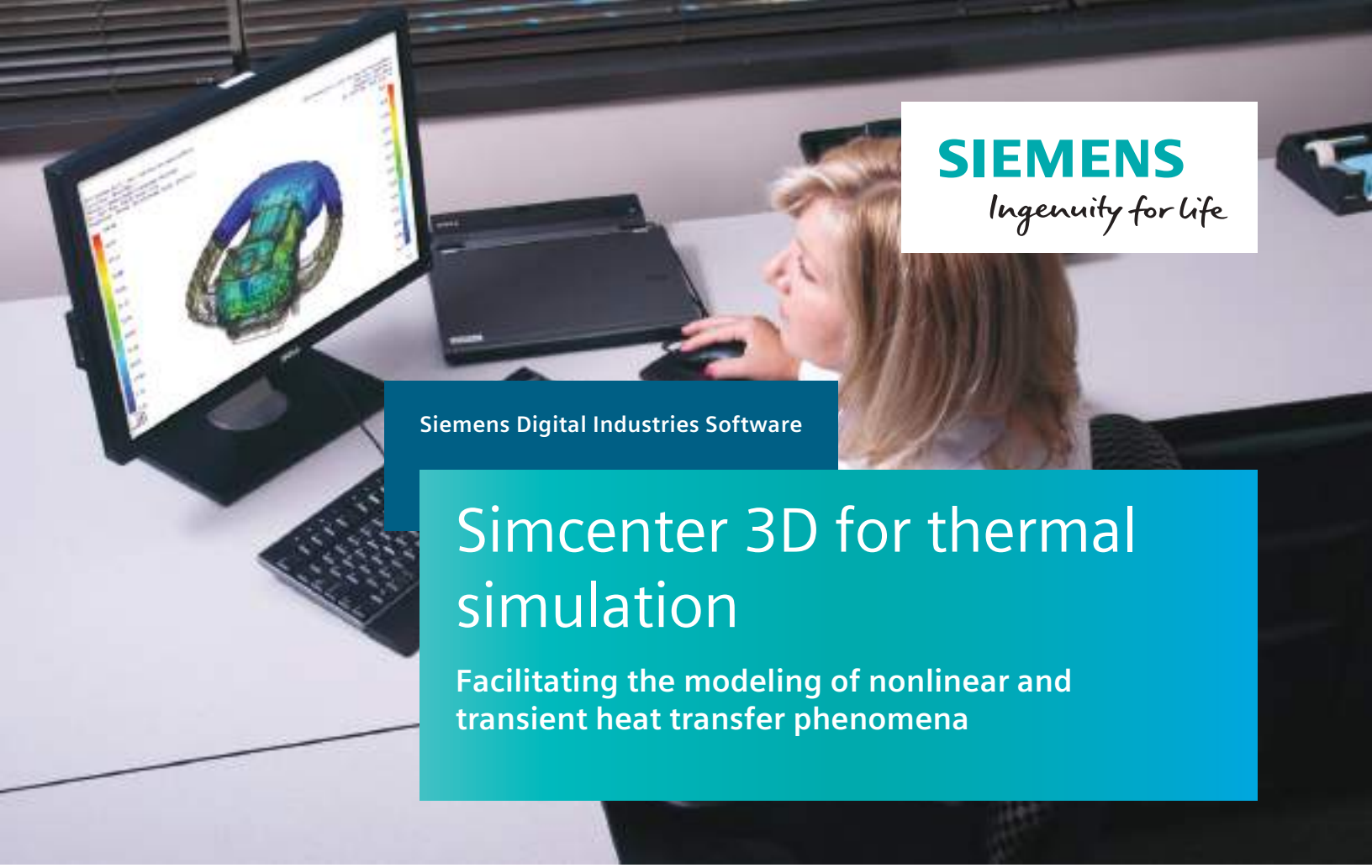


SIEMENS
Ingenuity for life

Siemens Digital Industries Software

Simcenter 3D for thermal simulation

Facilitating the modeling of nonlinear and transient heat transfer phenomena

Solution benefits

- Leverage the Simcenter 3D integrated environment to make quick design changes and provide rapid feedback on thermal performance
- Use Simcenter Nastran to understand thermoelastic effects with coupled physics analysis
- Minimize tedious rework and modeling errors with direct interfaces for ECAD systems
- Analyze condensation, humidity and dust particle transport in electronics systems
- Predict thermal performance for orbiting vehicles accurately and quickly
- Increase collaboration and team productivity with a thermal analysis solution that is easily integrated with your design and engineering process

Simcenter™ 3D software offers a complete solution for modeling nonlinear and transient heat transfer phenomena, accounting for conduction, convection, radiation and phase change. Dedicated thermal modeling capabilities are available, such as rapid thermal connection methods, an extensive physical model library and a wide array of thermal loads and boundary conditions. These provide flexibility and ease-of-use while addressing complex thermal challenges.

Gain reliable thermal insights

A pioneering tool in computational heat transfer modeling, Siemens Digital Industries Software's Simcenter 3D has been continuously developed for over three decades. It boasts a complete element, material and physical model library that is linked to an enriched, high-fidelity solver with a broad set of functionalities. This is further enhanced by intuitive pre-/postprocessing functionalities for thermal analysts.

Simcenter 3D for thermal simulation

Easily handle thermal exchange between dissimilar interfaces

Using Simcenter 3D, thermal connections can be automatically defined between disjoint components, dissimilar meshes and nonconforming geometry. Moreover, mesh congruence and proximity requirements are eliminated, which enables the user to build and solve large assemblies quickly.

Master complexity and productivity in industry verticals

The capabilities of Simcenter 3D for thermal simulation have been leveraged in vertical applications to satisfy specific industry needs. Simcenter 3D Space Systems Thermal enables the user to model the thermal performance and characteristics of orbiting and interplanetary vehicles. Simcenter 3D Advanced Thermal provides advanced capabilities for the aero-engine analyst community to perform analysis on the entire engine.

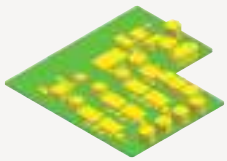
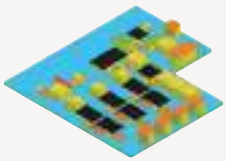
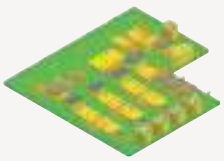
Automation and customization to manage a wide range of models

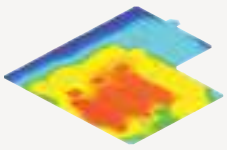
Simcenter 3D for thermal simulation provides an extensible solver architecture supporting user subroutines, user plugins, expressions and an open application programming interface (API) to automate and customize the product development workflow according to industry needs.

Providing a platform for multidiscipline simulation

The Simcenter 3D thermal solution is part of a larger, integrated multidiscipline simulation environment with the Simcenter 3D Engineering Desktop at the core for centralized pre-/postprocessing for all Simcenter 3D solutions. This integrated environment helps you to achieve faster CAE processes and streamline multidisciplinary simulation such as thermomechanical analyses based on structural solutions or conjugate heat transfer problems that are coupled with flow solutions.

Geometry preparation	Meshing and assembly	Preprocessing	Solving	Postprocessing
Close holes, remove blends, idealize parts, etc.	Mesh mating, material selection, etc.	Thermal couplings, thermal loads, radiation enclosures, constraints, boundary conditions, etc.	Coupled conduction, convection, radiation heattransfer, temperature dependent phase change, axisymmetric analysis, etc.	Temperatures, heat fluxes, view factors, heat transfer coefficients, thermal stress, etc.



What-if, optimization, feedback to designer

Industry applications

Thermal applications in Simcenter 3D include simulation and analysis for a range of heat transfer problems in aerospace, automotive, electronics, power generation, process and other industries.

Automotive and transportation

Simcenter 3D helps tackle a variety of analysis scenarios, such as under-hood thermal analysis, powertrain thermal management and thermal response and temperatures in automotive lighting systems. Simcenter 3D for thermal offers a complete solution for the thermal design of electric vehicles, including batteries and enclosures.

Aerospace and defense

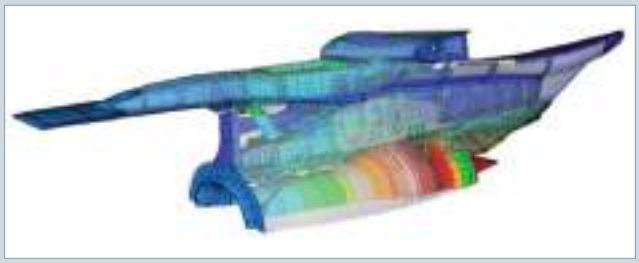
Simcenter 3D includes the ability to model the thermal response from a single component to a global aircraft system. The aero-engine turbine, compressor and entire engine may be modeled for a thermal analysis or a coupled thermomechanical analysis with Simcenter Nastran® software. Thermal dissipation from electrical components can be modeled using the nonlinear Joule heating capability. Aerothermal or ablation analysis is an area of strength.

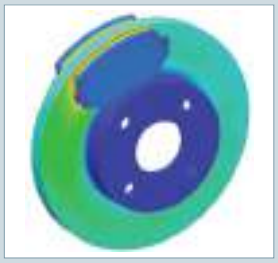
Electronics and consumer goods

Simcenter 3D thermal modules can be leveraged to meet the design requirements of compact and complex electronics systems. Examples include identifying recirculation zones and hot spots, predicting thermal response based on spatially varying and orthotropic conductivity and capacitance, and determining cooling strategies and heat sink modeling.

Industrial machinery

Simcenter 3D can be used to simulate a broad category of applications such as laser ablation and cutting, welding thermal response, mold-cooling analyses and phase change thermal analysis. In the cold-chain industry, Simcenter 3D can be used for performing predictive modeling of the quality of frozen and temperature-sensitive materials during shipping and handling.





Whole engine thermomechanical

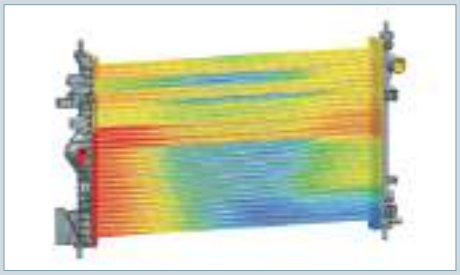
Spacecraft thermal performance

Electronics cooling

Orbital heating

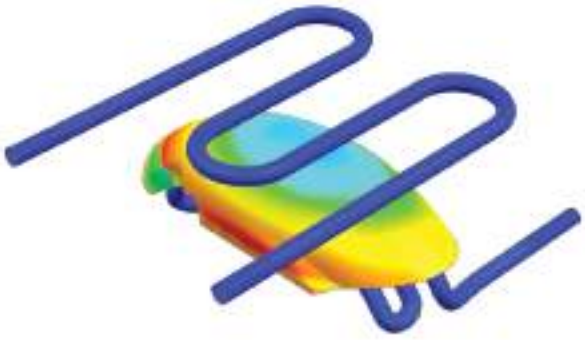
Powertrain thermal management

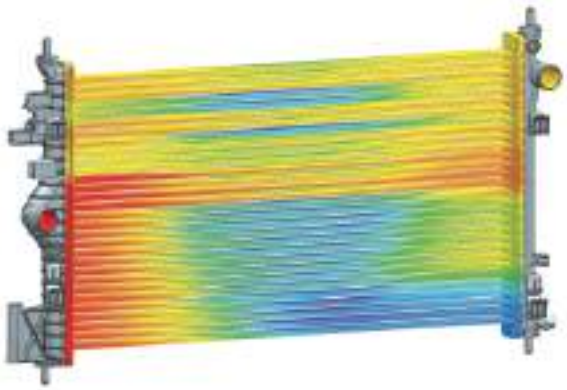
Cold chain



Simcenter 3D Thermal

Simcenter 3D Thermal provides heat transfer solutions and can simulate conduction, convection and radiation phenomena for complex products and large assemblies. The Simcenter 3D Thermal solver is based on a finite-element, finite-volume formulation to simulate heat transfer phenomena accurately and efficiently.





Module benefits

Use Simcenter Nastran software to understand thermomechanical effects of coupled physics analysis

Deliver full assembly finite element method (FEM) support to model complex systems

Key features

Fully coupled conduction, radiation and convection heat transfer simulation to steady-state and transient problems

Axisymmetric modeling and nonlinear thermal properties

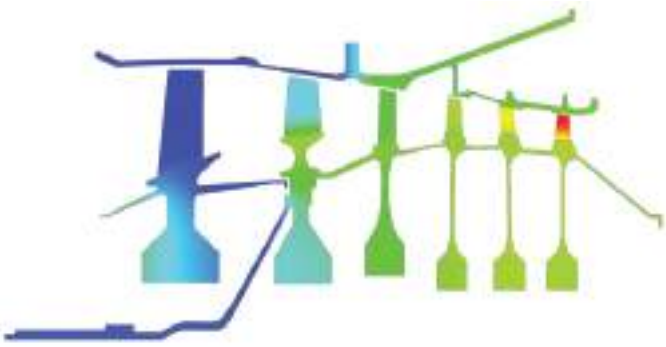
Thermally connect disjoint and dissimilar mesh faces and edges

Spatially varying heat transfer coefficients can be defined for thermal boundary conditions

Live results post-processing & solver parameters control during solve

Simcenter 3D Advanced Thermal

Simcenter 3D Advanced Thermal provides a wide range of methods for sophisticated radiation analysis, advanced optical properties, radiative and electrical heating models, one-dimensional hydraulic network modeling and advanced material models such as phase change, charring and ablation. Thermal control devices and articulation may also be modeled.



Module benefits

Solve complex heat transfer phenomena with a comprehensive set of modeling tools

Extend thermal solution capabilities in Simcenter 3D Thermal and Simcenter 3D Electronic Systems Cooling

Leverage open architecture to integrate user subroutines and grant greater control over the solution

Use parallelized thermal solver and view factor calculations to increase solution efficiency and reduce total run time

Key features

Simulate direction-dependent optical properties, bi-directional reflectance distribution function (BRDF)

Wavelength-dependent properties for nongray bodies

Advanced radiation methods such as deterministic and Monte Carlo ray tracing and nongray multiband radiative heat transfer

Dedicated turbomachinery-specific boundary conditions combining ducts and streams

Simcenter 3D Space Systems Thermal

Simcenter 3D Space Systems Thermal is the vertical application that provides a comprehensive set of tools to perform orbital thermal analyses in the Simcenter 3D environment. Simcenter 3D Space Systems Thermal helps resolve engineering challenges early in the design process and is a valuable tool for predicting and understanding thermal physics for space-bound, orbiting and interplanetary vehicles.

Module benefits

Predict thermal performance for orbiting vehicles accurately and quickly

Increase collaboration and team productivity with a thermal analysis solution that is easily integrated with your design and engineering process

Maximize process efficiency with a highly automated solution that requires no additional input files and carries out the analysis in a single pass

Key features

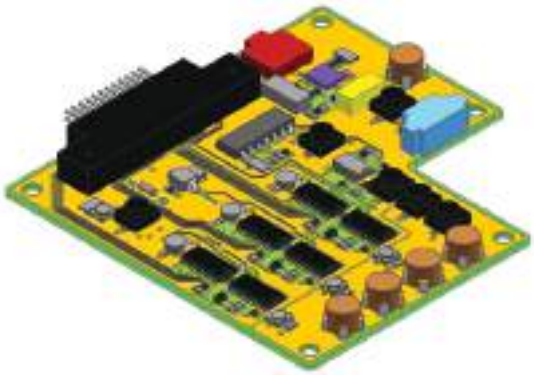
Model orbital heating for all planets of the solar system

Transient view factor recalculations with articulating geometries such as sun-tracking solar panels and directional antennas

Multilayer shell formulation for modeling multilayer insulation, composite panels and thermal protection systems

Simcenter 3D Electronic Systems Cooling

Simcenter 3D Electronic Systems Cooling software is an industry-specific vertical application that leverages Simcenter 3D Flow and Simcenter 3D Thermal solvers as well as NX™ software and the NX PCB Exchange module capabilities in an integrated multiphysics environment. This enables you to simulate 3D airflow and thermofluid behavior in densely packed, heat-sensitive electronic systems.



Module benefits

Simulate 3D airflow and thermal behavior in electronic systems

Minimize tedious rework and modeling errors with direct interfaces to electrical computer-aided design (ECAD) systems

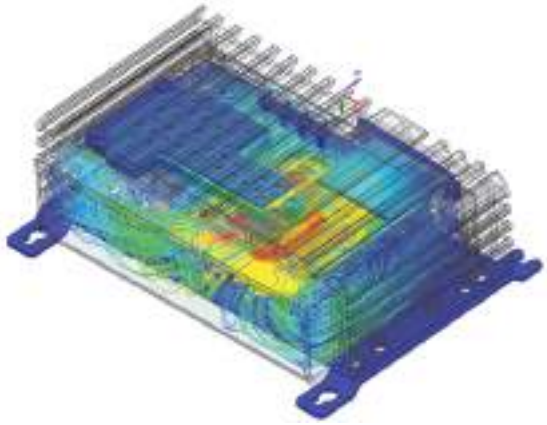
Transport condensation, humidity and dust particles in electronics systems

Key features

With NX PCB Exchange, fully three-dimensional board designs can be obtained from the leading printed circuit board (PCB) and flexible printed circuit (FPC) layout software packages from companies such as Siemens Digital Industries Software, Zuken, Cadence and Altium

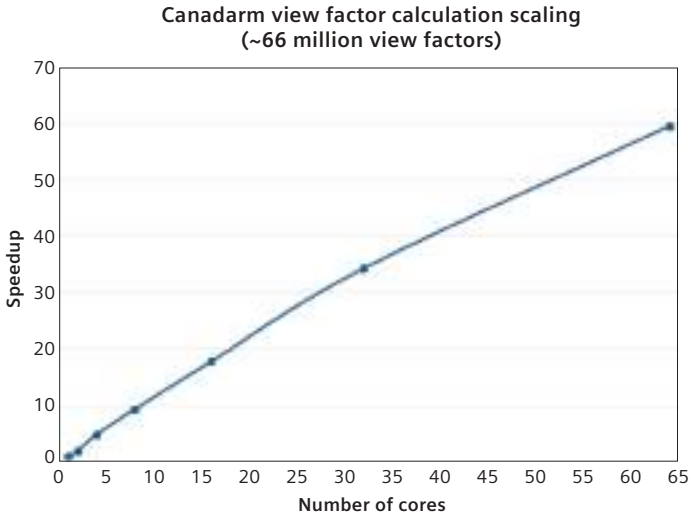
Radiation enclosures using hemicube-based view factor calculations (using graphics card hardware)

A catalog of fan curves is available out-of-the-box (OOTB), which can be extended with additional manufacturer data



Simcenter 3D Thermal HPC

Simcenter 3D Thermal high-performance computing (HPC) leverages hardware systems configured as a multiprocessor desktop or a multi-node cluster. One license of Simcenter 3D Thermal HPC together with the prerequisite solver licenses can be used to produce a solve over as many processors as available.



Module benefits

Leverage the flexibility of solving on a single machine or across a distributed network or cluster

Maximize the value of your hardware investments and greatly improve your solution

Key features

Cores may be co-located on a single workstation, distributed over a local area network (LAN), or exist within a standalone computational cluster

Limitations on the maximum number of cores are eliminated, allowing solve speeds to scale up or down based on the number of available cores, not the number of available licenses

Domain decomposition techniques are included for solving large-scale thermal models

The Simcenter 3D Thermal solver features parallel computation of radiation view factors, radiative heating and a solution for the thermal model

Capabilities chart

General capabilities	Specific capabilities	Simcenter 3D Thermal	Simcenter 3D Advanced Thermal	Simcenter 3D Space Systems Thermal	Simcenter 3D Electronic Systems Cooling	Simcenter 3D Thermal HPC
Solver(s)	DMP thermal parallel processing	+	+	+	+	•
	Thermal parallel processing (serial solver)		•	•	•	•
	Multiphysics solve		+	+		•
	Multithreading		•	•	•	
	User subroutine		•	•	•	
File export	cgns				•	
	esatan			•		
	INPF	•		•	•	
	Mapping constraint	•		•	•	
	primitive			•		
	Sinda-85			•		
File import	cgns				•	
	I-DEAS scratch file	•		•	•	
	INPF	•		•	•	
	NX xml	•		•	•	
	plot3d				•	
	primitive			•		
	Universal	•		•	•	
Modeling objects	Ablation charring		•	•		
	Active heater controller		•	•	•	
	Advanced parameters flow				•	
	Advanced parameters thermal	•		•	•	
	Axisymmetry source zone (multiphysics only)	•		•		
	Convection properties				•	
	Duct convection correction		•	•		
	Duct head loss		•	•		
	External conditions				•	
	External solver					
	Fan speed controller				•	
	Generic entity	•		•	•	
	Joint		•	•		
	Joint orbital tracker			•		
	Layer	•		•	•	
	Monte Carlo settings		•	•	•	
	Multiphysics thermal output request					

General capabilities	Specific capabilities	Simcenter 3D Thermal	Simcenter 3D Advanced Thermal	Simcenter 3D Space Systems Thermal	Simcenter 3D Electronic Systems Cooling	Simcenter 3D Thermal HPC
Modeling objects *(continued)*	Nongeometric element	•		•	•	
	Orbit			•		
	PCB layer			•	•	
	PCB via			•	•	
	Planar head loss				•	
	Reference temperature	•		•	•	
	Rotational periodicity source zone (multiphysics only)	•		•		
	Target temperature	•		•	•	
	Target temperature change	•		•	•	
	Thermal parameters (multiphysics only)	•		•		
	Thermal source zone	•		•		
	Thermo optical properties	•		•	•	
	Thermo optical properties advanced		•	•		
	Thermo optical properties state		•	•		
	Thermostat	•		•	•	
	Void NGE		•	•		
Loads	Gravity (component, magnitude and direction)		•	•		
	Rotation (model subset and whole model)		•	•		
	Thermal convecting zone		•	•		
	Thermal loads (heat load, heat flux, heat generation)	•		•	•	
	Thermal stream		•	•		
	Thermal void (with regions)		•	•		
Constraint	Association target zone	•			•	
	Convection to environment	•		•	•	
	Initial conditions	•	•	•	•	
	Film cooling		•			
	Flow mapping target set				•	
	Mapping	•		•	•	
	Rotational periodicity target zone	•		•	•	
	Simple environment radiation	•		•	•	
	Symmetry target zone	•		•	•	
	Temperature	•		•	•	
	Transverse gradient target set	•			•	

General capabilities	Specific capabilities	Simcenter 3D Thermal	Simcenter 3D Advanced Thermal	Simcenter 3D Space Systems Thermal	Simcenter 3D Electronic Systems Cooling	Simcenter 3D Thermal HPC
Simulation objects	Advanced thermal coupling		•	•		
	Convection coupling		•	•		
	Deactivation set	•		•		
	Deactivation set advanced		•	•	•	
	Disjoint fluid mesh pairing				•	
	Duct flow boundary condition		•	•	•	
	Flow blockage				•	
	Flow boundary condition					
	– Convective outflow				•	
	– Inlet				•	
	– Internal fan				•	
	– Opening				•	
	– Outlet				•	
	– Recirculation loop				•	
	– Static pressure				•	
	Flow surface				•	
	Free molecular heating			•		
	Immersed boundary				•	
	Interface resistance	•		•	•	
	Joule heating (current, electrical coupling, voltage)		•	•	•	
	Merge set			•		
	Orbital heating			•		
	Override set - thermal properties	•	•	•	•	
	Particle injection					
Simulation objects *(continued)*	PCB component				•	
	Peltier cooler		•	•	•	
	Printed circuit board				•	
	Radiation (all radiation and enclosure radiation)	•		•	•	
	Radiation thermal coupling (gap and object-to-object)	•		•	•	
	Radiative element subdivision		•	•		
	Radiative heating		•	•		
	Report	•		•	•	
	Screen				•	
	Selective results				•	
	Solar heating		•	•		
	Solar heating space		•	•		
	Solid motion effects (articulation, spinning)		•	•		
	Symmetry plane				•	
	Thermal coupling	•		•	•	
	Thermal rotational periodicity		•	•		
Catalogs	Advanced parameters	•		•	•	
	Component				•	
	Correction		•	•		
	Fan catalogs				•	
	Fan curves				•	

Legend:
• = included in module
+ = additional product required

Note: Simcenter 3D Engineering Desktop is a minimum prerequisite for all Simcenter 3D products. Other dependency or prerequisites may apply for individual products.

Siemens Digital Industries Software
siemens.com/software

Americas +1 314 264 8499
Europe +44 (0) 1276 413200
Asia-Pacific +852 2230 3333

© 2020 Siemens. A list of relevant Siemens trademarks can be found here.
Other trademarks belong to their respective owners.

77921-C10 7/20 H