

## **CST MPHYSICS STUDIO TECHNICAL SPECIFICATIONS**

### **Frontend Module**

**• For functionality and CAD/EDA import filter, see technical specifications of the CST STUDIO SUITE(tm)**

#### How to Get Started Quickly

We recommend that you proceed as follows:

1. Read the *CST Studio Suite - Getting Started* manual.
2. Work through this document carefully. It provides all the basic information necessary to understand the advanced documentation.
3. Look at the examples provided in the Component Library (*File: Component Library* ⇒ *Examples*). Especially the examples which are tagged as *Tutorial* provide detailed information of a specific simulation workflow. Press the *Help* ? button of the individual component to get to the help page of this component. Please note that all these examples are designed to give you a basic insight into a particular application domain. Real-world applications are typically much more complex and harder to understand if you are not familiar with the basic concepts.
4. Start with your own first example. Choose a reasonably simple example which will allow you to quickly become familiar with the software.
5. After you have worked through your first example, contact technical support for hints on possible improvements to achieve even more efficient usage of the software.

#### What is CST MPhysics Studio?

CST MPhysics Studio is a software package from the CST Studio Suite family which allows thermal and mechanical simulations. It simplifies the process of defining the structure by providing a powerful solid modeling front end, which is based on the ACIS modeling kernel. Strong graphic feedback simplifies the definition of your device even further. After the component has been modeled, a fully automatic meshing procedure is applied before a simulation engine is started.

A key feature of CST MPhysics Studio is its tight integration with the other CST Studio products. This allows an easy to use workflow for coupled EM-Multiphysics simulations.

A further outstanding feature is the full parameterization of the structure modeler, which enables the use of variables in the definition of your component. In combination with the built-in optimizer and parameter sweep tools, CST MPhysics Studio is capable of analyzing and designing thermal and mechanical aspects of devices.

#### Who Uses CST MPhysics Studio?

Anyone who needs to investigate thermal and mechanical aspects of electromagnetic devices. Of course it is also possible to use the product standalone, but the full set of capabilities deploys when coupling the thermal and mechanical simulators with other products from the CST Studio Suite family such as CST Microwave Studio®, CST Design Studio™, CST EM Studio® or CST Particle Studio®.

## CST MPhysics Studio Key Features

The following list gives you an overview of the CST MPhysics Studio main features. Note that not all of these features may be available to you because of license restrictions. Contact a sales office for more information.

### General

- Native graphical user interface based on Windows 7 (SP 1 or later), Windows 2008 Server R2 (SP 1 or later), Windows 8.1, Windows 2012 Server R2, Windows 10 and Windows Server 2016
- The structure can be viewed either as a 3D model or as a schematic. The latter allows for easy coupling of thermal simulation parameters with circuit simulation.
- Various independent types of solver strategies (based on hexahedral as well as tetrahedral meshes) allow accurate simulations with a high level of performance for a wide range of multi-physical applications.
- For specific solvers highly advanced numerical techniques offer features like Perfect Boundary Approximation® (PBA) for hexahedral grids and curved and higher order elements for tetrahedral meshes.

### Structure Modeling

- Advanced ACIS-based, parametric solid modeling front end with excellent structure visualization
- Feature-based hybrid modeler allows quick structural changes
- Import of 3D CAD data from ACIS® SAT/SAB, CATIA®, SOLIDWORKS®, Autodesk Inventor, IGES, VDA-FS, STEP, PTC Creo, Siemens NX, Parasolid, Solid Edge, CoventorWare, Mecadtron, NASTRAN, STL or OBJ files
- Import of 2D CAD data by DXF, GDSII and Gerber RS274X, RS274D files
- Import of EDA data from design flows including Cadence Allegro® / APD® / SiP®, Mentor Graphics Expedition®, Mentor Graphics PADS®, Mentor Graphics HyperLynx®, Zuken CR-5000® / CR-8000®, IPC-2581 and ODB++® (e.g. Altium Designer, Mentor Graphics Boardstation®, CADSTAR®, Visula®)
- Import of PCB designs originating from CST PCB Studio®
- Import of 2D and 3D sub models
- Import of Agilent ADS® layouts
- Import of Sonnet® EM models
- Import of a visible human model dataset or other voxel datasets
- Export of CAD data to ACIS SAT/SAB, IGES, STEP, NASTRAN, STL, DXF, GDSII, Gerber or POV files
- Parameterization for imported CAD files
- Material database
- Structure templates for simplified problem setup

### Mechanics Solver

- Temperature dependent Young's modulus
- Displacement boundary condition
- Traction boundary condition
- Thermal expansion
- Neo-Hookean material model for simulation of large deformations
- Various stress plots: von Mises, hydrostatic and tensor components
- Strain plots including visualization of the volumetric strain
- Nonlinear solver computes the Green-Lagrange and the Almansi-strain as well as the 2nd Piola-Kirchhoff and Cauchy stress tensors
- Displacement plot including visualization of deformed mesh
- Import of force densities from EM-solvers
- Export of deformed structure to CST Microwave Studio

### Thermal Steady State Solver

- Isotropic and anisotropic material properties
- Bioheat material properties
- Nonlinear material properties (Bioheat properties and thermal conductivity)



- Thermal contact resistance
- Moving media
- Convection for human voxel models
- Heat transfer by conduction in volumes
- Heat transfer by convection and radiation through surfaces
- Sources: fixed and floating temperatures, heat sources, eddy current and stationary current loss fields, volume/surface power loss distributions in dielectric or lossy metal materials imported from CST Microwave Studio, CST EM Studio or CST PCB Studio, crashed particle loss distribution from CST Particle Studio
- Adiabatic / fixed or floating temperature / open boundary conditions
- Automatic parameter studies using built-in parameter sweep tool
- Automatic structure optimization for arbitrary goals using built-in optimizer
- Network distributed computing for optimizations, parameter sweeps and remote calculations
- Thermal conductance matrix calculation
- Equivalent Circuit EMS/MPS/DS Co-Simulation for linear problems

### Thermal Transient Solver

- Isotropic and anisotropic material properties
- Bioheat material properties
- Nonlinear material properties (Bioheat properties, thermal conductivity and heat capacity)
- Thermal contact resistance
- Moving media
- Convection for human voxel models
- Heat transfer by conduction in volumes
- Heat transfer by convection and radiation through surfaces
- Sources: fixed, initial and floating temperatures, heat sources, eddy current and stationary current loss fields, volume/surface power loss distributions in dielectric or lossy metal materials imported from CST Microwave Studio, CST EM Studio or CST PCB Studio, crashed particle loss distribution from CST Particle Studio
- Adiabatic / fixed or floating temperature / open boundary conditions
- Low or high order time integration method, constant or adaptive time step width
- Network distributed computing for remote calculations
- Calculation of CEM43°C thermal dose in biological tissues

### Conjugate Heat Transfer Solver

- Steady-state solver for incompressible laminar or turbulent flows
- Conjugate heat transfer between solids and fluids
- Boussinesq approximation for buoyancy force in flows
- Surface-to-surface radiation with automatic calculation of view factors
- Opening: velocity- and pressure-based inlets and outlets
- Walls: slip/no slip, isothermal and adiabatic
- Internal heat sources
- External heat sources imported from CST Microwave Studio or CST EM Studio
- Axial fan model support
- Planar and volume flow resistance model support
- Two-resistor component model support
- Thermal contact properties: resistance
- Thermal surface properties: surface emissivity and heat transfer coefficient
- Full GPU acceleration support

### SAM (System and Assembly Modeling)

- 3D representations for individual components
- Automatic project creation by assembling the schematic's elements into a full 3D representation
- Manage project variations derived from one common 3D geometry setup
- Coupled Multiphysics simulations by using different combinations of coupled circuit/EM/Thermal/Stress projects

## Visualization and Secondary Result Calculation

- Online visualization of intermediate 1D results during simulation
- Import and visualization of external xy-data
- Copy / paste of xy-datasets
- Fast access to parametric data via interactive tuning sliders
- Automatic saving of parametric 1D results
- Multiple 1D result view support
  
- Various 2D and 3D field visualization options for thermal fields, heat flow densities, displacement fields, stress fields, etc.
- Animation of field distributions
  
- Display and integration of 2D and 3D fields along arbitrary curves
- Integration of 3D fields across arbitrary faces
  
- Hierarchical result templates for automated extraction and visualization of arbitrary results from various simulation runs. These data can also be used for the definition of optimization goals.

## Result Export

- Export of result data such as fields, curves, etc. as ASCII files
- Export screen shots of result field plots

## Automation

- Powerful VBA (Visual Basic for Applications) compatible macro language with editor and macro debugger
- OLE automation for seamless integration into the Windows environment (Microsoft Office®, MATLAB®, AutoCAD®, MathCAD®, Windows Scripting Host, etc.)