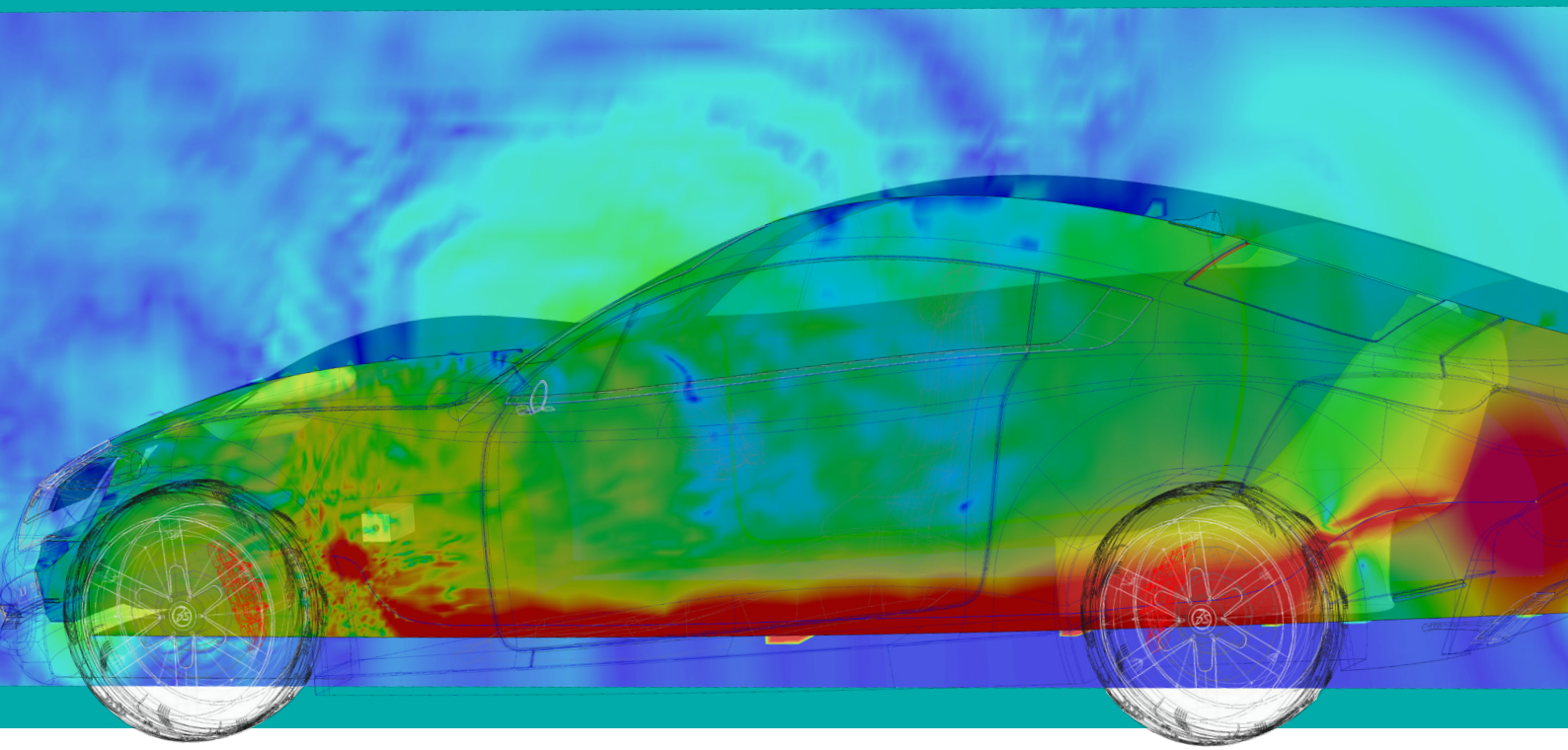
SIMULIA

3DEXPERIENCE

CST STUDIO SUITE DATASHEET

EM Simulation for Automotive Applications



Electronic components are increasingly important in automotive systems, especially with the rise of hybrid and electric mobility, autonomous driving and V2X communications. With the electromagnetic simulation tools in CST Studio Suite® vehicles can be evaluated using virtual prototyping from the early stages of the design process. CST Studio Suite allows components to be modeled both in isolation and integrated into larger systems where their performance can be analyzed and optimized, and the reliability and electromagnetic compatibility taken into account.

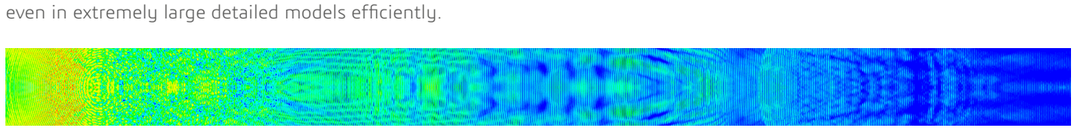
DASSAULT SYSTEMES

CONNECTIVITY AND V2X

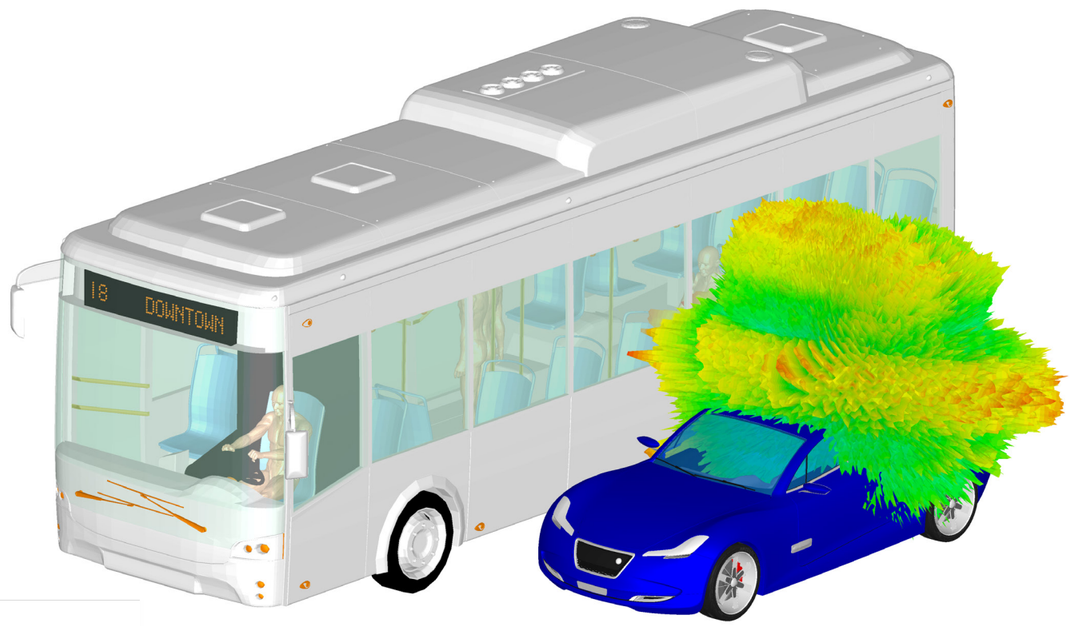
Antennas form the basis of all on-board communication, navigation and telemetry on a vehicle. Systems such as radio, Bluetooth, satellite navigation, vehicle tracking, collision notification and remote diagnostics all rely on high-performance antennas that perform as intended in challenging environments.

Simply placing an antenna on a vehicle can affect its performance, as the curved metal body of the car blocks, reflects and conducts the fields radiated by the antenna. Investigating this effect with measurement can be an expensive process requiring a large test facility and many hours of work. Simulation complements the measurement process by allowing antennas to be simulated as installed on the vehicle. CST Studio Suite can reduce measurement and prototyping costs and allow engineers to optimize antenna placement in order to improve performance.

Vehicle-to-vehicle (V2V) and vehicle-to-everything (V2X) systems require an even more detailed analysis of the automobile in its environment, including passing vehicles and surrounding infrastructure. High-performance computing and System Assembly and Modeling (SAM, see page 5) makes it possible to simulate antenna performance even in extremely large detailed models efficiently.



Vehicle-to-vehicle communication: E-field at 5.9 GHz for a V2V link between two vehicles 10 m apart.



V2V communication: Far field of a V2V antenna, showing the blocking effect caused by the passing bus.

ADAS AND RADAR

Sensors provide information on both the state of the car itself and on its surroundings. The dawn of autonomous vehicles means that sensor performance is more critical than ever, and vehicle safety rests on the reliability of these sensors in all conditions and environments.

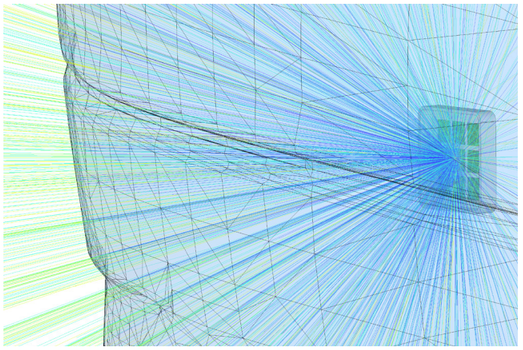
Simulation can be used to optimize the performance of sensors and investigate reliability in complex environments The sensors used in automotive applications span the frequency spectrum, from the static capacitive sensors used in touchscreens, through inductive sensors operating in kilohertz or megahertz used for purposes such as brake wear detection, up to parking radar which can operate at 77 GHz.

CST Studio Suite provides all of our solver technology in a common interface. This means that the appropriate solvers for each application are always at hand. With SAM (page 5), sensors can be simulated as installed on the vehicle and tested virtually in a range of scenarios.

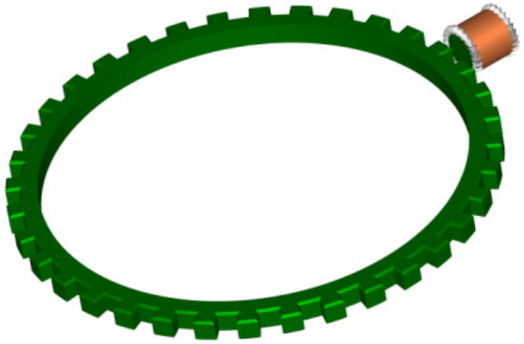
ELECTROMAGNETIC COMPATIBILITY (EMC)

Safety regulations and OEM requirements impose two strict limitations on the behavior of electrical components. First, they should not be susceptible to effects such as electromagnetic interference (EMI), electrostatic discharge (ESD) and environmental electromagnetic effects (E3), and nor should they produce emissions that could interfere with the working of other components. Simulation can be used to identify potential EMC problems as early as possible, avoiding the time, money and reputation costs of a redesign or recall.

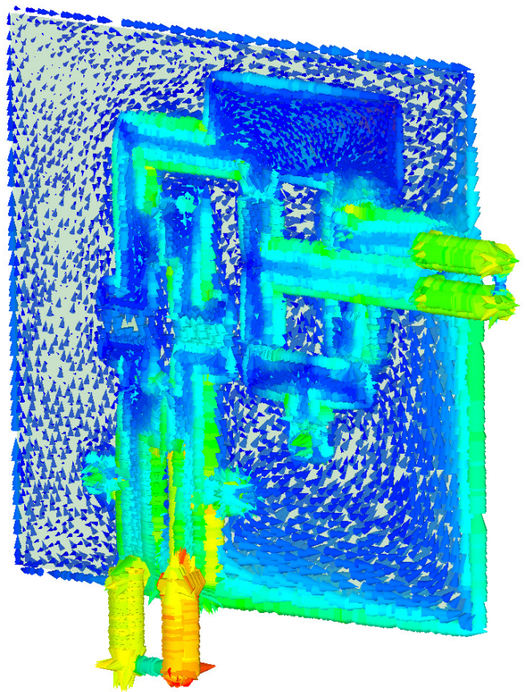
With CST Studio Suite, components can be simulated under a range of realistic settings to investigate how external fields and currents couple in and propagate through them. Cable shielding, enclosures and filters can be included to verify the effectiveness of mitigation techniques, and probes and field monitors allow the fields to be visualized in clear 3D to help engineers identify unforeseen coupling paths.



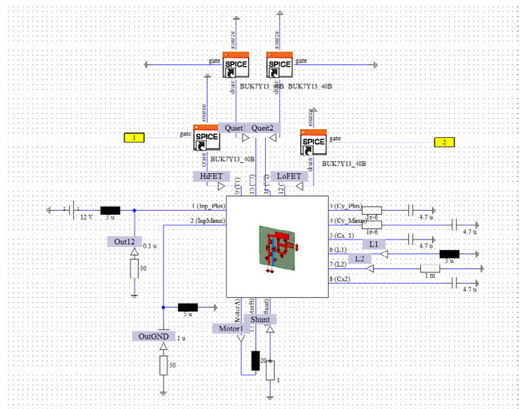
Parking radar: To accurately analyze the performance of a parking radar, the influence of the complex layered materials of the bumper need to be modeled.



ABS sensor: A reluctance sensor of this type is used by ABS systems to measure wheel speed. Optimizing features such as the tooth shape and the air gap can improve the sensitivity of the sensor to provide a technical advantage.



Electronic motor control: Surface currents at 50 kHz on a motor control PCB, showing the conducted emissions.



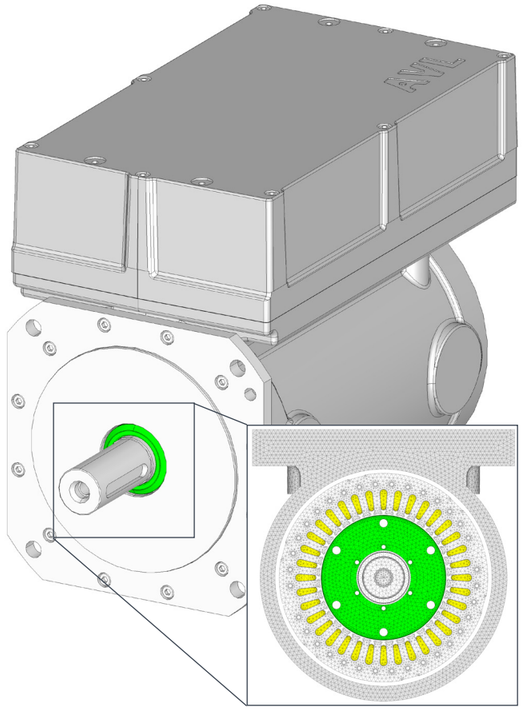
Co-simulation: Schematic circuit for a 3D EM/circuit co-simulation of a motor control.

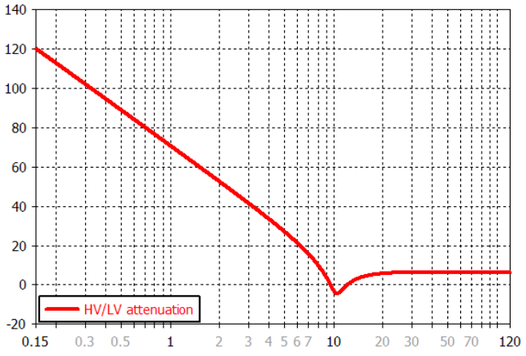
ELECTRIC MOBILITY: MOTORS AND POWER ELECTRONICS

Electrical machines have always been important parts of vehicles, but the rise of hybrid and electric vehicles makes them more important than ever and poses new challenges. The position and shape of the coils and magnets in an electrical machine can have a significant effect on its performance. CST Studio Suite includes specialized tools for simulating motors and actuators in order to optimize performance and efficiency.

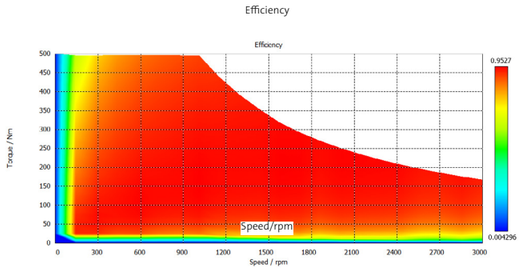
Simulation can also be used to design the electrical system of the car, including power electronics, inverters, high-voltage connectors and wireless charging systems. Optimizing these can improve energy efficiency, performance and charging time.

Motors and power electronics also pose special EMC challenges. Motors often combine high voltage and low voltage systems, and switching introduces high-frequency noise into what should be low-frequency or DC currents. CST Studio Suite can be used to calculate the HV/LV attenuation curve. Studying with simulation how currents propagate through motors and motor controls helps engineers characterize and control the EMC risks of a design.





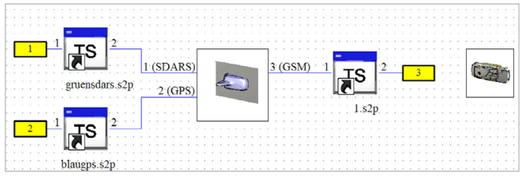
Motor design and EMC: A motor for an electric car, with a cross-section of the coil (top) and the HV/LV attenuation curve between the coil (HV) and the resolver (LV) (bottom), as often required by OEMs. Courtesy of AVL Trimerics.



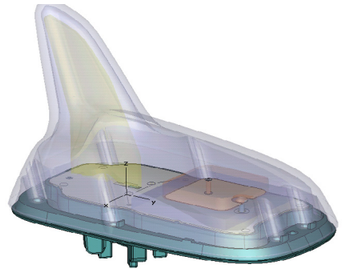
Motor efficiency: Efficiency maps such as these are essential for optimizing motor performance, and can be calculated automatically with CST Studio Suite.

SYSTEM ASSEMBLY AND MODELING (SAM)

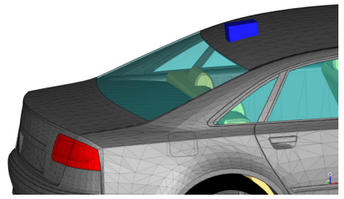
SAM is at the heart of CST Studio Suite, and represents a most powerful tool for integrated design. With SAM, multiple simulations using different solvers and mesh settings can be combined into an automatic workflow, using an intuitive schematic interface. Complex systems can be set up inside SAM and carried out automatically. Once each individual element has been designed, the Layout tool assists with combining the components into a full 3D model for a final simulation to verify the performance of the system.



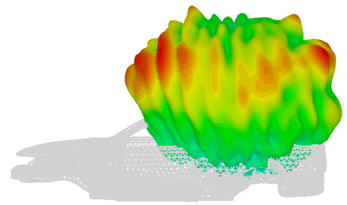
Feed network: The feed lines for the antenna are imported as Touchstone files and linked to the circuit to allow the effect of the feed network to be considered by the 3D simulation.



Detailed antenna model: The antenna is then simulated in full 3D to produce a field source.



Field source: The field source is installed on the 3D car model, and simulated with the appropriate method.

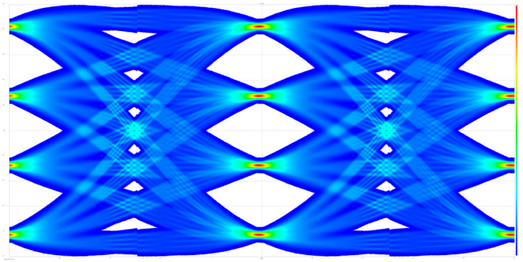


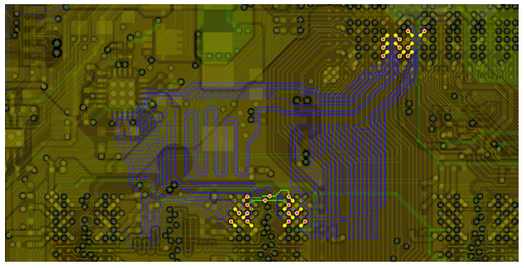
Final result: Using SAM accelerates the broadband time domain simulation by a factor of 6 in this case. Even greater time savings can be achieved if only a single frequency is required.

PCBS AND ELECTRONICS

Modern vehicles are full of electronic systems. Some are for communications or entertainment purposes, while others are essential for the operation of the vehicle.

Signal integrity (SI) and power integrity (PI) are important concerns when designing PCBs, as is the immunity of the PCB to external interference. Design rule checking with the CST Rule Check solver can quickly identify possible issues in a layout. The SI/PI solvers and full 3D solvers in CST Studio Suite allow a fuller analysis of the performance of the board as well as the optimization of component placements, and can identify coupling paths that are hard to identify with measurement alone.

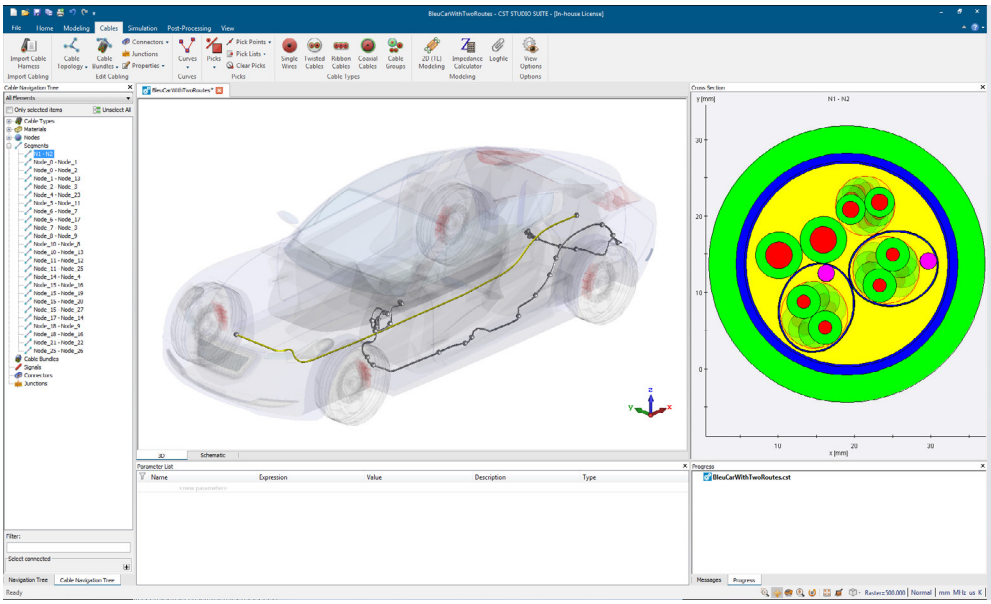




Signal integrity: Eye diagram of a DDR3 byte lane with all signals driven simultaneously, showing ISI (inter-signal interference) and crosstalk.

FEATURES

- **Powerful 3D modeling tools**
- **CAD and EDA import/export tools for a wide range of formats**
- **Full-wave 3D electromagnetic solvers**
- Time domain solver (FIT and TLM) for large, broadband or transient simulations
- Frequency domain solver (FEM) for small or highly-resonant structures
- Integral equation solver (MOM and MLFMM) for very large structures
- Low frequency, DC and static solvers for high-voltage and sensor applications
- **PCB/EDA simulation tools**
- Supports many widely-used EDA formats, including ODB++, GDSII, Zuken CR5000/CR8000 and IPC-2581, plus many Cadence® and Mentor Graphics® files.
- Specialized PCB simulation package
- SI and EMC design rule checking with the CST Rule Check solver
- **Cable and cable harness simulation**
- 3D parameteric cable definition
- Bidirectional hybrid simulation of cables in 3D environments
- **Automation**
- Integrated optimizers
- System Assembly and Modeling (SAM) for integrated simulation workflows
- Integration with MATLAB and VBA macro language
- **High performance computing**
- Distributed computing
- GPU computing
- MPI cluster computing
- Cloud computing
- **Common ribbon-based interface for all solvers**



Modeling Interface: The intuitive 3D modeling interface allows fully parametric model and cable construction within the simulation environment.

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