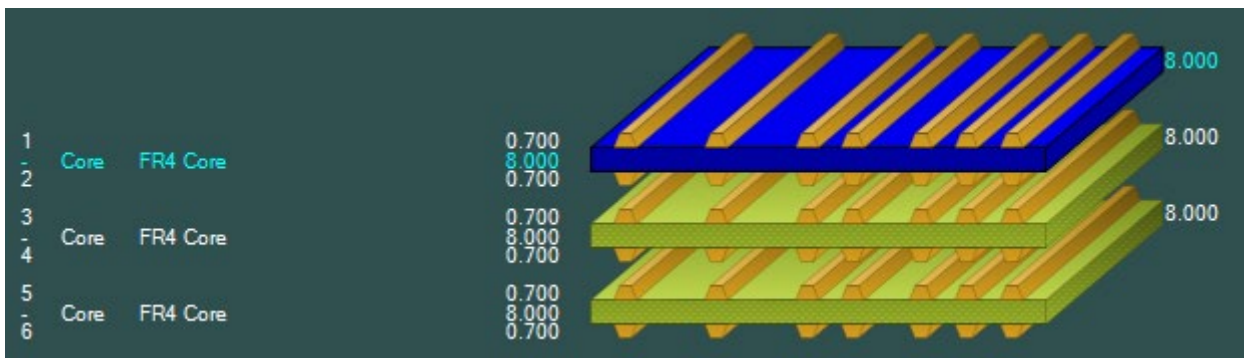
Symmetrical Builds

In Symmetrical Build mode the Speedstack maintains stack symmetry as the stack designer creates or edits a stack. Changes in one half of the stack are reflected in the opposite half of the stack to ensure a symmetrical stack.

This example considers an 8-layer stack – beginning with three cores and then using Symmetrical Build.

Creating a new stack

Create a new empty stackup and add three cores.

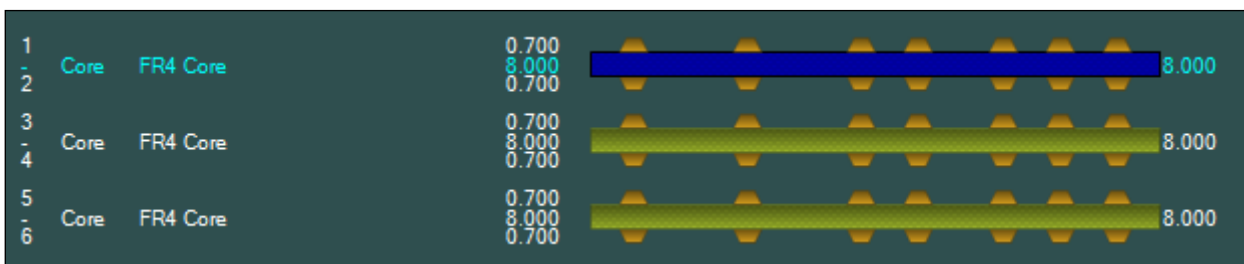


When constructing complex structures it will often be found easier to use the two dimensional aspect.



View 2D button

To change the view of the stackup from its default 3-dimensional aspect, click the See 2D View button. The stackup is displayed in 2-dimensional aspect.



Adding a prepreg layer in Symmetrical Mode

In this example it is necessary to add prepreg layers between cores to achieve the required dimensions.



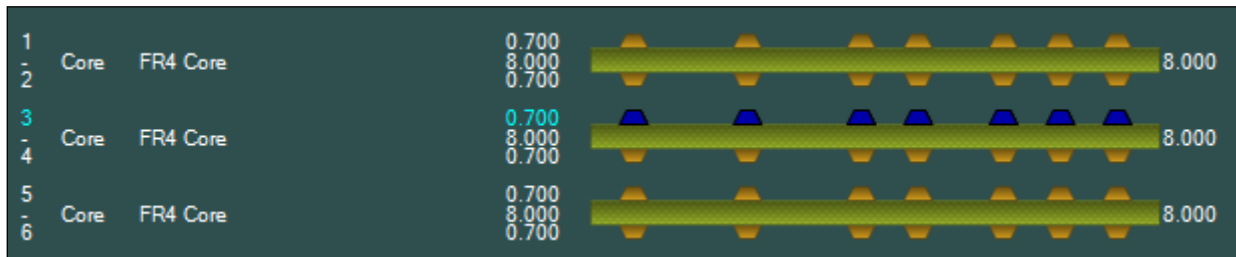
Symmetrical OFF



Symmetrical ON

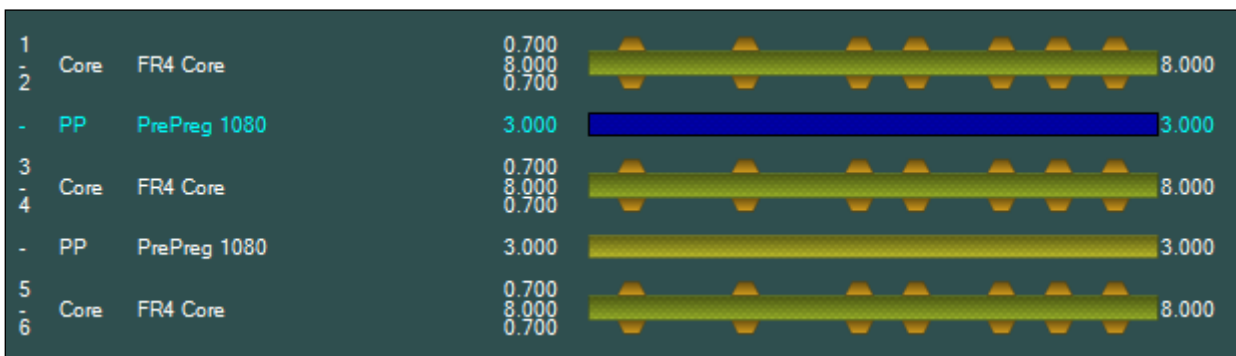
Switch to Symmetrical Mode and work in the top half of the stack – in Symmetrical Mode as layers are added to the top half of the stackup the Speedstack will add layers to the lower half of the stackup to maintain stack symmetry.

To add a layer of prepreg between Layers 2 and 3 select Layer 3 (the selected layer is shown highlighted in the figure below.)



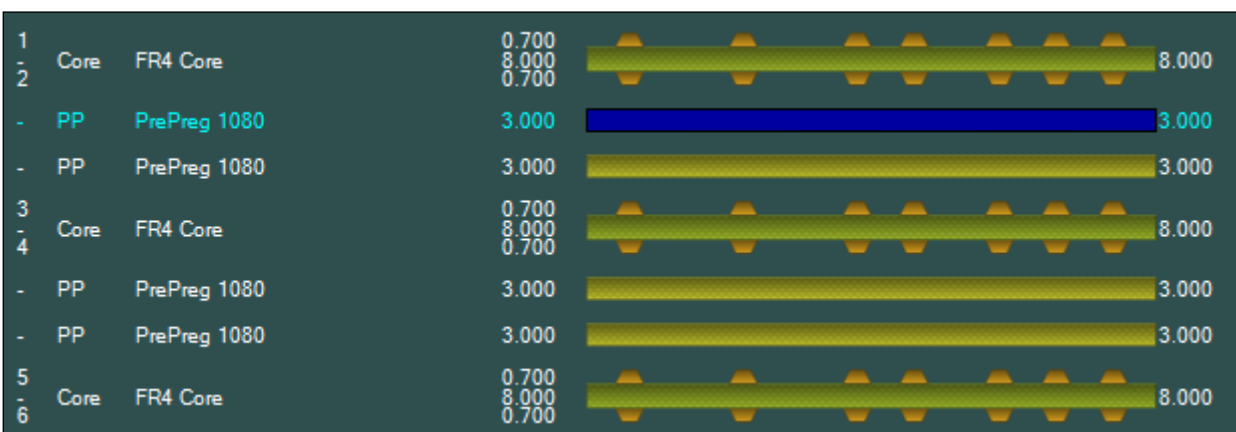
Click the Add Material button and add a layer of prepreg above Layer 3 (shown highlighted in the figure below).

In Speedstack's symmetrical mode the prepreg layer is automatically reflected in the lower half of the structure.



Adding a second prepreg layer

Now add a second layer of PrePrep 1080 above the layer just added; the new prepreg layer is reflected in the lower half of the stack as shown below.



Next, add a layer of prepreg above layer L1 in the upper half of the stackup.

Speedstack in symmetrical mode automatically maintains stack balance by adding the corresponding layer below L6.

| | | | | | |
|---|------|--------------|-------|--|-------|
| - | PP | PrePreg 1080 | 3.000 | | 3.000 |
| 1 | | | 0.700 | | |
| 2 | Core | FR4 Core | 8.000 | | 8.000 |
| | | | 0.700 | | |
| - | PP | PrePreg 1080 | 3.000 | | 3.000 |
| - | PP | PrePreg 1080 | 3.000 | | 3.000 |
| 3 | | | 0.700 | | |
| 4 | Core | FR4 Core | 8.000 | | 8.000 |
| | | | 0.700 | | |
| - | PP | PrePreg 1080 | 3.000 | | 3.000 |
| - | PP | PrePreg 1080 | 3.000 | | 3.000 |
| 5 | | | 0.700 | | |
| 6 | Core | FR4 Core | 8.000 | | 8.000 |
| | | | 0.700 | | |
| - | PP | PrePreg 1080 | 3.000 | | 3.000 |

Adding foil, LPI Mask and Ident layers

Next, add a foil layer (L1 below) which is mirrored as L8; as part of the process Speedstack inverts layer L8.

| | | | | | |
|---|------|--------------|-------|--|-------|
| 1 | Foil | Copper Foil | 1.400 | | |
| - | PP | PrePreg 1080 | 3.000 | | 3.000 |
| 2 | | | 0.700 | | |
| 3 | Core | FR4 Core | 8.000 | | 8.000 |
| | | | 0.700 | | |
| 6 | | | 0.700 | | |
| 7 | Core | FR4 Core | 8.000 | | 8.000 |
| | | | 0.700 | | |
| - | PP | PrePreg 1080 | 3.000 | | 3.000 |
| 8 | Foil | Copper Foil | 1.400 | | |

Next, LPI solder mask is applied to the top side of the stackup and reflected on the bottom side.

| | | | | | |
|---|------|----------------------------|-------|--|-------|
| - | SM | Liquid PhotoImageable Mask | 1.000 | | 1.000 |
| 1 | Foil | Copper Foil | 1.400 | | |
| - | PP | PrePreg 1080 | 3.000 | | 3.000 |
| - | PP | PrePreg 1080 | 3.000 | | 3.000 |
| 8 | Foil | Copper Foil | 1.400 | | |
| - | SM | Liquid PhotoImageable Mask | 1.000 | | 1.000 |

Ident layers (which are not considered components of electrical symmetry) will not be automatically reflected by Speedstack as they are added and must be applied separately to each side of the board.

Select the upper solder mask and add an Ident material above; select the lower solder mask and add an Ident material below.

| | | | | | |
|---|------|----------------------------|-------|--|-------|
| - | ID | Screened Ident | 2.000 | | 2.000 |
| - | SM | Liquid PhotoImageable Mask | 1.000 | | 1.000 |
| 1 | Foil | Copper Foil | 1.400 | | |
| 8 | Foil | Copper Foil | 1.400 | | |
| - | SM | Liquid PhotoImageable Mask | 1.000 | | 1.000 |
| - | ID | Screened Ident | 2.000 | | 2.000 |



Set Layer To Plane

Assigning ground planes

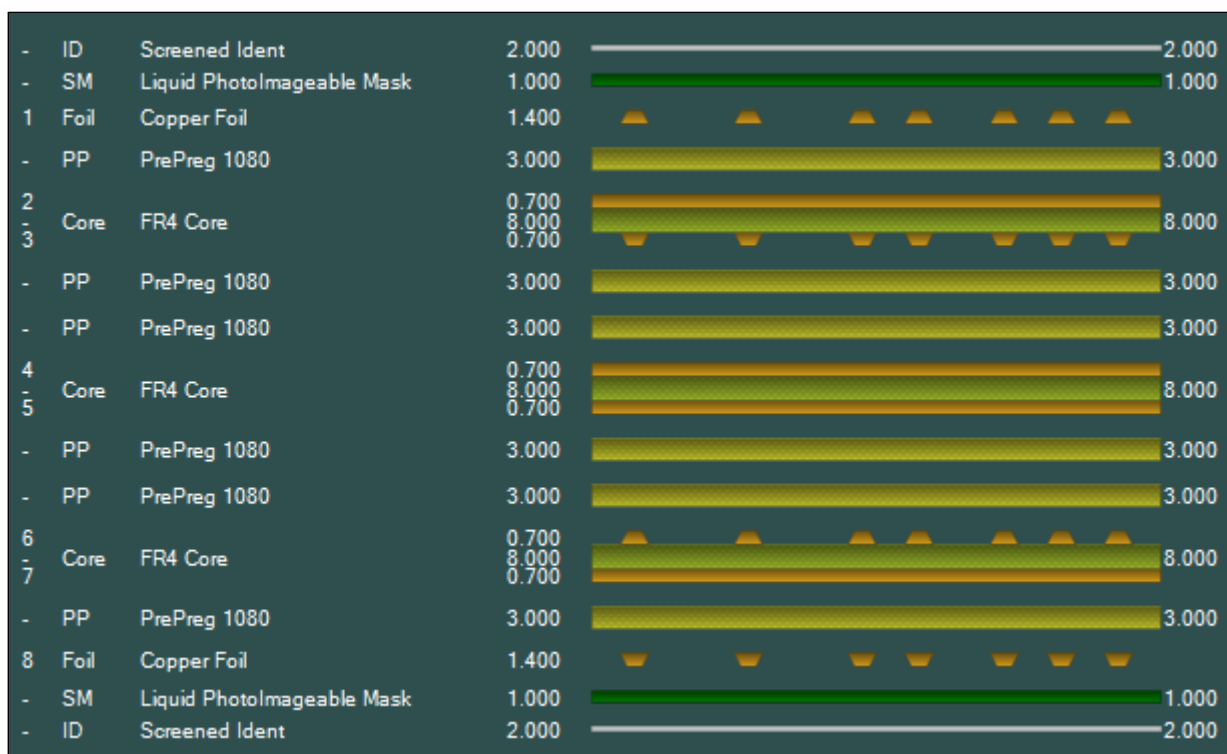
With all the material in place, assign ground planes; begin with layer L2 – it's reflected in layer L7. Right click the copper (L2) in the top core and choose Set Layer to Plane.

| | | | | | | |
|---|----|--------------|--------------|-------|--|-------|
| 2 | - | Core | FR4 Core | 0.700 | | 8.000 |
| 3 | - | PP | PrePreg 1080 | 0.700 | | |
| - | PP | PrePreg 1080 | | 3.000 | | 3.000 |
| - | PP | PrePreg 1080 | | 3.000 | | 3.000 |
| 4 | - | Core | FR4 Core | 0.700 | | 8.000 |
| 5 | - | PP | PrePreg 1080 | 8.000 | | |
| - | PP | PrePreg 1080 | | 0.700 | | |
| - | PP | PrePreg 1080 | | 3.000 | | 3.000 |
| - | PP | PrePreg 1080 | | 3.000 | | 3.000 |
| 6 | - | Core | FR4 Core | 0.700 | | 8.000 |
| 7 | - | PP | PrePreg 1080 | 8.000 | | |
| - | PP | PrePreg 1080 | | 0.700 | | |

Repeat the process for the other ground plane layers; layer L4 is designated a ground plane, the change is reflected in L5 in the lower half of the stack.

| | | | | | | |
|---|----|--------------|--------------|-------|--|-------|
| - | PP | PrePreg 1080 | | 3.000 | | 3.000 |
| 4 | - | Core | FR4 Core | 0.700 | | 8.000 |
| 5 | - | PP | PrePreg 1080 | 8.000 | | |
| - | PP | PrePreg 1080 | | 0.700 | | |
| - | PP | PrePreg 1080 | | 3.000 | | 3.000 |

The completed stack is shown below



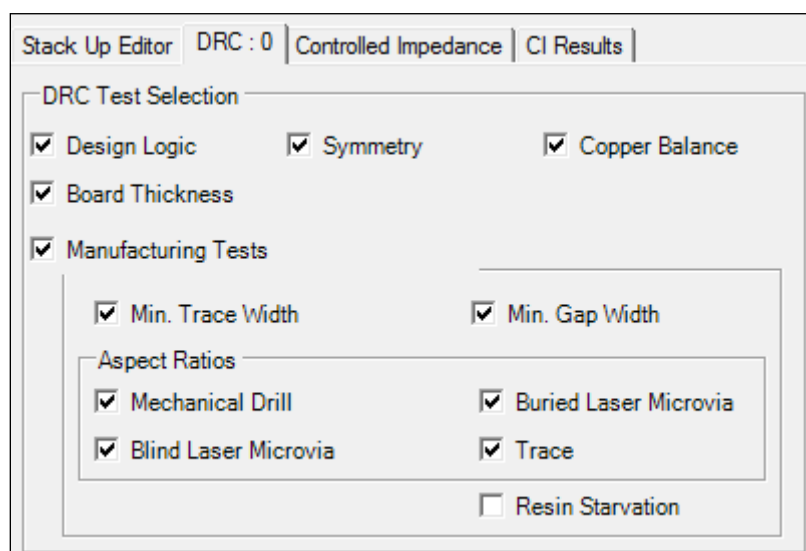
Design rule checking

Speedstack includes facilities to check for errors in stackup design, such as layers placed in invalid order or asymmetrical structures. The condition of the design rule checkboxes is carried over from session to session.

The Design Rule Checker (DRC) displays results in the DRC dialog. As each design rule is broken the Speedstack increments the error count on the DRC tab.

Viewing design rule errors

Click the DRC tab to view errors.



The Design Rule Checker checks include checking for:

Two adjacent copper layers

Resin coated copper on internal layer

External prepreg layers

Internal solder mask material

Internal ident material

Internal peelable mask

Symmetry – different material types

Copper not balanced

Board thickness (if the board is outside tolerance the Stack Information in the Stack editor is displayed in red)

Manufacturing tests

Minimum trace width (the test is carried out when calculating controlled impedance)

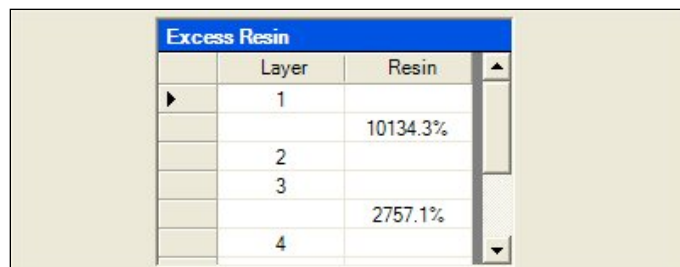
Minimum trace separation (the test is carried out when calculating controlled impedance)

Drill aspect ratios for plated holes

Track aspect ratio

Excess resin test (Resin Starvation)

If the Resin Starvation check box is ticked values are shown as below; scroll through the layers as required



| | Layer | Resin |
|---|-------|----------|
| ▶ | 1 | 10134.3% |
| | 2 | |
| | 3 | 2757.1% |
| | 4 | |

Note: If the Resin Starvation check box is ticked, all prepregs must include valid values for the excess resin field.

Polar Application Note [AP509](#) includes a discussion on calculating excess resin.

Users can choose to display all errors or to select from a combination of design errors, symmetry errors and copper balance errors, etc.; check the boxes as required.

Click on the errors shown in the list to highlight the errors in the stackup screen.

| | |
|------------------|---------|
| Resin Level Low: | -100.0% |
| Resin Level Low: | -100.0% |
| Resin Level Low: | -100.0% |
| Resin Level Low: | -100.0% |

Errors are highlighted in red.

| | | | | | | | | | | | |
|---|------|--------------|-------|--|--|--|--|--|--|--|-------|
| 1 | Foil | Copper Foil | 1.400 | | | | | | | | |
| - | PP | PrePreg 1080 | 3.000 | | | | | | | | 3.000 |
| 2 | | | 0.700 | | | | | | | | |
| - | Core | FR4 Core | 8.000 | | | | | | | | 8.000 |
| 3 | | | 0.700 | | | | | | | | |

Correcting design rule errors

Users are strongly recommended to work through and correct errors in the order in which the errors are listed. Note that clearing each error may clear other errors in the process.

Manufacturing tests should be fixed before sending the PCB for manufacture. Hole sizes should be adjusted to comply. Failures with track and gap should be corrected, possibly by changing prepreg thickness and/or dielectric constants.

A collection of manufacturing constraints can be defined and the required one selected.

Creating and using manufacturing constraints

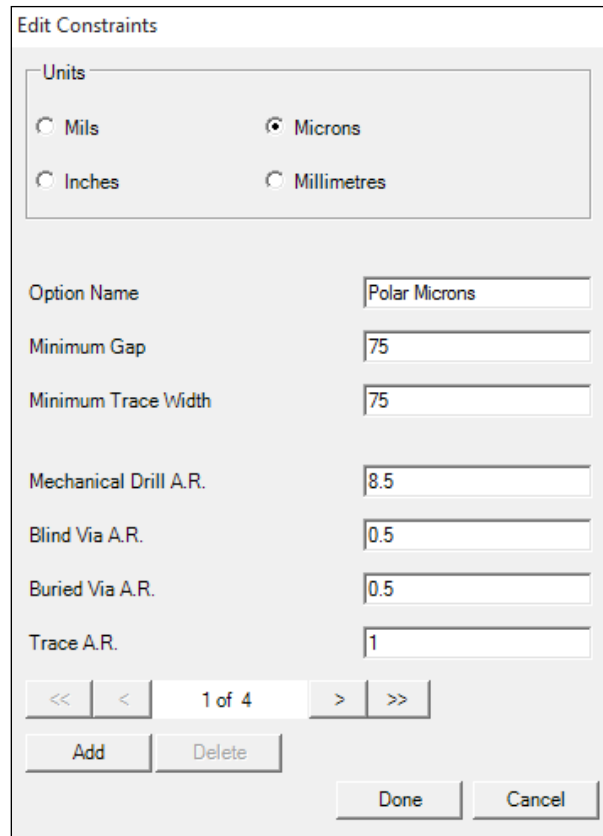
From the Tools menu, select Manufacturing Constraints: the Manufacturing Constraints window opens, displaying any manufacturing constraints added.

| Manufacturing Constraints | | | | | | | | |
|---------------------------|---------------------|-----------------------|---------------------|------------------------|-------------|---------------------|-------------|-------------|
| | Manufacturer's Name | Blind Laser Via A. R. | Buried Laser Via A. | Mechanical Drill A. R. | Minimum Gap | Minimum Trace Width | Trace A. R. | Units |
| ► | Polar Microns | 0.5 | 0.5 | 8.5 | 75 | 75 | 1 | Microns |
| | Polar Mils | 0.5 | 0.5 | 8.5 | 3 | 3 | 1 | Mils |
| | Polar Millimetres | 0.5 | 0.5 | 8.5 | 0.075 | 0.075 | 1 | Millimetres |
| | Polar Inches | 0.5 | 0.5 | 8.5 | 0.003 | 0.003 | 1 | Inches |
| Current Active Constraint | | | | | | | | |
| Highlight | | Set New | | Close | | | | |

By default there will always be at least one. It is important to always have one constraint set active.

Editing constraints

Double-click on a constraint row will bring up the Edit Constraints dialog; use the dialog to add, delete or edit constraints (gaps, trace widths, aspect ratios, etc.)



The 'Edit Constraints' dialog box is shown. It has a title bar 'Edit Constraints'. Inside, there is a 'Units' section with four radio buttons: 'Mils', 'Microns' (selected), 'Inches', and 'Millimetres'. Below this, there are several input fields with labels: 'Option Name' (containing 'Polar Microns'), 'Minimum Gap' (containing '75'), 'Minimum Trace Width' (containing '75'), 'Mechanical Drill A.R.' (containing '8.5'), 'Blind Via A.R.' (containing '0.5'), 'Buried Via A.R.' (containing '0.5'), and 'Trace A.R.' (containing '1'). At the bottom, there are navigation buttons: '<<', '<', '1 of 4', '>', '>>'. Below these are 'Add' and 'Delete' buttons. At the very bottom are 'Done' and 'Cancel' buttons.

To edit a constraint set, use the navigation buttons to select the set to be modified, change the values as required and then press Done.

To delete a constraint set, use the navigation buttons to select the set, then press Delete.

To add a new constraint set, press the Add button, this will add a new (empty) constraint row, enter the name and constraint values and press Done.

Adding controlled impedance structures

Speedstack incorporates the facility to add controlled impedance structures to a layer in the stackup.

Speedstack is integrated with the Polar Instruments Si8000m/9000e controlled impedance field solvers so impedance values for a structure may be calculated at the click of a button.

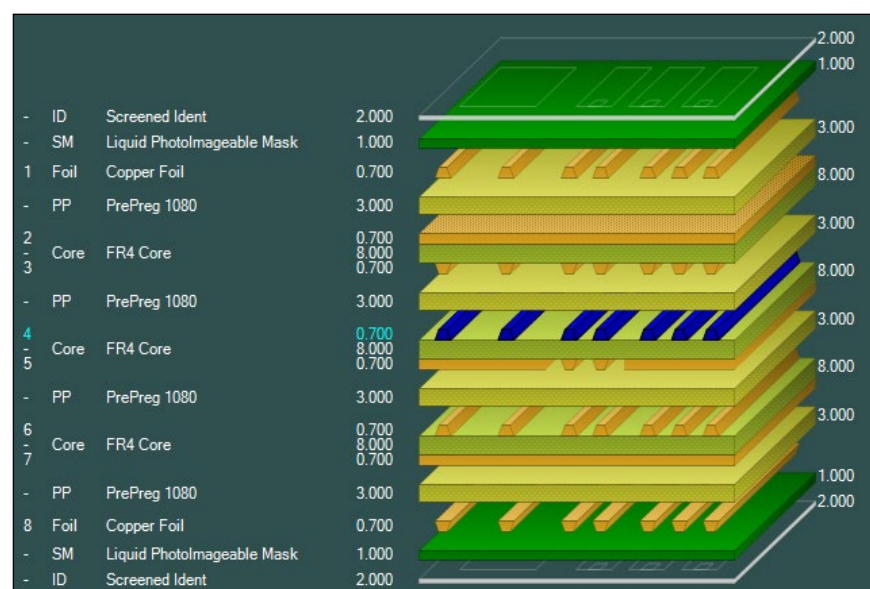
Structure parameters may be copied to the field solver for processing (for example by the Si8000m/9000e Goal Seeking function) and calculated values pasted back into Speedstack for insertion into the stackup.

Each structure can be assigned up to five net class names. These net class names provide a link to the matching impedance nets inside the ECAD PCB layout system.

Speedstack Si caters for frequency dependent calculations, adding comprehensive insertion loss capability into Speedstack. Bidirectional copy and paste from Speedstack Si into Si9000e includes all the relevant loss tangent, roughness and roughness modeling methods along with frequencies of interest.

Adding a controlled impedance structure

For the example stack below, add a controlled impedance structure to signal layer 4.



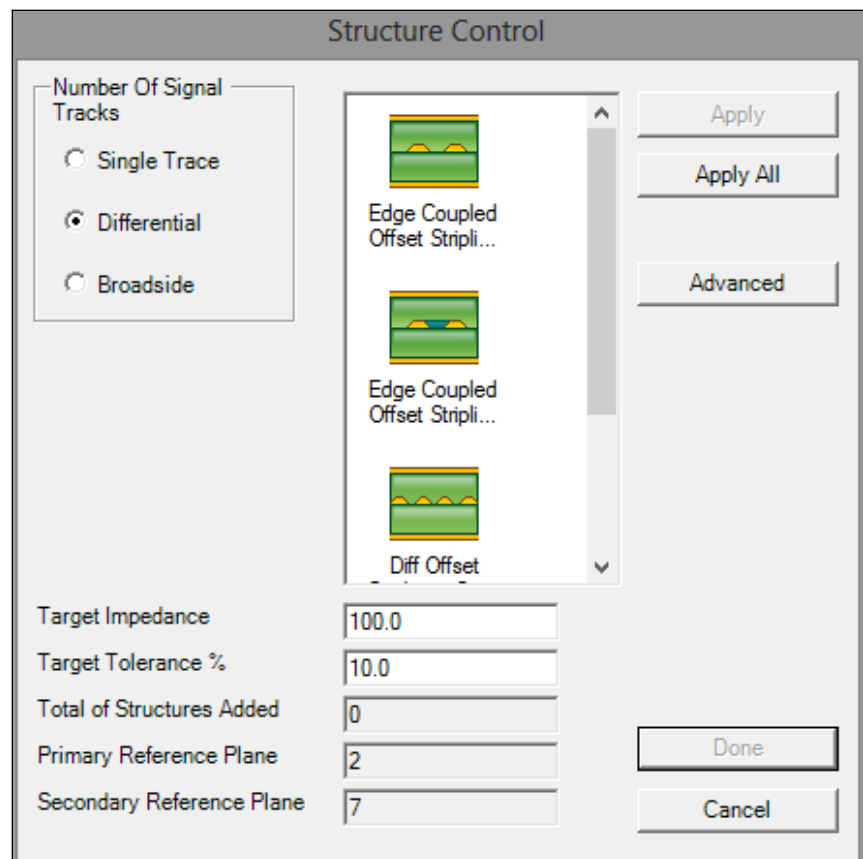
Sample stackup (showing signal layer 4 selected)

Note that in this example Layer 5 is a mixed signal/plane layer. Potential reference planes for Signal Layer 4 are therefore Plane Layer 2, mixed Signal/Plane Layer 5 and plane Layer 7.

With Layer 4 selected, click the Controlled Impedance tab. The Add Structure button is displayed.



Click the Add Structure button; the Structure Control dialog is displayed containing the controlled impedance structures applicable to the selected layer in the stack. Choose values for the target impedance and tolerance. If necessary, resize the Structure Control dialog to view all structures.



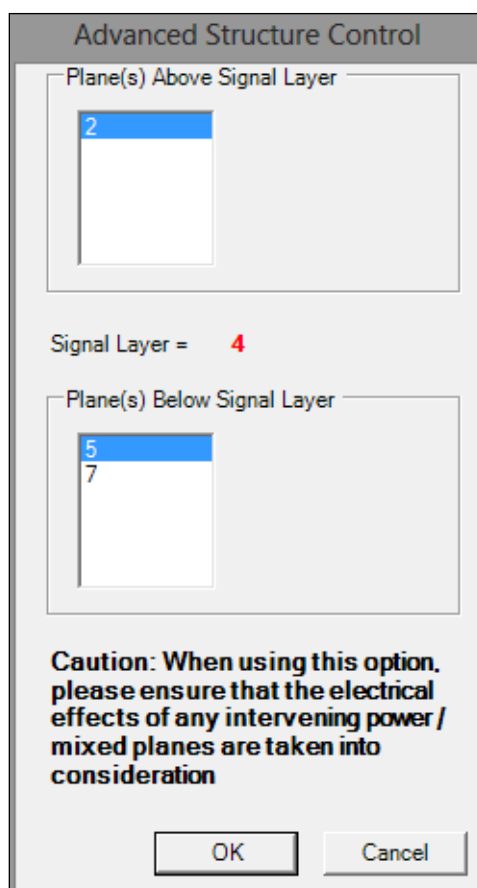
Click the Single Trace, Differential or Broadside option button as appropriate (in this case, choose Single Trace|Offset Stripline 1B1A with a 50 Ohm impedance.)

Note: Broadside only appears as an option where the signal trace is between two reference planes and Differential is selected.

Specify the values for Target Impedance and Tolerance.

Choosing reference planes

As there are multiple reference planes available (layers 2, 5 and 7), it will be necessary to specify which planes to use for this structure. Click Advanced.

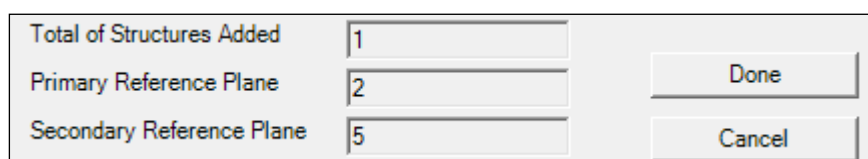


The 'Advanced Structure Control' dialog box is shown. It has two list boxes: 'Plane(s) Above Signal Layer' containing '2' and 'Plane(s) Below Signal Layer' containing '5' and '7'. The 'Signal Layer =' field is set to '4'. A caution message is displayed: 'Caution: When using this option, please ensure that the electrical effects of any intervening power / mixed planes are taken into consideration'. At the bottom are 'OK' and 'Cancel' buttons.

Choose a reference plane from the list of available planes. In the example structure plane layer 2, mixed plane 5 and plane layer 7 are available for reference.

Note: if plane layer 7 is chosen as reference, it will be necessary to take into account the electrical effects of mixed signal/layer plane 5.

In this example choose mixed signal/plane layer 5. Press OK to confirm. The chosen reference planes are shown below.

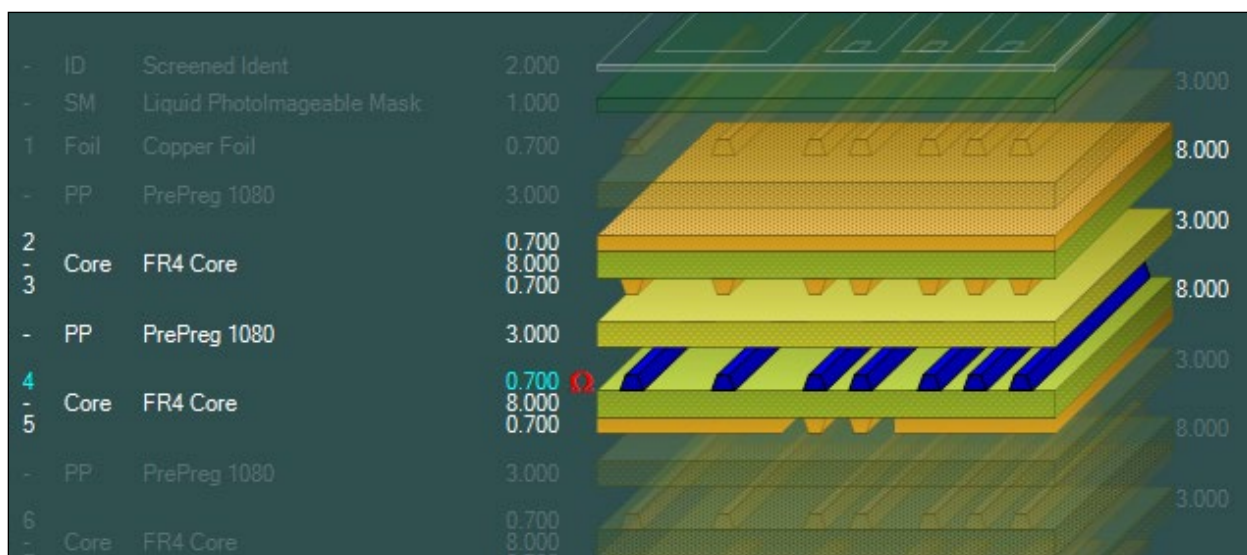


A summary dialog box with three rows: 'Total of Structures Added' with value '1', 'Primary Reference Plane' with value '2', and 'Secondary Reference Plane' with value '5'. To the right are 'Done' and 'Cancel' buttons.

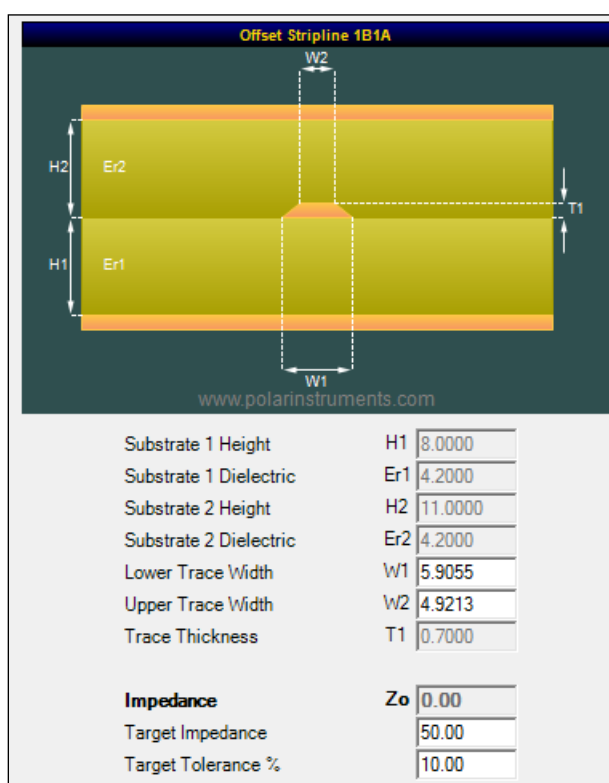
Repeat for all structures to be added. Click Apply for each structure then click Done to finish. In this example, choose a single structure.



Layers with controlled impedance structures are indicated by a red Ohms symbol.



The stackup window changes to reflect the selected signal layer and its associated reference planes. The applied structure is displayed in the Controlled Impedance pane.



The window displays the parameters of the controlled impedance structure. Fields shown "greyed out" are values derived from the choice of materials in the stackup. For this structure, enter the appropriate values for lower and upper trace widths.



Calculate Displayed Structure

Click the Calculate Displayed Structure button to display the impedance value of the structure with the current parameters. The parameters may then be varied to alter the value of the final impedance. In the example above the trace width can be fine-tuned in order to approach the value of the target

impedance; other parameters are changed by modifying the stackup dimensions (for example, core thickness, H1.)

Hint: clicking Apply All in the Structure Control dialog adds a single instance of all structures matching the stackup layer and the chosen criteria; the designer can then choose the structure producing the value nearest the target impedance and delete the structures that are not needed.

Controlled impedance toolbar

Controlled impedance operations are performed via the Controlled Impedance toolbar.



Add controlled impedance structure to current layer



Delete structure from current layer



Clear all structures from current layer



Rebuild and recalculate all structures



Calculate displayed structure



Mirror structures



Goal seek



Set CITS test



Free hand notes



Structure layer properties



Structure validation

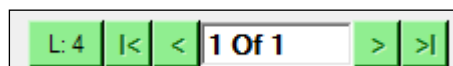


Structure Net Classes



Frequency Dependent Properties

Use the structure browse control to display the structure on each layer and navigate through the structures



Changing parameter values

Clicking the Calculate function yields a value for impedance. Parameters (for example, the dielectric height) may be amended to yield a value for impedance closer to the target impedance.

For this example, select the core layers; click the Swap Selected Material button and choose a different core (ensure the same dimensional units are used throughout the structure) and click the Refresh and Calculate Impedance button. The impedance is recalculated to its new value.

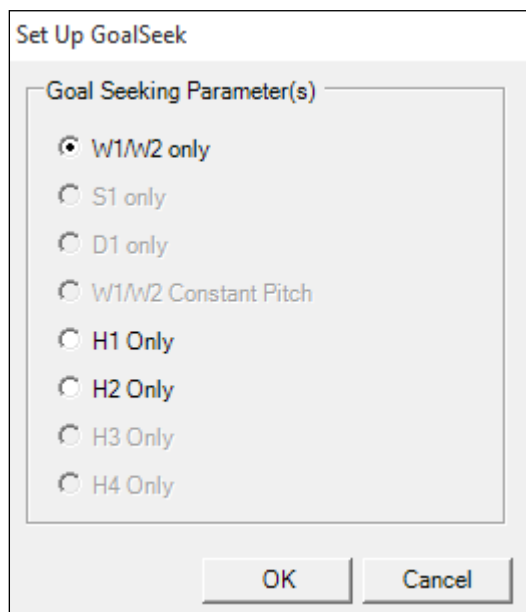
To achieve an impedance acceptably close to the target impedance, use the goal seeking function of the Si8000m to alter other parameters (in this case, change the upper and lower trace widths).

Goal seeking with Speedstack

Speedstack provides the facility to solve for horizontal parameters (e.g. trace width and separation, ground strip separation, etc.) to produce the target impedance (or calculate that the target impedance is unachievable with the current values).



Click the Goal Seek button to display the Set Up GoalSeek dialog; the options available will depend on the controlled impedance structure.



Click OK; the Speedstack attempts to arrive at the target impedance by iteratively modifying the specified parameters. It may be necessary to add or delete prepregs to achieve the target impedance.

Goal seeking with the Si8000m/9000e

Speedstack Stackup Builder is fully integrated with the Si8000m/Si9000e Controlled Impedance Field Solvers. Users can transfer Stackup layer dimensions to the Field Solver, solve for stackup parameters to produce the target impedance (or calculate that the target impedance is unachievable with the current values) then transfer the solved dimensions back to Speedstack.

Ensure the Field Solver is running and that its units match the Speedstack units.



To Field Solver

With the stackup parameters displayed in the Controlled Impedance window, click To Field Solver to transfer the current Speedstack parameters to the Si8000m/Si9000e.



Paste from Speedstack

Switch to the field solver and click the Paste from Speedstack button to load the parameters into the associated field solver fields. The field solver reflects the structure and parameters of that selected in Speedstack.

| | | | Tolerance | Minimum | Maximum | |
|------------------------|-----|--------|-----------|---------|---------|-----------|
| Substrate 1 Height | H1 | 6.0000 | ± 0.0000 | 6.0000 | 6.0000 | Calculate |
| Substrate 1 Dielectric | Er1 | 4.2000 | ± 0.0000 | 4.2000 | 4.2000 | Calculate |
| Substrate 2 Height | H2 | 9.0000 | ± 0.0000 | 9.0000 | 9.0000 | Calculate |
| Substrate 2 Dielectric | Er2 | 4.2000 | ± 0.0000 | 4.2000 | 4.2000 | Calculate |
| Lower Trace Width | W1 | 5.9978 | ± 0.0000 | 5.9978 | 5.9978 | |
| Upper Trace Width | W2 | 5.0136 | ± 0.0000 | 5.0136 | 5.0136 | Calculate |
| Trace Thickness | T1 | 0.7000 | ± 0.0000 | 0.7000 | 0.7000 | Calculate |
| Impedance | Zo | 50.00 | | 50.00 | 50.00 | Calculate |

[More...](#)

For the data shown above seek a final value for impedance of 50 Ohms; H1, Er1 and T1 are fixed, so goal seek on W1,W2.

Click the Upper Trace Width (W2) Calculate button to goal seek on trace width. The field solver returns new values for trace width to produce 50 Ohms final impedance.

| | | | | | | |
|-------------------|----|--------|----------|--------|--------|-----------|
| Lower Trace Width | W1 | 5.9907 | ± 0.0000 | 5.9907 | 5.9907 | |
| Upper Trace Width | W2 | 4.9907 | ± 0.0000 | 4.9907 | 4.9907 | Calculate |



Copy to Speedstack

Click the Copy to Speedstack button, switch to Speedstack and click the From Field Solver button to display the solved parameters for the target impedance.



From Field Solver

Note: it may be necessary to round some dimensions (for example, the dielectric heights) to the nearest practical values and recalculate the impedance.

Changing layer functionality

It is often convenient to base a new design on an existing stackup and then add or remove electrical layers to create the new stack, leaving the previous existing structures intact or to switch between layer types (Signal, Plane, Mixed, Hatched) without removing structures.

Speedstack allows the designer to retain and re-allocate structures when changes are made to the electrical layers of the stackup. This enables reallocation of structures after the following stackup changes:

- Adding foils and/or cores – increasing the layer count

- Deleting foils and/or cores – reducing the layer count

- Moving foils and cores up and down, even beyond another copper layer – maintaining the layer count but, for example, exchanging two different thickness cores within the stackup

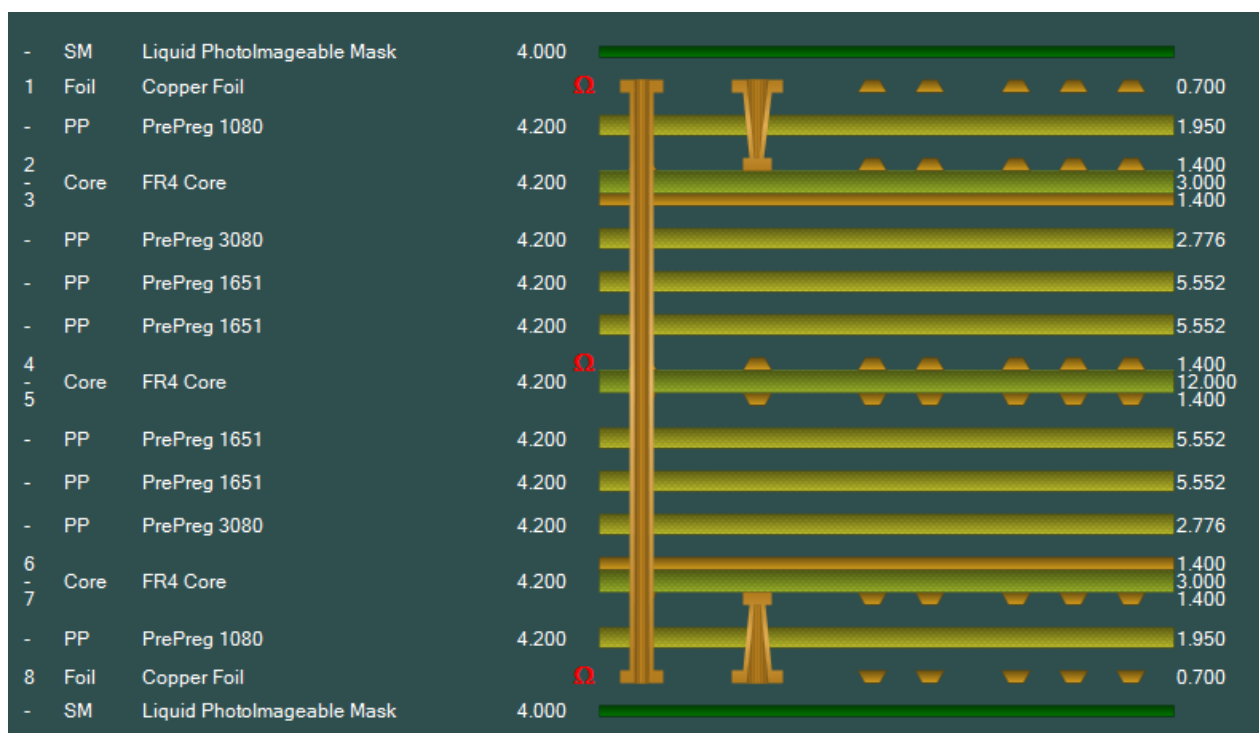
- Copying and pasting foil or core – increasing the layer count

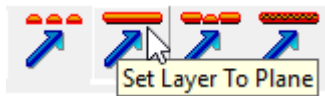
- Changing layer type – signal to plane, plane to signal, mixed to signal or plane, signal to hatch, hatch to signal

- Deleting a rigid core and adding a flex core – to maintain layer count but swapping material type

- Deleting a rigid core and adding two foils – to maintain layer count but switching to an HDI type build

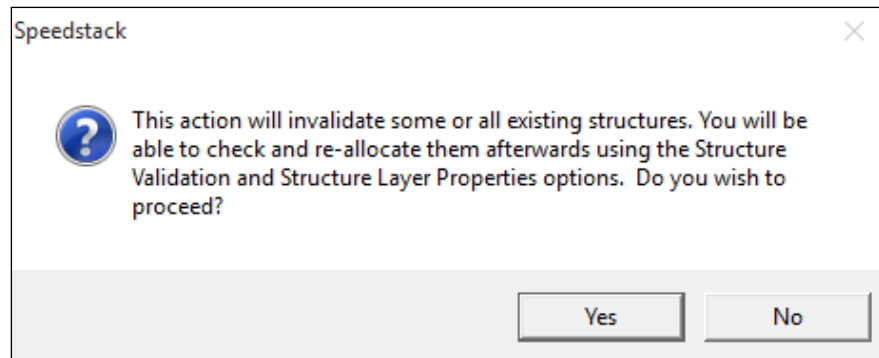
For the following examples, consider the stack below.





Switching layer types and reallocating structures

Switch signal layer 2 to a plane layer and plane layer 3 to a signal layer. Speedstack issues a warning indicating that continuing with the change will require the existing structures to be re-allocated.



Select Yes to confirm the change to the stackup. The stack editor reflects the change in the stackup, layer 2 is a plane layer and layer 3 a signal layer.

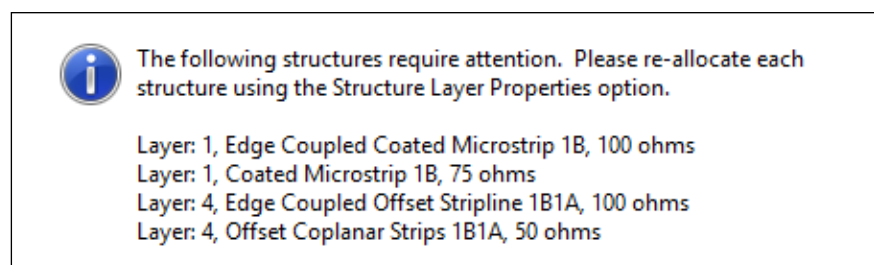
| | | | | | |
|---|------|----------------------------|-------|--|-------|
| - | SM | Liquid Photolmageable Mask | 4.000 | | |
| 1 | Foil | Copper Foil | | | 0.700 |
| - | PP | PrePreg 1080 | 4.200 | | 1.950 |
| 2 | Core | FR4 Core | 4.200 | | 1.400 |
| 3 | | | | | 3.000 |
| | | | | | 1.400 |
| - | PP | PrePreg 3080 | 4.200 | | 2.776 |
| - | PP | PrePreg 1651 | 4.200 | | 5.552 |

Speedstack also displays a flashing Rebuild indicator; due to the changes to the stackup it is necessary to refresh the structures.
















Rebuild and Recalculate

Click the Rebuild and Recalculate icon – Speedstack displays an information dialog indicating which structures need re-allocating.

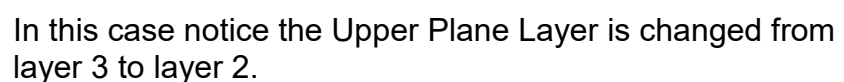


Stack Up Editor | DRC : 3 | Controlled Impedance | CI Results

All | I< | < | **Rebuild** | > | Structure Layer Properties

The New column allows the structure to be re-allocated to reflect the new stackup layer types.



In many cases multiple structures will have the same Signal / Plane layer assignments. In the example above Speedstack indicates that there are two structures affected. Click the Move All check box to re-allocate all matching structures in a single operation then click Apply.



Rebuild and Recalculate

Rebuilding the stack indicates that other structures (i.e. the two structures on layer 4) also require layer reallocation.

| | | | | |
|---|----|--------------|--------------|-------|
| - | PP | PrePreg 1651 | 4.200 | 5.552 |
| 4 | - | Core | FR4 Core | 4.200 |
| 5 | - | PP | PrePreg 1651 | 4.200 |
| - | PP | PrePreg 1651 | 4.200 | 5.552 |



The following structures require attention. Please re-allocate each structure using the Structure Layer Properties option.

Layer: 4, Edge Coupled Offset Stripline 1B1A, 100 ohms
Layer: 4, Offset Coplanar Strips 1B1A, 50 ohms



Structure Layer Properties

Use the structure selection arrow keys to step through to the structures on layer 4 then click Structure Layer Properties.

Structure Layer Properties

Edge Coupled Offset Stripline 1B1A

www.polarinstruments.com

| | Current | New |
|--|---------|--|
| Upper Signal Layer | 4 | 3 |
| Lower Signal Layer | | |
| Upper Plane Layer | 3 | 2 |
| Lower Plane Layer | 6 | 6 |
| Structure Inverted | False | |
| Number of Structures on same Signal / Plane Layers | 2 | <input checked="" type="checkbox"/> Move All |

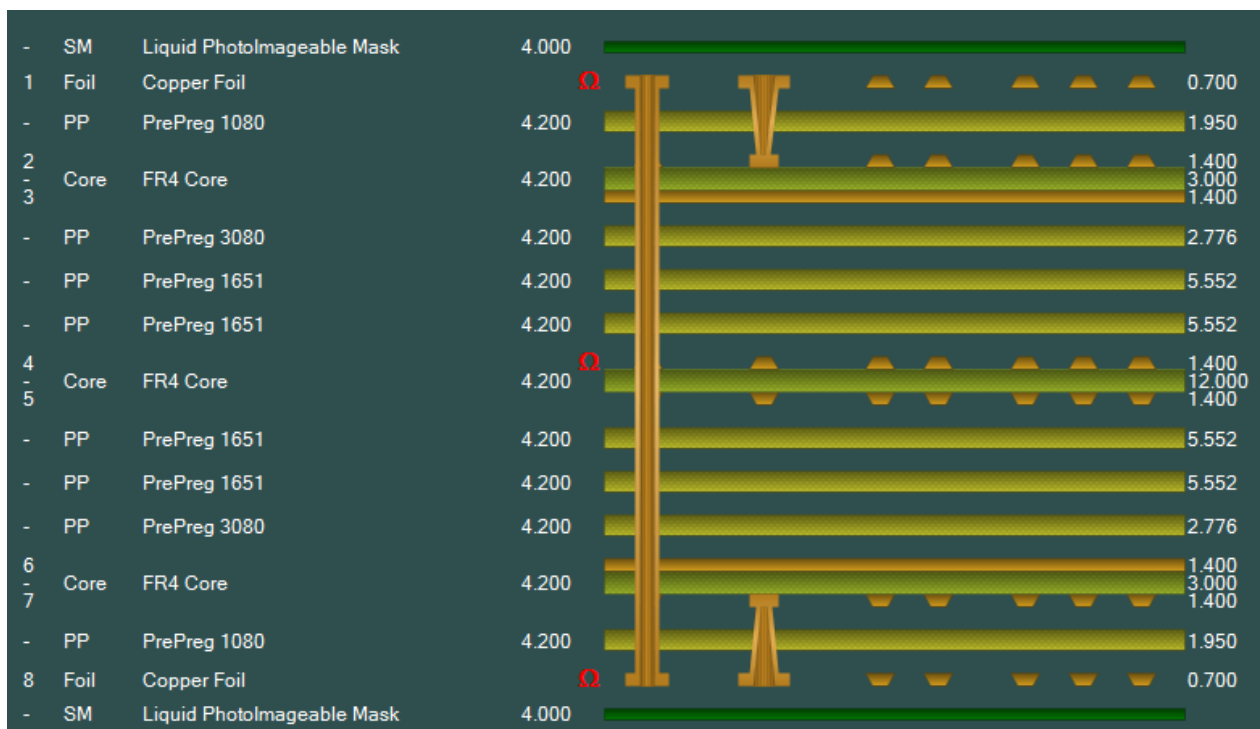
Reallocate the layers as required then click Apply. With the structures re-allocated Rebuild and Calculate the structures as described earlier.

Note that structure Trace Width and Separation parameters are retained at their original values together with the Target Impedance and Tolerance. (Depending upon how the structures have been re-allocated it may be necessary to goal seek the trace width and separation parameters to meet the target impedance.)

Increasing the layer count

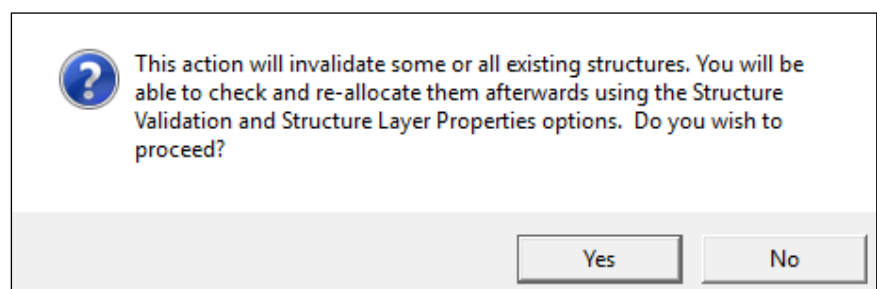
It is a common requirement for designers to base a new design on an existing proven stackup and then add or remove electrical layers to create a new stack, leaving the previous existing structures intact.

Consider the 8 layer stack below.



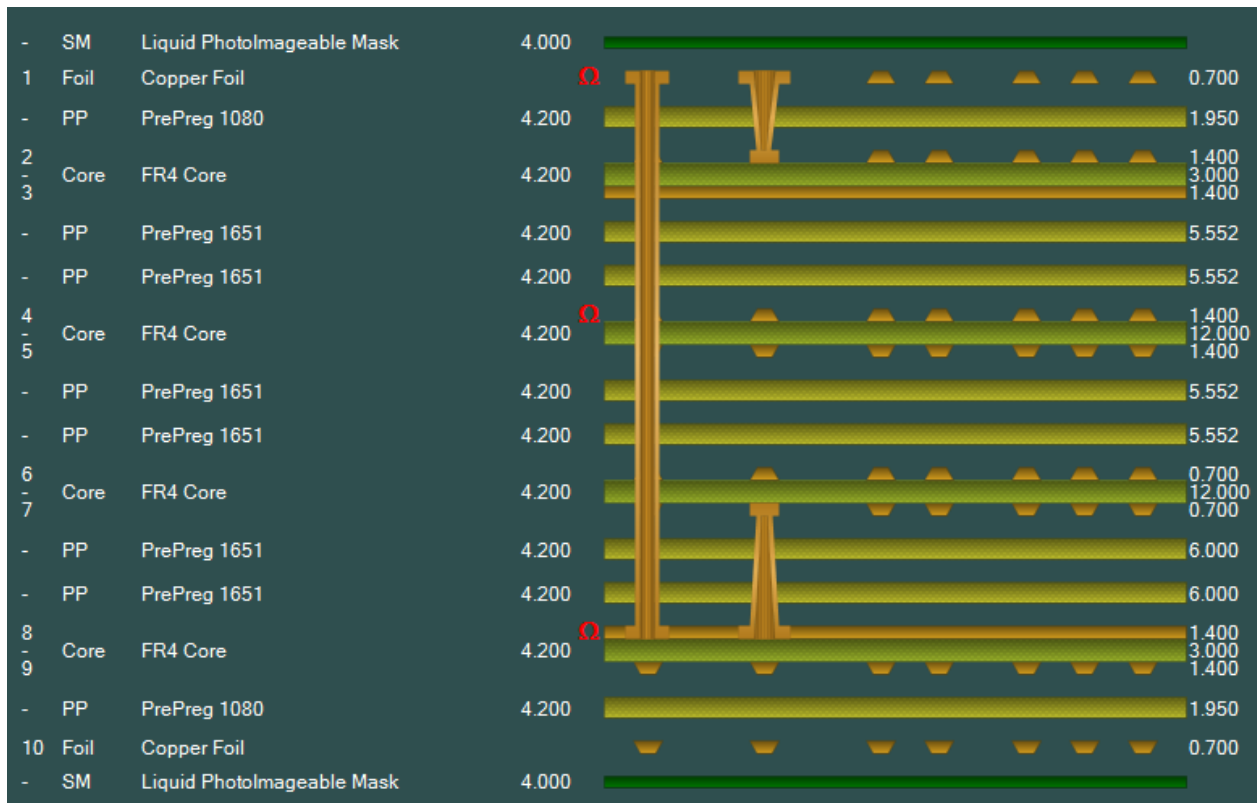
For this example, add a core between layers 5 and 6.

Speedstack will display a warning that proceeding with the change will require the existing structures to be reallocated.



Click Yes to proceed.

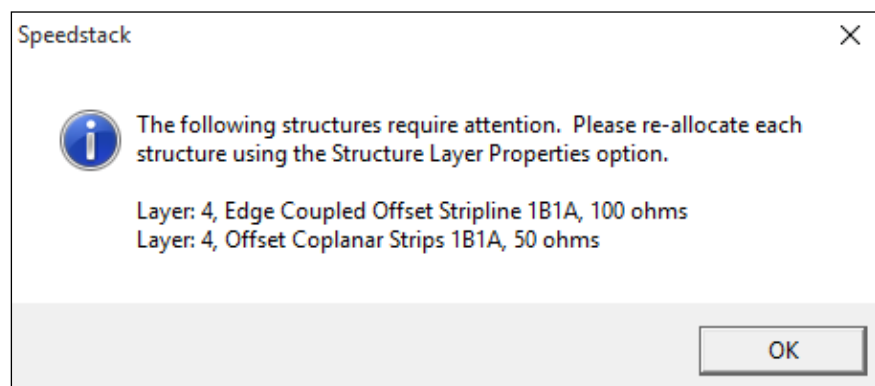
In order to maintain a symmetrical stack, delete the Prepreg 3080 materials and add Prepreg 1651 materials to create a symmetrical 10 layer stack.



Rebuild and Recalculate

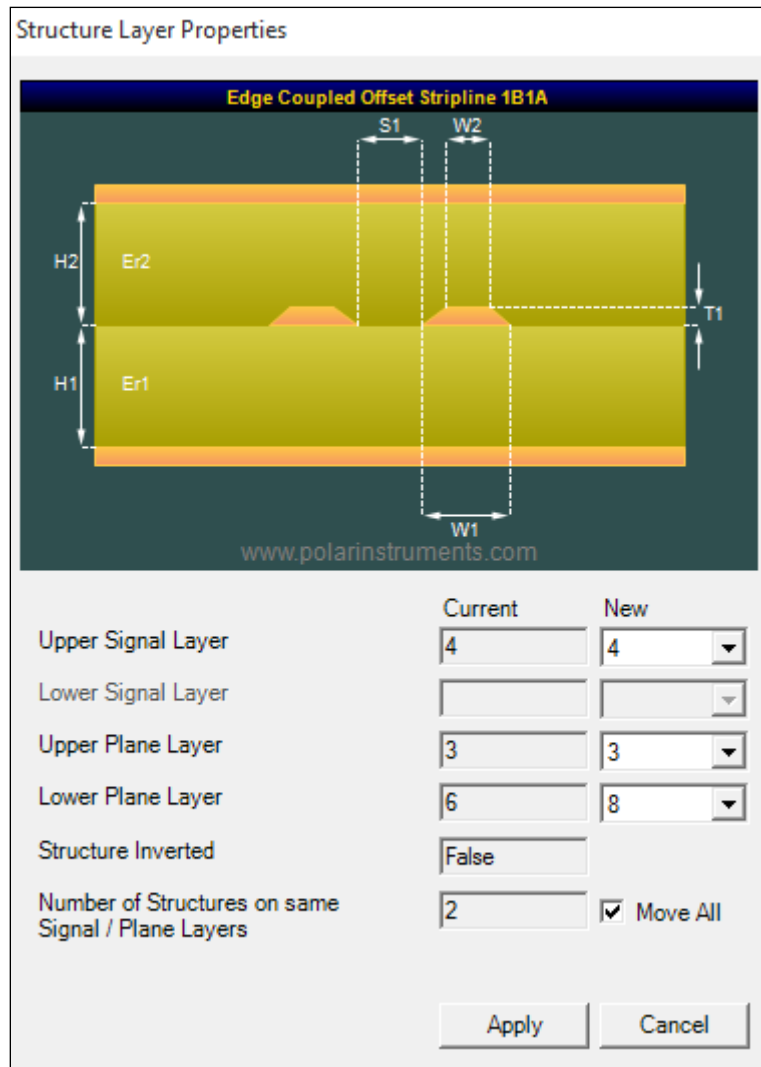
Click Rebuild and Recalculate

Speedstack displays an information dialog indicating the structures that need reallocating.



Click OK.

Use the structure navigation buttons to select the structure layer then click the Structure Layer Properties button to display the Structure Layer Properties dialog.



Note that for the modified stack the lower plane layer has been reallocated to layer 8.

Click Apply and then Rebuild and Recalculate.

If necessary, goal seek on line widths to bring the impedance within specification.

For the above stack edit the Drill Properties to finalise the stack changes.

Repeat the procedure for each structure as necessary.

Structure net classes

Speedstack allows up to five Net Class names to be stored with each structure. These net class names provide a link to the matching impedance nets inside the ECAD PCB layout system. Net classes are supported in Speedstack's import / export file formats.

Net class columns can be selected for display on the technical report.



Net classes

To display the Structure Net Classes dialog click the Net Classes button

Enter the net class names in the text boxes and click Apply.

Structure Net Classes

Net Class 1: TX0

Net Class 2: TX1

Net Class 3: RX0

Net Class 4: RX1

Net Class 5:

Buttons: Apply, Cancel

Up to five net class names may be stored with each structure.



Select Impedance Columns

Click the Select Impedance Columns button and Select the Net Class columns to display the net classes on the Speedstack technical report.

Select Controlled Impedance Table Columns

Selected Columns:

- Impedance Signal Layer
- Ref. Plane 1 in Layer
- Ref. Plane 2 in Layer
- Lower Trace Width (W1)
- Upper Trace Width (W2)
- Trace Separation (S1)
- Target Impedance
- Tol (+/- %)
- Calculated Impedance
- NetClass1
- NetClass2
- NetClass3
- NetClass4
- NetClass5

Available Columns:

- Structure Name
- Broadside 2nd Layer
- Trace Pitch (S1+ W1)
- Lower Ground Strip Width (G1)
- Upper Ground Strip Width (G2)
- Trace Offset (O1)
- Ground Strip Separation (D1)
- Substrate 1 Height (H1)
- Substrate 2 Height (H2)
- Substrate 3 Height (H3)
- Substrate 4 Height (H4)
- Substrate 1 Dielectric (Er1)
- Substrate 2 Dielectric (Er2)
- Substrate 3 Dielectric (Er3)

Buttons: <, <<, Up, Down, Delete, Clear All, OK, Cancel

The chosen columns are displayed in the selected order.

| Impedance ID | Structure Image | Impedance Signal Layer | Ref. Plane 1 in Layer | Ref. Plane 2 in Layer | Lower Trace Width (W1) | Upper Trace Width (W2) | Trace Separation (S1) | Target Impedance | Tol (+/- %) | Calculated Impedance | NetClass1 | NetClass2 | NetClass3 | NetClass4 | NetClass5 |
|--------------|-----------------|------------------------|-----------------------|-----------------------|------------------------|------------------------|-----------------------|------------------|-------------|----------------------|-----------|-----------|-----------|-----------|-----------|
| 1 | | 1 | 3 | 0 | 8.224 | 7.224 | 8.391 | 100.000 | 10.000 | 99.930 | TX0 | TX1 | RX0 | RX1 | |

Working with Si Projects in Speedstack and Si8000m/Si9000e

Si Projects

The Si Projects feature incorporated in Speedstack and Si8000m/Si9000e allows for easy transfer of controlled impedance structures from the Speedstack stackup design tool into the Si8000m and Si9000e field solvers.

Si Projects allows groups of structures to be saved and recalled in Si8000m/Si9000e and entire stackups of structures to be pasted from Speedstack into Si8000m and Si9000e with just a few clicks of the mouse.



To Si Project

The To Si Project toolbar icon copies a group of structures from Speedstack and places them onto the clipboard, these structures can then be pasted directly into the Si8000m or Si9000e Project group

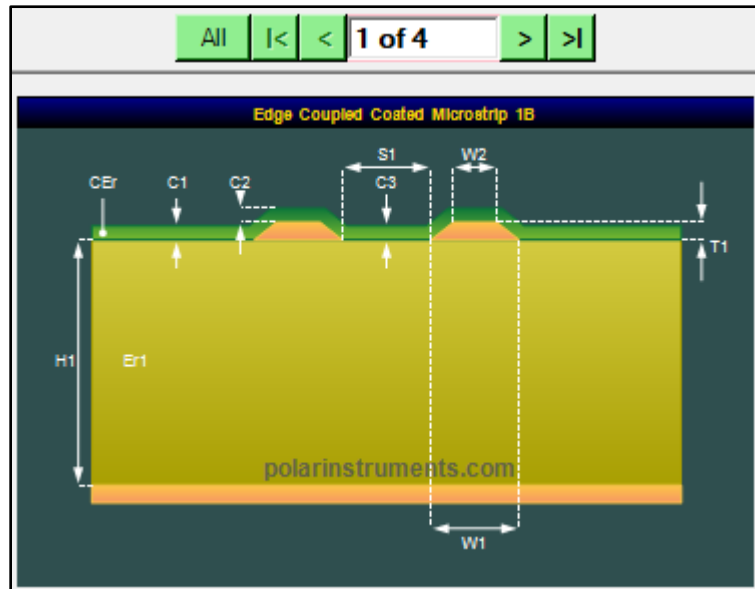
Transferring structures from Speedstack to the field solver



The stackup below in Speedstack's Stackup Editor contains controlled impedance structures in the layers indicated by the Ohms symbol.

| | | | | |
|---|------|-----------------------------|--------|---|
| - | SM | Liquid PhotolImageable Mask | 4.000 | |
| 1 | Foil | Copper Foil | 0.700 | Ω |
| - | PP | PrePreg 1080 | 1.950 | |
| 2 | | | | |
| - | Core | FR4 Core | 1.400 | |
| 3 | | | 3.000 | |
| - | PP | PrePreg 3080 | 2.776 | |
| - | PP | PrePreg 1651 | 5.552 | |
| - | PP | PrePreg 1651 | 5.552 | |
| 4 | | | | Ω |
| - | Core | FR4 Core | 1.400 | |
| 5 | | | 12.000 | |
| - | PP | PrePreg 1651 | 5.552 | |
| - | PP | PrePreg 1651 | 5.552 | |
| - | PP | PrePreg 3080 | 2.776 | |
| 6 | | | | |
| - | Core | FR4 Core | 1.400 | |
| 7 | | | 3.000 | |
| - | PP | PrePreg 1080 | 1.950 | |
| 8 | Foil | Copper Foil | 0.700 | Ω |
| - | SM | Liquid PhotolImageable Mask | 4.000 | |

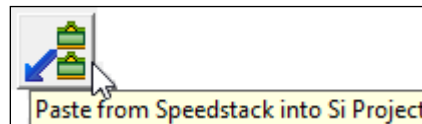
Click Speedstack's Controlled Impedance tab and use the structure navigation controls to step through and display the structures.



To Si Project

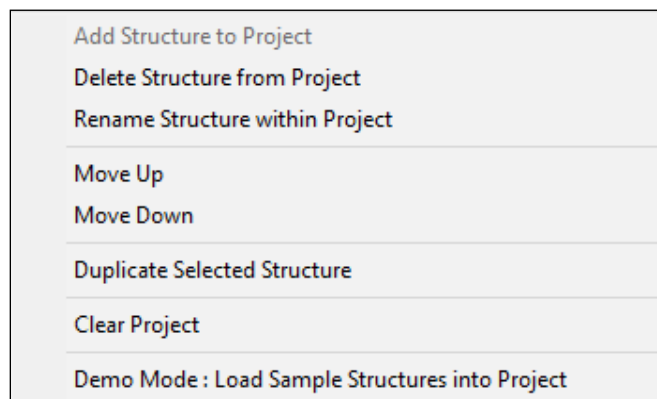
Use the Si Project toolbar buttons in the Speedstack and the Si8000m/Si9000e interface to transfer the structures via the Windows clipboard to the field solver.

Switch to the field solver and paste the structures from the clip board into the field solver Si project.



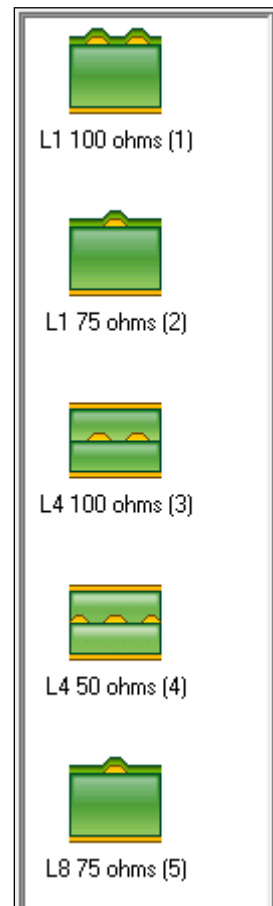
The complete set of structures appears in the field solver's Project window.

The Si Project window lists the transferred structures in layer order, showing the layer number and value along with a thumb nail graphic indicating the structure configuration. Right click on a structure in the structure list to view the structure options.

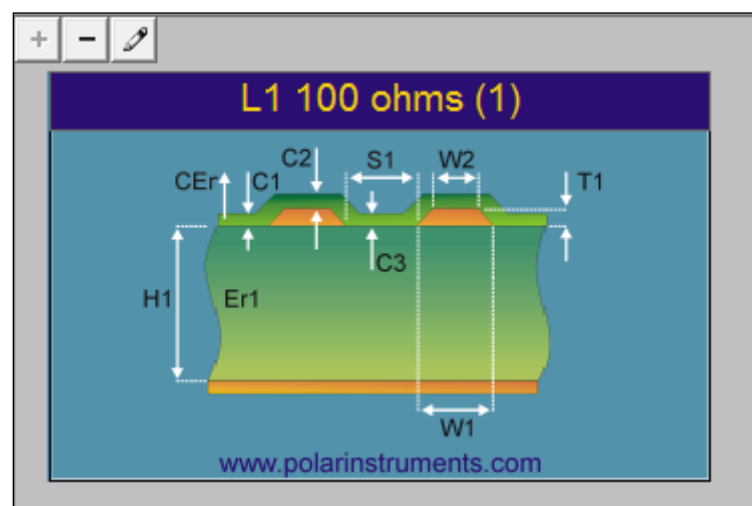


Adding/deleting and modifying structures

Selecting each structure displays its associated graphic in a grey background.



Click the + and – buttons in the structure graphic to add additional structures from the Si structure library or remove selected structures from the Project folder. Click the Rename Structure (the pencil icon) to assign the structure a descriptive name.



With a structure selected the structure parameters can be modified as required and the impedance recalculated.

Frequency dependent loss calculations (Speedstack Si only)

Note: Frequency dependent loss calculations are available in Speedstack only when used in conjunction with the Si9000e Transmission Line Field Solver.

Speedstack Si (Speedstack stackup builder plus Si9000e transmission line field solver) provides for calculations of frequency dependent loss given the information applicable to loss in the transmission line structure. The information includes material properties, comprising dielectric constant and loss tangent, conductor properties such as trace conductivity and surface roughness and the frequency range over which the transmission line structure will operate

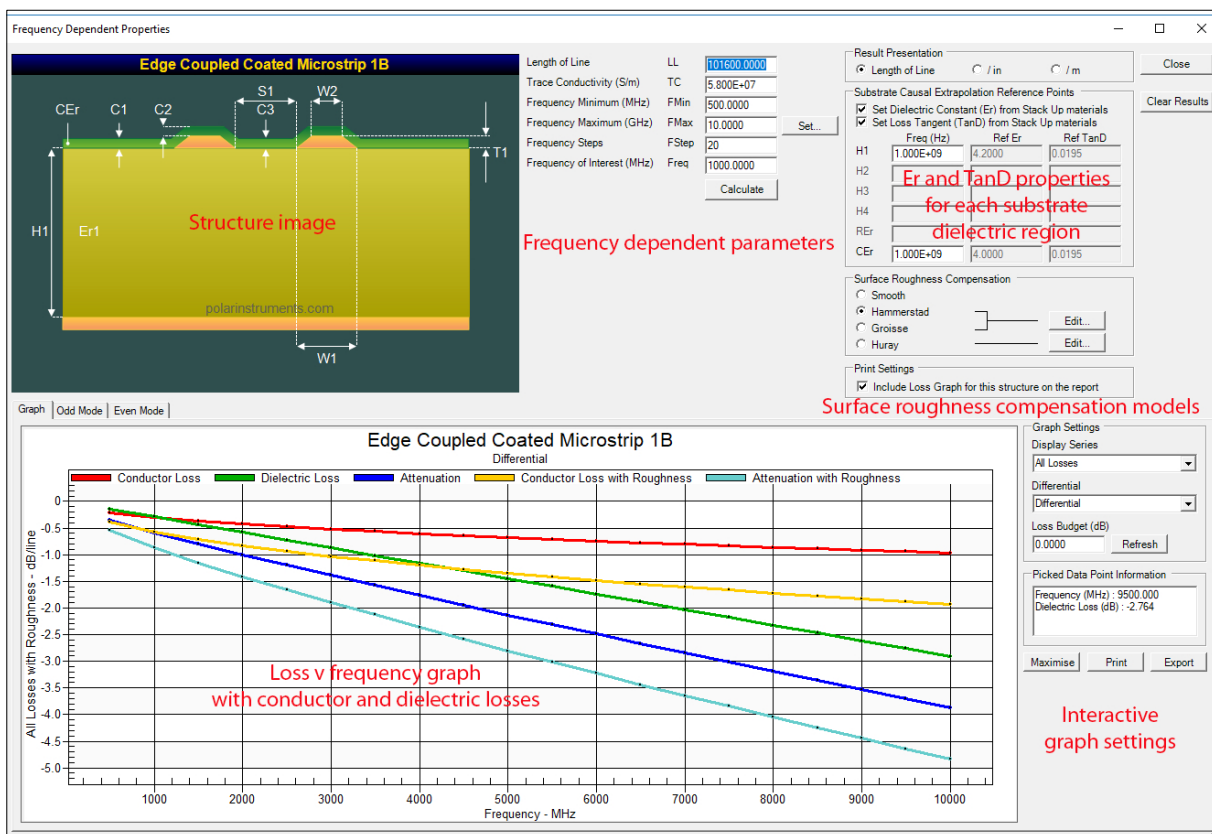
Graphing against frequency is provided for impedance magnitude, conductor loss and dielectric loss (with or without roughness compensation,) inductance, capacitance, resistance, conductance and skin depth. Graphing for differential structures include differential, odd and even modes.



Frequency Dependent Properties

Each structure in the stack includes a set of frequency dependent properties.

Click the Frequency Dependent Properties icon to load the Frequency Dependent Properties dialog.



The Frequency Dependent Properties dialog includes:

the structure image of the selected structure

frequency dependent parameters for the user defined frequency range and *frequency of interest*

a table of substrate causal extrapolation reference points for each substrate dielectric/region

surface roughness compensation model selection between Hammerstad, Grosse and Cannonball-Huray methods

the loss v frequency graph showing the data series for conductor and dielectric losses and total attenuation

interactive graph setting with data point selection allowing drilling down to the underlying loss data

data tables for the selected frequency range

| Graph Odd Mode Even Mode | | | | | | | | | | | | | | |
|--------------------------|-----------------|---------------------------|--------------------------------|--------------------------------|----------------------|-------------------------|-----------------------|-----------------------|---------------------|------------------------------|-------------------------------|------------------------|--|---|
| | Frequency Hz | Impedance Real Ohms | Impedance Imaginary Ohms | Impedance Magnitude Ohms | Inductance H/line | Resistance Ohms/line | Capacitance F/line | Conductance S/line | Skin Depth in | Conductor Loss dB/line | Dielectric Loss dB/line | Attenuation dB/line | Conductor Loss With Roughness dB/line | Attenuation With Roughness dB/line |
| ▶ | 5.000E+08 | 5.049E+01 | -2.190E-01 | 5.049E+01 | 3.084E-08 | 2.518E+00 | 1.210E-11 | 6.579E-04 | 1.164E-04 | -2.166E-01 | -1.442E-01 | -3.608E-01 | -4.004E-01 | -5.446E-01 |
| | 1.000E+09 | 5.048E+01 | -2.527E-02 | 5.048E+01 | 3.060E-08 | 3.547E+00 | 1.201E-11 | 1.316E-03 | 8.228E-05 | -3.051E-01 | -2.885E-01 | -5.936E-01 | -5.868E-01 | -8.753E-01 |
| | 1.500E+09 | 5.051E+01 | 6.176E-02 | 5.051E+01 | 3.050E-08 | 4.334E+00 | 1.195E-11 | 1.974E-03 | 6.718E-05 | -3.726E-01 | -4.331E-01 | -8.057E-01 | -7.261E-01 | -1.159E+00 |
| | 2.000E+09 | 5.054E+01 | 1.140E-01 | 5.054E+01 | 3.044E-08 | 4.998E+00 | 1.192E-11 | 2.633E-03 | 5.818E-05 | -4.295E-01 | -5.778E-01 | -1.007E+00 | -8.425E-01 | -1.420E+00 |
| | 2.500E+09 | 5.056E+01 | 1.499E-01 | 5.056E+01 | 3.039E-08 | 5.583E+00 | 1.189E-11 | 3.291E-03 | 5.204E-05 | -4.795E-01 | -7.227E-01 | -1.202E+00 | -9.443E-01 | -1.667E+00 |
| | 3.000E+09 | 5.059E+01 | 1.765E-01 | 5.059E+01 | 3.036E-08 | 6.112E+00 | 1.186E-11 | 3.950E-03 | 4.750E-05 | -5.247E-01 | -8.677E-01 | -1.392E+00 | -1.036E+00 | -1.904E+00 |
| | 3.500E+09 | 5.061E+01 | 1.974E-01 | 5.061E+01 | 3.034E-08 | 6.598E+00 | 1.184E-11 | 4.608E-03 | 4.398E-05 | -5.662E-01 | -1.013E+00 | -1.579E+00 | -1.120E+00 | -2.133E+00 |
| | 4.000E+09 | 5.063E+01 | 2.143E-01 | 5.063E+01 | 3.032E-08 | 7.051E+00 | 1.183E-11 | 5.267E-03 | 4.114E-05 | -6.048E-01 | -1.158E+00 | -1.763E+00 | -1.198E+00 | -2.356E+00 |
| | 4.500E+09 | 5.065E+01 | 2.255E-01 | 5.065E+01 | 3.031E-08 | 7.572E+00 | 1.181E-11 | 5.925E-03 | 3.879E-05 | -6.492E-01 | -1.303E+00 | -1.953E+00 | -1.287E+00 | -2.591E+00 |
| | 5.000E+09 | 5.067E+01 | 2.374E-01 | 5.067E+01 | 3.029E-08 | 7.985E+00 | 1.180E-11 | 6.584E-03 | 3.679E-05 | -6.843E-01 | -1.449E+00 | -2.133E+00 | -1.358E+00 | -2.807E+00 |
| | 5.500E+09 | 5.069E+01 | 2.478E-01 | 5.069E+01 | 3.028E-08 | 8.378E+00 | 1.178E-11 | 7.242E-03 | 3.508E-05 | -7.178E-01 | -1.594E+00 | -2.312E+00 | -1.425E+00 | -3.020E+00 |
| | 6.000E+09 | 5.070E+01 | 2.568E-01 | 5.070E+01 | 3.027E-08 | 8.753E+00 | 1.177E-11 | 7.901E-03 | 3.359E-05 | -7.497E-01 | -1.740E+00 | -2.490E+00 | -1.490E+00 | -3.230E+00 |
| | 6.500E+09 | 5.072E+01 | 2.648E-01 | 5.072E+01 | 3.026E-08 | 9.114E+00 | 1.176E-11 | 8.559E-03 | 3.227E-05 | -7.804E-01 | -1.885E+00 | -2.666E+00 | -1.551E+00 | -3.437E+00 |
| | 7.000E+09 | 5.073E+01 | 2.718E-01 | 5.073E+01 | 3.025E-08 | 9.461E+00 | 1.175E-11 | 9.219E-03 | 3.110E-05 | -8.086E-01 | -2.031E+00 | -2.841E+00 | -1.611E+00 | -3.647E+00 |

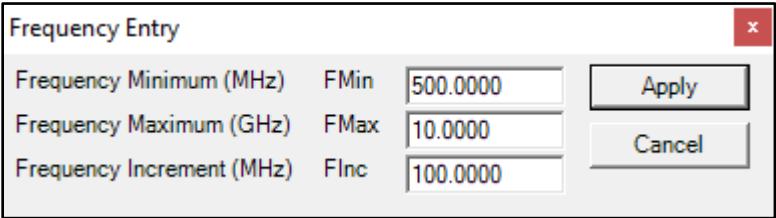
Frequency dependent parameters

Speedstack Si runs a detailed analysis of the transmission line structure for controlled impedance and insertion loss. Each structure in Speedstack can store a complete set of frequency dependent parameters: Length of Lines, Frequency Minimum, Frequency Maximum, Frequency Steps, substrate data, surface roughness and loss budget. Supply the values in the dialog below.

| | | | |
|--|-------|--|---------------------------------------|
| Length of Line | LL | <input type="text" value="4000.0000"/> | <input type="button" value="Set..."/> |
| Trace Conductivity (S/m) | TC | <input type="text" value="5.800E+07"/> | |
| Frequency Minimum (MHz) | FMin | <input type="text" value="500.0000"/> | |
| Frequency Maximum (GHz) | FMax | <input type="text" value="10.0000"/> | |
| Frequency Steps | FStep | <input type="text" value="20"/> | |
| Frequency of Interest (MHz) | Freq | <input type="text" value="5000.0000"/> | |
| <input type="button" value="Calculate"/> | | | |

Specify the line length and trace conductivity along with the frequency range and *frequency of interest*.

To specify the frequency range click the Set... button and enter the minimum frequency (in MHz) and maximum frequency (in GHz); specify the frequency increment (in MHz) then click Apply.



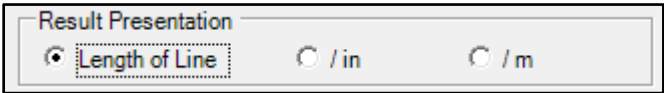
The 'Frequency Entry' dialog box contains three input fields: 'Frequency Minimum (MHz)' with 'FMin' and a value of '500.0000', 'Frequency Maximum (GHz)' with 'FMax' and a value of '10.0000', and 'Frequency Increment (MHz)' with 'FInc' and a value of '100.0000'. There are 'Apply' and 'Cancel' buttons on the right.

With all parameters entered, click Calculate. Results are displayed in graphical and tabular form.

To provide for applications where the insertion loss requirements or loss budget specifications are needed for a given frequency the results for the specified frequency of interest are highlighted in green in the table of data.

Presentation of results

Use the Result Presentation dialog to choose units in which to present plots and tables of results.



The 'Result Presentation' dialog box has three radio buttons: 'Length of Line' (which is selected), '/ in', and '/ m'.

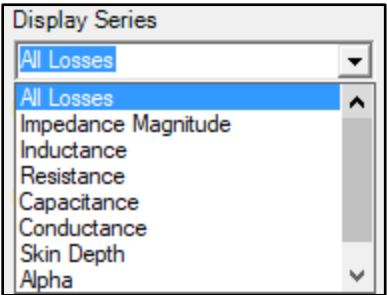
The graphs are able to display results in dB/line length, dB/inch or dB/metre.

Click the unit of choice and click Calculate to refresh the graphical display of data.

Graph settings

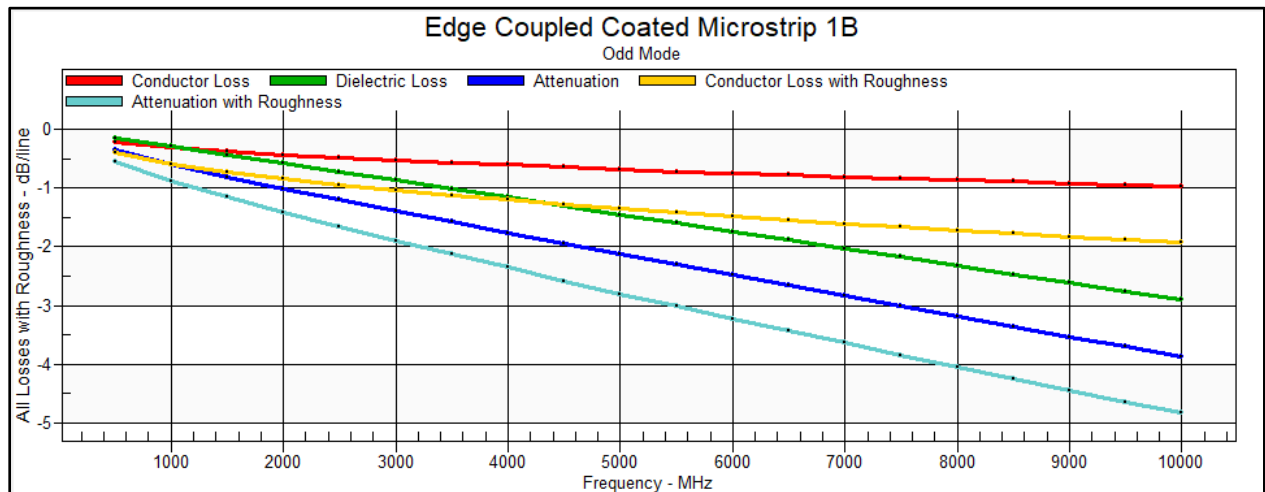
Use the Graph Settings dialog to choose the display series.

Speedstack Si graphs All Losses – conductor loss, dielectric loss and total attenuation.



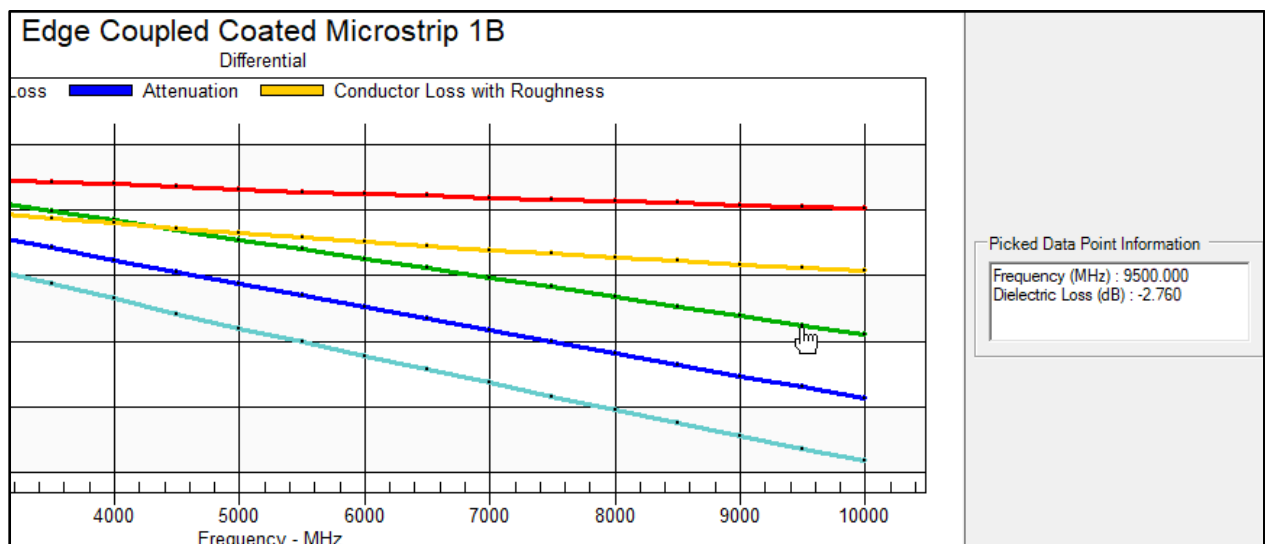
The 'Display Series' dialog box shows a list of options: 'All Losses' (selected), 'All Losses', 'Impedance Magnitude', 'Inductance', 'Resistance', 'Capacitance', 'Conductance', 'Skin Depth', and 'Alpha'.

If roughness compensation is applied the data series conductor loss with roughness and attenuation with roughness are added to the graph.

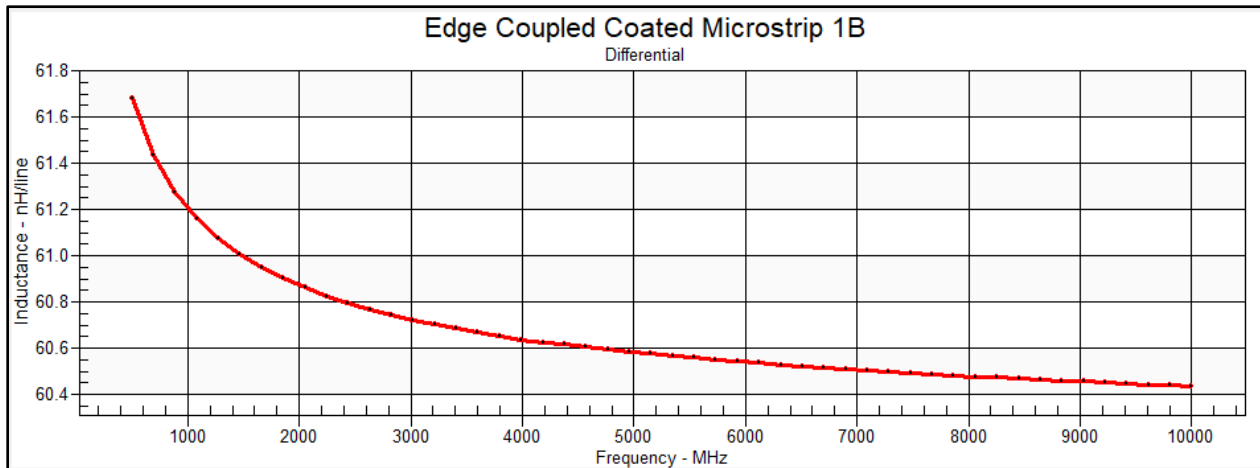


All losses with roughness

Speedstack charts are interactive. Click on a point on the data series of interest to display the data point value in the Picked Data Point Information text box



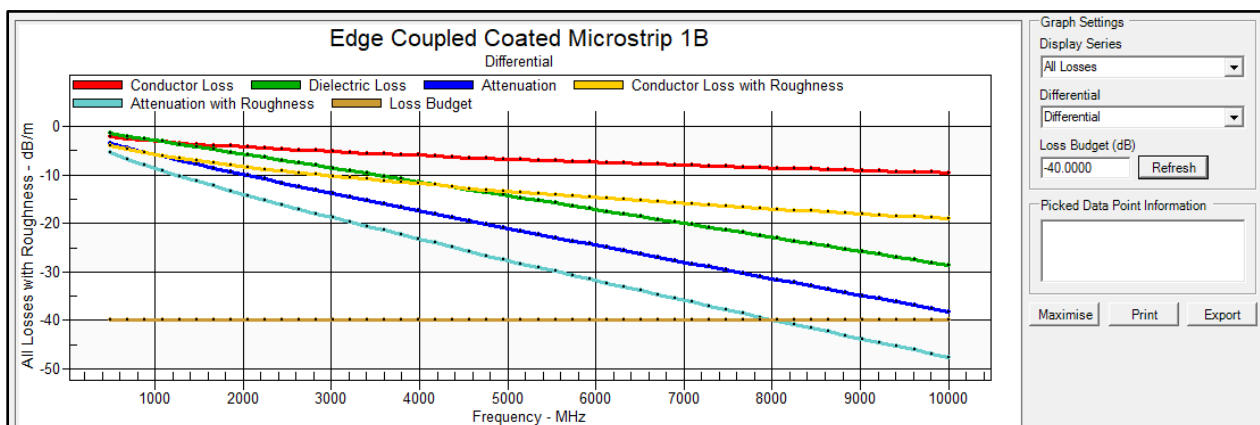
The range of data series includes losses, impedance magnitude, inductance, capacitance and skin depth: Choose the data series from the Display Series drop down.



Graph of inductance v frequency

Displaying the loss budget

A value for loss budget can be added to a graph. A loss budget line will allow losses that exceed the budget to be easily identified.



The plot above indicates that the loss budget is exceeded by the total attenuation (cyan) beyond 8000MHz (8GHz.)

Setting the Loss Budget stores the value with the structure for future use. This would prove useful if the stack up is changed and it is necessary to ensure that the structure still meets the loss requirements after the changes.

Material and surface roughness properties

The Speedstack graph above charts all losses, the dielectric loss and the significant increase in the overall loss due to surface roughness, allowing the materials supplier to isolate the contributions of the different loss mechanisms.

Dielectric loss

In order accurately to calculate dielectric loss it is necessary to understand the material / substrate properties.

Speedstack Si allows substrate properties including dielectric constant (Er) and loss tangent (TanD) to be specified for each structure substrate region.

| Substrate Causal Extrapolation Reference Points | | | |
|---|-----------|--------|----------|
| <input checked="" type="checkbox"/> Set Dielectric Constant (Er) from Stack Up materials <input checked="" type="checkbox"/> Set Loss Tangent (TanD) from Stack Up materials | | | |
| | Freq (Hz) | Ref Er | Ref TanD |
| H1 | 1.000E+09 | 4.2000 | 0.0195 |
| H2 | | | |
| H3 | | | |
| H4 | | | |
| REr | | | |
| CEr | 1.000E+09 | 4.0000 | 0.0195 |

Speedstack Si causally extrapolates Er and TanD over the specified frequency range using a single value of Er and TanD to enable Svensson-Djordjevic frequency dependent permittivity modelling for each dielectric layer in the current controlled impedance structure. The table above therefore provides the ability to specify the extrapolation reference points for each substrate region; the reference point data is usually available from the material supplier data sheets. The values of Er and TanD can, optionally, be derived from the materials in the stack. (See the Polar Application Note [AP8184](#) or the Si9000e User Guide for a more detailed discussion of causally extrapolating substrate data.)

The fields shown active in the table in the dialog reflect the structure selected; inapplicable fields are shown greyed out.

The fields shown above allow values to be specified for the frequency of interest, the dielectric constant, Er, and loss tangent, TanD for the prepreg dielectric and the coating. Enter the parameters and click Calculate to refresh results.

Conductor losses – surface roughness compensation

In order to provide good adhesion between copper and dielectric materials in core layers PCB materials vendors control the roughness of the associated copper layers (typically by chemical treatment). Speedstack Si provides industry standard methods of compensation for surface roughness in frequency dependent calculations; the compensation methods include:

- Smooth copper, (no compensation for Cu loss at all)
- Hammerstad modelling
- Groisse modelling
- Huray modelling

Speedstack charts dielectric losses along with conductor losses and attenuation values that optionally include compensation for surface roughness. Roughness is a random quantity and is commonly specified in terms of the rms (root mean square) height h of the surface unevenness for the Hammerstad and Grosse compensation methods. Huray modeling is based on a non-uniform distribution of stacked copper nodules shapes resembling “snowballs”.

Surface roughness compensation methods

Accurate calculation of conductor loss requires the surface roughness parameters for each method:

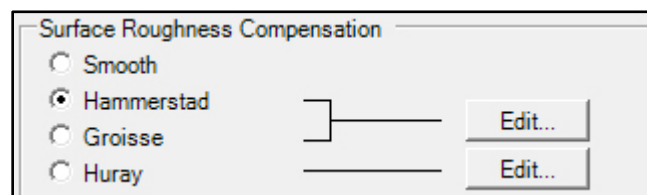
The Smooth copper option provides for no compensation for copper loss.

Hammerstad modelling is a proven technique that has stood the test of time but has practical limitations when used over 4GHz as the model tends to saturate.

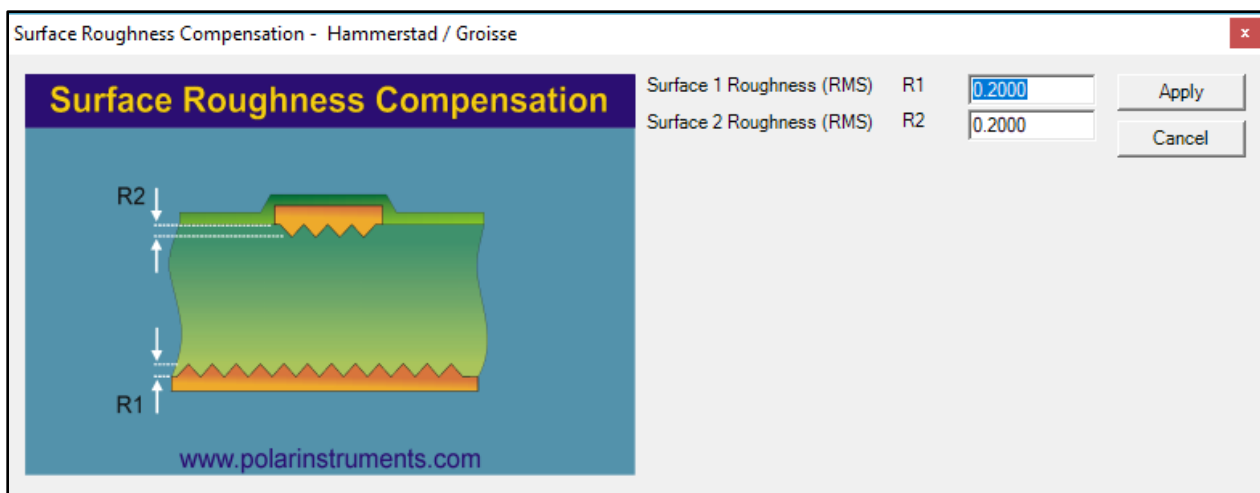
Grosse modeling can, with care, be used to extend the modelling up to 7 to 10 GHz before saturation in the model blunts its accuracy.

Hammerstad/Grosse methods

To specify the roughness parameters for the Hammerstad or Grosse methods, click the option button for the method:



Click the Hammerstad/Grosse Edit button.

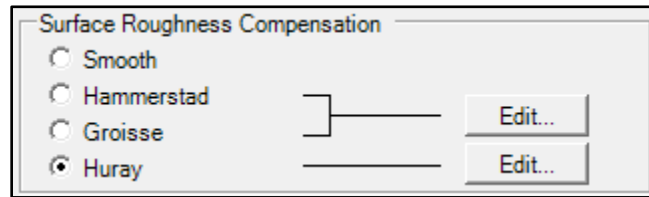


Enter the values for roughness in the R1 and R2 fields and click Apply. Click Calculate to refresh results.

Huray method

Huray modelling extends the roughness modeling validity up to 40 to 50GHz (and possibly beyond).

Click the Huray option button:



Surface Roughness Compensation

☐ Smooth

☐ Hammerstad

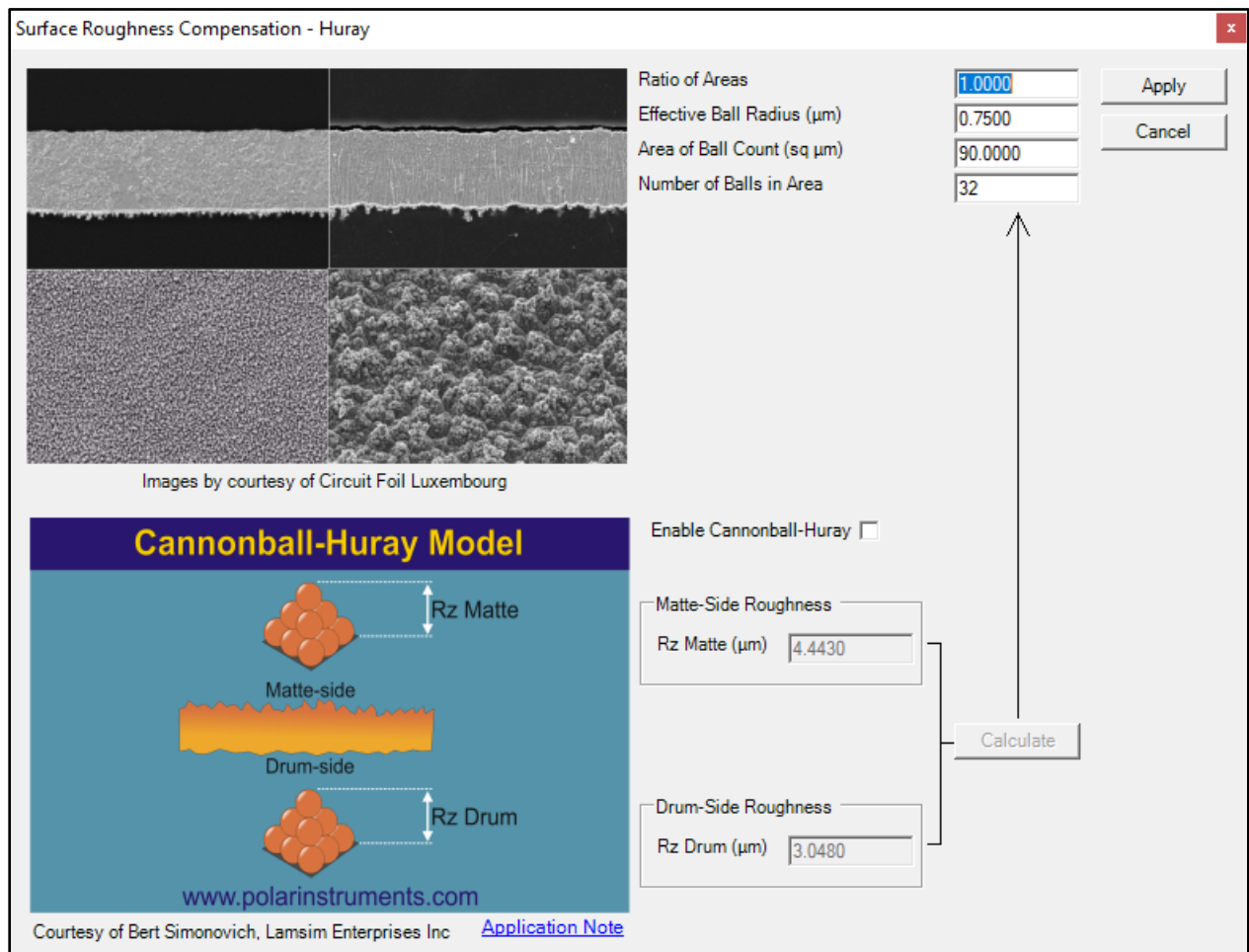
☐ Grosse

☒ Huray

_____ Edit...

_____ Edit...

Click the Huray Edit button and specify the parameters for the Huray spheres (snowballs.)



Surface Roughness Compensation - Huray

Images by courtesy of Circuit Foil Luxembourg

Ratio of Areas: 1.0000

Effective Ball Radius (μm): 0.7500

Area of Ball Count ($\text{sq } \mu\text{m}$): 90.0000

Number of Balls in Area: 32

Apply

Cancel

Enable Cannonball-Huray ☐

Matte-Side Roughness

Rz Matte (μm): 4.4430

Drum-Side Roughness

Rz Drum (μm): 3.0480

Calculate

Cannonball-Huray Model

Rz Matte

Matte-side

Drum-side

Rz Drum

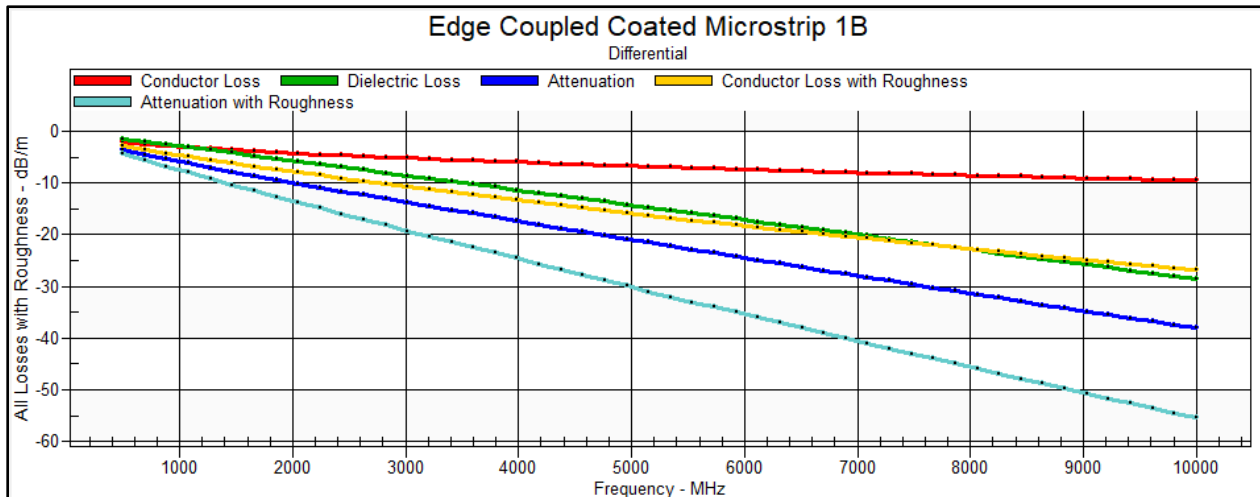
www.polarinstruments.com

Courtesy of Bert Simonovich, Lamsim Enterprises Inc [Application Note](#)

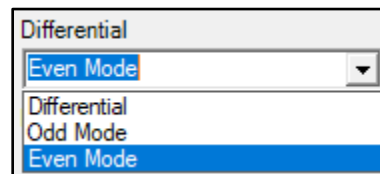
Supply the values in the associated fields and click Apply.

If the Huray values are not available, click Enable Cannonball-Huray and supply the Rz values for matte and drum side roughness and click Calculate to populate the Huray fields, then click Apply.

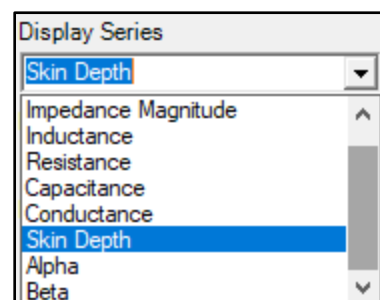
Click the Application Note link to access the paper *Practical Modeling of High-speed Channels Based on Data Sheet Input* (Bert Simonovich, LamSim Enterprises Inc.) which includes a description of roughness modelling using the Cannonball-Huray Model.



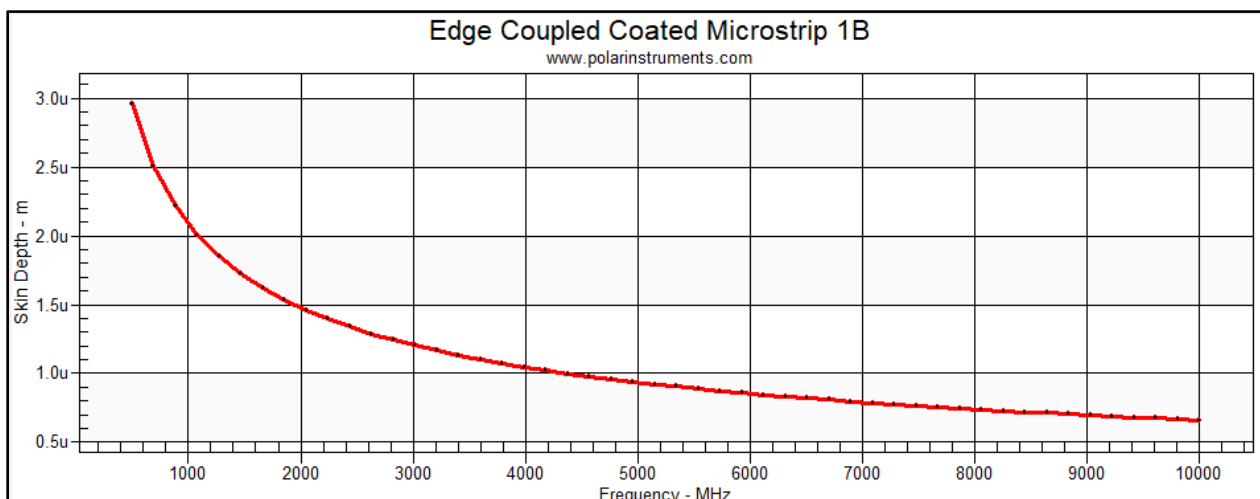
Speedstack charts a range of data series, including losses, impedance magnitude, inductance, resistance, capacitance and conductance; for differential structures select the transmission line mode, differential, odd or even mode.



Click on the Display Series drop down to select the data to be charted.



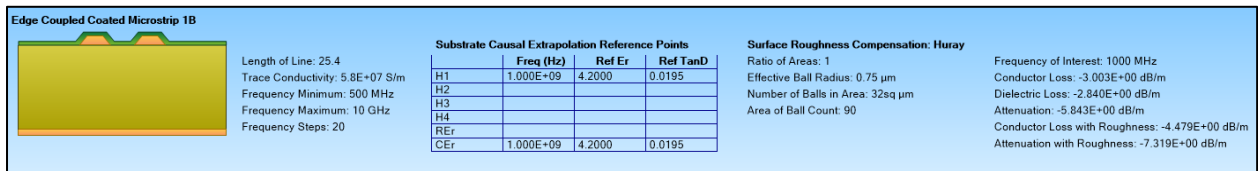
The chart below displays skin depth v frequency



Printing the technical report

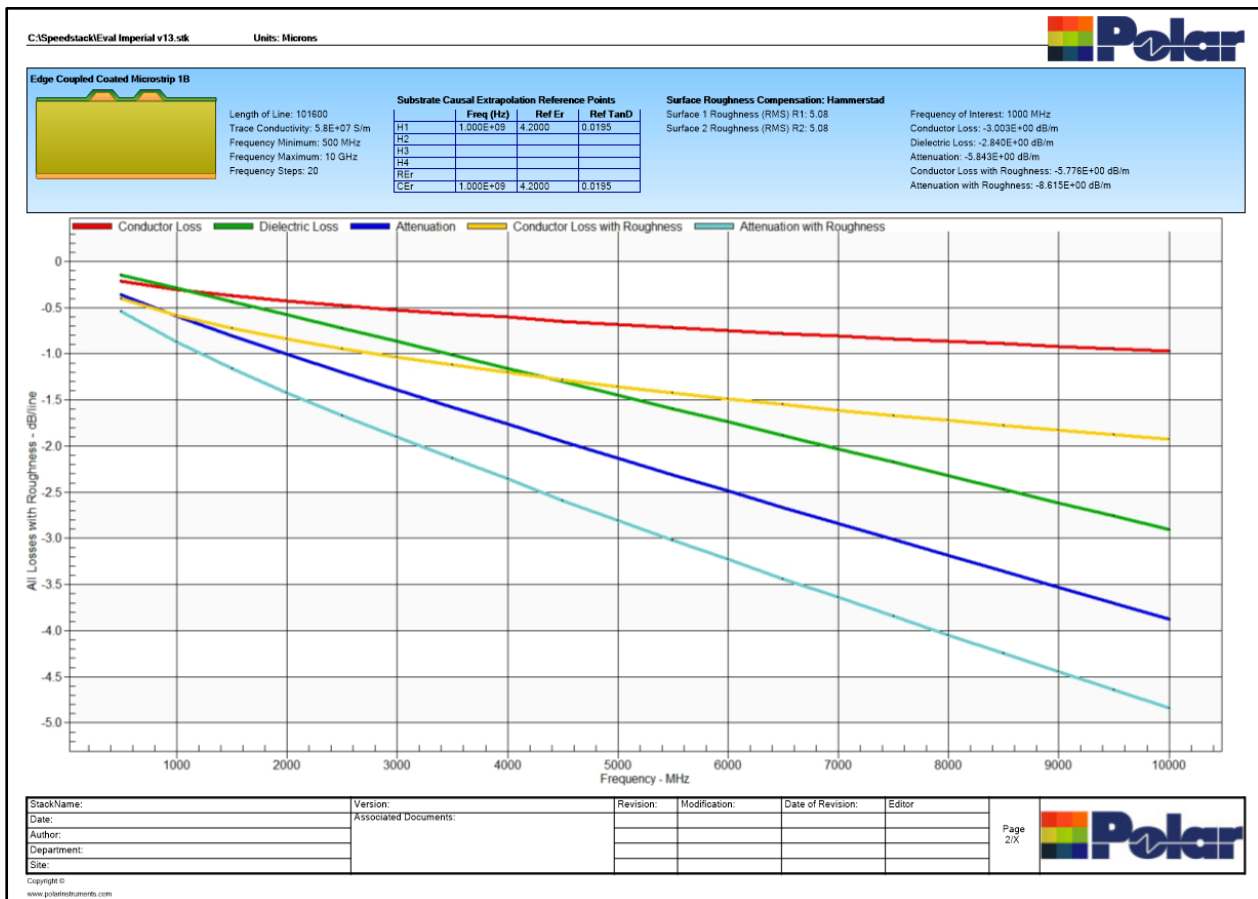
The Speedstack Si technical report includes the stackup with its stack data, the controlled impedance structures and structure data, the drill data and loss data for each structure in the stack.

Displayed loss data for each structure reflects the structure type, the frequency dependent parameters, the substrate causal extrapolation reference points, the surface roughness method and settings, frequency of interest and associated loss values for dielectric and conductor losses and total attenuation and losses with roughness.



Click File|Print|Print Technical Report, Speedstack refreshes the loss data results and displays them in high quality graphical form.

Step through the pages to view the stack, impedance and drill data and the frequency dependent loss graphs for each structure in sequence in the stack.



Speedstack Si to Si9000e data transfer

Speedstack and Si9000e incorporate the facility to realise bidirectional transfer of all structure parameters (i.e. both lossless and frequency dependent) for a single structure or all structures via the clipboard.

Parameter transfer is accomplished via the data transfer icons:

Single structures



To Field Solver

Use Speedstack's To Field Solver icon to transfer the parameters of a single structure via the clipboard from Speedstack to the Si9000e



From Field Solver

Use Speedstack's From Field Solver icon to transfer the parameters of a single structure via the clipboard from Si9000e to Speedstack



Paste Structure from Speedstack

Use the Si9000e's Paste Structure from Speedstack to paste the whole structure with all its parameters into the Si9000e – the currently displayed structure will be replaced



Copy Structure to Speedstack

With all calculations complete click the Copy Structure to Speedstack to return the structure to the stackup in Speedstack.

Multiple structures



To Si Project

Use Speedstack's To Si Project icon to transfer all structures as a project from Speedstack to the Si9000e



Paste from Speedstack into Si Project

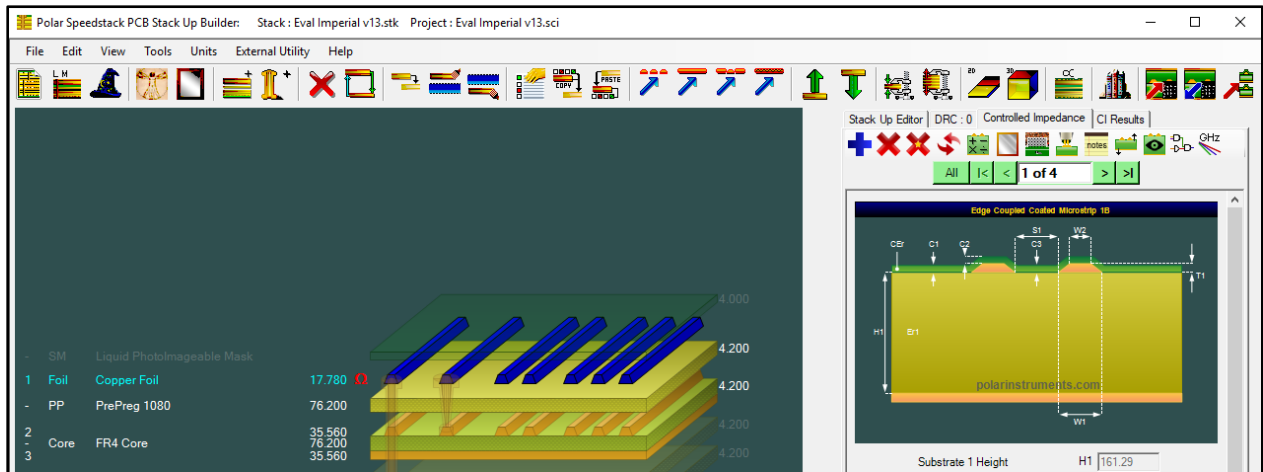
Use the Si9000e's Paste from Speedstack into Si Project to paste the set of structures into the Si9000e as a project.

Sharing structure properties

Each structure in Speedstack can store a complete set of frequency dependent parameters, so each structure can have its own Length of Line, range of frequencies (FMin, FMax, FSteps and Frequency of interest) substrate data, surface roughness compensation and loss budget.

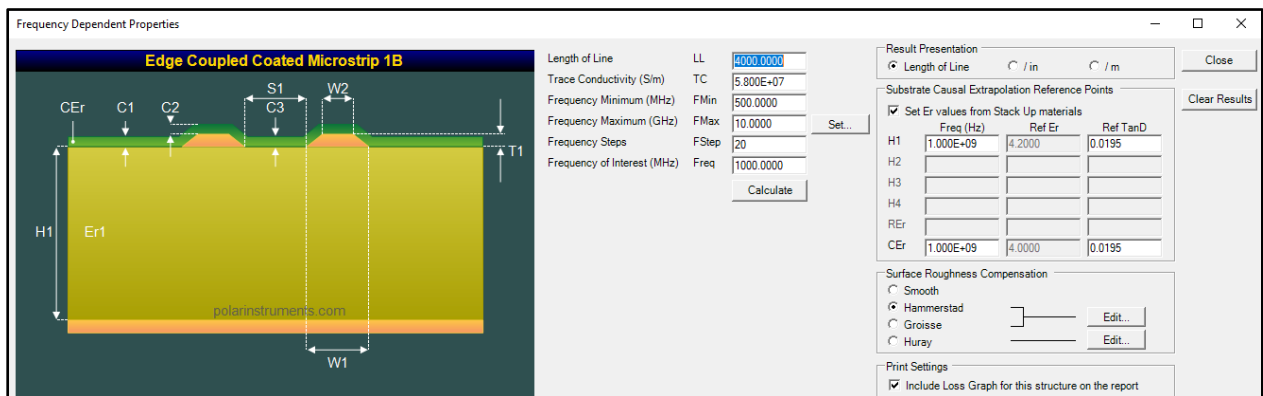
Using the data transfer icons within Speedstack allows a selected set of structure properties to be shared between other structures on the same electrical layer on the stackup.

To share parameters between structures, select the source structure (structure 1, Edge Coupled Coated Microstrip 1B.)



Frequency Dependent Properties

Select the Frequency Dependent Properties button to display the frequency dependent properties.



All the structure's properties, including all the frequency dependent parameters, will be available for sharing with the target structure.



To Field Solver

Close the dialog and click the To Field Solver button to copy the parameters to the clipboard.



From Field Solver

Select the target structure (in this example, structure 2, single ended Coated Microstrip 1B as shown below) and click the From Field Solver button.

All |< < 2 of 4 > >|

Coated Microstrip 1B

| | | |
|-------------------------|-----|--|
| Substrate 1 Height | H1 | <input type="text" value="161.29"/> |
| Substrate 1 Dielectric | Er1 | <input type="text" value="4.2000"/> |
| Lower Trace Width | W1 | <input type="text" value="114.30"/> |
| Upper Trace Width | W2 | <input type="text" value="88.90"/> |
| Trace Thickness | T1 | <input type="text" value="17.78"/> |
| Coating Above Substrate | C1 | <input type="text" value="25.40"/> |
| Coating Above Trace | C2 | <input type="text" value="25.40"/> |
| Coating Dielectric | CEr | <input type="text" value="4.0000"/> |
| Impedance | | Zo <input type="text" value="75.87"/> |
| Target Impedance | | <input type="text" value="75.00"/> |
| Target Tolerance % | | <input type="text" value="10.00"/> |

Speedstack displays the Paste Structure Properties dialog

Paste Structure Properties ✕

Please select the Property Groups that you wish to paste to the selected structure:

- ☐ Impedance Parameters (H1, Er1, W1, W2, S1 etc)
- ☒ Frequency Dependent Parameters (LL, TC, FMin, FMax etc)
- ☒ Substrate Causal Extrapolations Reference Points (Ref Freq, Ref Er, Ref TanD)
- ☒ Surface Roughness Compensation (Hammerstad, Grosse, Huray)

Select the properties to be pasted – in this case, the impedance parameters are unchecked as the source structure's 100 ohm differential impedance does not apply.

The frequency dependent parameters, along with the causal extrapolation reference points (frequency, Er and TanD) and surface roughness compensation method are applied to the target structure.

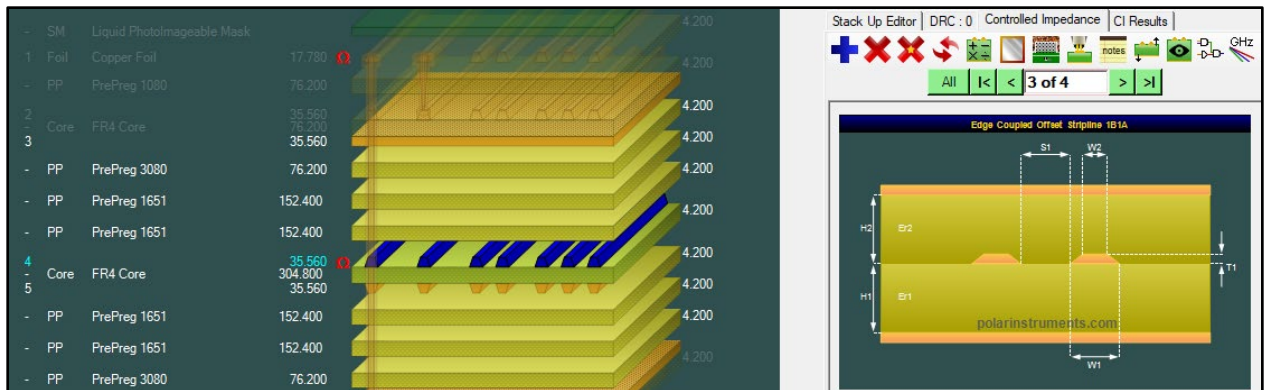
Transferring structures between Speedstack and Si9000e

Speedstack Si is fully integrated with the Si9000e transmission line field solver.

Users can transfer structures to the field solver for processing then transfer the solved properties back to Speedstack Si.

Transferring a single structure

Ensure the field solver is running. Select the structure to be copied to the Si9000e



To Field Solver

Click the To Field Solver button to transfer the structure and all parameters to the Si9000e.

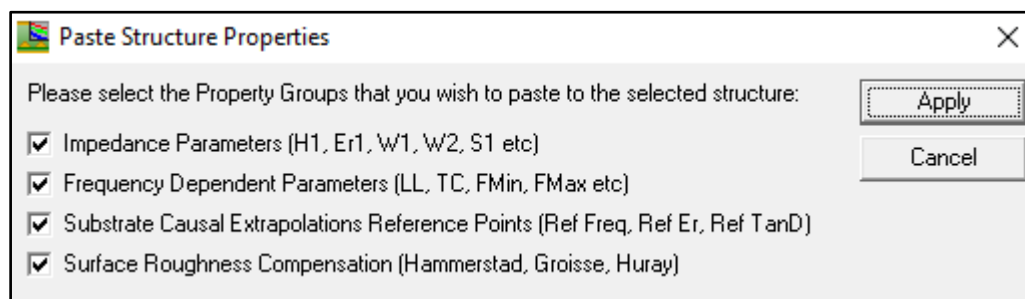
Switch to the Si9000e.



Paste Structure from Speedstack

Click the Si9000e's Paste Structure from Speedstack button to paste the structure complete with all impedance and frequency dependent parameters into the Si9000e.

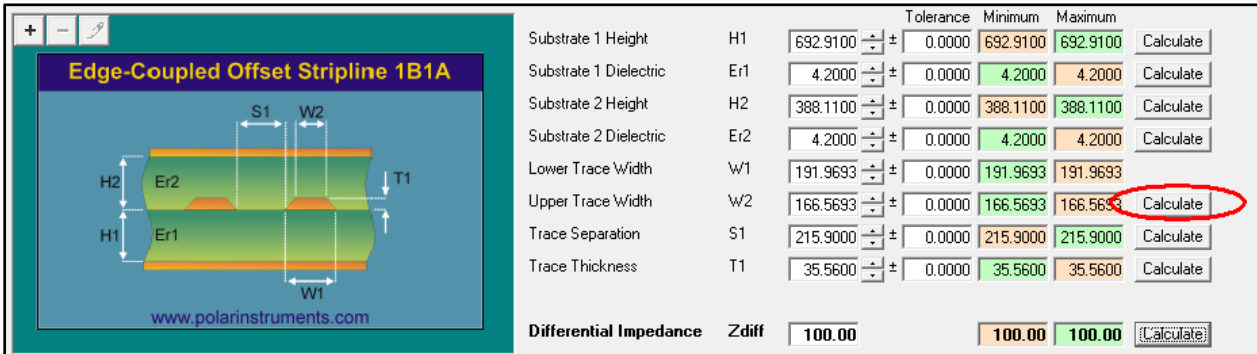
The Si9000e displays the Paste Structure Properties dialog.



Choose which groups of properties are to be pasted into the field solver and click Apply. The impedance, lossless and frequency dependent properties are pasted into the field solver for processing. The units setting in Speedstack will replace the setting in Si9000e.

Solving for impedance

With the structure loaded into the Si9000e switch to the Lossless Calculation tab to display the structure graphic and lossless parameters.

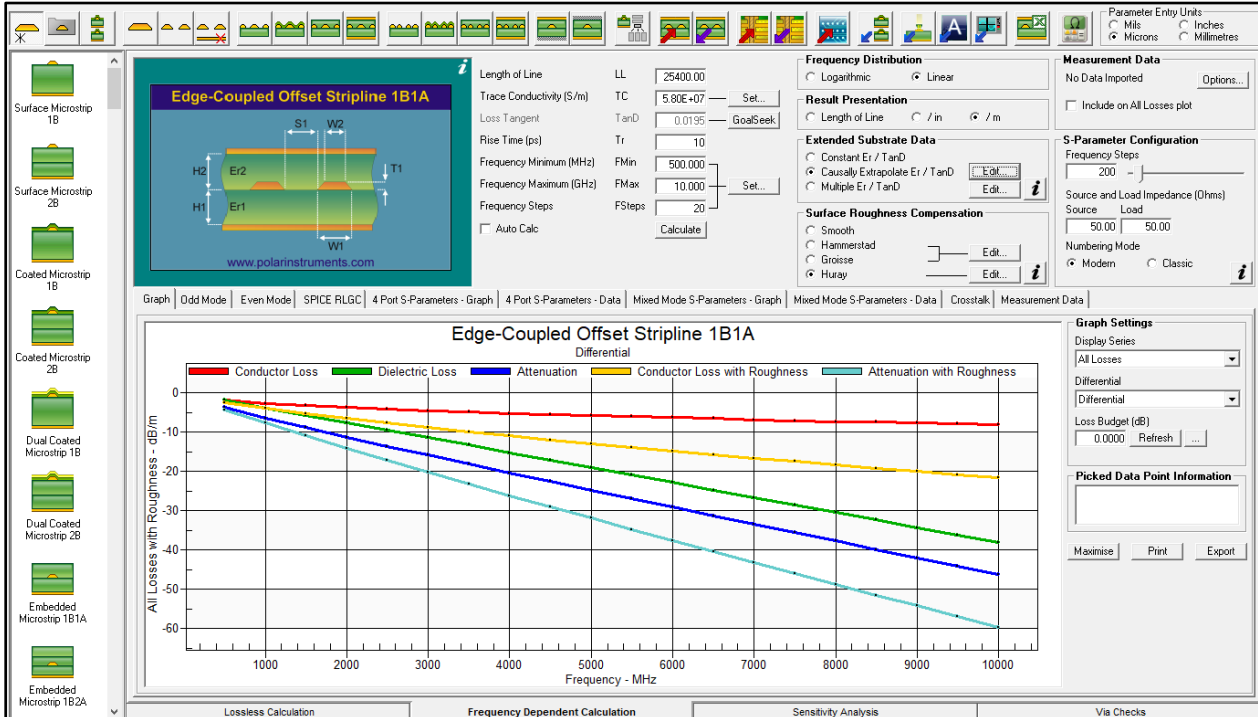


| Parameter | Value | Tolerance | Minimum | Maximum | Action |
|------------------------|-------|-----------|----------|----------|-----------|
| Substrate 1 Height | H1 | 692.9100 | ± 0.0000 | 692.9100 | Calculate |
| Substrate 1 Dielectric | Er1 | 4.2000 | ± 0.0000 | 4.2000 | Calculate |
| Substrate 2 Height | H2 | 388.1100 | ± 0.0000 | 388.1100 | Calculate |
| Substrate 2 Dielectric | Er2 | 4.2000 | ± 0.0000 | 4.2000 | Calculate |
| Lower Trace Width | W1 | 191.9693 | ± 0.0000 | 191.9693 | Calculate |
| Upper Trace Width | W2 | 166.5693 | ± 0.0000 | 166.5693 | Calculate |
| Trace Separation | S1 | 215.9000 | ± 0.0000 | 215.9000 | Calculate |
| Trace Thickness | T1 | 35.5600 | ± 0.0000 | 35.5600 | Calculate |
| Differential Impedance | Zdiff | 100.00 | 100.00 | 100.00 | Calculate |

Specify the target impedance then click the Calculate button for the parameter to be used in the goal seek (e.g. trace width); with the target impedance reached switch to the Frequency Dependent Calculation tab.

Running frequency dependent calculations

Enter the frequency dependent parameters, the extended substrate data settings, the surface roughness compensation method and values and click Calculate to refresh the results.



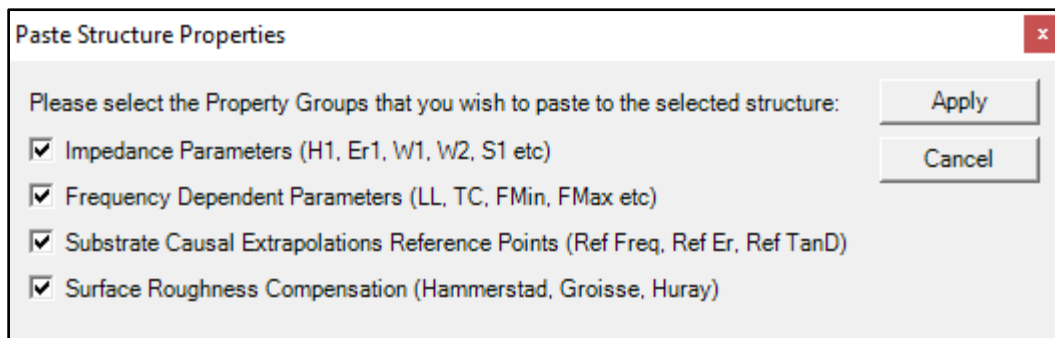
For detailed Si9000e operation see the Si9000e User Guide.



Copy Structure to
Speedstack

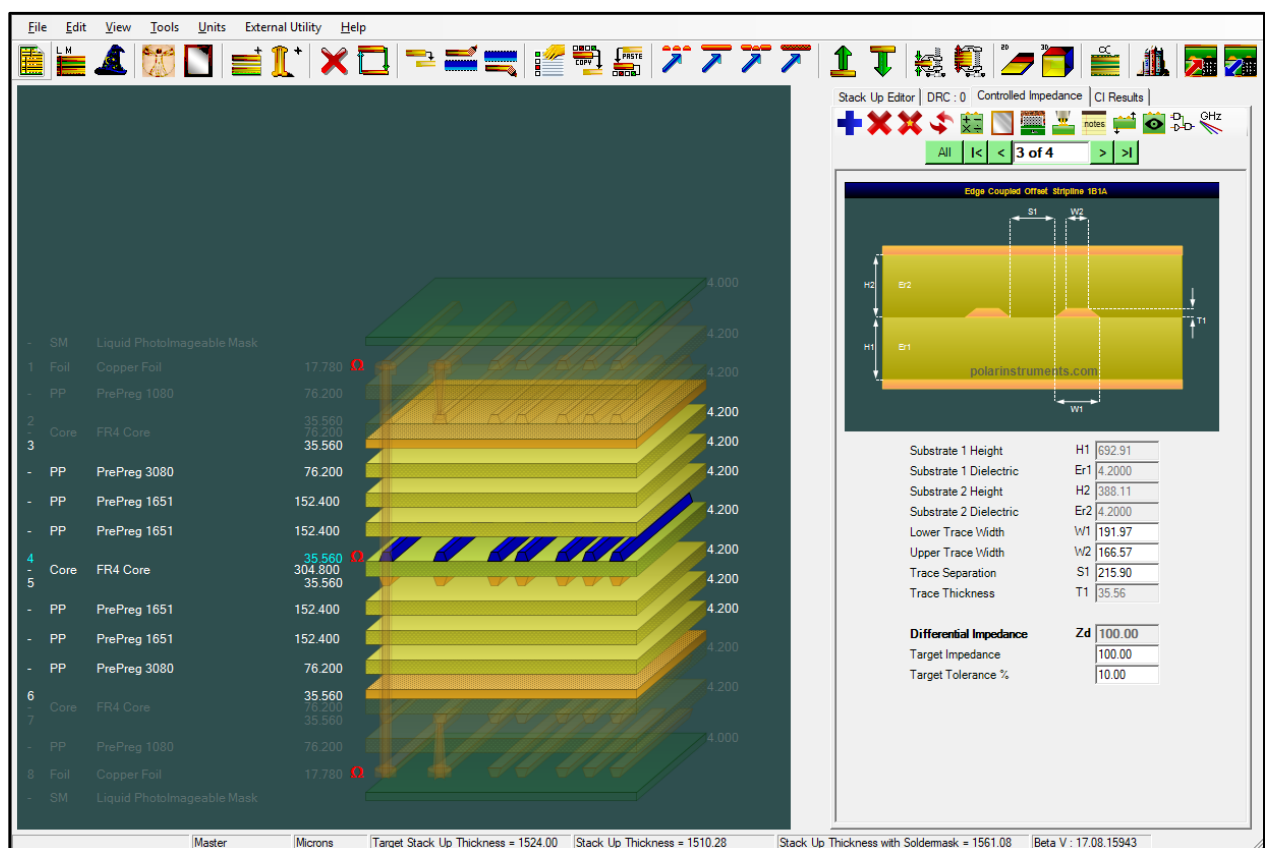
With all calculations complete click the Copy Structure to Speedstack to return the structure to the stackup in Speedstack.

The Paste Structure Properties dialog is displayed.



Choose which properties are to be updated and click Apply.

Rebuild and calculate the structure in Speedstack. The structure reflects the updated values.



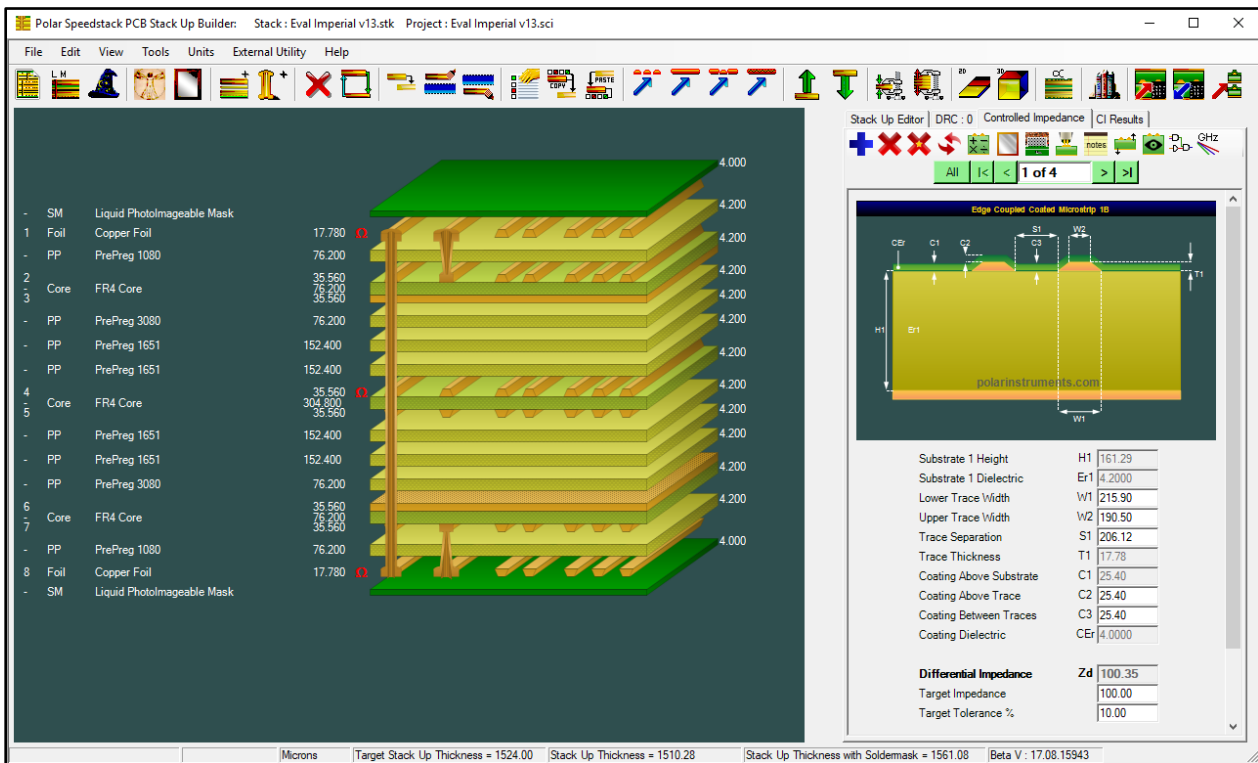
Transferring multiple structures via Si Projects

To transfer all the structures in a stack use the Si Projects transfer function incorporated in Speedstack Si and Si9000e.

Si Projects allows for transfer of all controlled impedance structures along with all lossless and frequency dependent parameters from Speedstack Si into the Si9000e field solver.

Si Projects allows groups of structures to be saved and recalled in Si9000e and the updated structures pasted back into Speedstack.

The stackup in the example below contains four structures.



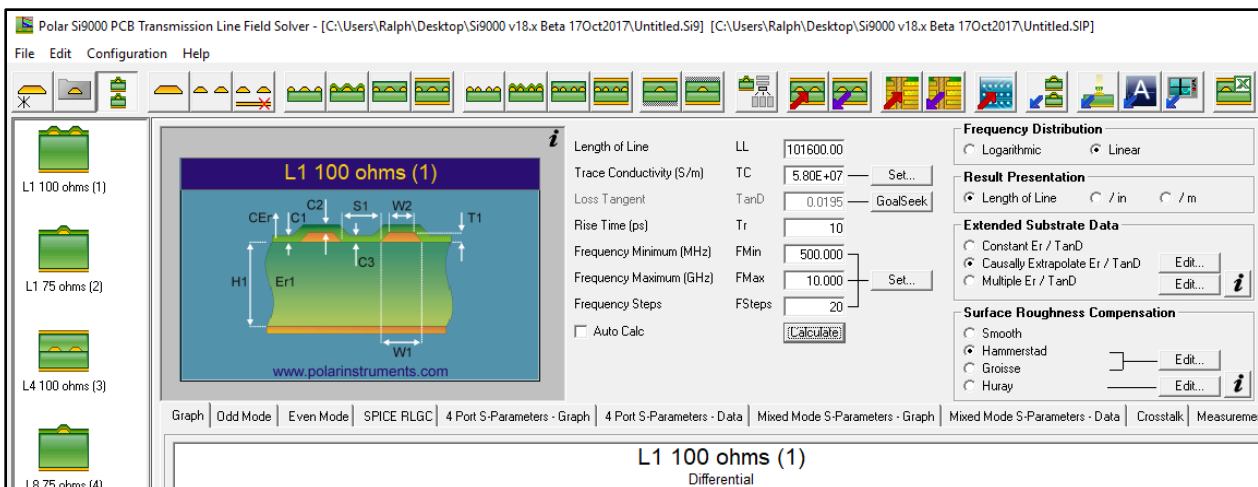
To Si Project

Use the To Si Project toolbar icon to copy the group of four structures from Speedstack Si and place them onto the clipboard; these structures can then be pasted directly into the Si9000e as a new project.



Paste from Speedstack into Si Project

Switch to the Si9000e and use the Si9000e's Paste from Speedstack into Si Project to paste the set of four structures into the Si9000e as a project.



The Si9000e and Speedstack should automatically switch to the units that were in use when the structure was copied. (For instance, if Speedstack is in Mils and Si9000e is in Microns and a structure is copied from Speedstack to Si9000e the Si9000e should automatically switch to Mils.)

The complete set of structures appears in the field solver's Project window in the same order as shown in Speedstack.

The Si Project window lists the transferred structures in Speedstack's display order, showing the order number and impedance value along with a thumb nail graphic indicating the structure configuration.

Modifying structures

Selecting each structure displays its associated graphic in a grey background.

With a structure selected the structure parameters can be modified as required and all values recalculated. The recalculated structures can be pasted back into Speedstack.

To paste a structure back into Speedstack select the target structure in Speedstack, switch to the Si9000e, select the structure for transfer and use the transfer icons to update the selected structure in Speedstack.



*Rebuild and Recalculate
Displayed Structure*

Click the Rebuild and Recalculate Displayed Structure to refresh the displayed structure.



*Rebuild and Recalculate
All Structures*

Click the Rebuild and Recalculate All Structures to update all structures in the stack

Creating CITS test files

Speedstack can create CITS test file data for each controlled impedance structure in the stack.



Set CITS Test

Select each structure and click Set CITS Test to display the Edit Test data dialog; specify the CITS test parameters for each structure to be tested and click OK.

Edit Test data

Structure Details

Structure Description

Offset Coplanar Strips 1B1A

Impedance

50.00

Signal Layer

4

Channel Select

☒ Single Ended

Probe ID

Chan 1

☐ Differential

Horizontal

Units

Inches

Test From

3

Test To

7

Test Method

Absolute

Vp

☒ Default

☐ User

Vertical

Ohms/Division

10

Tolerance

☒ Locked

Plus

10

%

Minus

10

%

Exporting the CITS test file

With the test data specified for each structure, from the File menu choose Export To|Export CITS File. Add descriptive Board Details and notes as required.

Board Details

Customer

Polar

Board Type

G308 back plane

Part Number

1234

Revision Number

Rev 06

Click Make File and navigate to a suitable folder and save the CITS (.cif) test file.

Working with flex-rigid stackups

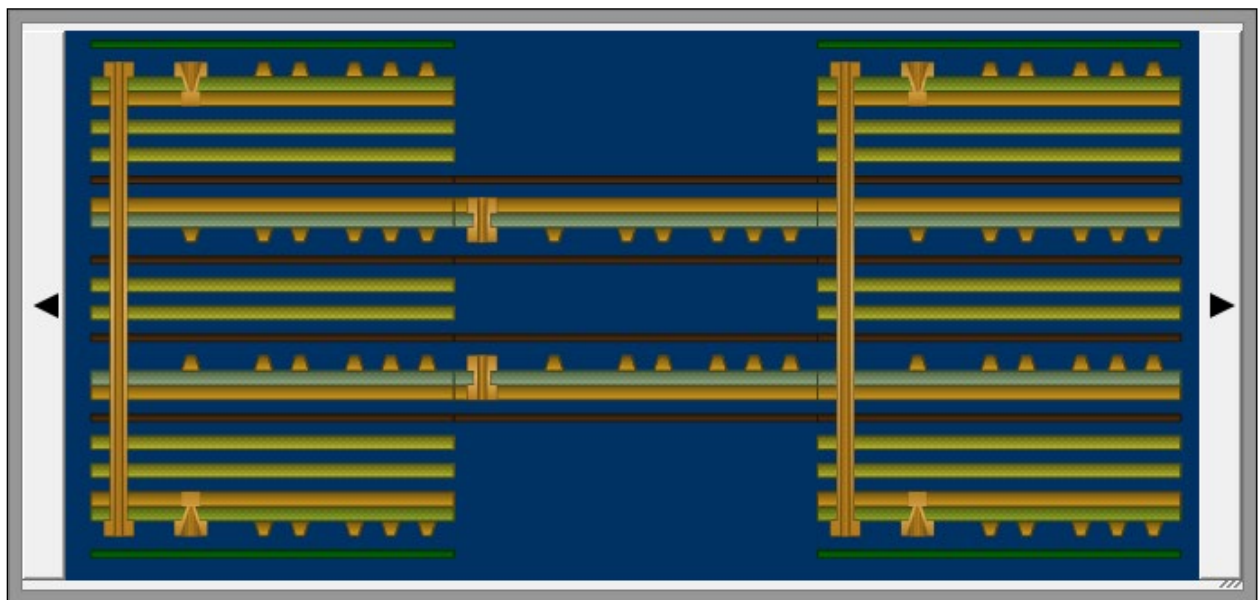
Speedstack Flex

Speedstack Flex allows PCB fabricators and OEM engineers quickly to create and document accurate and efficient flex-rigid PCB layer stackups.

The graphical stackup display

The Speedstack Flex Navigator enables the board designer to link and document as many cross sections as necessary in order to fully document a flex-rigid build up.

Speedstack Flex supports documentation of common flex-rigid constructions, including *doublets* where stacked pairs of flex link two rigid sections of the flex-rigid construction together (see graphic below.)



Speedstack's Navigator works from a master stack comprising the full set of materials used in the final stackup and documents each rigid and flex-rigid section with as many "sub-stacks" as needed for the design. There are no limits to the number of sub-stacks or layer count of the total build.

A range of materials including flexible adhesives, bondply and FlexiCore can be enabled or disabled for each layer, and impedance structures can be added to each sub-stack.

Mesh / Crosshatch ground planes

When used with Polar's Si8000m and Si9000e field solvers, Speedstack Flex permits modelling and documenting mesh/crosshatch ground planes from within the Speedstack Flex environment. Mesh geometry and structure data can be easily shared between Si8000m and Si9000e.

Internal Coverlays

Advanced rules allow impedance structures to be added when coverlays exist internally within a stack. When a coverlay is beyond the outer copper it will behave like a coating, when internal it will behave like a bondply or prepreg.

Definable colours per material

Speedstack Flex can set and store individual material colours via the material Properties dialog. This will help ensure that special build requirements are obvious during fabrication. This will be found useful for documenting plated layers or highlighting specific material usage such as no-flow prepreps and flexible cores.

Enabling Speedstack Flex/HDI

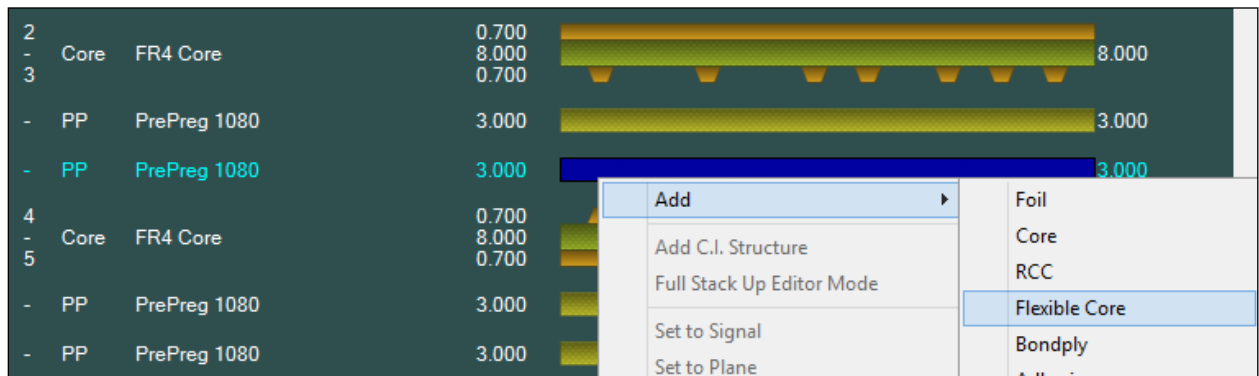
To enable Speedstack Flex/HDI select Tools|Options and ensure the Licensing pane purchasable option Speedstack Flex/HDI License check box is ticked.

Adding a flexible core

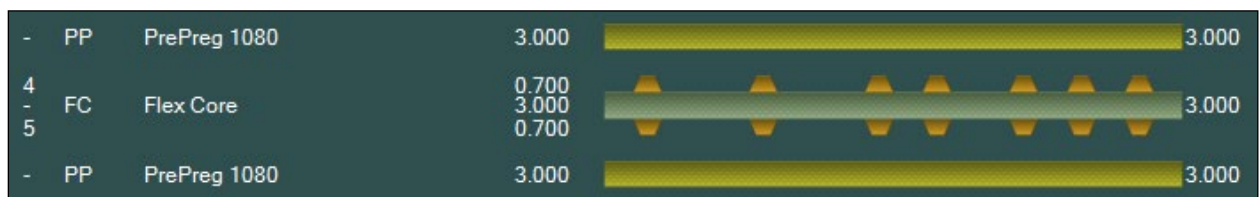
Create and save a symmetrical 6-layer stackup as shown in the sample stack below

| | | | | | |
|---|------|----------------------------|-------|--|-------|
| - | SM | Liquid PhotoImageable Mask | 1.000 | | 1.000 |
| 1 | Foil | Copper Foil | 0.700 | | |
| - | PP | PrePreg 1080 | 3.000 | | 3.000 |
| - | PP | PrePreg 1080 | 3.000 | | 3.000 |
| 2 | - | | 0.700 | | |
| - | Core | FR4 Core | 8.000 | | 8.000 |
| 3 | - | | 0.700 | | |
| - | PP | PrePreg 1080 | 3.000 | | 3.000 |
| - | PP | PrePreg 1080 | 3.000 | | 3.000 |
| 4 | - | | 0.700 | | |
| - | Core | FR4 Core | 8.000 | | 8.000 |
| 5 | - | | 0.700 | | |
| - | PP | PrePreg 1080 | 3.000 | | 3.000 |
| - | PP | PrePreg 1080 | 3.000 | | 3.000 |
| 6 | Foil | Copper Foil | 0.700 | | |
| - | SM | Liquid PhotoImageable Mask | 1.000 | | 1.000 |

Ensure Symmetrical mode is off, right click the prepreg above Layer 4 copper and add a flexible core:



The flexible core is added as the new layers 4 and 5.



Using the Navigator

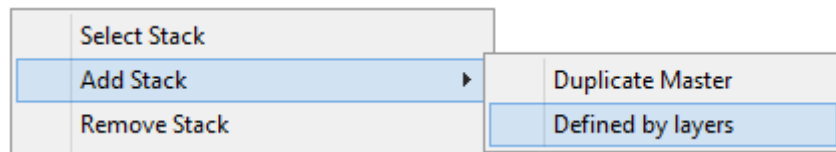
Press F4 to display the Navigator



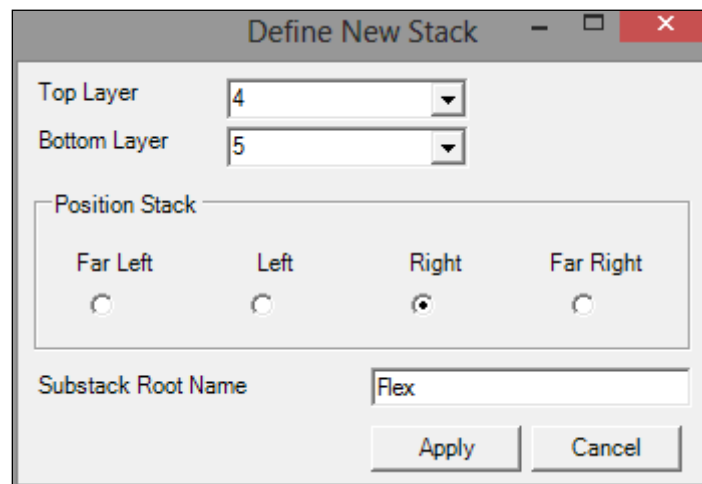
Right click the Navigator and choose Docking|Float to allow the Navigator window to be resized. The Navigator will move with Speedstack's Stack Editor. Choose Free to allow the Navigator to move independently of the Stack Editor.

Adding stacks

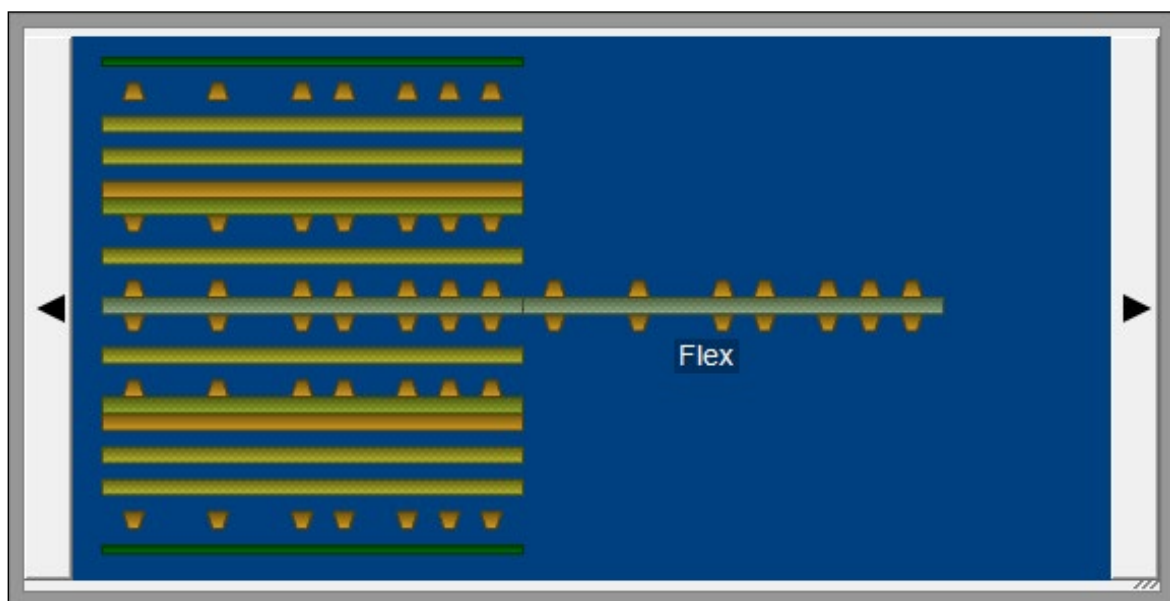
Select the stack in the Navigator window and click Add Stack and choose Defined by Layers



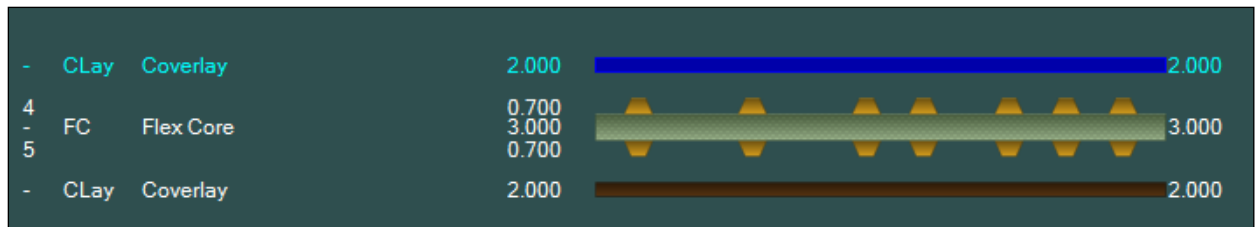
From the drop-down list choose Layer 4 as the Top Layer and Layer 5 as the Bottom Layer as shown below and enter Flex as the Substack Root Name.



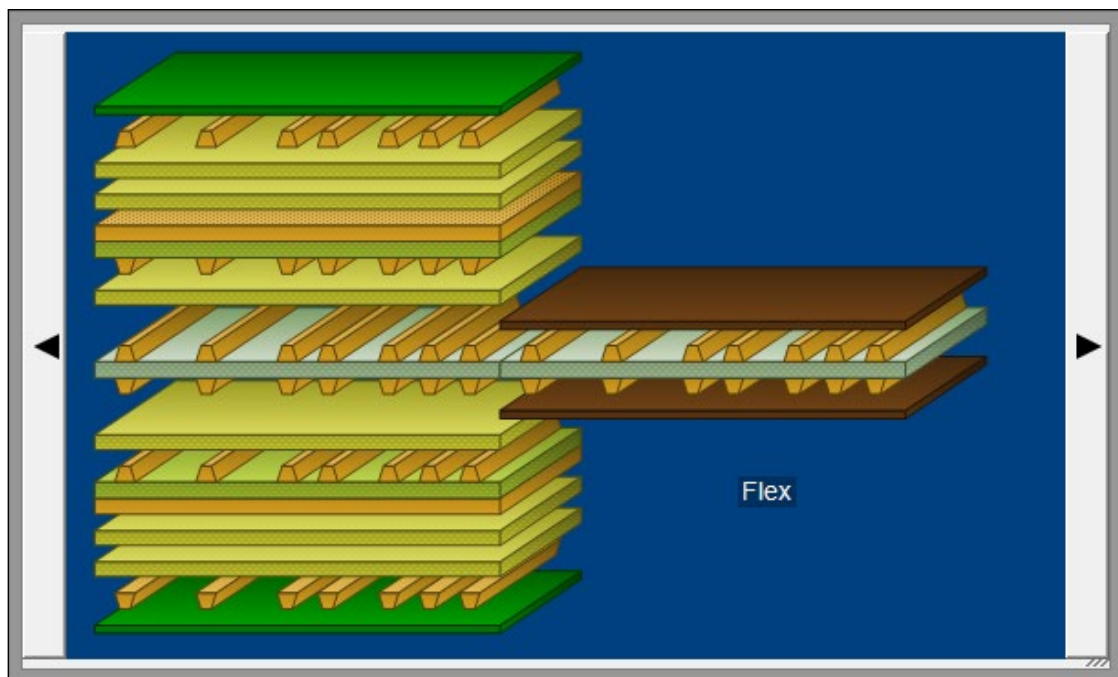
The new stack is added to the Navigator. Each sub-stack can be renamed individually as required.



Click the new stack – the selected stack is reflected in the Stack Editor and listed in the status bar. Select Symmetrical mode, in the Stack Editor click the new core and add a coverlay above.



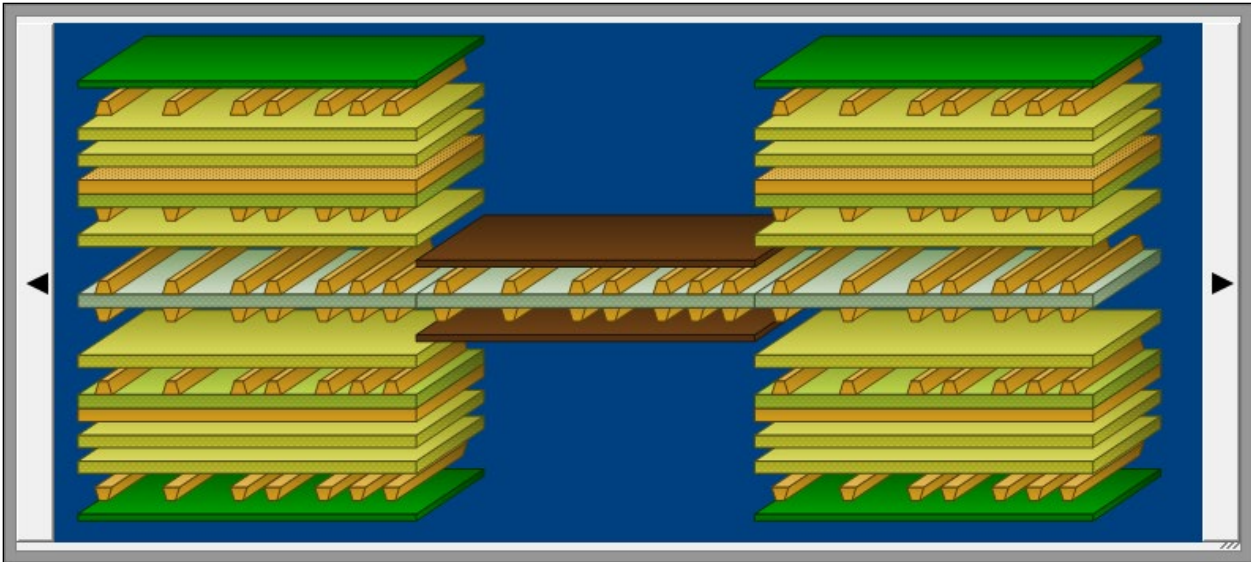
The coverlays are added symmetrically about the core. Changes made in the Stack Editor are reflected in the Navigator. Click into the Navigator – use the mouse wheel to resize. The Navigator can display in 2D or 3D views.



The new stack with its added materials appears in the Navigator; clicking each stack in the Navigator displays it in the Stack Editor and allows editing as described earlier to add controlled impedance structures, change layer types, add non-copper layers, etc.

Adding a new stack

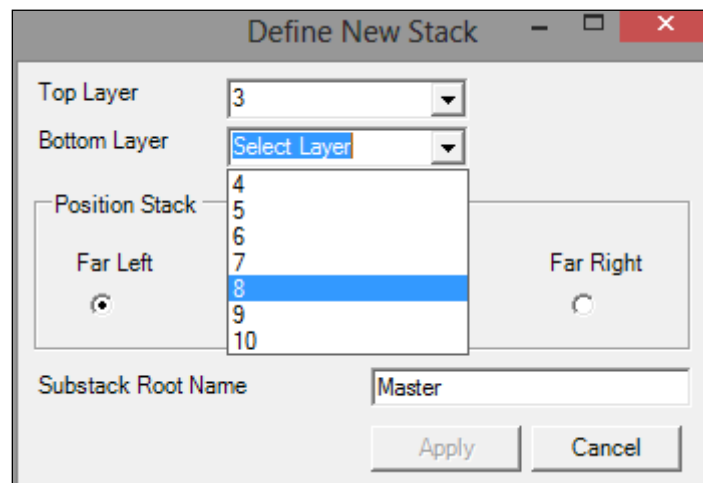
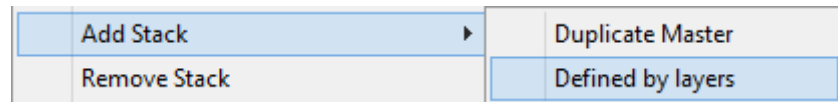
Right click the Navigator and choose Add Stack|Duplicate Master, rename the new stack and click OK.



The new stack is added to the Navigator. Click on each stack to display it in the Stack Editor and then edit as required.

Defining new stacks

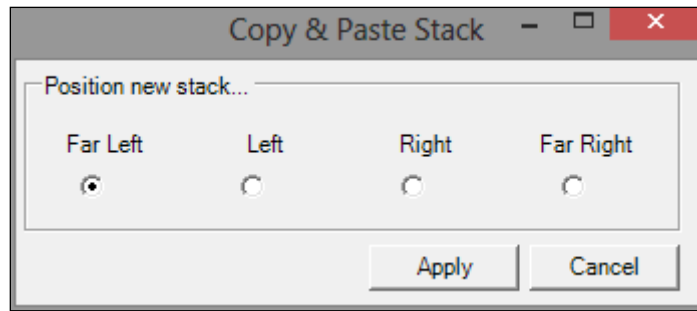
New stacks may be added defined by layers of the master stack. Choose Add Stack|Defined by Layers:



Choose the starting and finishing layers and specify a position for the new stack, choose a descriptive sub-stack root name and click Apply.

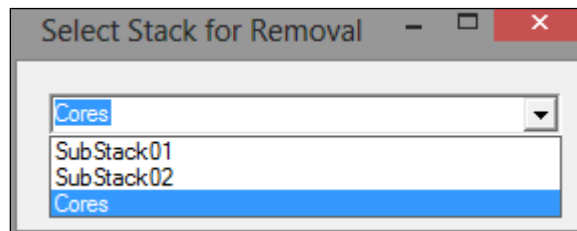
Copying and pasting stacks

To copy a stack in the Navigator select the stack, choose Copy and Paste Stack, then from the dialog below choose the position of the new stack



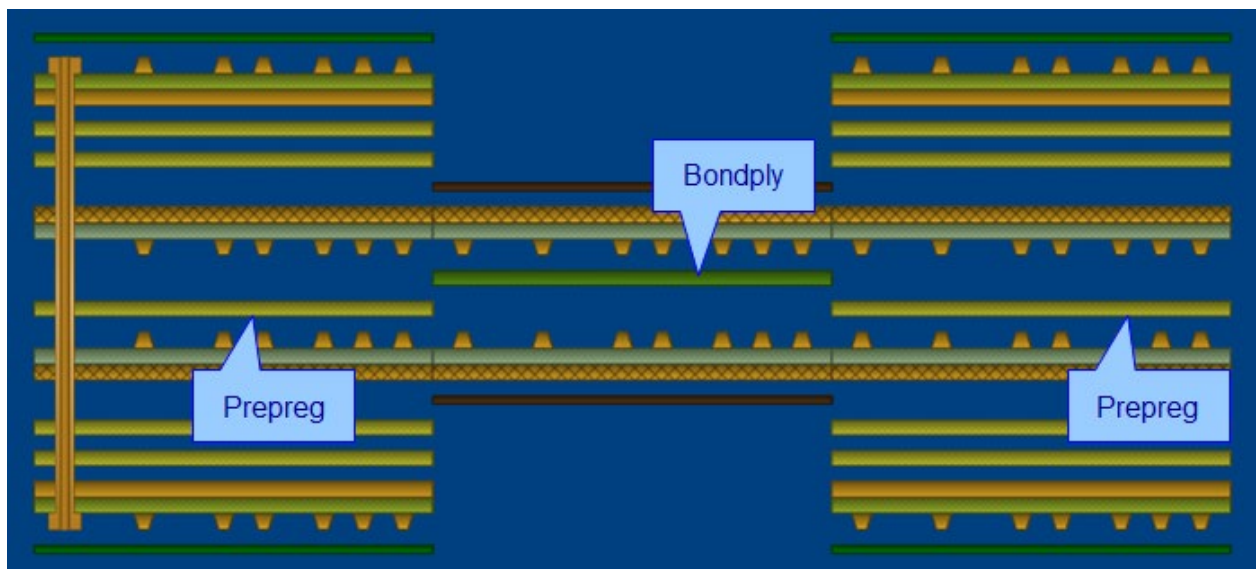
Removing stacks

To remove a stack right click the Navigator, choose Remove Stack and select the stack to be removed.



Aligning materials in the navigator

On occasions, adding a flexible stack results in misalignment between layer materials displayed in the navigator, for example, between the bondply and coverlay layers and the associated prepreg layers – see the graphic below.

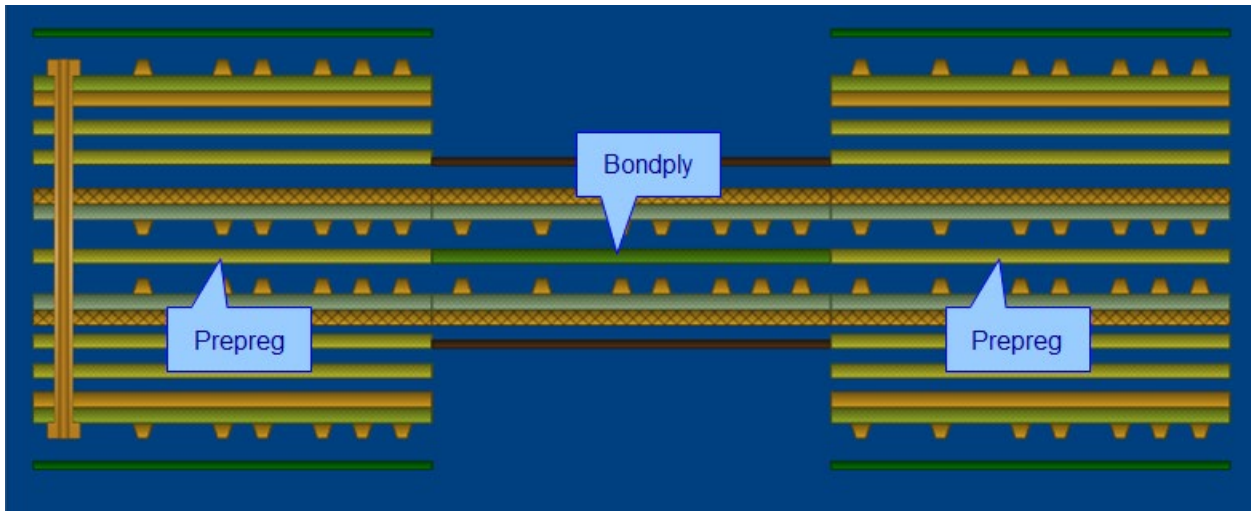


To move the layers into alignment, select the stack in the Stack Editor and use the FlexNav Move Up and FlexNav Move Down commands from the Edit menu.

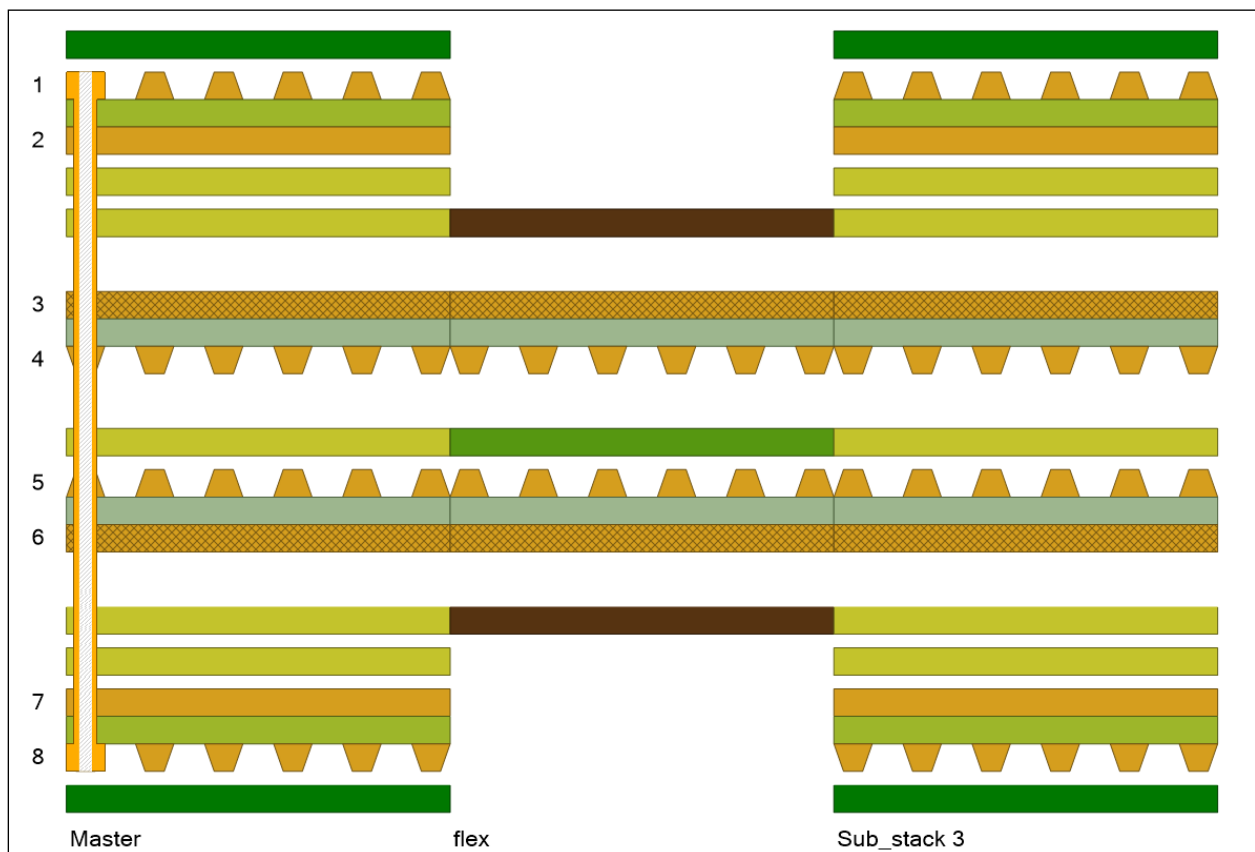
In the example above select the flexible stack in the Stack Editor, select the upper Coverlay layer and shift the layer up into alignment with the prepreg layer in the rigid stack (use the Ctrl + Shift + Up arrow keys)

Repeat the alignment for the bondply and lower coverlay materials (using the Ctrl + Shift + Down arrow keys.) The materials are displayed aligned in the navigator – below.

From the Edit menu Reset All NVDP (Navigator Visual Display Position) Attributes to return the stack to its original alignments.



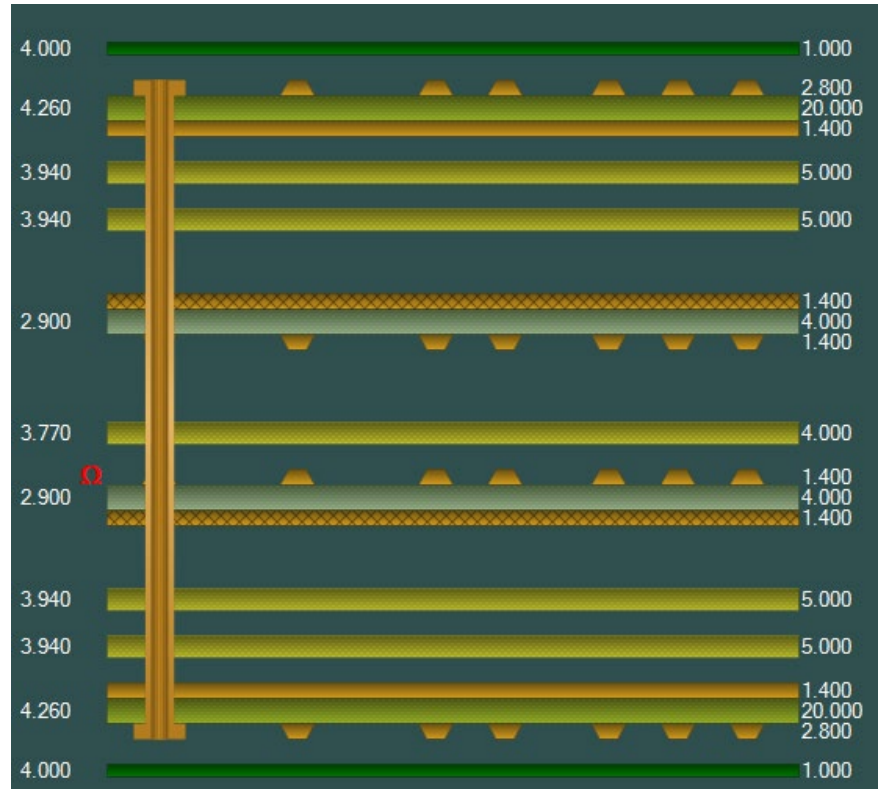
The navigator display is reproduced in the Technical Report



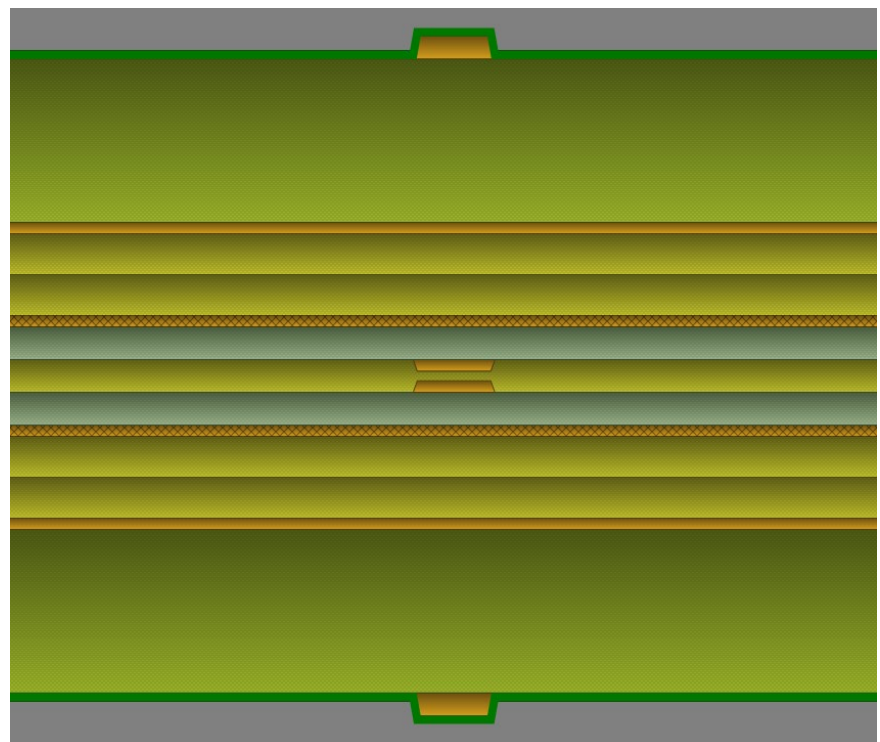
The technical report also supports different materials on the same dielectric layer, improving the clarity of documentation between the stackup designer and fabricator.

Displaying the stack in Proportional View

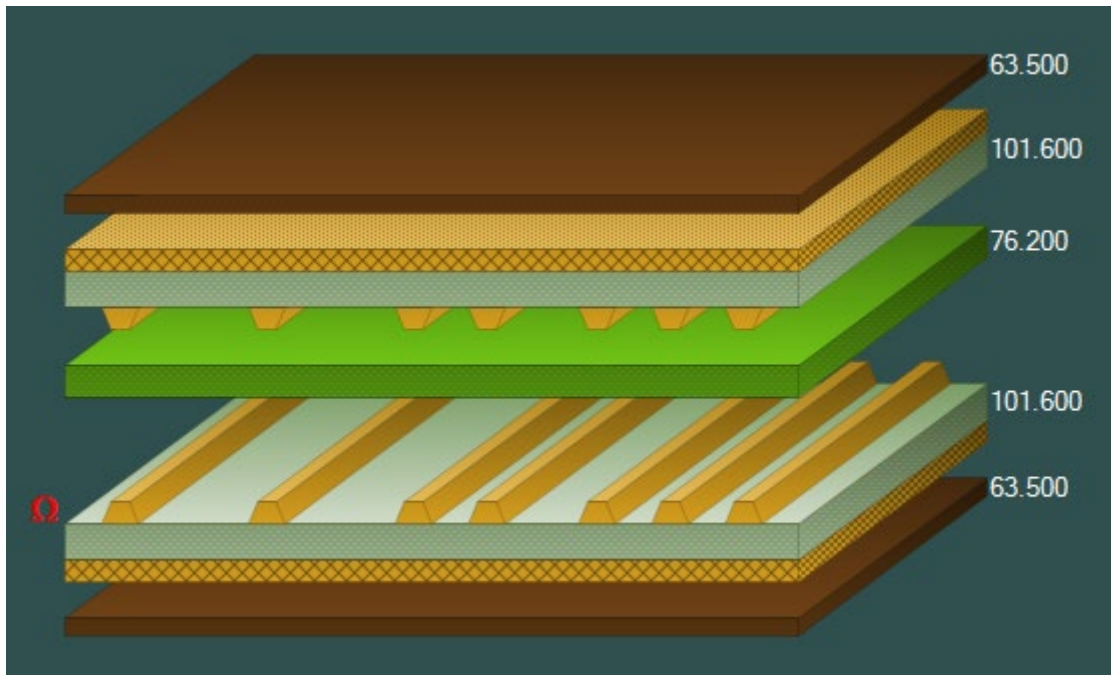
Speedstack can display the stackup so that the material thicknesses are shown proportional to each other. Select the stack in the Stackup Editor and from the View menu choose Proportional Stack Viewer.



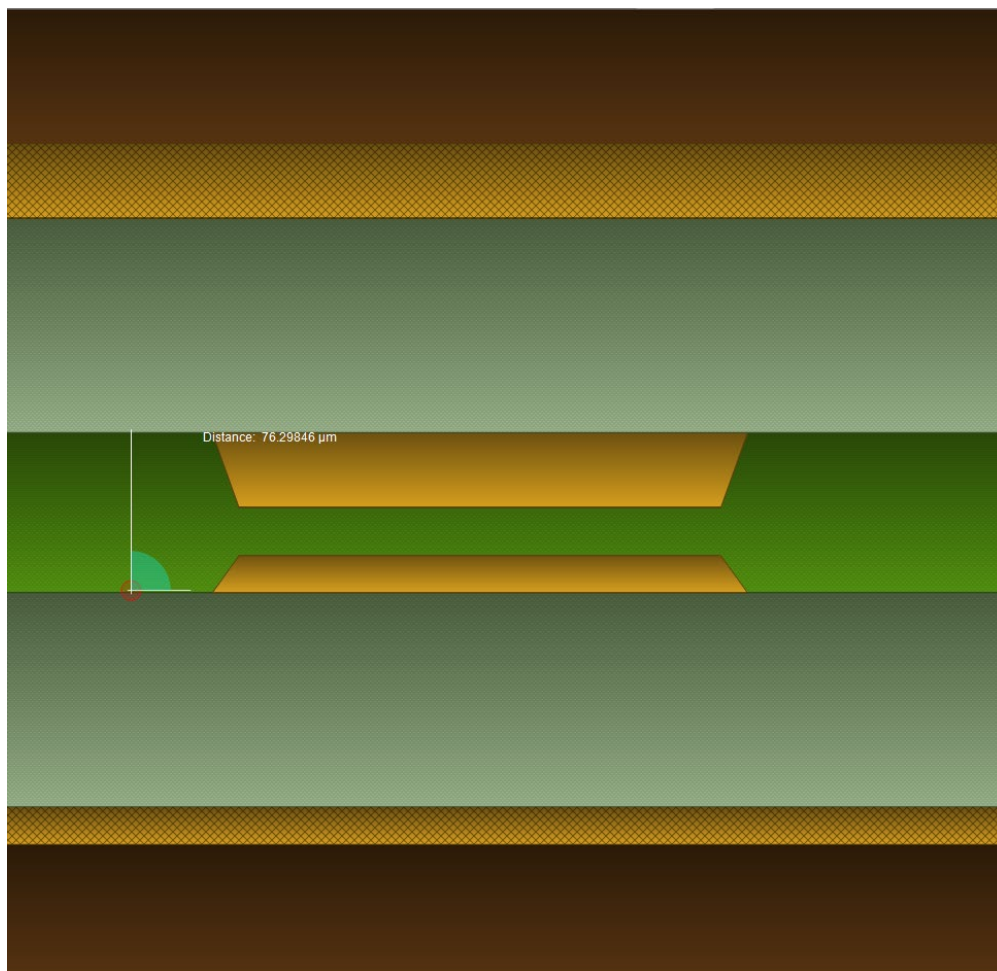
This visual aid will be found useful when considering the dielectric thicknesses between electrical layers.



Using the Ruler within Proportional view
Select the stack in the Stackup Editor



Switch to Proportional View and click the ruler on.



Zoom in as required and use the ruler to measure material dimensions, thicknesses, trace widths, etc.

Working with HDI builds

Speedstack HDI

For HDI PCB fabricators, Speedstack HDI provides the flexibility to quickly calculate the possible impact of substituting alternative materials to improve manufacturability and reduce cost while maintaining the specified parameters and performance of the board.

Easy graphical stackup display

The HDI navigator provides a rapid guide through the sequential sub-stack lamination sequence and presents the complete assembly in a parsed graphical display that shows each phase of the multi-step lamination sequence of an HDI PCB. User-definable settings within the navigator allow engineers to display layers in transparent, invisible or 3D mode.

Sub-stack reordering

Speedstack Navigator makes re-ordering and renaming sub-stacks quick and easy in HDI builds; sub-stacks can be simply moved left or right within the Navigator window.

HDI builds

Use the Speedstack Navigator to document HDI press/drill cycles. Speedstack can document press cycles based on foil locations or drill start and end layers.

Sequential plan

The Sequential plan command creates sub-stacks that represent each press cycle in a sequential lamination from the Master stack based on foil locations.

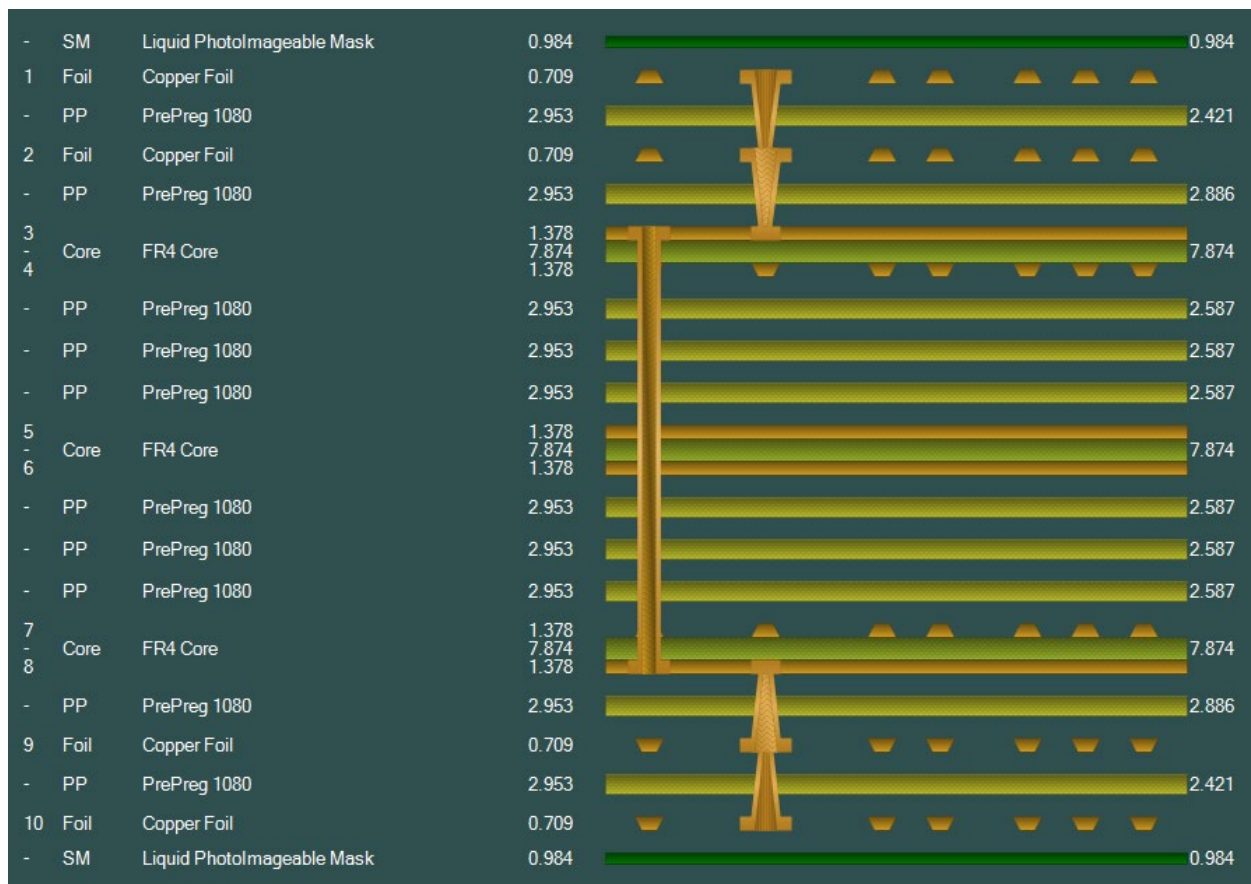
Drill plan

Using Drill Plan, Speedstack determines the sub-stacks by the start / end layers of the drills.

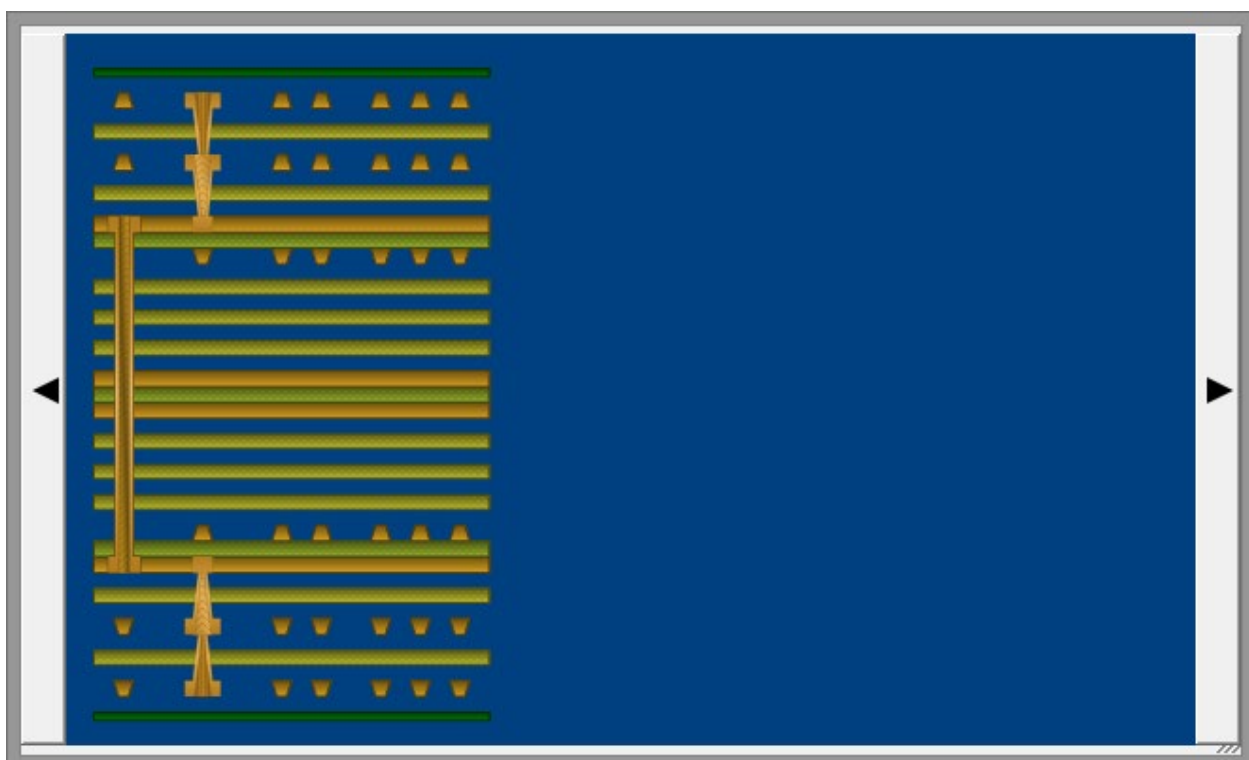
Creating the target stack with the Stack Editor

Consider the target stack below – it will require three press cycles. Build and document the stack in the Stack Editor.

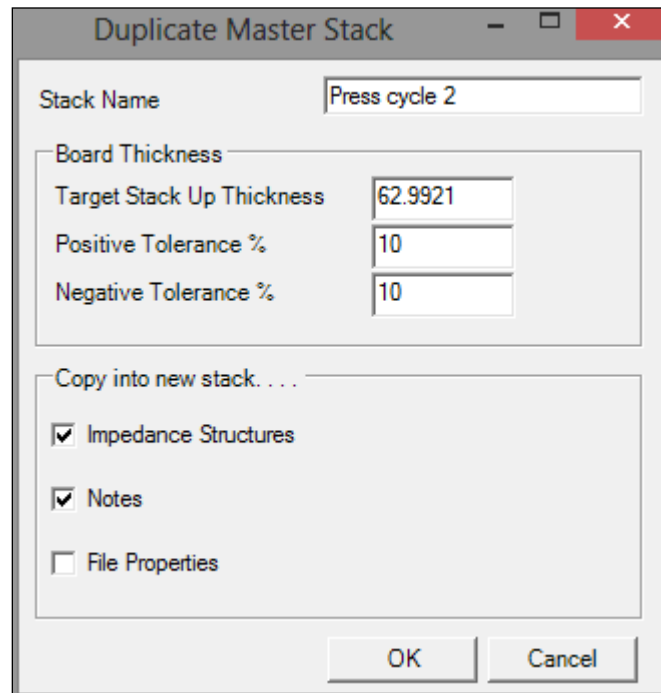
Switch to 2D View.



With the target stack completed use the Navigator's Add Stack to document each press cycle, building up the stack in the Navigator. Press F4 to start the Navigator and display the master stack.



Click Add Stack to copy the stack and name the new sub-stack Press cycle 2.



Duplicate Master Stack

Stack Name

Board Thickness

Target Stack Up Thickness

Positive Tolerance %

Negative Tolerance %

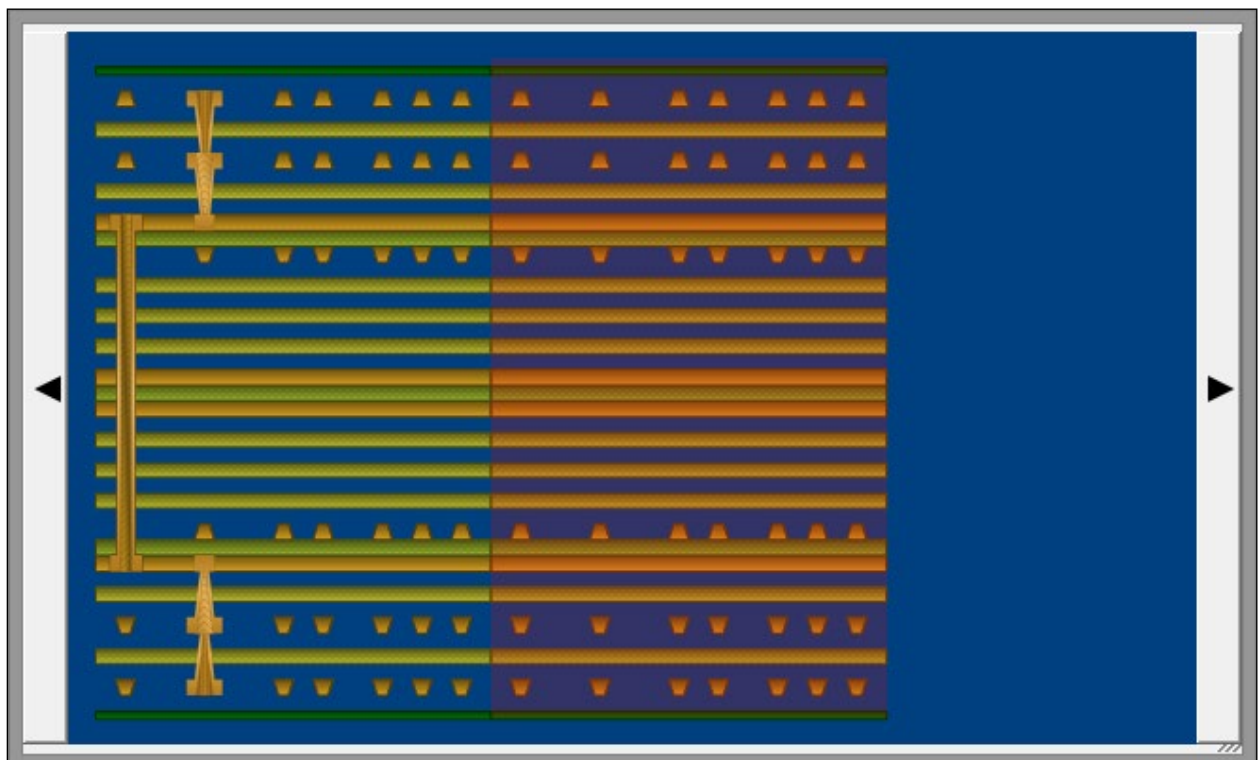
Copy into new stack. . . .

☒ Impedance Structures

☒ Notes

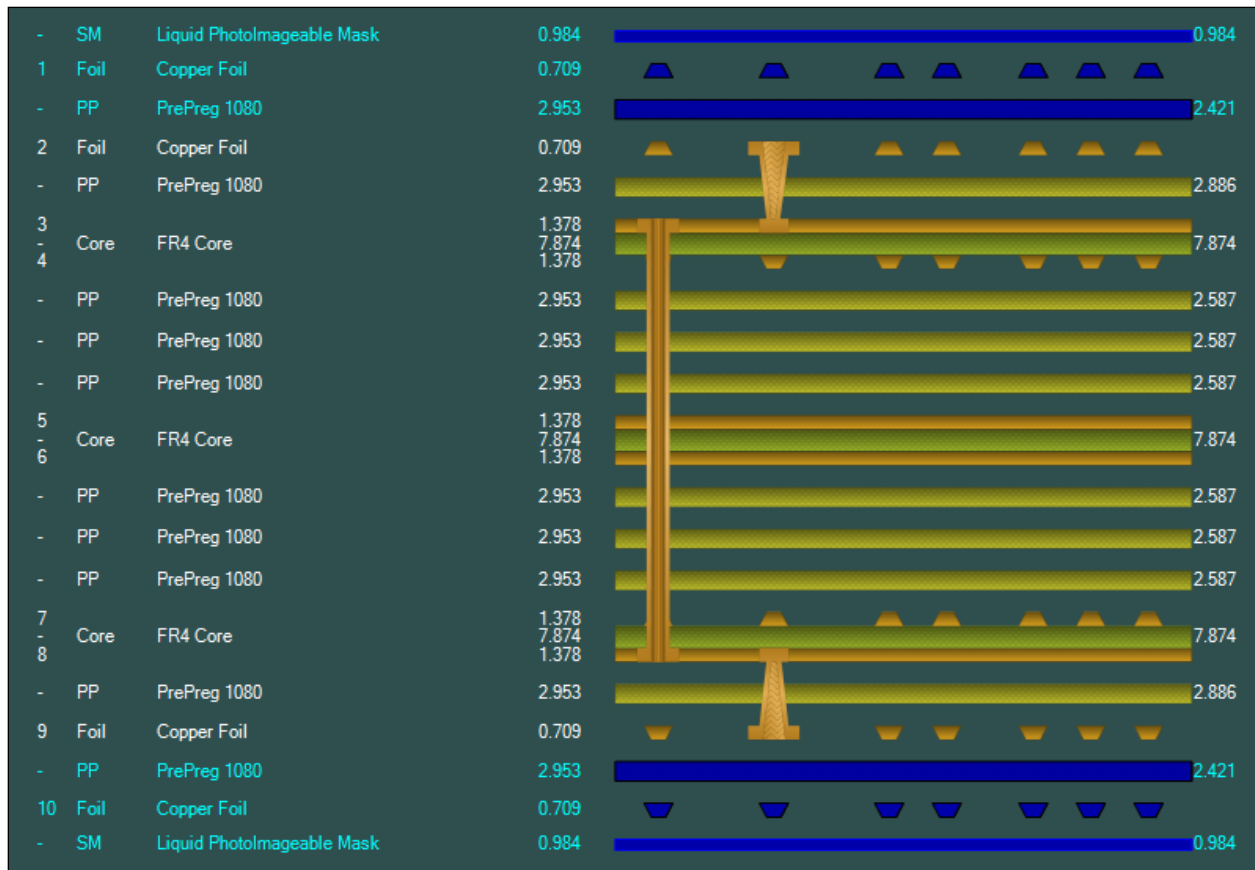
☐ File Properties

OK Cancel

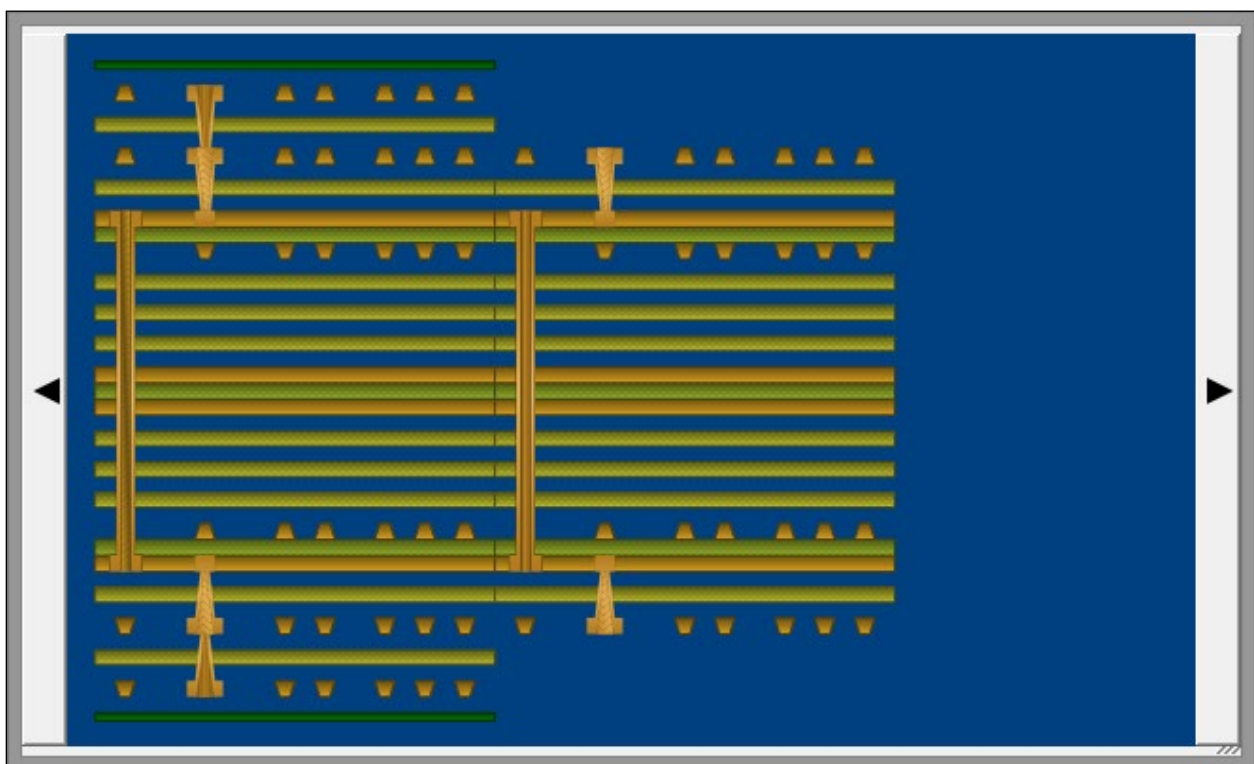


The new sub-stack is copied into the navigator window

Click the sub-stack to display it in the Stack Editor. In the Stack Editor add the drills and disable the materials that are added in the final press cycle.

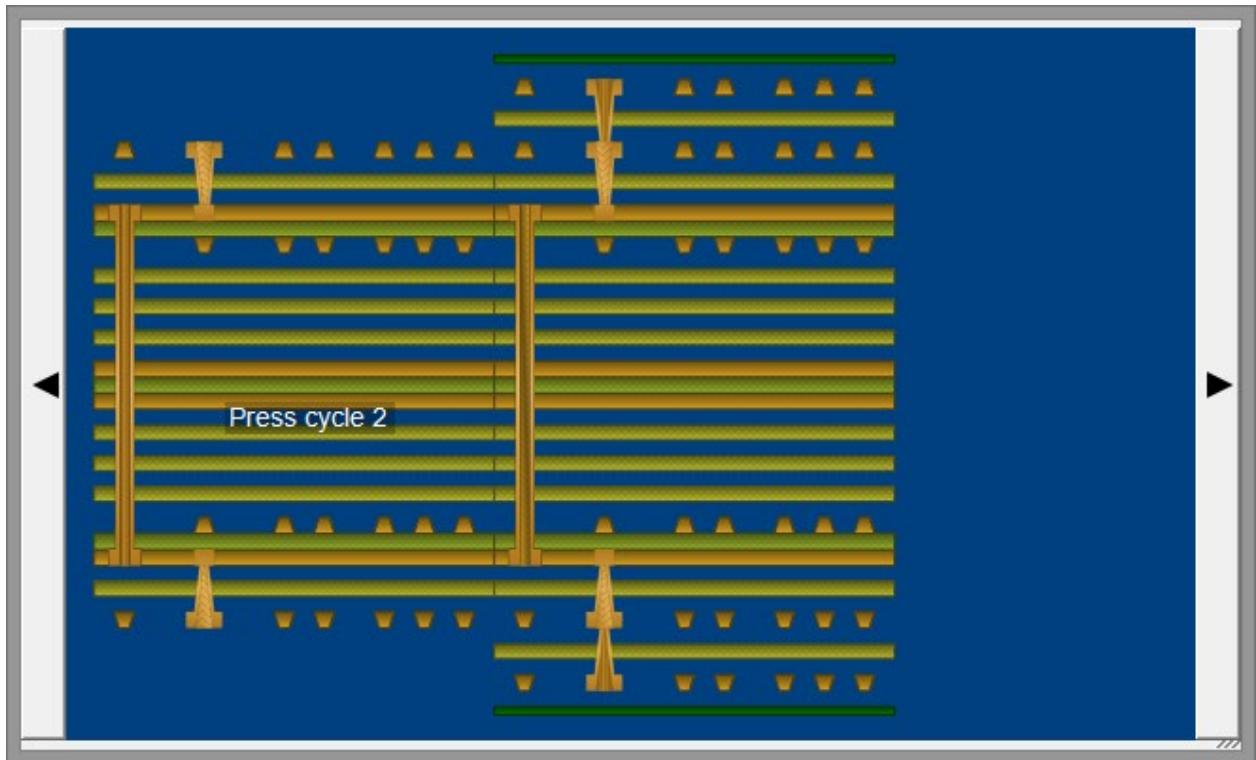


The Navigator displays the second press cycle alongside the master stack.

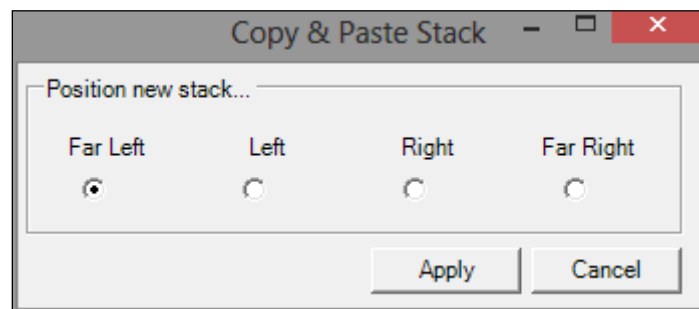


The sub-stack can be displayed either to the right or left of the master stack. Right click the sub-stack and from the context menu choose Move Left.

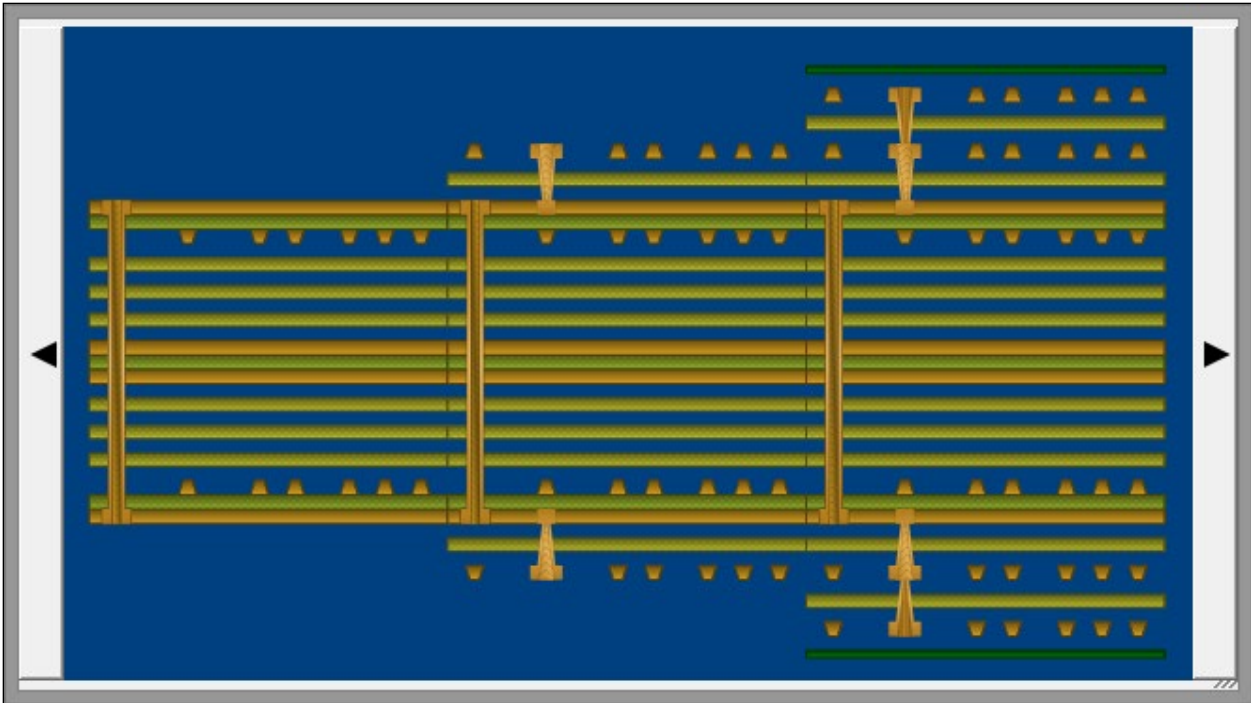
Sub-stack Press cycle 2 is shown to the left of the master.



To add the first press cycle right click the sub-stack and choose Copy and Paste Stack and position the new sub-stack to the far left.



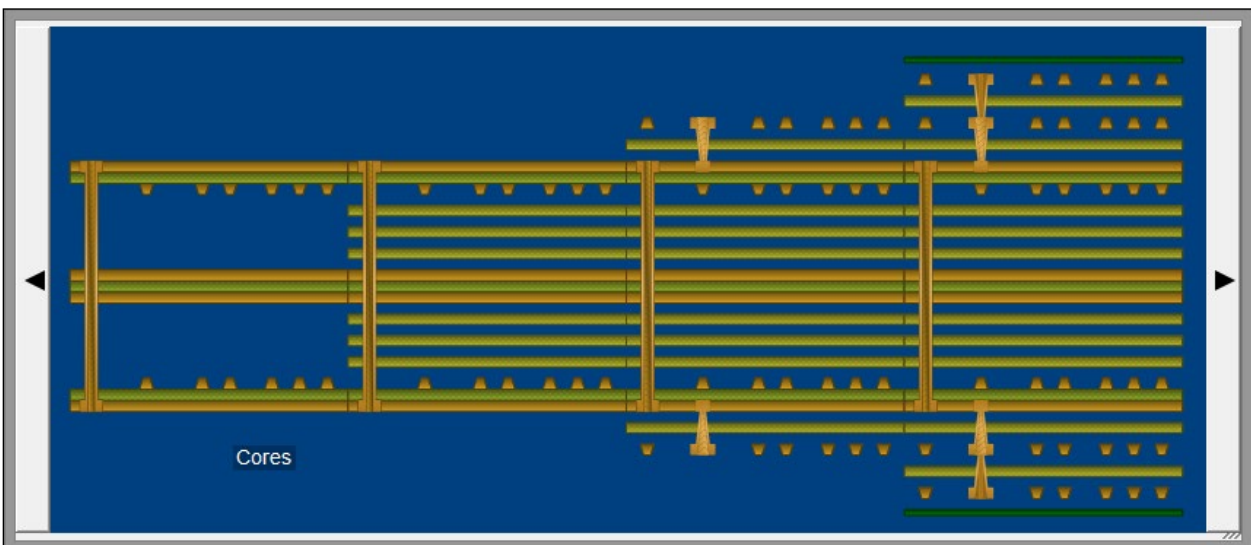
Modify the new sub-stack in the Stack Editor as previously described and display the completed stack in the Navigator.



Each press cycle appears as a separate stack in the Navigator.

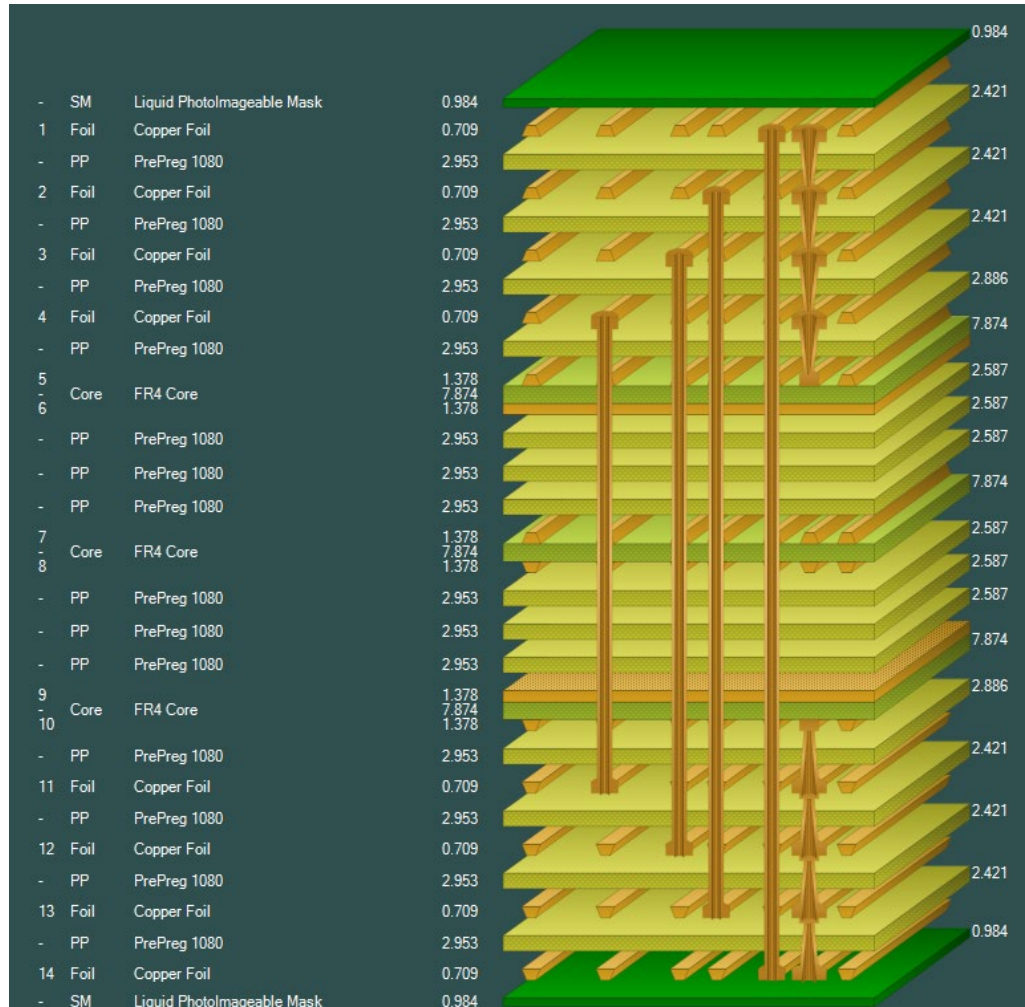
In the fabrication process the manufacturer will process all the core materials first, prior to bonding where each core is interleaved with prepreg materials. It is sometimes useful, therefore, to see all the core materials on a single sub-stack.

Right click the Navigator window and choose HDI Build|Expose Cores to display the core layers.

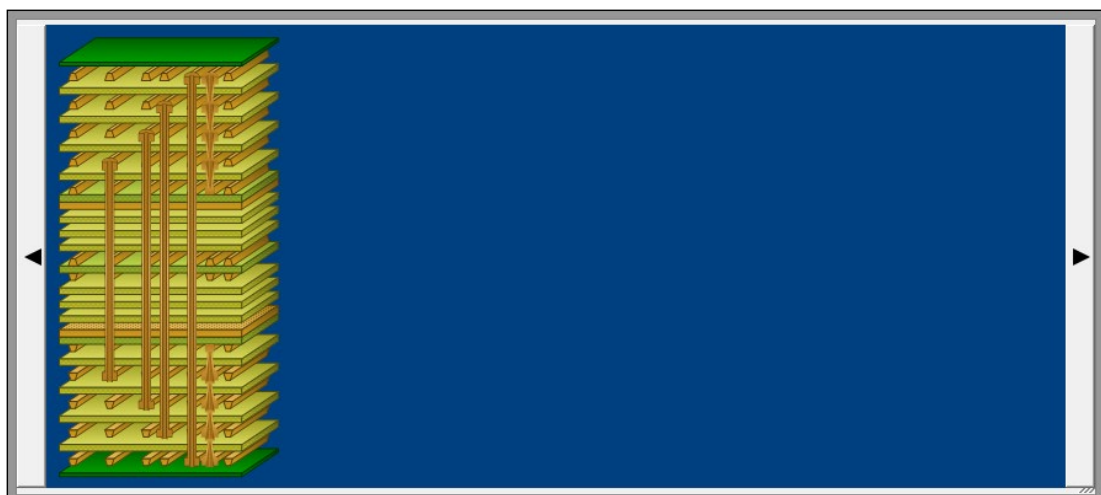


Using the Sequential Plan

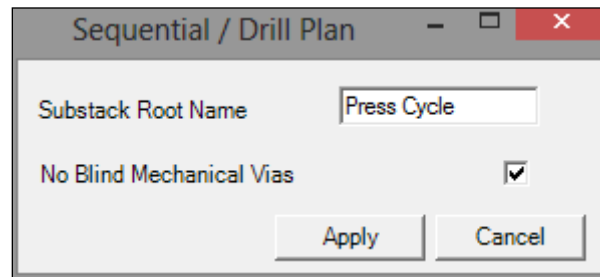
Sequential Plan creates sub-stacks that represents each press cycle in a sequential lamination from Master stack based on foil locations. Consider the 14-layer stack below – this stack will need several press cycles to manufacture.



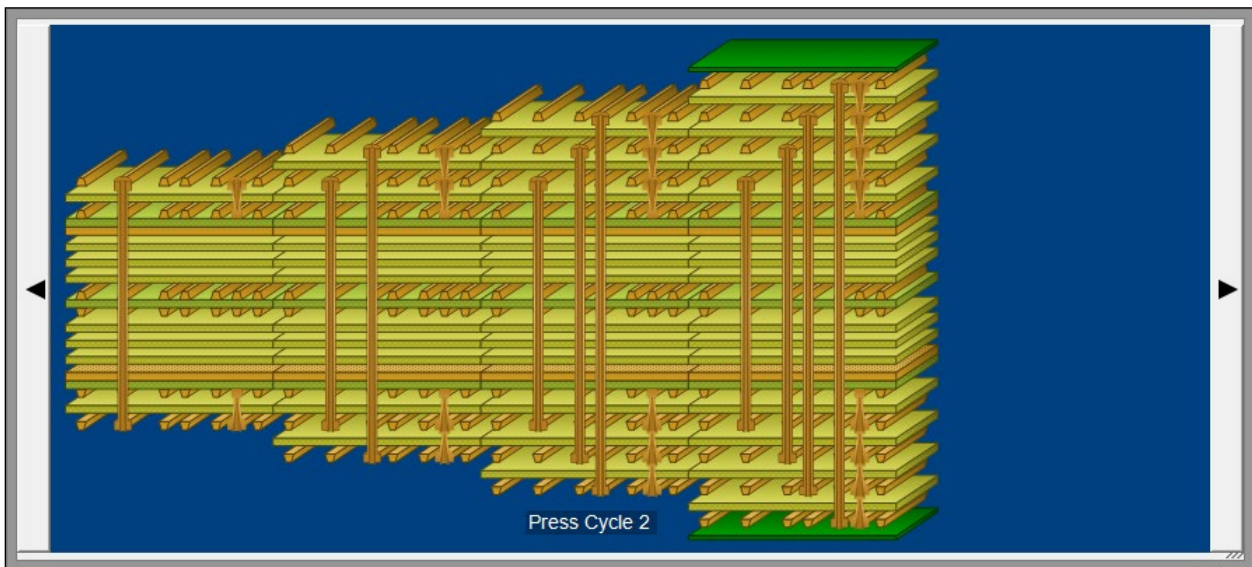
Opening the Navigator will display the completed master stack (shown below) in the Navigator window.



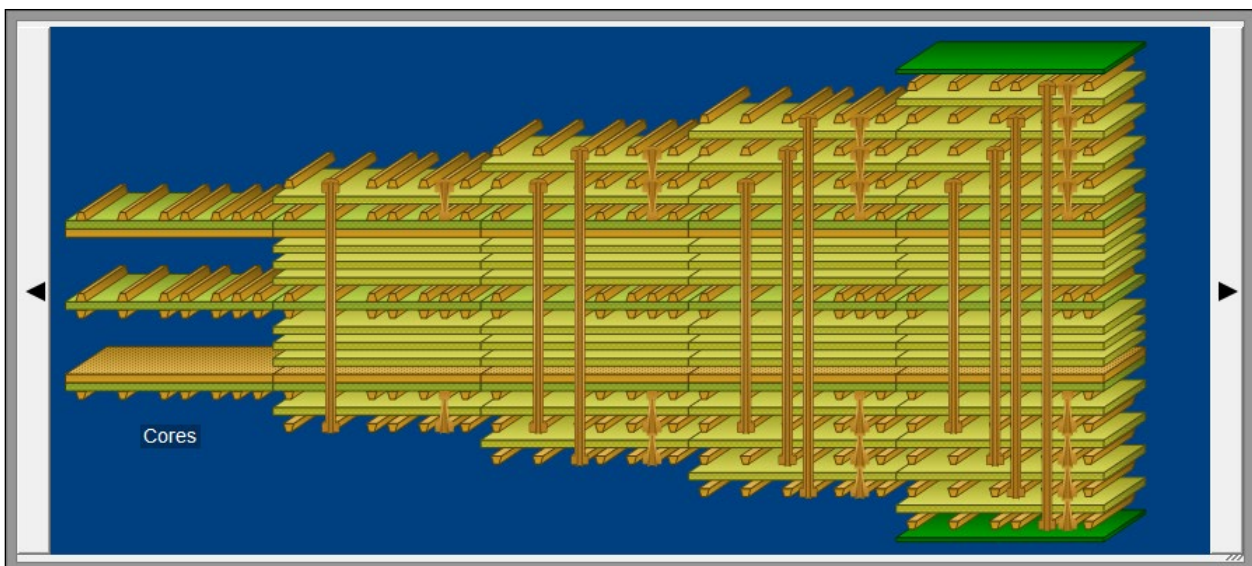
Right click the Navigator window and choose HDI Build | Sequential Plan and name the sub-stacks:



Click Apply – the Navigator displays the 4 press cycles

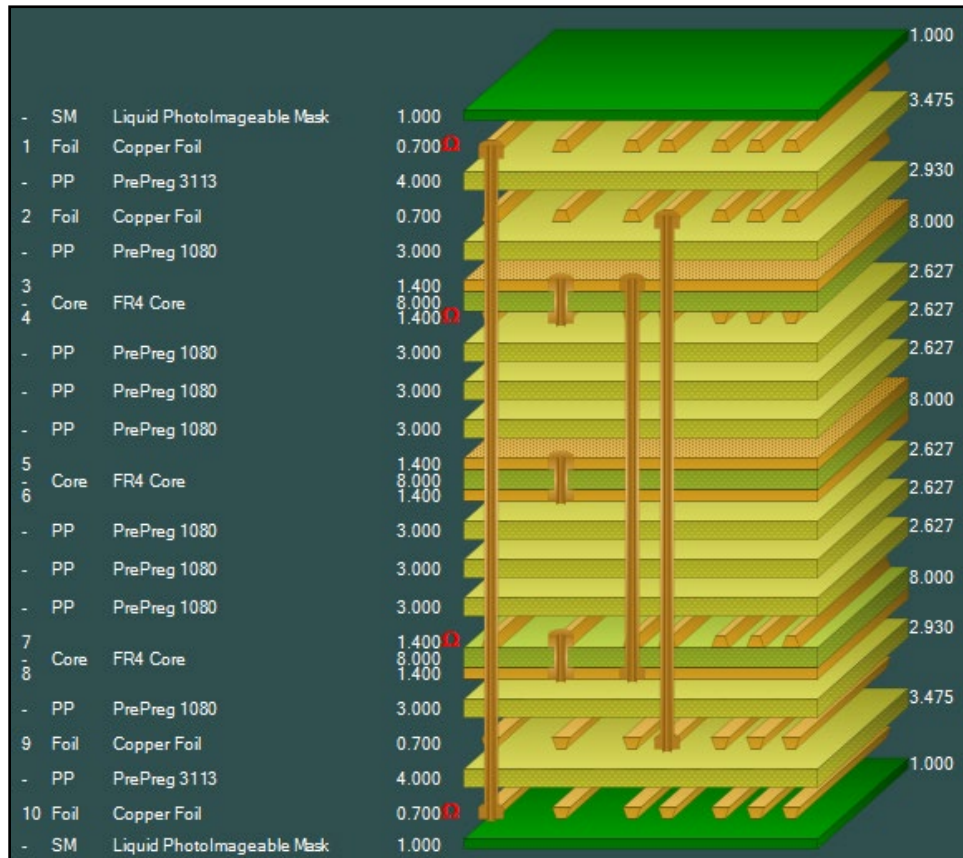


Choose HDI Build | Expose Cores – the cores are displayed in the Navigator window alongside the press cycles.

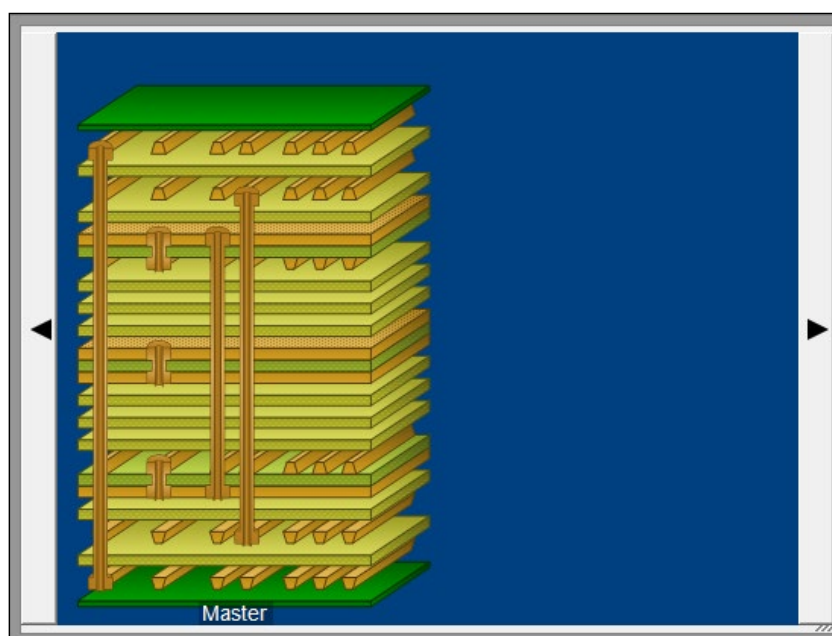


Using the Drill Plan

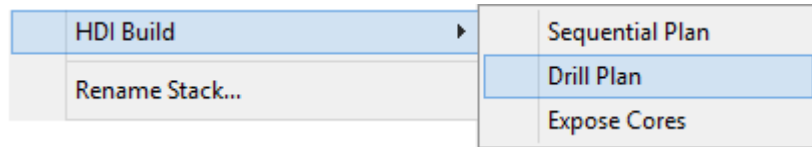
The HDI Build|Drill Plan creates sub-stacks that represents each press cycle from the Master stack based on drill start-end layers. Consider the stackup below – a 10 layer sequential lamination construction.



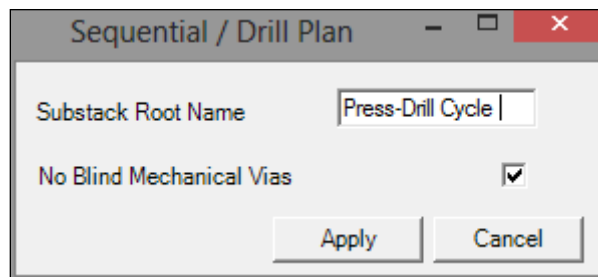
Press the F4 key to open the Navigator



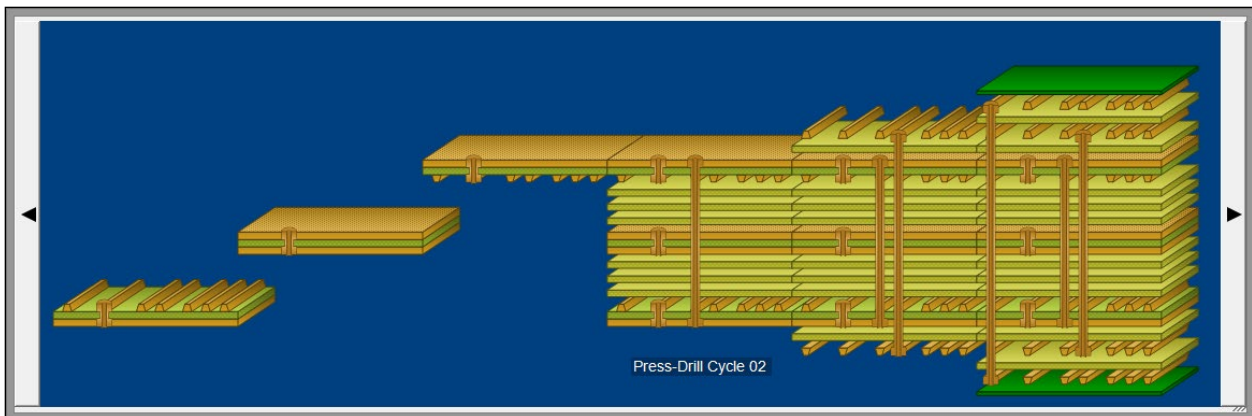
The completed Master stack is displayed. Right click the Navigator and choose HDI Build|Drill Plan.



Supply the Sub-stack root name – the name will be used when numbering the press-drill cycles.

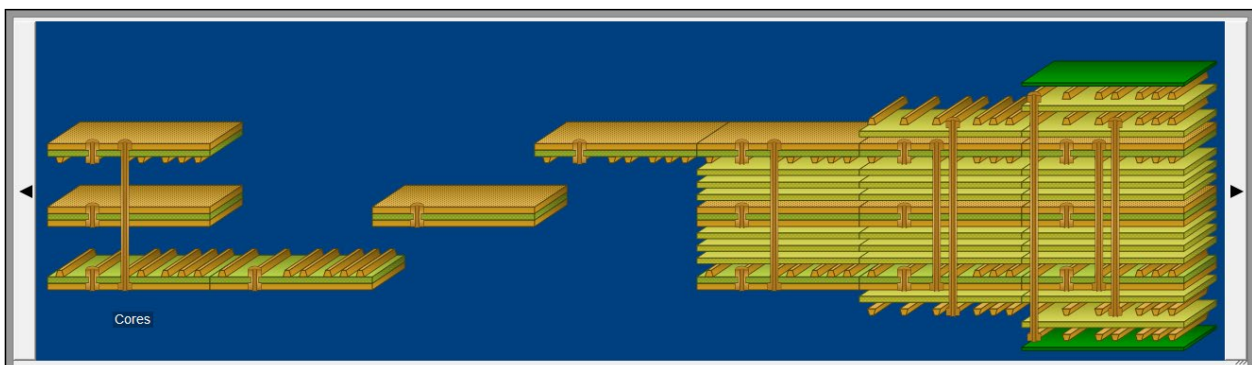


Click Apply – Speedstack documents the build-up stages of the sequential lamination.



Exposing cores

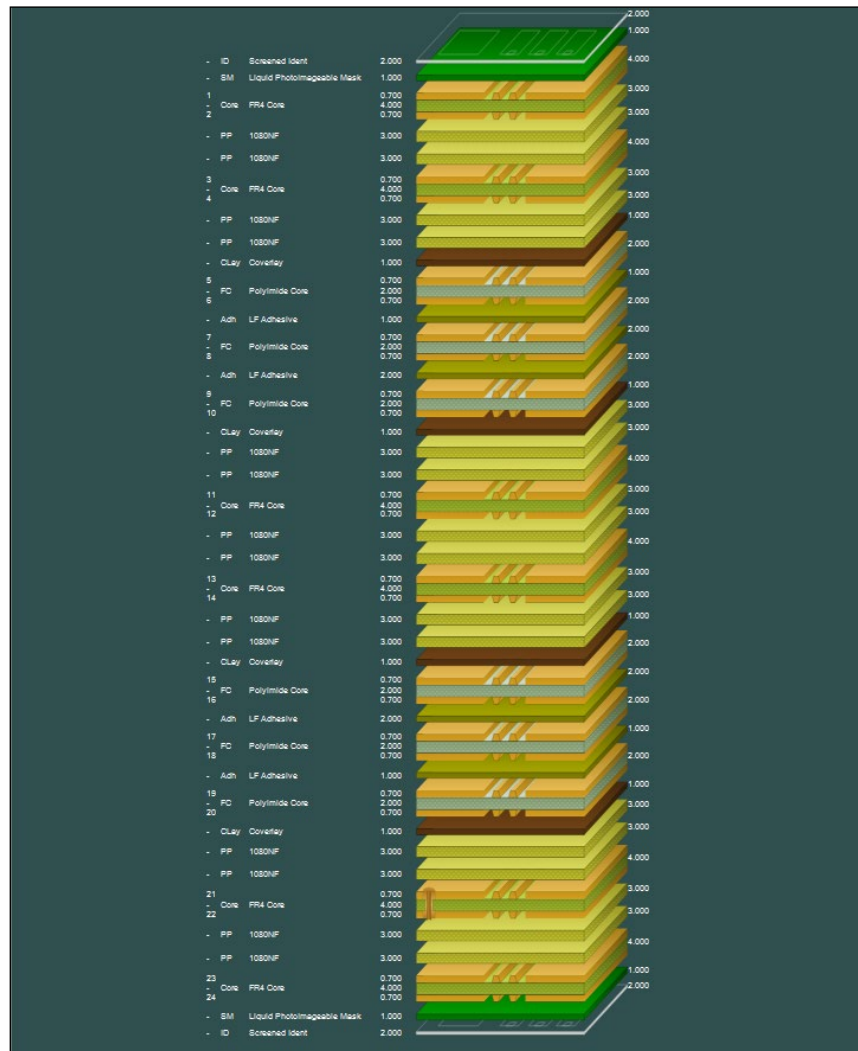
Right click the Navigator and choose HDI Build|Expose Cores – the cores are shown alongside the press cycles.



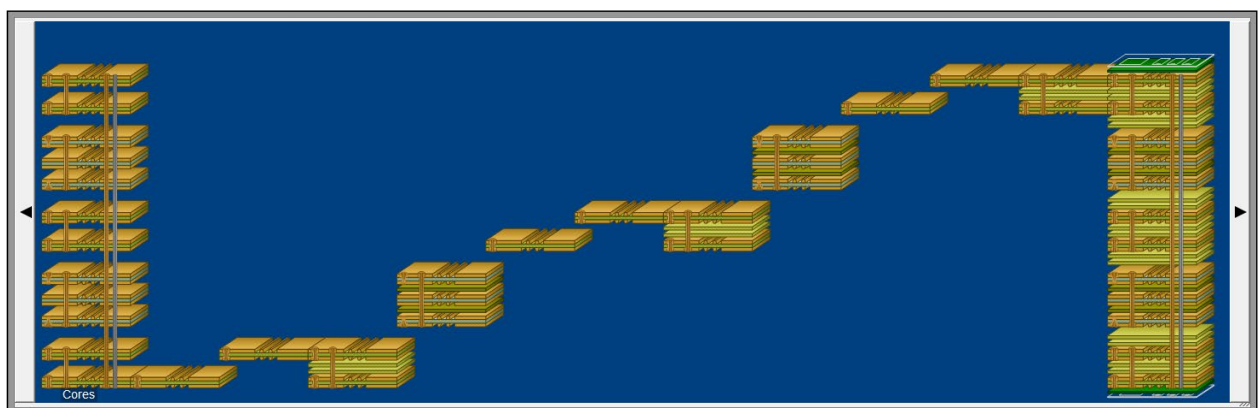
There are no limits to the number of press cycles that may be documented.

Working with multiple press cycles

The stack below is a 24 layer stack with multiple press-drill cycles. Open the Navigator, choose HDI Build|Drill Plan.



The Navigator displays the drill plan and cores below:



Printing the Navigator screen

From the File menu choose Print Technical Report – Speedstack prints the Navigator screen with its press cycles along with individual stack data, impedance data and drill data tables.

Using Speedstack materials libraries

The materials libraries allow designers to manage their own libraries of board materials. Libraries may be created and materials added. Up to date libraries of materials may be downloaded from the Polar Online Material Library.

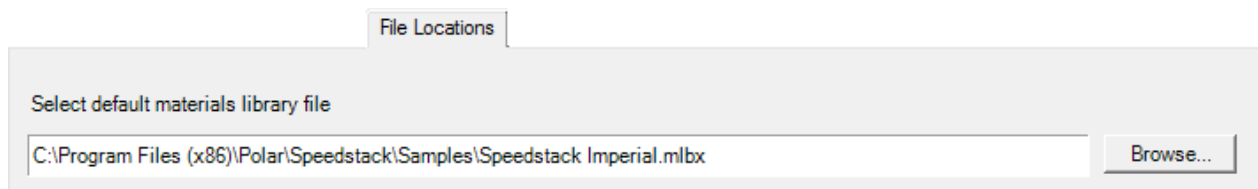


Materials Library

Click the Materials Library button to display the Materials Library window.

Working with the materials libraries

When Speedstack is started the materials library specified as the default materials library file (via Tools|Options|File Locations) is opened.



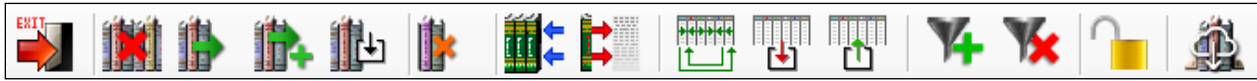
Each library component type is accessible via its associated tab. Click on the tab to view or edit the component type.

| Foils | Prepregs | RCCs | Cores | Solder Masks | Ident Inks | Peelable Masks | Coverlays | Bond Ply | Adhesive | Flexible Cores |
|---------------|----------------------|-------------|--------------|---------------------------|-------------------------------|---------------------|--------------|-------------------------|-------------------------|----------------|
| Supplier | Supplier Description | Description | Stock Number | Dielectric Base Thickness | Dielectric Finished Thickness | Dielectric Constant | Loss Tangent | Upper Cu Base Thickness | Lower Cu Base Thickness | Resin Content |
| Polar Samples | COI001 | FR4 Core | 400-001 | 50 | 50 | 4.2 | 0.0195 | 18 | 18 | 75 |
| Polar Samples | COI002 | FR4 Core | 400-002 | 50 | 50 | 4.2 | 0.0195 | 35 | 35 | 75 |
| Polar Samples | COI003 | FR4 Core | 400-003 | 50 | 50 | 4.2 | 0.0195 | 70 | 70 | 75 |
| Polar Samples | COI004 | FR4 Core | 400-004 | 75 | 75 | 4.2 | 0.0195 | 18 | 18 | 60 |
| Polar Samples | COI005 | FR4 Core | 400-005 | 75 | 75 | 4.2 | 0.0195 | 35 | 35 | 60 |
| Polar Samples | COI006 | FR4 Core | 400-006 | 75 | 75 | 4.2 | 0.0195 | 70 | 70 | 60 |
| Polar Samples | COI007 | FR4 Core | 400-007 | 100 | 100 | 4.2 | 0.0195 | 18 | 18 | 53 |
| Polar Samples | COI008 | FR4 Core | 400-008 | 100 | 100 | 4.2 | 0.0195 | 35 | 35 | 53 |
| Polar Samples | COI009 | FR4 Core | 400-009 | 100 | 100 | 4.2 | 0.0195 | 70 | 70 | 53 |
| Polar Samples | COI010 | FR4 Core | 400-010 | 125 | 125 | 4.2 | 0.0195 | 18 | 18 | 50 |
| Polar Samples | COI011 | FR4 Core | 400-011 | 125 | 125 | 4.2 | 0.0195 | 35 | 35 | 50 |
| Polar Samples | COI012 | FR4 Core | 400-012 | 125 | 125 | 4.2 | 0.0195 | 70 | 70 | 50 |
| Polar Samples | COI013 | FR4 Core | 400-013 | 150 | 150 | 4.2 | 0.0195 | 18 | 18 | 47 |
| Polar Samples | COI014 | FR4 Core | 400-014 | 150 | 150 | 4.2 | 0.0195 | 35 | 35 | 47 |
| Polar Samples | COI015 | FR4 Core | 400-015 | 150 | 150 | 4.2 | 0.0195 | 70 | 70 | 47 |
| Polar Samples | COI016 | FR4 Core | 400-016 | 200 | 200 | 4.2 | 0.0195 | 18 | 18 | 45 |
| Polar Samples | COI017 | FR4 Core | 400-017 | 200 | 200 | 4.2 | 0.0195 | 35 | 35 | 45 |
| Polar Samples | COI018 | FR4 Core | 400-018 | 200 | 200 | 4.2 | 0.0195 | 70 | 70 | 45 |
| Polar Samples | COI019 | FR4 Core | 400-019 | 300 | 300 | 4.2 | 0.0195 | 18 | 18 | 46 |
| Polar Samples | COI020 | FR4 Core | 400-020 | 300 | 300 | 4.2 | 0.0195 | 35 | 35 | 46 |
| Polar Samples | COI021 | FR4 Core | 400-021 | 300 | 300 | 4.2 | 0.0195 | 70 | 70 | 46 |
| Polar Samples | COI022 | FR4 Core | 400-022 | 540 | 540 | 4.2 | 0.0195 | 18 | 18 | 41 |
| Polar Samples | COI023 | FR4 Core | 400-023 | 540 | 540 | 4.2 | 0.0195 | 35 | 35 | 41 |
| Polar Samples | COI024 | FR4 Core | 400-024 | 540 | 540 | 4.2 | 0.0195 | 70 | 70 | 41 |
| Polar Samples | COI025 | FR4 Core | 400-025 | 1000 | 1000 | 4.2 | 0.0195 | 18 | 18 | 45 |
| Polar Samples | COI026 | FR4 Core | 400-026 | 1000 | 1000 | 4.2 | 0.0195 | 35 | 35 | 45 |
| Polar Samples | COI027 | FR4 Core | 400-027 | 1000 | 1000 | 4.2 | 0.0195 | 70 | 70 | 45 |
| Polar Samples | COI028 | FR4 Core | 400-028 | 1000 | 1000 | 4.2 | 0.0195 | 18 | 35 | 45 |
| Polar Samples | COI026 | FR4 Core | 400-028 | 1000 | 1000 | 4.2 | 0.0195 | 18 | 0 | 45 |

* Click on a material row to edit it

Materials library toolbar

Use the toolbar to load and save libraries, import or export libraries, arrange data columns and filter by data field or access the online or on-premise libraries. The Toolbar and button functions are shown below.



Exit library



Clear materials library



Open materials library



Open and Append



Save materials library



Clear current data table



Import CSV library



Export CSV library



Select & arrange column fields



Save column order



Load column order



Set filter



Clear filter



Library lock



Online / on-premise library



*Open Materials
Library*

Opening a library

To open, or load, a library click the Open Library icon and browse to the library; click Open – the currently loaded library will be replaced.



*Open and Append
Library*

Opening and appending a library

To open a library and add the materials to an existing library click the Open and Append Library icon, browse to the library and click Open: the material will be added to the existing library table.



*Clear Materials
Library*

Creating a new library

To create a new library, click Clear Materials Library; the library is removed from the library manager. Import materials as described below and save the library.



*Save Materials
Library*

Click Save Materials Library and supply a name and destination folder to create the new library. To have the library load as Speedstack starts, specify it as the default materials library file via Tools|Configuration Options|File Locations

Importing material to the Speedstack materials library

Speedstack allows users to add existing material lists (usually supplied from the material manufacturer data sheets) to its library; material data must be arranged in the format and order used by the Speedstack library.

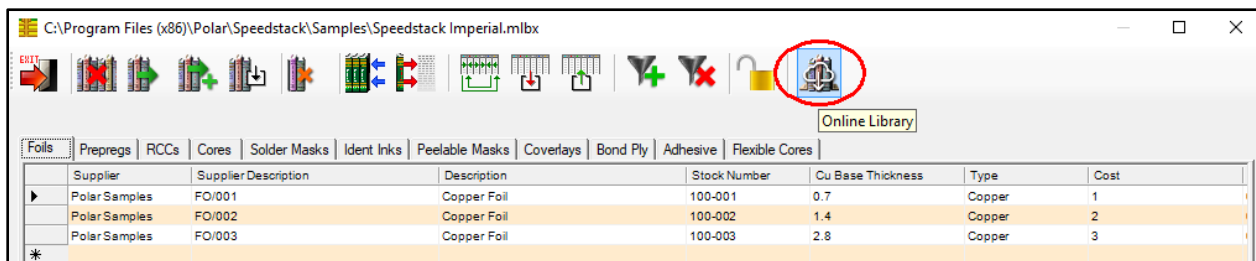
Library materials can be imported from the Polar Online / On-Premise Library or from local library files.

The Online Library comprises the most up to date copies of the material files supplied from materials manufacturers who are members of the Polar Speedstack Supplier Partner program. Each new version of Speedstack adds new materials to the Polar online library; utilisation of the online library requires access to the internet.

The On-Premise copy of the online library is available on request for Polarcare subscribers who may have restricted access to the internet (for example, as a result of IT security policies.). Contact polarcare@polarinstruments.com with your Polarcare Contract number and Speedstack version.

Importing from the Polar Online Library

Choose the material table tab (Foils, Prepregs, etc.) and click the Online Library icon.

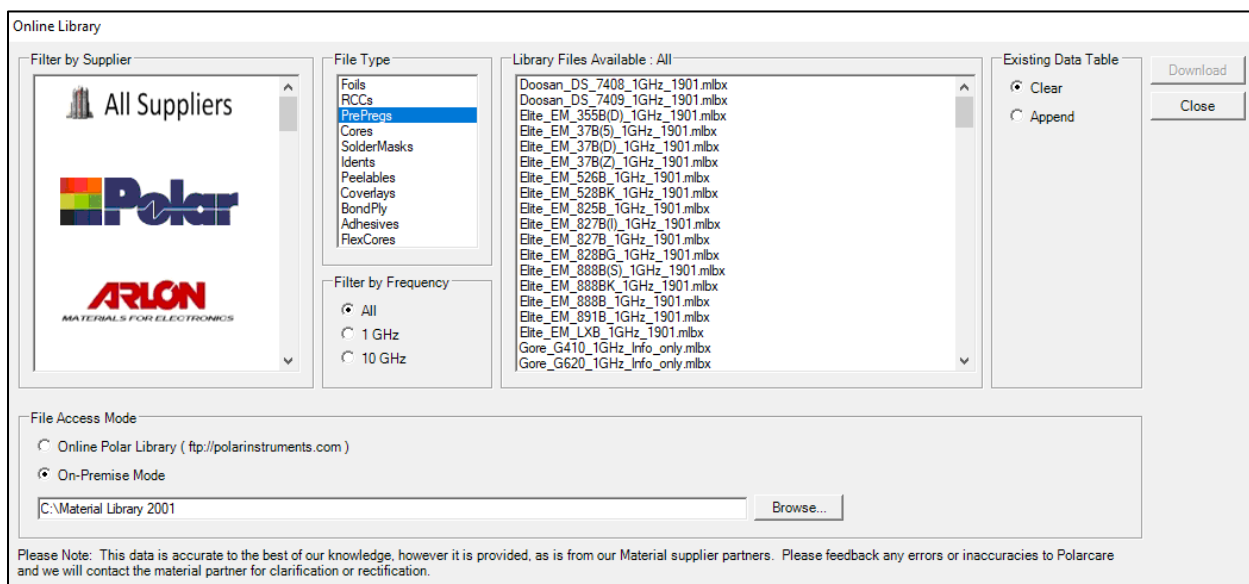


Speedstack connects to the Online Library and displays the materials available for each file type from all the suppliers in the Speedstack Supplier Partner program; click on a material supplier's name in the Filter by Supplier pane to view just the materials available from that supplier.

Filtering libraries by frequency

Material libraries contain values for dielectric constant (Dk) and loss tangent (Df) measured at frequencies specified by the supplier. The measurement frequency is indicated in the library file name.

Use the Filter by Frequency function to list all files or just the files with Dk and Df specified at 1GHz or 10GHz.



On-Premise libraries

Where access to the online library is unavailable or a local copy is required, a complete set of the online libraries is available on request to Polarcare subscribers; contact polarcare@polarinstruments.com with your Polarcare contract number and Speedstack version. The supplied libraries should be copied to a suitable local folder with the file/folder structure preserved. Choose On-Premise Mode and browse to the local copy: the library files should appear as a local online library; import materials as described above.

Downloadable mlbx files

Note that the Online Library only lists files with .mlbx extensions and that follow the file naming convention:

<Supplier>_<MaterialFamily>_<freq>_<release>.mlbx

(No spaces are permitted in downloadable library file names.)

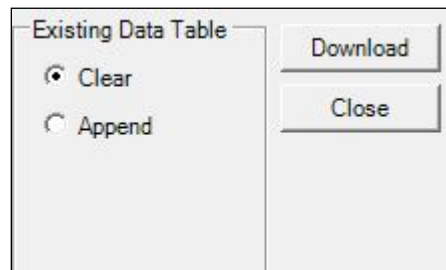
All .mlbx file names reflect the frequency at which dielectric constant and loss tangent is specified and the Speedstack release version.

Although the .mlbx file format will support multiple material types (Foils, Prepregs, Cores, etc.) in the same file *the downloadable .mlbx file only contains a single material type.*

Choosing material files

Browse through the list of available materials or scroll through the list of suppliers and choose a supplier to filter the materials by that supplier.

Choose the File Type and material. From the Existing Data Table dialog select Clear to replace the contents of the selected table type or Append to add the new materials to the table.



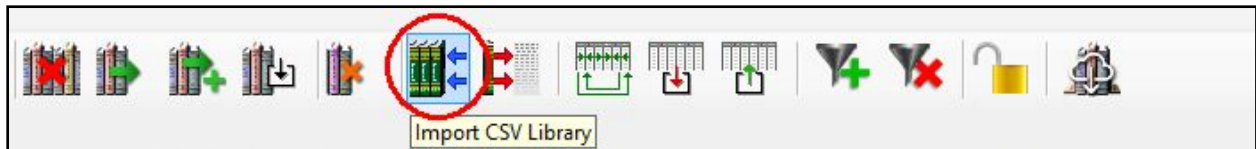
Click Download; repeat for each material to be added to the library then click Close.

Note: Many organisations connect to the Internet via proxy servers to provide caching and controlled access. In some cases, a proxy server may return library content in a format that prevents successful download into Speedstack. If your organisation connects to the internet via a proxy server, you may need to request the MIS department to grant address <ftp://polarinstruments.com> permission to bypass the proxy server – if this is not possible the libraries can be supplied for local (on-premise) access (see above.)

Importing from local material files

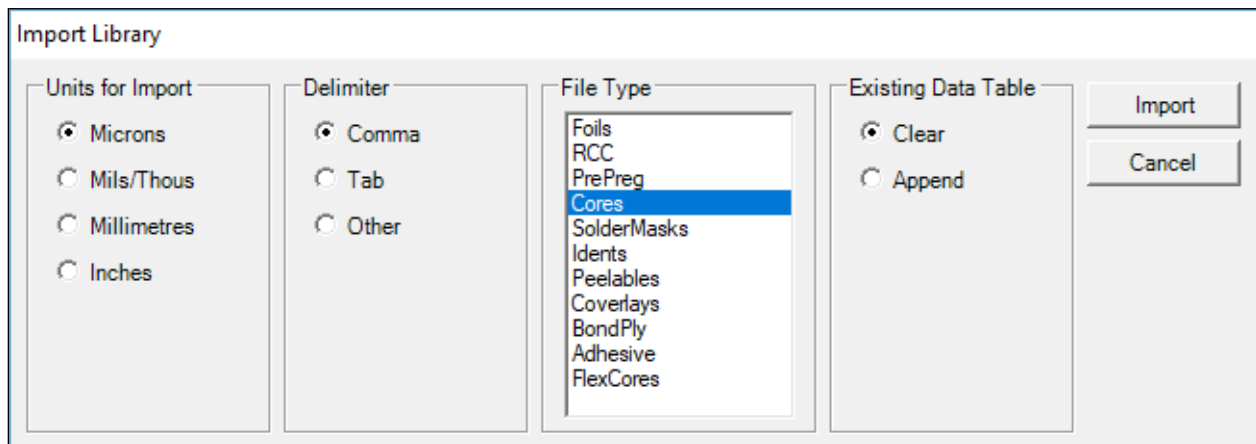
Prior to importing the material data file ensure the file is not open in another process (e.g. Microsoft® Excel®.)

Click the Speedstack Materials Library button to open the Library, and then click Import CSV Library to open the Import dialog.



| Supplier | Supplier Description | Description | Dielectric Base Thickness | Dielectric Finished Thickness | Dielectric Constant | Upper Cu Base Thick |
|---------------|----------------------|-------------|---------------------------|-------------------------------|---------------------|---------------------|
| Polar Samples | CO/001 | FR4 Core | 50 | 50 | 4.2 | 18 |
| Polar Samples | CO/002 | FR4 Core | 50 | 50 | 4.2 | 35 |
| Polar Samples | CO/003 | FR4 Core | 50 | 50 | 4.2 | 70 |
| Polar Samples | CO/004 | FR4 Core | 75 | 75 | 4.2 | 18 |
| Polar Samples | CO/005 | FR4 Core | 75 | 75 | 4.2 | 35 |
| Polar Samples | CO/006 | FR4 Core | 75 | 75 | 4.2 | 70 |
| Polar Samples | CO/007 | FR4 Core | 100 | 100 | 4.2 | 18 |
| Polar Samples | CO/008 | FR4 Core | 100 | 100 | 4.2 | 35 |

When importing materials set the Import options in the Import Library dialog: specify the units, delimiter and material type and specify whether the material will be used to clear the current data table or append to the existing library.



Replacing existing material tables

Choose the Clear Existing Data Table option and choose the field delimiter type. The library import function can accept files in a variety of formats, tab delimited, comma separated and Excel worksheet and template formats but must be in the format of the supplied sample files with columns in the correct order.

Specify the units for import, file delimiter and choose the file type (Foil, RCC, Prepreg, etc.) and click Import. Navigate to the file via the Open dialog and click Open.

Repeat the procedure for every file type to be imported. Save the file as a .mlbx library file.

Adding material data to an existing library

To add material data to an existing library table, open the library, click Import CSV Library, click the Append to Existing Data Table and click Import.

Navigate to the .csv or .txt file and click Open. Save the modified library file as a .mlbx file.

Exit the library when all file types have been imported.

Adding new material to the data tables

Caution: ensure consistency of units

When defining dimensions, e.g. layer thicknesses, for a stackup ensure that all measurements are defined using the same units (mils, mm, etc.) throughout the structure and its associated libraries.

Open the library to be modified. To add individual materials to a library click the associated component type tab; click onto a material, or empty line. An editing box will open which will contain the material clicked on, or the last material in that type library.

| Review/Edit Cores | | | |
|---|--|--------|-------------------------------|
| Supplier | <input type="text" value="Polar Samples"/> | Size | <input type="text" value=""/> |
| Supplier Description | <input type="text" value="CO/022"/> | Note 1 | <input type="text" value=""/> |
| Description | <input type="text" value="FR4 Core"/> | | |
| Stock Number | <input type="text" value="400-022"/> | | |
| Type | <input type="text" value="FR4"/> | Note 2 | <input type="text" value=""/> |
| Base Thickness | <input type="text" value="540.00"/> | | |
| Finished Thickness | <input type="text" value="540.00"/> | | |
| Dielectric Constant | <input type="text" value="4.2"/> | Note 3 | <input type="text" value=""/> |
| Loss Tangent | <input type="text" value="0.0195"/> | | |
| Resin Content | <input type="text" value="41"/> | | |
| Tg | <input type="text" value="180"/> | Note 4 | <input type="text" value=""/> |
| Td | <input type="text" value="0"/> | | |
| CAF Resistance | <input type="text" value="0"/> | | |
| Z Axis Expansion | <input type="text" value="0"/> | Note 5 | <input type="text" value=""/> |
| Tolerance +/-% | <input type="text" value="10"/> | | |
| Upper Cu Thickness | <input type="text" value="18.00"/> | | |
| Lower Cu Thickness | <input type="text" value="18.00"/> | | |
| Cost | <input type="text" value="22"/> | | |
| Lead Time | <input type="text" value="0"/> | | |
| Use in Auto Stack | <input checked="" type="checkbox"/> | | |
| Planes Both Sides | <input type="checkbox"/> | | |
| Laser Drillable | <input type="checkbox"/> | | |
| <div><input type="button" value="Add"/> <input type="button" value="Delete"/> <input type="button" value="22 of 29"/> <input type="button" value="OK"/></div> | | | |

The material can be edited or deleted, or a new material can be added. To speed up the process of adding families of materials, when a material is added the properties of the last

material are copied to the new material. The details can then be edited. Clicking OK will add any new materials to the end of the list.

Importing material to the data tables

Speedstack allows users to add existing material lists to its library; material data must be arranged in the format and order used by the Speedstack library.

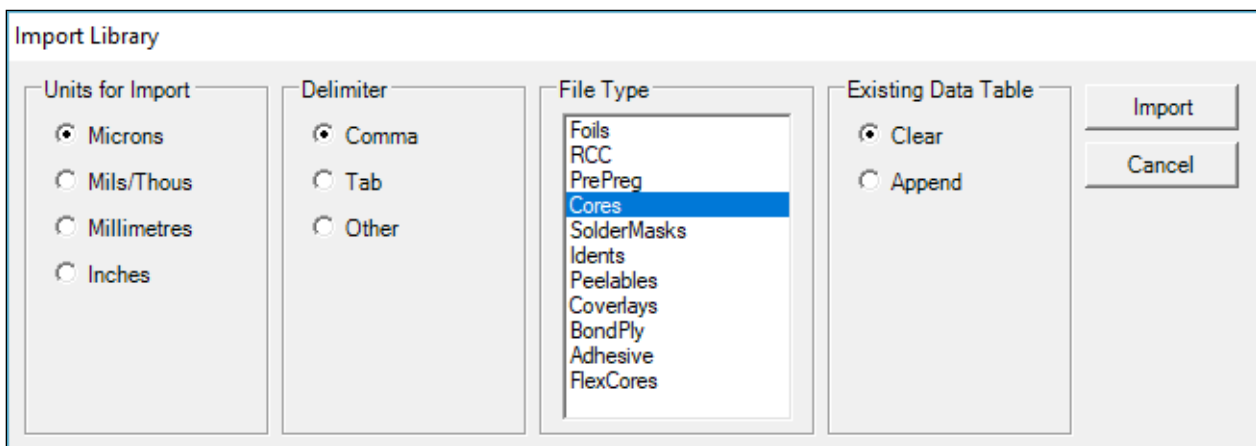
Library sample files

Sample files for all material types in comma separated value format and Microsoft Excel spreadsheet and template formats suitable for importing to the Speedstack are available on request from Polar Instruments.



Import CSV Library

Click the Materials Library button to open the Library, and then click Import CSV Library to open the Import dialog.



Choose Clear or Append to Existing Data Table as appropriate.

Creating a new materials library table

Choose Clear Existing Data Table, click Export Library as CSV and choose microns as units and the field delimiter type and click Export. The data table is exported as a “template”.

Open the file in a suitable text file editor – the file below is opened in Microsoft Excel and shows the file header rows with the column headers in the order and format expected by the Speedstack library manager. Add the material data to the associated columns and save in text format. As noted above, templates for all materials are available on request from Polar Instruments.

| | A | B | C | D | E | F | G | H | I | J | K | L | M | N |
|---|-------|----------|----------------------|-------------|--------------|--------------|------|-----------|---------|---------|---------|---------|---------|------|
| 1 | *Foil | | | | | | | | | | | | | |
| 2 | *Type | Supplier | Supplier Description | Description | Stock Number | Cu Thickness | Cost | Lead Time | Notes 1 | Notes 2 | Notes 3 | Notes 4 | Notes 5 | Size |
| 3 | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | |

Empty Foils library table

The library import function can accept files in a variety of formats, tab delimited, comma separated and Excel worksheet and template formats.

Sections of the sample files suitable for Speedstack are shown below.

| | A | B | C | D | E | F | G | H | I |
|----|---------|---------------|----------------------|-------------|--------------|--------------------|--------------------|----------------|--------------------|
| 1 | * Cores | | | | | | | | |
| 2 | * | | | | | | | Dielectric | Dielectric |
| 3 | *Type | Supplier | Supplier Description | Description | Stock Number | Upper Cu Thickness | Lower Cu Thickness | Base Thickness | Finished Thickness |
| 4 | FR4 | Polar Samples | CO/001 | FR4 Core | 400-001 | 0.018 | 0.018 | 0.05 | 0.05 |
| 5 | FR4 | Polar Samples | CO/002 | FR4 Core | 400-002 | 0.035 | 0.035 | 0.05 | 0.05 |
| 6 | FR4 | Polar Samples | CO/003 | FR4 Core | 400-003 | 0.07 | 0.07 | 0.05 | 0.05 |
| 7 | FR4 | Polar Samples | CO/004 | FR4 Core | 400-004 | 0.018 | 0.018 | 0.075 | 0.075 |
| 8 | FR4 | Polar Samples | CO/005 | FR4 Core | 400-005 | 0.035 | 0.035 | 0.075 | 0.075 |
| 9 | FR4 | Polar Samples | CO/006 | FR4 Core | 400-006 | 0.07 | 0.07 | 0.075 | 0.075 |
| 10 | FR4 | Polar Samples | CO/007 | FR4 Core | 400-007 | 0.018 | 0.018 | 0.1 | 0.1 |
| 11 | FR4 | Polar Samples | CO/008 | FR4 Core | 400-008 | 0.035 | 0.035 | 0.1 | 0.1 |

Sample Cores library file in Microsoft Excel format

```
* Cores,,,,,,,,,,,,,
*,,,,,,Dielectric,Dielectric,Dielectric,Dielectric,Dielectric,Dielectric,Dielectric,Dielectric,Dielectric,Dielectric,Dielectric,,,,,,
*Type,Supplier,Supplier Description,Description,Stock Number,Upper Cu Thickness,Lower Cu Thickness,Base Thickness,Finished Thickness,
Content,Tg,Td,CAF Resistance,ZAxisExpansion,ExcessResin,Tolerance,Cost,Lead Time,Notes 1,Notes 2,Notes 3,Notes 4,Notes 5,Size
FR4,Polar Samples,CO/001,FR4 Core,400-001,0.018,0.018,0.05,0.05,4.2,75,180,0,0,0,0,10,0,0,,,,,*
FR4,Polar Samples,CO/002,FR4 Core,400-002,0.035,0.035,0.05,0.05,4.2,75,180,0,0,0,0,10,0,0,,,,,*
FR4,Polar Samples,CO/003,FR4 Core,400-003,0.07,0.07,0.05,0.05,4.2,75,180,0,0,0,0,10,0,0,,,,,*
FR4,Polar Samples,CO/004,FR4 Core,400-004,0.018,0.018,0.075,0.075,4.2,60,180,0,0,0,0,10,0,0,,,,,*
```

Sample library file in comma separated format

Files for importing into the library must be in the above format, *with columns in the correct order*.

Specify the delimiter if necessary and choose the file type (Foil, RCC, Prepreg, etc.) and units for import and click Import and Clear or Append as required.

Choose the file from the list displayed in the Open dialog and click Open. Repeat the procedure for every file type. Save the file as a .mlbx library file.

Exit the library manager when all file types have been imported.

Adding material data to an existing library

To add material data to an existing library, open the library click Import CSV Library, click the Append to Existing Data Table and click Import.

Choose the .csv or .txt file and click Open. Save the modified Library file as a .mlbx file.

Selecting Materials from the Library

Column Order (Materials Library)

The default setting displays all columns. The columns displayed and the order they are displayed can be set in the materials Library form.

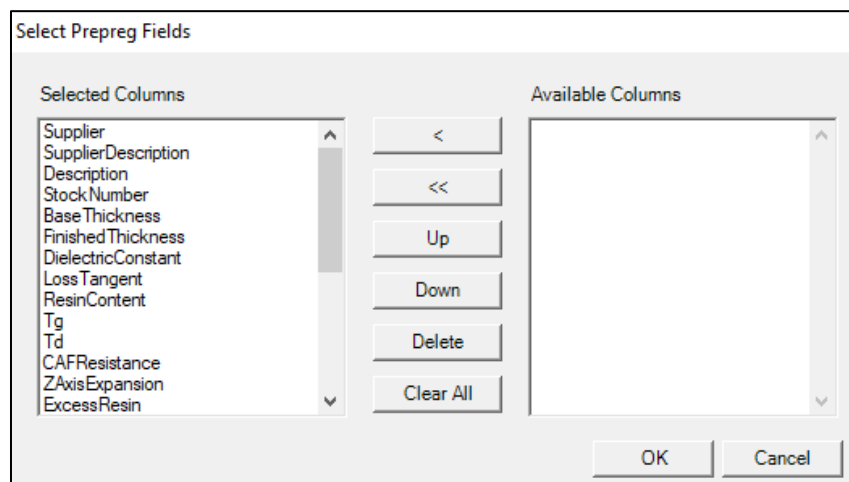
Arranging Columns in Library Forms

The Library windows can be customised in respect of which columns to display and in which order.

Click the Go to Materials Library button and select Arrange Columns; the dialog associated with the selected material tab (Foils, Prepregs, etc.) is opened.



Arrange Columns



The Left box of the dialog shows the columns that will be displayed and the order top to bottom is the order they will be displayed left to right in the library window.

Click OK to return to the Materials Library, which will show the columns as set.

Until the column order is saved the column order is only available during the current session. Click Save Column Order to define the selected column order as the default order whenever the program is run.



Save Column Order



Load Column Order

Click Load column Order to apply a saved column arrangement.

Filtering Materials

When adding or swapping materials, available materials (Foils, Prepregs, etc.) are listed in the associated material library dialog. Lists can be filtered for materials matching desired parameters (dielectric thickness, Er, etc.)



.Set Filter

In the library window click the Set Filter to display the Set Filter String dialog.

| Field | Operand | Criteria | AND/OR |
|-------------------------------|---------|----------|--------|
| Dielectric Finished Thickness | >= | 5 | AND |
| Dielectric Finished Thickness | <= | 7 | (null) |

Dielectric Finished Thickness >= 5 AND Dielectric Finished Thickness <= 7

FinishedThickness >= 5 AND FinishedThickness <= 7

Filter strings can be created and saved for future use. To save click Save Filter, to recall an existing filter click the Load Filter button, choose the filter (.mlf) file and click OK.

Building the filter string

Build the filter string by selecting parameters, operands and criteria from the drop-down boxes. If the AND/OR box is selected another row is automatically added to the grid. The filter language is a sub-set of common database commands.

Use the Up/Down buttons to select a row for deletion. The arrowhead at the side of the grid indicates the selected row.

Click OK to apply the filter immediately to the selected library. If desired, save the filter string for future use. (The Speedstack provides for interaction between the library dialog and filter form. This allows complex strings to be built line-by-line and tested without saving until the string is completed.)

When saving the filter choose a descriptive name for the file that reflects the purpose of the filter. The Speedstack automatically names the files for the material type.

Using the Like operator

Use the Like operand to filter results via wild card characters. The characters * and % can be used to represent groups of starting or ending characters.

For example, specifying Like 'Po%' or 'Po*' as the criterion for the Suppliers field will show all suppliers beginning with 'Po'.

Similarly, specifying Like '%es' or '*es' as the criterion for the Suppliers field will show all suppliers ending with 'es'.

Click the Clear Filter to remove the filter and display all materials of the selected type.



Clear Filter

Locking the library

The materials library can be locked and password protected to prevent unauthorised or accidental editing. If no password has been set the Material Library remains open for any changes and modifications.

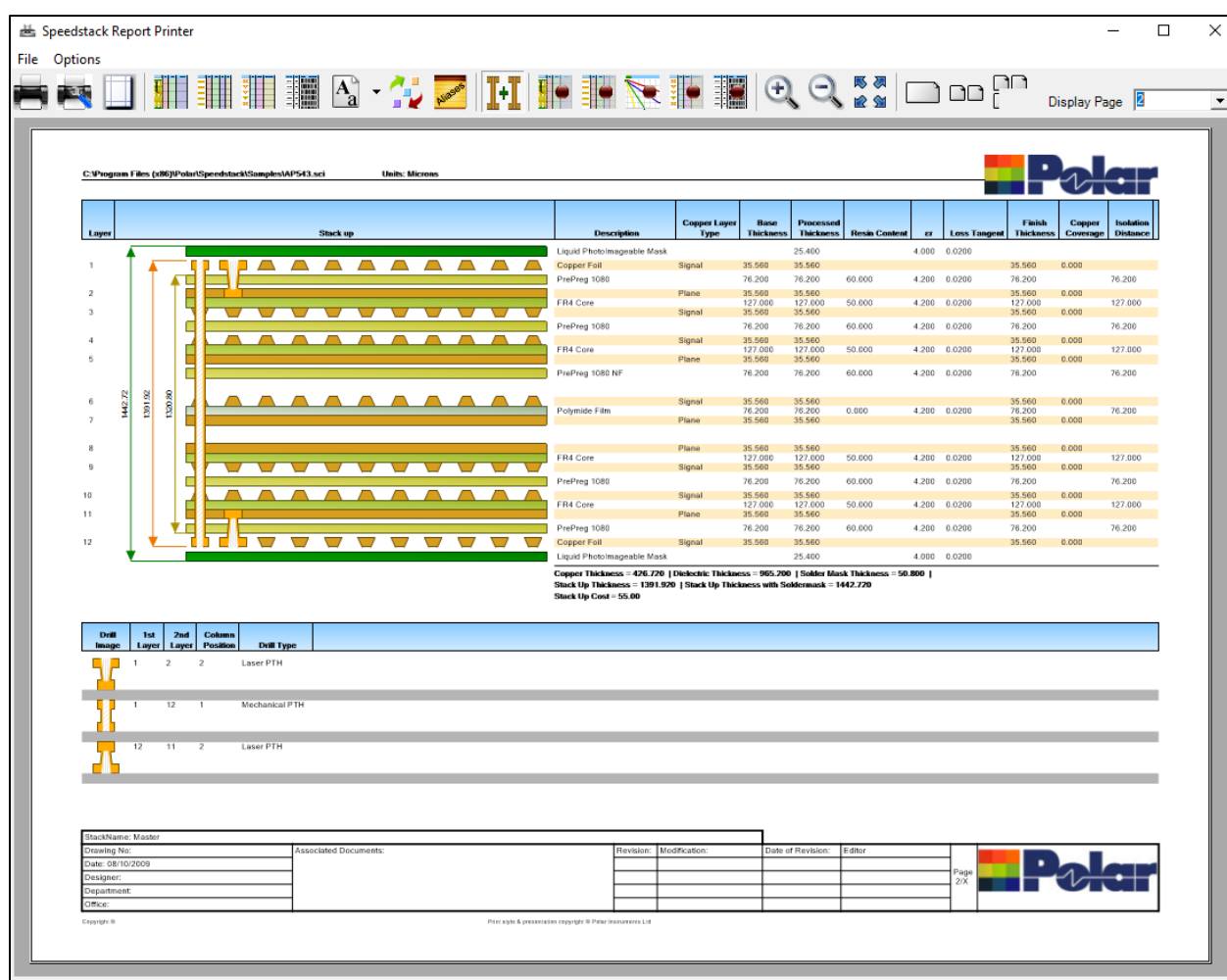
To lock the library, click the Library Lock button and supply a password; the library is then locked and any editing requires the password to be entered (via clicking on the padlock). Once unlocked it will remain unlocked until Speedstack is closed or the padlock is clicked again.



Library Lock

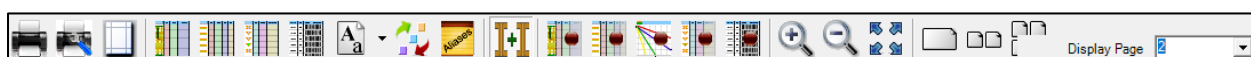
Printing stackup information

To print the stackup information, choose the Print command. Print Technical Report includes stack details, controlled impedance structures – with optional loss frequency graphs for each structure, drill specifications, bill of materials information, frequency dependent properties and information entered into the Stack File Properties.



Speedstack Report Printer toolbar

The Speedstack Report Printer toolbar provides shortcut access to the most commonly used printing commands.



Use these commands to set up the printer, page orientation and margins, font size and printing order, select data columns for display, display or suppress data tables and choose the on-screen zoom levels. Button functions are described below.



Send report to printer



Print set up – choose printer, print range, copies



Page set up – orientation and margins



Select stack data columns



Select impedance data columns



Select drill data columns



Select BOM data columns



Change font size



Select stack/drills/impedance/notes print order



Set note field aliases



Show expanded drills – toggle wide stack and narrow stack image



Toggle suppress stack data table



Toggle suppress controlled impedance data table



Toggle suppress frequency dependent loss graphs



Toggle suppress drill data table



Toggle suppress BOM data table



Zoom in / Zoom out



Fit page to viewer



Preview one / two / four pages

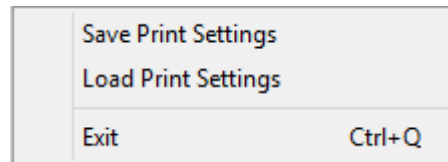
Display Page

Display Page select

Speedstack Report Printer menu system

File menu

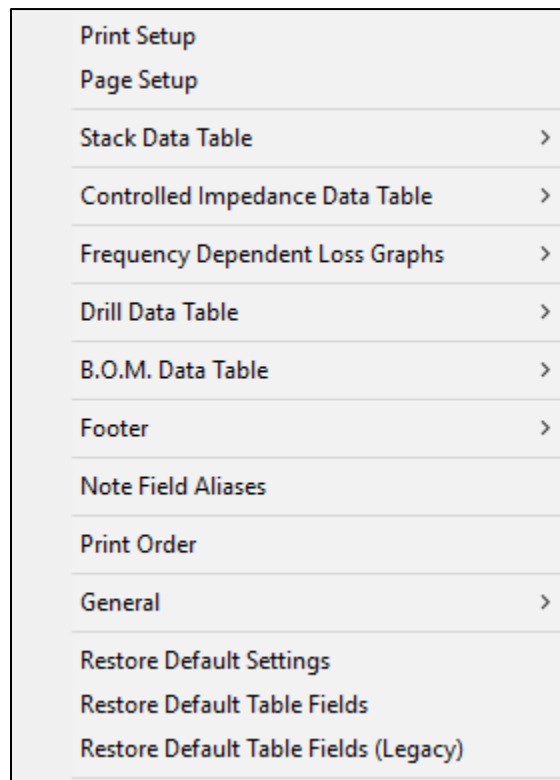
Use the File menu under the Printing window to save and load print settings.



Whichever settings were last used in a session will become the default when the Printing window is next loaded.

Options menu

The Speedstack Report Printer Options menu contains all the settings for printing.



Print Setup

Use the Print Setup command to choose the target printer, along with its properties, the range of pages to print and

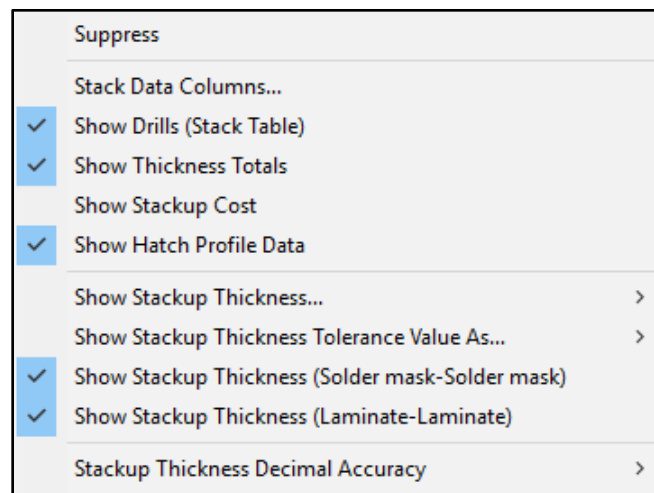
number of copies. Optionally, click the Print to file check box to save the output to a file (e.g. to save the file as a document in PDF format) when printed.

Page Setup

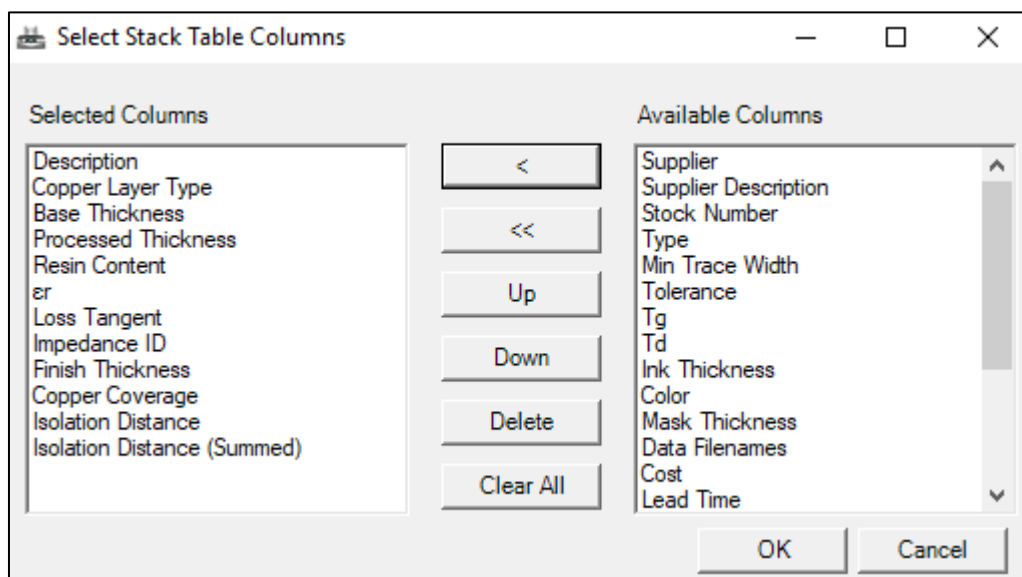
Page Setup displays the Page Setup dialog to change the size and orientation, paper source and margins.

Stack Data Table

The Stack Data Table commands allow for optional display of stack parameters, drills, thickness totals and tolerances.



Stack Data Columns: select, combine and order the data columns available for the stack as desired.



The stack data table is displayed in selected column order:

| Layer | Stack up | Description | Copper Layer Type | Base Thickness | Processed Thickness | Resin Content | zr | Loss Tangent | Impedance ID | Finish Thickness | Copper Coverage | Isolation Distance | Isolation Distance (Summed) |
|--|----------|-----------------------------|-------------------|----------------|---------------------|---------------|-------|--------------|--------------|------------------|-----------------|--------------------|-----------------------------|
| 1 | | Liquid Photolamageable Mask | | | 25.400 | | 4.000 | 0.0195 | | | | | |
| | | Copper Foil | Signal | 17.780 | 17.780 | | | | 1.2 | 17.780 | 0.000 | | |
| 2 | | PrePreg 1080 | | 76.200 | 49.530 | 60.000 | 4.200 | 0.0195 | | 76.200 | | 49.530 | 49.530 |
| 3 | | FR4 Core | Signal | 35.560 | 35.560 | 60.000 | 4.200 | 0.0195 | | 35.560 | 0.000 | 76.200 | 76.200 |
| | | PrePreg 3080 | Plane | 76.200 | 70.510 | 60.000 | 4.200 | 0.0195 | | 76.200 | | 70.510 | 352.552 |
| | | PrePreg 1651 | | 152.400 | 141.021 | 47.000 | 4.200 | 0.0195 | | 152.400 | | 141.021 | - |
| | | PrePreg 1651 | | 152.400 | 141.021 | 47.000 | 4.200 | 0.0195 | | 152.400 | | 141.021 | - |
| 4 | | FR4 Core | Signal | 35.560 | 35.560 | 46.000 | 4.200 | 0.0195 | 3 | 35.560 | 0.000 | 304.800 | 304.800 |
| 5 | | PrePreg 1651 | Signal | 304.800 | 304.800 | | | | | 304.800 | 0.000 | | |
| | | PrePreg 1651 | | 152.400 | 141.021 | 47.000 | 4.200 | 0.0195 | | 152.400 | | 141.021 | 352.552 |
| | | PrePreg 1651 | | 152.400 | 141.021 | 47.000 | 4.200 | 0.0195 | | 152.400 | | 141.021 | - |
| | | PrePreg 3080 | | 76.200 | 70.510 | 60.000 | 4.200 | 0.0195 | | 76.200 | | 70.510 | - |
| 6 | | FR4 Core | Plane | 35.560 | 35.560 | | | | | 35.560 | 0.000 | | |
| 7 | | PrePreg 1080 | Signal | 76.200 | 76.200 | 60.000 | 4.200 | 0.0195 | | 76.200 | | 76.200 | 76.200 |
| | | Copper Foil | Signal | 35.560 | 35.560 | | | | | 35.560 | 0.000 | | |
| 8 | | PrePreg 1080 | | 76.200 | 49.530 | 60.000 | 4.200 | 0.0195 | | 76.200 | | 49.530 | 49.530 |
| | | Copper Foil | Signal | 17.780 | 17.780 | | | | 4 | 17.780 | 0.000 | | |
| | | Liquid Photolamageable Mask | | | 25.400 | | 4.000 | 0.0195 | | | | | |
| Copper Thickness = 248.920 Dielectric Thickness = 1261.364 Solder Mask Thickness = 50.800 Stack Up Thickness = 1510.284 Stack Up Thickness with Soldermask = 1561.084 Stack Up Cost = 54.00 | | | | | | | | | | | | | |

Use the Drills (Stack Table) command to show or hide the drills in the stackup graphic in the Stack Table.

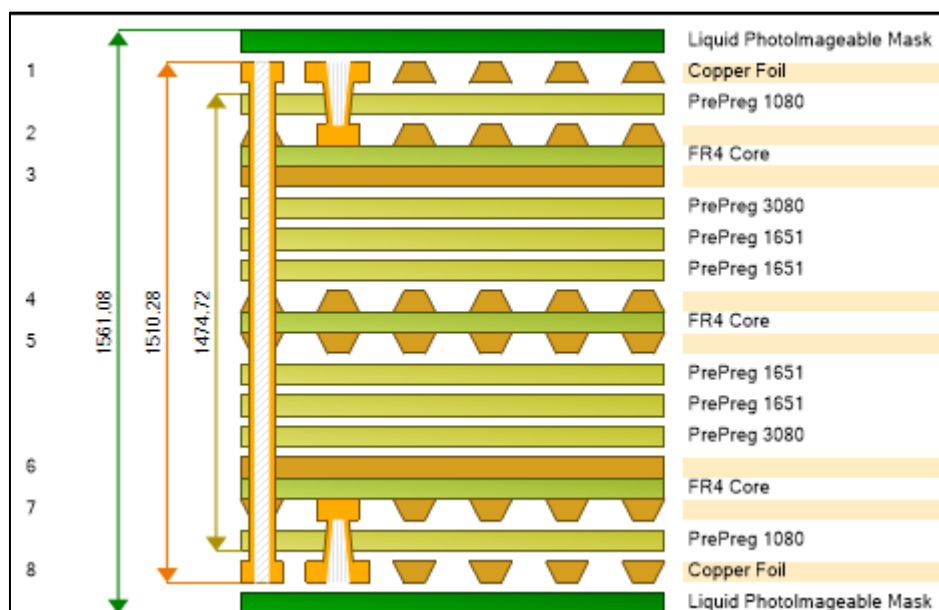
The Thickness Totals provides optional display of the sum of materials thicknesses, copper, dielectric, solder mask and the stackup – with and without the solder mask thickness.

Use the Show Stackup Cost option to display the cost in the stack summary.

Select Show Hatch Profile Data to include the hatch pitch and width and copper area percentage in the stack summary.

Use the Show Stackup Thickness commands to display or hide the target or calculated values of total stack thickness.

Values can optionally include solder mask and laminate thicknesses.

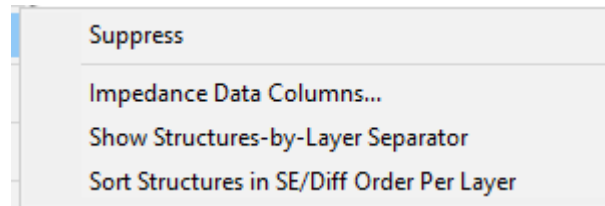


When the target value of the Stackup thickness is chosen the Stackup Thickness Tolerance values can be displayed as percentages of the target stack thickness or as actual values.

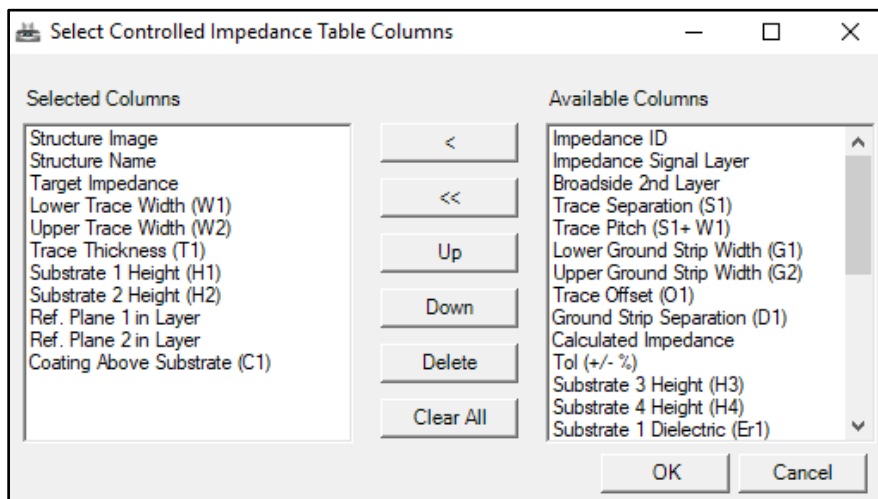
Choose Stackup Thickness Accuracy to display accuracy by number of decimal places.

Controlled Impedance Data Table

Use the Controlled Impedance Data Table options to show or hide the controlled impedance structures and parameters.







Impedance Data columns can be selected for display and ordered as required. Choose the parameters for display from the Available Columns pane and change the order of display using the Up and Down buttons.



Grouping structures by layer





Within the Impedance Data Table structures can be grouped by layer; choose Show Structures-By-Layer Separator. The Separator will add a black structure separator bar on the print out between structure groups, allowing the structures to be sorted by layer number rather than the order that the structures are added to the stack.

| Structure Image | Structure Name | Target Impedance | Calculated Impedance | Lower Trace Width (W1) | Upper Trace Width (W2) | Trace Thickness (T1) | Substrate 1 Height (H1) | Substrate 2 Height (H2) | Ref. Plane 1 in Layer | Ref. Plane 2 in Layer | Coating Above Substrate (C1) |
|---|------------------------------------|------------------|----------------------|------------------------|------------------------|----------------------|-------------------------|-------------------------|-----------------------|-----------------------|------------------------------|
|  | Coated Microstrip 1B | 75.000 | 75.870 | 114.300 | 88.900 | 17.780 | 161.290 | 0.000 | 3 | 0 | 25.400 |
|  | Edge Coupled Coated Microstrip 1B | 100.000 | 100.350 | 215.900 | 190.500 | 17.780 | 161.290 | 0.000 | 3 | 0 | 25.400 |
|  | Edge Coupled Offset Stripline 1B1A | 100.000 | 101.280 | 184.150 | 158.750 | 35.560 | 692.912 | 388.112 | 3 | 6 | 0.000 |
|  | Coated Microstrip 1B | 75.000 | 75.870 | 114.300 | 88.900 | 17.780 | 161.290 | 0.000 | 6 | 0 | 25.400 |

Sorting impedance structures by type





The technical report, by default, prints the structures within a layer in the order in which they were added to the stack.

In the example stack below the structures were added to the stack in the order shown.

| Impedance ID | Structure Image | Structure Name | Impedance Signal Layer | Ref. Plane 1 in Layer | Ref. Plane 2 in Layer | Lower Trace Width (W1) | Upper Trace Width (W2) | Trace Separation (S1) | Target Impedance | Tol (+/- %) | Calculated Impedance |
|--------------|---|-----------------------------------|------------------------|-----------------------|-----------------------|------------------------|------------------------|-----------------------|------------------|-------------|----------------------|
| 1 |  | Edge Coupled Coated Microstrip 1B | 1 | 3 | 0 | 8.500 | 7.500 | 8.115 | 100.000 | 10.000 | 100.350 |
| 2 |  | Coated Microstrip 1B | 1 | 3 | 0 | 4.500 | 3.500 | 0.000 | 75.000 | 10.000 | 75.870 |
| 3 |  | Coated Microstrip 1B | 1 | 3 | 0 | 11.476 | 10.476 | 0.000 | 50.000 | 10.000 | 49.520 |
| 4 |  | Edge Coupled Coated Microstrip 1B | 1 | 3 | 0 | 12.542 | 11.542 | 10.000 | 85.000 | 10.000 | 85.220 |

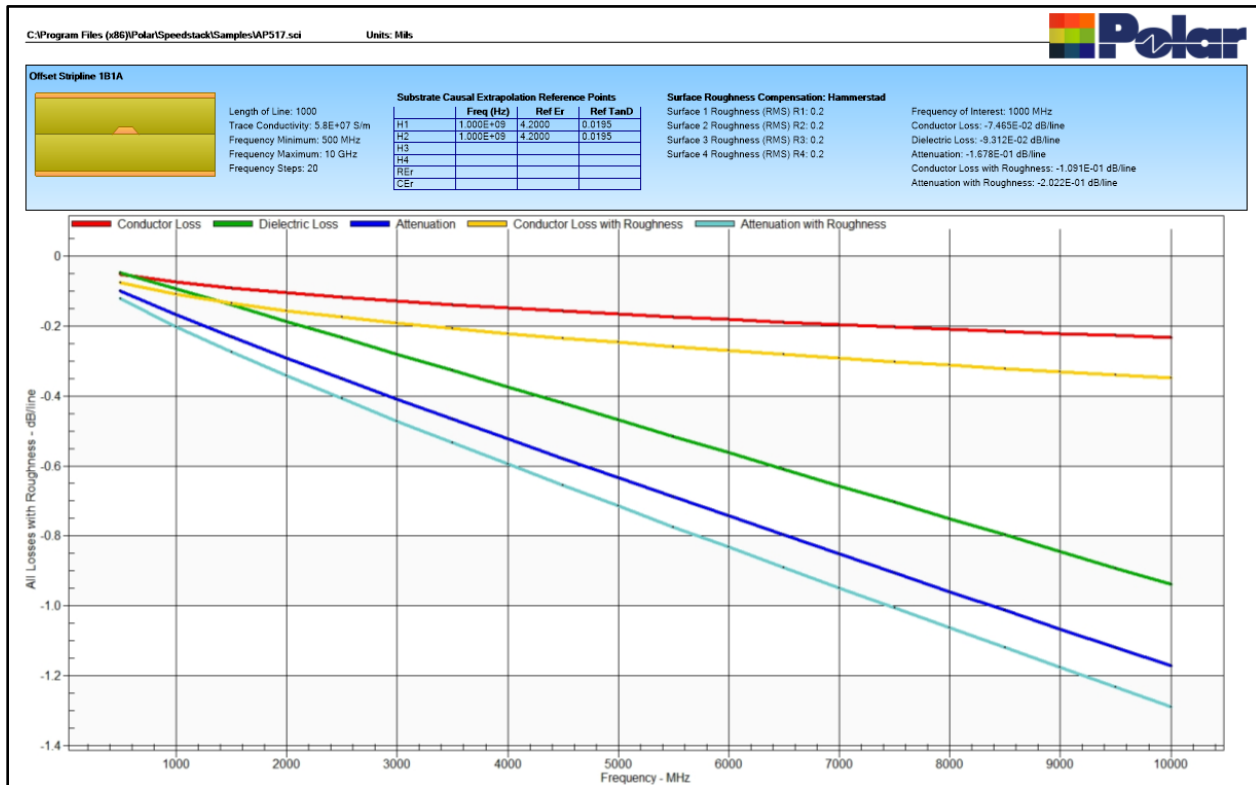
Structures within each layer can be grouped by type, single ended and differential.

To sort the structures by type choose the Sort Structures by SE/Diff Order per Layer; the structures within each layer will be ordered in single ended then differential order as shown in the graphic below.

| Impedance ID | Structure Image | Structure Name | Impedance Signal Layer | Ref. Plane 1 in Layer | Ref. Plane 2 in Layer | Lower Trace Width (W1) | Upper Trace Width (W2) | Trace Separation (S1) | Target Impedance | Tol (+/- %) | Calculated Impedance |
|--------------|---|-----------------------------------|------------------------|-----------------------|-----------------------|------------------------|------------------------|-----------------------|------------------|-------------|----------------------|
| 2 |  | Coated Microstrip 1B | 1 | 3 | 0 | 4.500 | 3.500 | 0.000 | 75.000 | 10.000 | 75.870 |
| 3 |  | Coated Microstrip 1B | 1 | 3 | 0 | 11.476 | 10.476 | 0.000 | 50.000 | 10.000 | 49.520 |
| 1 |  | Edge Coupled Coated Microstrip 1B | 1 | 3 | 0 | 8.500 | 7.500 | 8.115 | 100.000 | 10.000 | 100.350 |
| 4 |  | Edge Coupled Coated Microstrip 1B | 1 | 3 | 0 | 12.542 | 11.542 | 10.000 | 85.000 | 10.000 | 85.220 |

Frequency dependent loss graphs

Speedstack Si provides graphing and tabular display of the frequency dependent properties of each controlled impedance structure in the stackup. The technical report includes the option of displaying the loss v frequency graph of every structure in the stackup – see below.



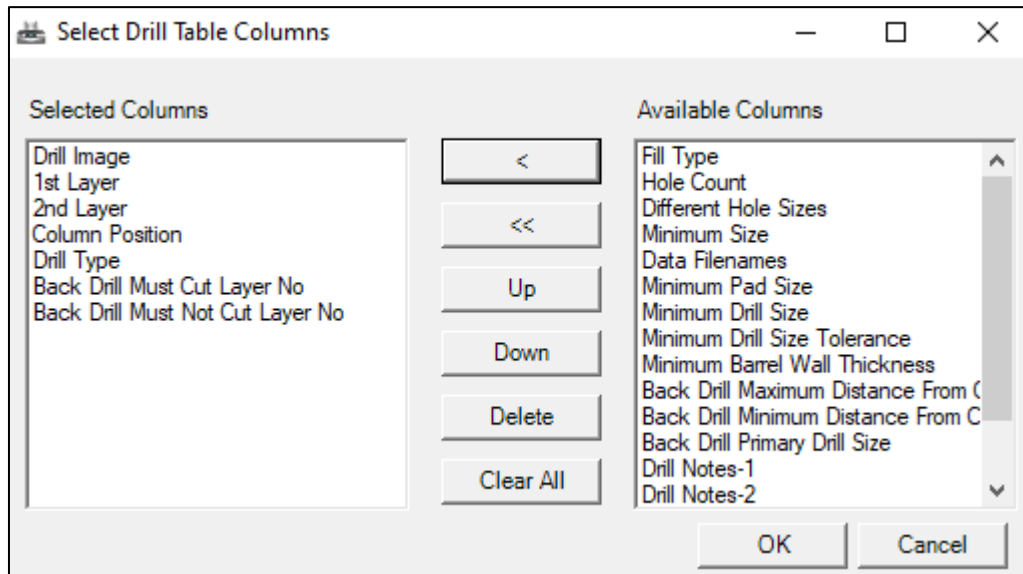
When the technical report is selected for print Speedstack recalculates and displays the loss v frequency for the frequency dependent properties of each structure in the stackup.

The display for each structure includes the structure graphic and the associated frequency dependent parameters, the substrate causal extrapolation reference points, the surface roughness method and settings and the losses and attenuation at the user defined frequency of interest.

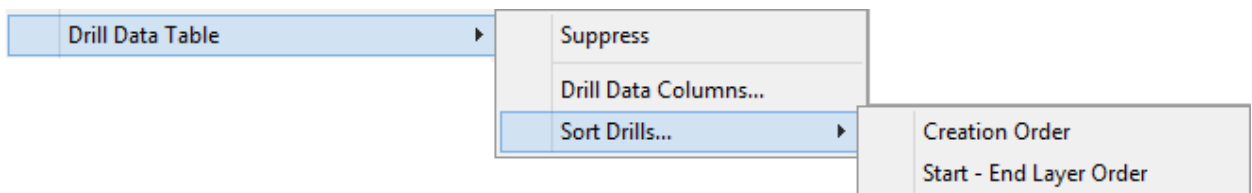
From the Options menu, choose Frequency Dependent Loss Graphs|Suppress to toggle display of frequency dependent loss graphs and tables.

Drill Data Table

Use the Drill Data Table command to show or hide the table of drill parameters and to select and order parameter values for display.

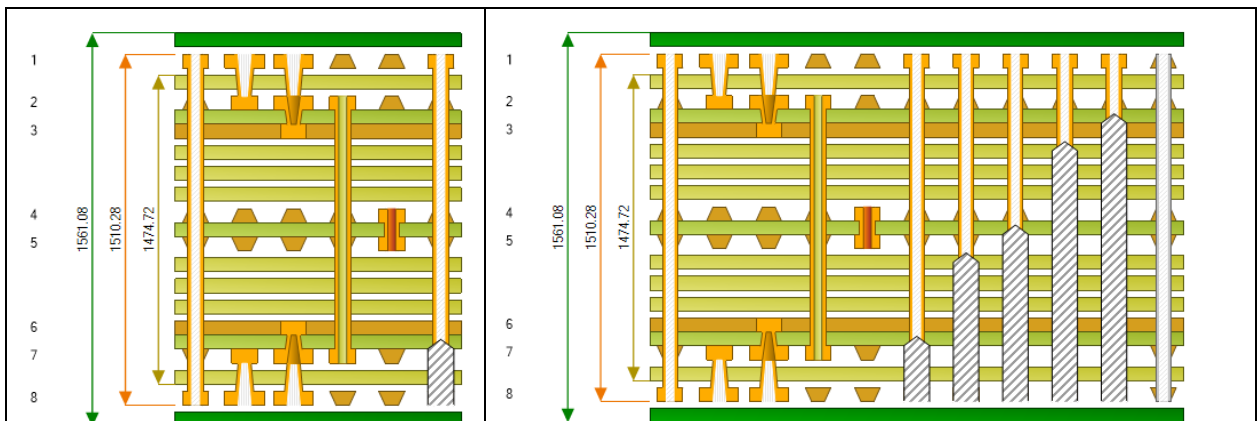


Use the Sort Drills... command to order the drill table – drills can be sorted by start-end layer order or creation order.










Showing expanded drills

Speedstack can display up to eleven drill columns in a stack, but many users won't ever need more than six columns. I to allow the user to toggle between wide stack and narrow stack image mode, if they would prefer to use the horizontal space for data columns they can select the narrow stack up image. If drills exist beyond column six and narrow stack mode is selected we display a warning.



Bill of Materials Table

Speedstack's Technical Report incorporates the Bill of Material (BOM) table with the stock-number displayed optionally as a barcode. The table contains fields for Total Quantity (No. Panels * Stack Quantity) and Total Cost (Unit Cost * Total Quantity.)

| Supplier | Supplier Description | Description | Type | Stock Number | Stack Quantity | Unit Cost | Stack Cost | Total Quantity | Total Cost |
|--|----------------------|----------------------------|------------|---|----------------|-----------|------------|----------------|------------|
| Polar Samples | SM/001 | Liquid Photoimageable Mask | SolderMask |  | 2 | 0.00 | 0.00 | 2 | 0.00 |
| Polar Samples | FQ/001 | Copper Foil | Copper |  | 2 | 1.00 | 2.00 | 2 | 2.00 |
| Polar Samples | PP/001 | PrePreg 1080 | Dielectric |  | 2 | 1.00 | 2.00 | 2 | 2.00 |
| Polar Samples | CQ/005 | FR4 Core | FR4 |  | 2 | 5.00 | 10.00 | 2 | 10.00 |
| Polar Samples | PP/002 | PrePreg 3080 | Dielectric |  | 2 | 2.00 | 4.00 | 2 | 4.00 |
| Polar Samples | PP/004 | PrePreg 1651 | Dielectric |  | 4 | 4.00 | 16.00 | 4 | 16.00 |
| Polar Samples | CQ/020 | FR4 Core | FR4 |  | 1 | 20.00 | 20.00 | 1 | 20.00 |
| | | | | | | | 54.00 | | 54.00 |
| No. of Panels = 1 Circuits Per Panel = 1 Price Per Circuit = 54.00 | | | | | | | | | |

The table includes totals for the Stack Cost and the Total Cost columns.

A summary section presents 3 values: No. of Panels, Circuits Per Panel and Price Per Circuit. The No. of Panels and Circuits Per Panel can be entered by the user at any time or optionally at the start of each print session.

From the Options menu choose B.O.M. Data Table | Panels / Circuits per Panel...








| | |
|---------------------|--------------------------------|
| B.O.M. Data Table > | Suppress |
| | Stock Number > |
| | Panels / Circuits per Panel... |

Price Per Circuit is a calculated value (Total Stack Cost / Circuits Per Panel).

Bill of Materials Table columns can be selected for display and ordered as required. Choose the parameters for display from the Available Columns pane and change the order of display using the Up and Down buttons.

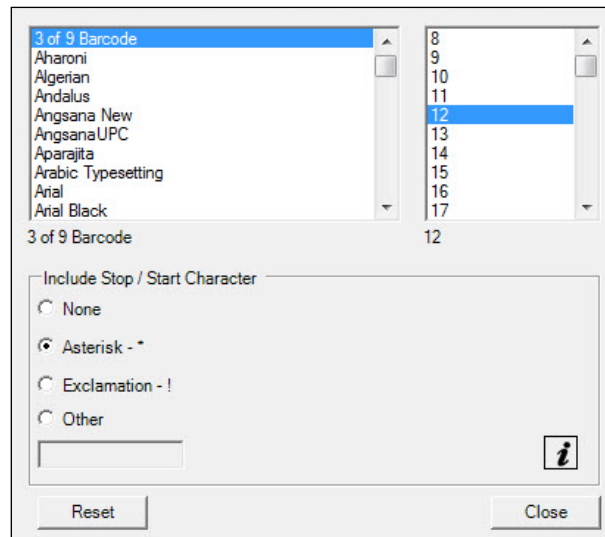
From the Options menu choose B.O.M. Data Table to display or suppress the table. The Suppress command toggles the B.O.M. table on and off in the report.

Stock numbers can be displayed in alpha-numeric form or as barcodes. Choose Stock Number|Show as Barcode to toggle the Stock Number display between barcodes or alpha-numeric text.

| Description | Type | Stock Number | Stack Quantity | Unit Cost |
|----------------------------|------------|---|----------------|-----------|
| Liquid PhotoImageable Mask | SolderMask |  | 2 | 0.00 |
| Copper Foil | Copper |  | 2 | 1.00 |
| PrePreg 1080 | Dielectric |  | 2 | 1.00 |
| FR4 Core | FR4 |  | 2 | 5.00 |
| PrePreg 3080 | Dielectric |  | 2 | 2.00 |
| PrePreg 1651 | Dielectric |  | 4 | 4.00 |
| FR4 Core | FR4 |  | 1 | 20.00 |

Choosing the bar code font

From the Stock Number command choose Barcode Font and Start/Stop Character. The Select Barcode font and Start/Stop Marker Characters dialog is displayed.



Choose the font and font size and the start / stop character as appropriate. (The barcode font must already be installed on the host computer.)

Choosing the start/stop character

The Start/Stop character is a requirement for certain barcode types such as Code 39 (also referred to as Code 3 of 9, Code 3/9, Type 39, etc.) The Code 39 asterisk character is normally reserved as a start/stop character rendering the data a valid barcode.

As an example, if the Stock-Number is 123-456, selecting the Asterisk option will add enclosing asterisks to the Stock-Number so that the barcode is valid.

(In some instances asterisks may already be included in the Stock-Number in which case choose the None option.)

There are other situations where another character may be used. Exercise caution when determining the appropriate font choice and start/stop character to use. In the event that an inappropriate font is chosen, the results may be unpredictable.

Footer


The report footer section is an optional item and may be displayed or suppressed (hidden).

| | | |
|--------|---|--------------------------|
| Footer | > | Suppress |
| | | Enable Expanded Footer |
| | | Override Footer Label... |

Suppressing the footer

When the Footer section is suppressed the space is used for other data, often reducing the number of pages required for the technical report.

| | | | | | | |
|--------------------|-----------------------|-----------|---------------|-------------------|--------|----------|
| StackName: M-Board | Version: V19.05 | Revision: | Modification: | Date of Revision: | Editor | |
| Date: 12 June 2019 | Associated Documents: | Rev #1 | Coll | 1 Dec 2018 | JB | Page 1/X |
| Author: B Johnson | | Rev #2 | Data Net | 1 Apr 2019 | JB | |
| Department: Eng | | | | | | |
| Site: North Side | | | | | | |



Using the expanded footer

Use the Expanded Footer option to allow longer and more descriptive stack names to be displayed.

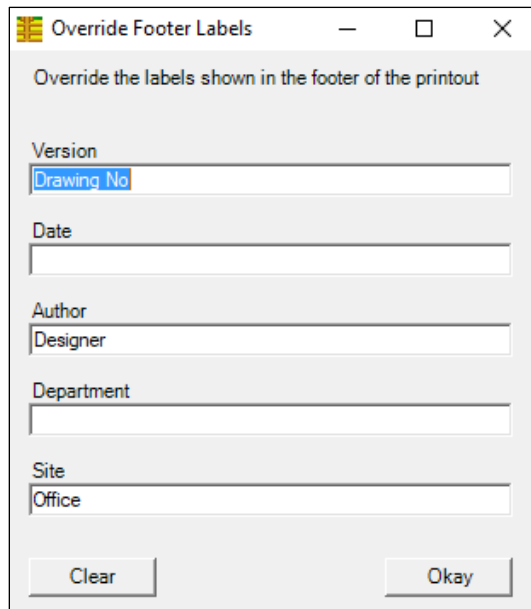
| | | | | | |
|--|-----------------------|--|--|-----------|-------------------|
| StackName: Controller M-Board MWPD1636 | | | | | |
| Version: V19.05 | Associated Documents: | | | Revision: | Date of Revision: |
| Date: 12 June 2019 | | | | Rev #1 | 1 Dec 2018 |
| Author: B Johnson | | | | Rev #2 | 1 Apr 2019 |
| Department: Eng | | | | | |
| Site: North Side | | | | | |

Overriding the footer labels

The labels in the footer may be changed to reflect the stackup design workflow and organisational structure.

Choose Footer | Override Footer Label...

The Override Footer Labels dialog is displayed:



Override Footer Labels

Override the labels shown in the footer of the printout

Version
Drawing No

Date

Author
Designer

Department

Site
Office

Clear Okay

The new labels will be reflected in the footer:

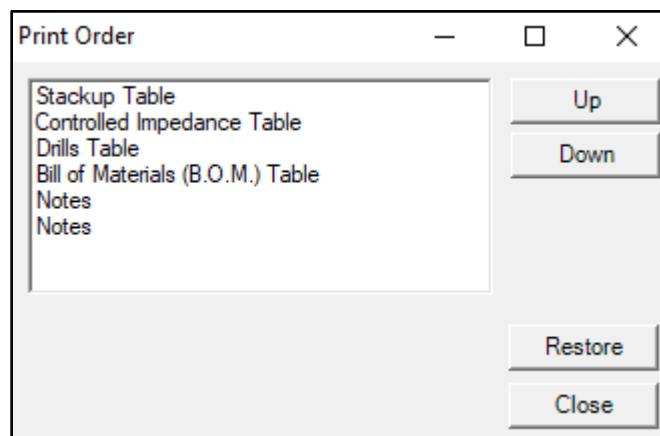
| | |
|-------------|-----------------------------|
| StackName: | Controller M-Board MWPD1636 |
| Drawing No: | 19.05 |
| Date: | 12 June 2019 |
| Designer: | B Johnson |
| Department: | Eng |
| Office: | North Side |

Note Field Aliases

Note Field Aliases allows for the free-text note fields (for the Stack and Controlled impedance tables) to be given descriptive names.

Print Order

Use the Print Order dialog to move the Controlled Impedance Table, Drill Tables and Notes sections up or down within the report.



Print Order

Stackup Table
Controlled Impedance Table
Drills Table
Bill of Materials (B.O.M.) Table
Notes
Notes

Up
Down

Restore
Close

Note: the Stack/Materials data Table cannot be reordered and must remain the first item in the print order.

General options

Use the General Options to specify

| | |
|-----------------------------------|---|
| Polar Logo | ▶ |
| User Logo | ▶ |
| Copyright | ▶ |
| Data Number Format | ▶ |
| Data Alignment | ▶ |
| Stack Alignment (Flex-Rigid only) | ▶ |
| Font Size | ▶ |
| Colours | |
| File Path | ▶ |
| Margin Guides | ▶ |

Polar Logo: toggles on and off the Polar Instruments logo.

User Logo: toggles on and off the user-defined logo (as set in the application configuration).

Copyright: toggles on and off the copyright information and allows copyright text to be edited.

Data Number Format: sets the precision of numeric data in the printout.

Data Alignment: specifies alignment (left, centre, etc.) for stack, impedance and drill data.

Stack Alignment (Flex-Rigid only): – Align to Master Stack allows the vertical position of sub-stacks (printed on separate pages within the report) to be preserved with respect to the master stack; Align to Page Top presents each sub-stack at the top of each page.

Colours: allows for the colours of items within the report to be customised. Click Override Default Colours and Change to specify the new colour. Click Reset All to return to the default colours.

File Path: toggles on and off the file path/file name

Margin Guides: toggles on and off boundary markings (in the user selected units.) These match the Speedstack units selected within the Stackup Editor | Units menu.

The margin guides allow for display of the printable area of the page – which can vary depending upon the device – even though the page size remains the same. (With some devices the report cannot use the full extents of the page.)