CST CABLE STUDIO
TECHNICAL SPECIFICATIONS

Welcome to CST Cable Studio, the powerful and easy-to-use package for analyzing conducted transmission, EMI (Electromagnetic Interference) and EMS (Electromagnetic Susceptibility) on complex cable structures.

This program combines transmission line, circuit and 3D "full-wave" simulation in a convenient and sophisticated way, which makes it highly suitable to simulate cables inside electrically large systems.

CST Cable Studio is embedded into the design environment of CST Studio Suite, which is explained in the *CST Studio Suite Getting Started* manual. The following explanations assume that you have already installed the software and familiarized yourself with the basic concepts of the user interface.

How to Get Started Quickly

We recommend that you proceed as follows:

1. Read the *CST Studio Suite Getting Started* manual.

2. Acquire a working knowledge of transmission lines. You should be familiar with wo-conductor and multiconductor lines.

3. Work through this document carefully. It should provide you with all the basic information necessary to understand the advanced documentation found in the online help.

4. Look at the examples provided in the Component Library (*File: Component Library ⇨ Examples*), especially the examples which are tagged as *Tutorial,* since they 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.

5. Start with your first own example. Create your first CST Cable Studio model and simulation. Choose a reasonably small and simple harness that will allow you to quickly become familiar with the software.

What is CST Cable Studio?

CST Cable Studio is an electromagnetic simulation tool specially designed for the fast and accurate investigation of real-world cables in complex electromagnetic environments of electrically large systems by combining transmission line, circuit and 3D full-wave simulation. It allows to investigate multi-scale problems which are otherwise difficult to solve with full-wave solvers. Typical multi-scale problems are for instance cables with dimensions down to the micrometer range built in towers, cars or aircraft with overall system dimensions in meter.

CST Cable Studio offers a user interface that makes it easy to define a complex cable harness. The 3D topology can be defined either from scratch or by loading an existing harness via a NASTRAN or STEP AP212-KBL import filter. Separate dialog boxes enable the definition of four basic types of cables: single wires, twisted cables, ribbon cables and coaxial cables / shielded wires with compact, foil or braided shields.

Any combination of these basic cable types can be defined as cable groups and stored in a user defined library. A couple of dialog boxes allow the convenient definition of exact or random cable cross sections.

The transfer impedance of a shielded cable can be either directly defined or calculated by using the built-in transfer impedance calculator, which extracts the impedance from the geometric characteristics of the shield. In addition, it is possible to load and assign measured transfer impedance curves.

CST Cable Studio generates equivalent circuits from the cable harness based on classical transmission line theory. It automatically meshes the cable harness along its length and calculates the transmission line parameters on these segments. Skin effect and dielectric loss

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are modeled in both frequency and time domain simulations. The equivalent circuits can be exported in several SPICE formats.

CST Cable Studio uses the powerful 3D solid modeling front end of CST Microwave Studio to set up or import arbitrary metallic 3D shapes, ranging from simple ground planes to complex chassis structures. Moreover, the powerful 3D full-wave solvers from CST Microwave Studio are used to calculate the electromagnetic field in the environments of cables.

CST Cable Studio uses CST Design Studio's easy-to-use schematic to define passive and active devices at cable terminations. The powerful built-in network simulator in CST Design Studio enables the simulation of a whole system consisting of the equivalent circuit of the cable harness and its terminations.

CST Cable Studio controls the data exchange between the circuit simulation engine and the various 3D EM solvers for currents (on the cable harness) and electromagnetic fields (around the cable harness). This enables simulating both the effects of fields coupling into the cables and fields radiating from the cables.

Applications

- ☐ Transmission and crosstalk simulations of extended cable structures in time and frequency domains
- ☐ E3: analysis of complex cables in electromagnetic environments of large systems
- ☐ EMI: analysis of radiated electromagnetic fields from complex cables lying along and apart metallic structures
- ☐ EMS: analysis of coupled electromagnetic fields into complex cables lying along and apart metallic structures

CST Cable Studio Key Features

An overview of the main features of CST Cable Studio is provided in the following list.

For the circuit simulator only some selected key features are listed below. Additional information can be found in the *CST Studio Suite - Circuit Simulation and SAM (System Assembly and Modeling) manual* and *Online Help*.

For the 3D solid modeling front end and the 3D full-wave simulation only some selected key features are listed below. A full list can be found in the *CST Studio Suite - High Frequency Simulation* manual.

General

- ☐ Native graphical user interface based on Windows operating systems.
- ☐ Tight interface to CST Design Studio and CST Microwave Studio enabling cable modeling, circuit simulation and 3D full-wave analysis in one environment.
- ☐ Transmission line modeling method for fast and accurate simulation of TEM / Quasi-TEM propagation modes inside complex cable structures.
- ☐ Hybrid method combining transmission line analysis with 3D "full-wave" analysis.

Harness Structure Modeling

- ☐ Easy definition of complex harness topology.
- ☐ Import of harness via NASTRAN and STEP AP212-KBL.
- ☐ Interactive cable editing dialog boxes for all relevant types of cables.
- ☐ Parameterization of cable position.

Harness Electric Modeling

- ☐ Automatic meshing and extraction of 2D transmission line parameters.
- ☐ Modelling of all relevant cable types in any combination (single wire, ribbon cables, twisted cables and shielded cables).
- ☐ Consideration of skin and proximity effects as well as dielectric loss in time and frequency domains.

- ☐ Consideration of transfer impedance for compact, foil or braided shields.
- ☐ Impedance calculator for characteristic line impedances.
- ☐ Export of equivalent SPICE circuits.

Circuit Simulator

- ☐ Schematic editor enables the easy definition of passive and active devices on the cable's equivalent circuit.
- ☐ Fast circuit simulation in time and frequency domains.
- ☐ Import of SPICE sub-circuits (Berkley SPICE syntax).
- ☐ Support of IBIS models.
- ☐ Import and Export of S-Parameter data via TOUCHSTONE file format.
- ☐ Parameterization of termination circuitry and parameter sweep.

3D Full-Wave Simulator

- ☐ Automatic transfer of impressed common mode currents on cable bundles from circuit simulator to the 3D "full-wave" simulator.
- ☐ Automatic transfer of induced voltages on cable bundles to circuit simulator.
- ☐ Advanced solid modelling to define scattering or antenna structures.
- ☐ Import of 3D CAD data by SAT, Autodesk Inventor®, IGES, VDA-FS, STEP, ProE®, CATIA 4®, CATIA 5®, CoventorWare®, Mecadtron®, NASTRAN or STL files to define scatter and antenna structures.
- ☐ Plane wave excitation (linear, circular, elliptical polarization).
- ☐ Ideal voltage and current sources for antenna excitation.
- ☐ Accurate and efficient time domain solvers, based on the Finite Integration Technique (FIT) and the Transmission-Line Matrix (TLM) method.
- ☐ Fully automatic creation of hexahedral grids in combination with the Perfect Boundary Approximation (PBA), Thin Sheet Technique (TST) and Octree-based meshing.
- ☐ Calculation of various electromagnetic fields and quantities such as electric fields, magnetic fields, surface currents and voltages.

About This Manual

This manual is primarily designed to enable a quick start on the modeling capabilities of CST Cable Studio. It is not intended as a complete reference guide to all available features, but rather as an overview of the key concepts. Understanding these concepts will allow to learn the software efficiently with help of the online documentation.

To learn more about the circuit simulator, please refer to the *CST Studio Suite - Circuit Simulation and SAM (System Assembly and Modeling)*.

To learn more about the 3D full-wave simulator, please refer to the *CST Studio Suite - High Frequency Simulation* manual.

The next chapter, *Overview*, is dedicated to explaining the general concepts of CST Cable Studio and to show the most important objects and related dialog boxes. The Chapter *Examples* will guide you through three important examples which provide a good overview of the capabilities of CST Cable Studio. We strongly recommend studying both chapters carefully.

Document Conventions

- ☐ Buttons that should be pressed within dialog boxes are always written in italics, e.g. *OK*.
- ☐ Key combinations are always joined with a plus (+) sign. *Ctrl+S* means that you should hold down the *Ctrl* key while pressing the *S* key.
- ☐ The program's features can be accessed through a Ribbon command bar at the top of the main window. The commands are organized in a series of tabs within the Ribbon. In this document a command is printed as follows: *Tab name: Group name ⇨ Button name ⇨ Command name.* This means that you should activate the proper tab first and then press the button *Command name*, which belongs to the group *Group name*. If a keyboard shortcut exists, it is shown in brackets after the command. Example: *View: Change View ⇨ Reset View (Space)*

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☐ The project data is accessible through the navigation tree on the left side of the application's main window. An item of the navigation tree is referenced in the following way: *NT: Tree folder ⇨ Sub folder ⇨ Tree item*.

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