

# Electronics and Lighting Applications

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## Inside the CFdesign Advanced Module

Upfront CFD is all about using simulation to drive design decisions. The CFdesign Base Module contains an extensive collection of functionality, and is capable of solving a wide breadth of applications. Some situations, however, are a little more complex, and require physical models that are beyond the scope of the Base System. The best solution for these situations is the CFdesign Advanced Module.

License Requirements: The CFdesign Base System is a requisite for the Advanced Module.

## Advanced Simulation Scope

The CFdesign Advanced Module provides additional flow and thermal simulation functionality to further expand the solution scope.

### Advanced Fluid Flow

- Supersonic compressible
- Transient (time varying)
- Two-phase flows (humidity and steam mixtures)
- Height of fluid formulation
- Two-fluid scalar mixture model
- Compressible liquid (water hammer)
- Cavitation

### Advanced Heat Transfer

- Internal radiation heat transfer
- Radiation through transparent media
- Solar Loading
- Temperature dependent emissivity
- Joule heating with temperature dependent resistivity

### Advanced Conditions

- Relative humidity
- Steam quality
- Fill level
- Time varying boundary conditions
- Current
- Voltage

It's important, however, to understand how these models solve real-world problems. Let's explore the following questions for the Advanced functional items that are most commonly used for Electronics and Lighting applications:

1. *What is it?*
2. *Why would you need it?*
3. *What can you do with it?*

***A major challenge faced by engineers in the Electronics industry is to ensure that components operate below their temperature limits. The challenge is further compounded by the relentless drive to reduce device size while device power steadily increases. In the lighting world, the LED is the preeminent environmentally-conscious solution. Because a great deal of the total energy applied to an LED is converted into heat, and LEDs need to run at much cooler temperatures than other lamp types, engineers in the Lighting industry are faced with significant thermal management issues as well.***

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## Radiation

### *What is Radiation?*

Radiation is a surface-to-surface heat transfer mode that relies on a direct line of sight between surfaces. Unlike conduction or convection, radiation does not need a medium such as a solid or carrier gas. Heat radiates through empty space with electromagnetic waves.

### *Why would you need Radiation?*

Radiative heat transfer is integral to the performance of many electronic devices and enclosures. Incorporating radiation often leads to greater solution accuracy for high temperature applications.

In many cases, neglecting radiation can lead to inaccurate temperature prediction, which can lead to flawed design decisions.

### *What can you do with Radiation?*

The CFdesign Radiation Model is a physically rigorous model that provides a high level of solution accuracy. Using an optical view factor calculation, the Radiation model produces an accurate energy balance and enforces reciprocity between solid objects.

- Achieve accurate temperature predictions in demanding, high-Wattage applications such as telecommunications devices, data center equipment, and LED fixtures.
- Use the radiation model to include the effects of temperature-dependent emissivity to simulate the effects of spectral radiation.
- Accurately simulate components by specifying the emissivity properties of solid objects.

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## Transient

### *What is Transient?*

A process that is “transient” varies with time. Unlike a steady state process, the flow distribution and temperature change from one moment to the next. CFdesign uses an implicit time stepping method to compute the time-dependent solution.

### *Why would you need Transient?*

Understanding the effects of time-dependent variations such as oscillatory flow is essential to making informed design decisions. If the amount of flow varies with time, the transient module provides valuable insight into how the flow develops and how the system adapts to changing inputs. If the amount of heat added or removed from the device is controlled with a transient boundary condition, predicting this is even harder with hand calculations or experimental methods.

### *What can you do with Transient?*

The Transient functional item provides a great deal of value through a diversity of applications including:

- Vary the amount of flow or heat entering or leaving an enclosure using transient boundary conditions. Many systems are subject to cyclical inputs, and the Transient module simulates this input variation.
- Simulate the effect of activating or deactivating a heat-dissipating component at a particular moment in time. Assess the thermal effects of such a component on the entire system.
- Review the time history by animating results. Share your results using several formats: Dynamic Images for viewing in the CFdesign 3D Viewer, AVI, and MPEG.

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## Joule heating

### *What is Joule Heating?*

Also known as “resistance heating” and “Ohmic heating,” Joule heating is the generation of heat that occurs when an electric current is passed through a metal object such as a wire, electrical connector, or stove-top burner element.

### *Why would you need Joule Heating?*

Depending on the application, Joule heating can either be the intended result or something to be avoided. If the design intent is to achieve resistance heating, the Joule Heating physical model provides insight into the temperature distribution throughout the device produced by the heating element. If the design objective is to mitigate the effects of Joule heating (such as in electrical connectors or electrical transformers), use the Joule Heating physical model to modify design for the removal of unwanted component heat.

### *What can you do with Joule Heating?*

Use Joule heating to simulate thermal performance of a wide variety of devices including electrical resistance heaters, stove-top burner elements, and electrical transformers.

- Specify either a current or a potential difference across the device.
- Define temperature-dependent resistivity physical properties for a physically realistic simulation.
- Visualize the temperature distribution throughout the device and the neighboring components within the system. This provides design insight into how effective heat is removed from the device and sunk to other areas or to the ambient.

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## Solar Heating

### *What is Solar Heating?*

A sub-set of radiation heat transfer, solar heating is radiative heat from the sun. Unlike conduction or convection, solar radiation does not rely on a medium such as a solid or carrier gas. Heat radiates through empty space with electromagnetic waves.

### *Why would you need Solar Heating?*

The Solar Heating model is essential for optimizing the thermal performance of devices that operate out-of-doors, especially in environments exposed to harsh sunlight with little shade.

Critical components such as telecommunications equipment (both civilian and military), buildings, and even cars are subjected to harsh conditions imposed by the sun. They must be designed to withstand the high temperatures and day-to-day thermal cycling that play a serious factor on product life-span and durability.

### *What can you do with Solar Heating?*

CFdesign provides a comprehensive set of tools for specifying the exact location, time, date, and physical orientation to ensure accuracy for a wide range of applications.

- Asses the thermal effects of solar heat loading to make design decisions that will affect product durability and life-span.
  - Simulate the effects of shadowing. The relative location of objects significantly influences how solar energy affects other objects or devices.
  - Study the long-term effects of diurnal heating. Vary the sky temperature and emissivity to simulate thermal cycling from day to night and back to day.
  - Accurately account for the amount of cloud cover and ambient light by specifying the albedo (the amount of radiant energy that is reflected off the sky and back to earth).
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