



Southwire®

SWRate User's Manual

v2.3.0



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1 *Welcome to SWRate Software*

1.1 *What is SWRate Software?*

Southwire's SWRate software is a PC-based program that calculates resistance, reactance, and thermal ratings of overhead conductors in accordance with current standards. SWRate Lite software is available as a no-cost "lite" version of the SWRate Pro software. Each software includes an extensive database of overhead conductors and cables. The calculation methods used in SWRate software are based on IEEE 738-2023. Data provided in the conductor tables and conductor calculations are based on ASTM standards.

1.2 *Who Can Use SWRate Software?*

Southwire intends the SWRate program to be used by qualified engineers and designers who have a foundation of knowledge in overhead power transmission and distribution lines, and the performance of conductors used in those lines. When using the SWRate program, a qualified engineer should review the parameters input for the calculations, and the resulting calculated data, and verify that they are correct for the specific application.

1.3 *SWRate Highlights*

1.3.1 *SWRate Features*

Inside an easy-to-use menu-driven interface, SWRate software will calculate, for a specific set of input conditions:

- DC/AC resistance at any operating temperature (interpolated resistance mode also available; DC available in Pro version only)
- DC/AC thermal ratings for a determined temperature range under various combinations of solar and wind conditions (Pro version only)
- A steady-state conductor thermal rating for a given conductor temperature
- A steady-state conductor temperature given a steady-state current
- A steady-state conductor thermal rating for a given surface/core temperature (Pro version only)
- Steady-state surface/core temperatures given a steady-state current (Pro version only)
- A transient conductor thermal rating provided a maximum transient temperature, duration, and starting condition
- A transient conductor temperature provided a transient current, duration, and starting condition
- Conductor GMR (Pro version only)
- Conductor reactance for various bundle/phase configurations (Pro version only)
- Batch steady-state and transient results for multiple conductors and multiple sets of calculation conditions, including columns for conductor properties, resistance, and reactance (Pro version only)
- Results in U.S. Standard or Metric units



Data furnished includes conductor properties for the following conductor types:

- AAC
- AAC/TW
- AAAC
- ACAR
- AACSR
- ACSR
- ACSR/TW
- ACSR/MR
- ACSR/AW
- ACSS
- ACSS/TW
- ACSS/AW
- ACSS/TW/AW
- Max Storm™
- ACCS/TW/C7®-TS
- ZTACCR/TW/C7®-TS
- ACCS/TW/C7®-TP
- ZTACCR/TW/C7®-TP
- ACCR
- ACCR/TW
- AAC/VR2
- ACSR/VR2
- ZTACSR/VR2
- Al Bare
- Al Duplex
- Al Triplex
- Al Quadruplex
- HD Copper
- MHD Copper
- SD Copper
- HD Copper Contact Wire
- Bronze Alloy 55 Contact Wire
- Bronze Alloy 80 Contact Wire
- Cu Duplex
- Cu Triplex
- Cu Quadruplex
- AAC Line Wire
- AAAC Line Wire
- ACSR Line Wire
- AAC Tree Wire/Spacer Cable
- ACSR Tree Wire
- C7® Tree Wire

Covered conductors are only available in the Pro version. Custom conductors can also be modeled, saved, and deleted (Pro version only). See Section 2.2, *Conductor Selection*, for more information.

1.4 Installation

1.4.1 Southwire's SWRate Software Package Includes:

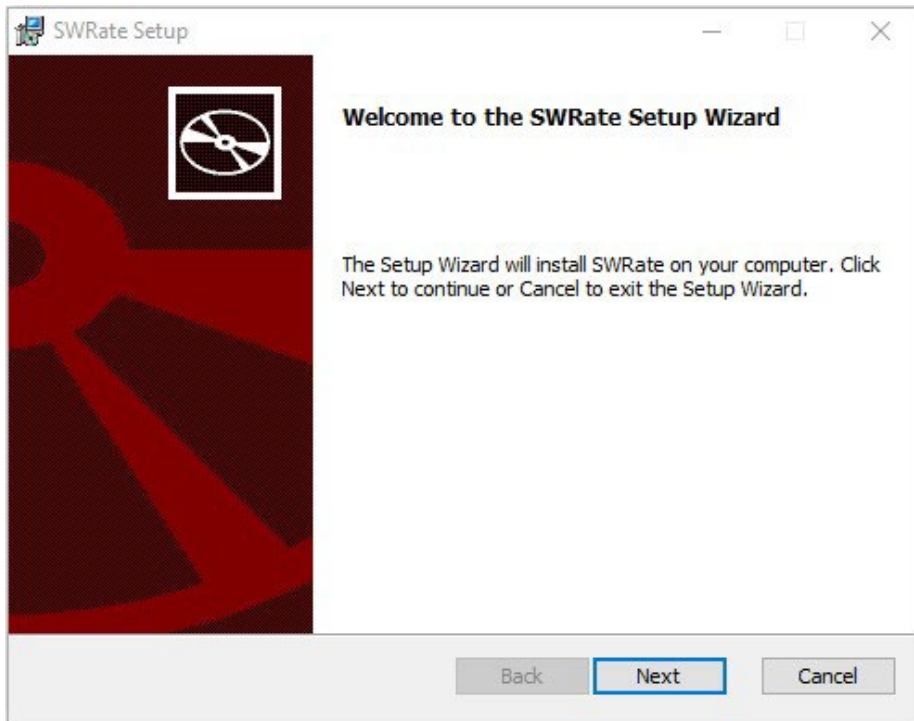
1. Product key
2. Download link
3. Installation Instructions link
4. Documentation link
5. User's Manual link
6. Other helpful links

1.4.2 SWRate Installation Instructions

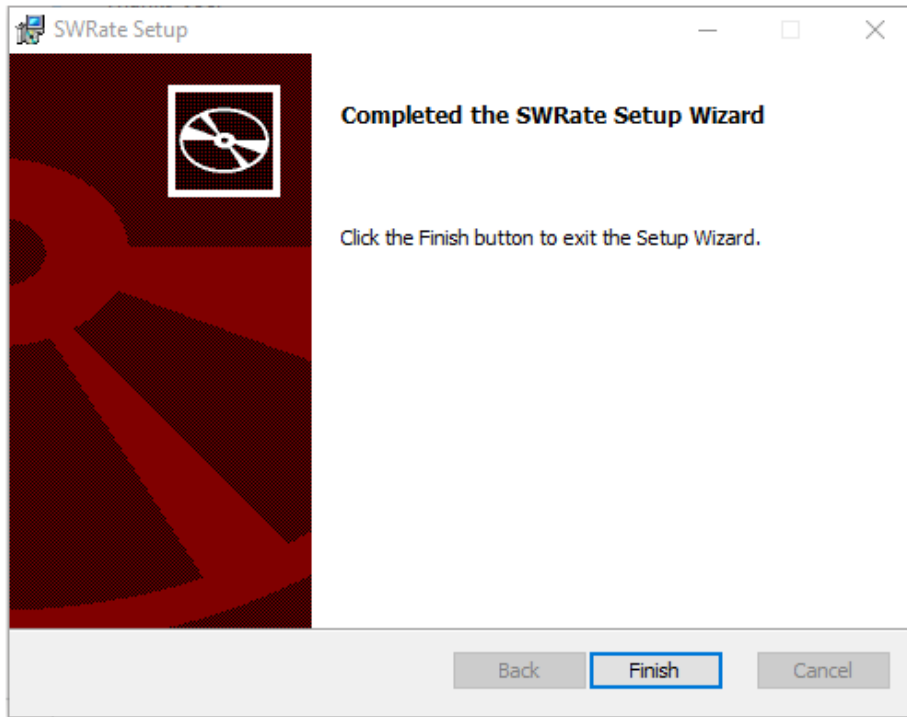
1. After downloading the SWRate installer, double-click the “*SWRate_install.msi*” file to begin installing SWRate software.



Click **Next** on the **Welcome to the SWRate Setup Wizard** screen.



2. By default, the SWRate program will be installed under the “*C:\Program Files (x86)\Southwire\SWRate*” folder.
3. Click **Finish**.



4. To launch the SWRate program, either double-click the Desktop shortcut or search "SWRate" in the Start menu.

1.4.3 SWRate Pro Licensing

If you have purchased SWRate Pro software, you will need to enter a valid product key to activate the full version of the software with **Advanced** features. To do so, click **Upgrade to Pro** at the top of the SWRate **Main Menu** screen after opening the program (Contact OHT@southwire.com for a product key).

1. In the **Southwire Licensing** screen, enter your **Product Key** in the space provided.



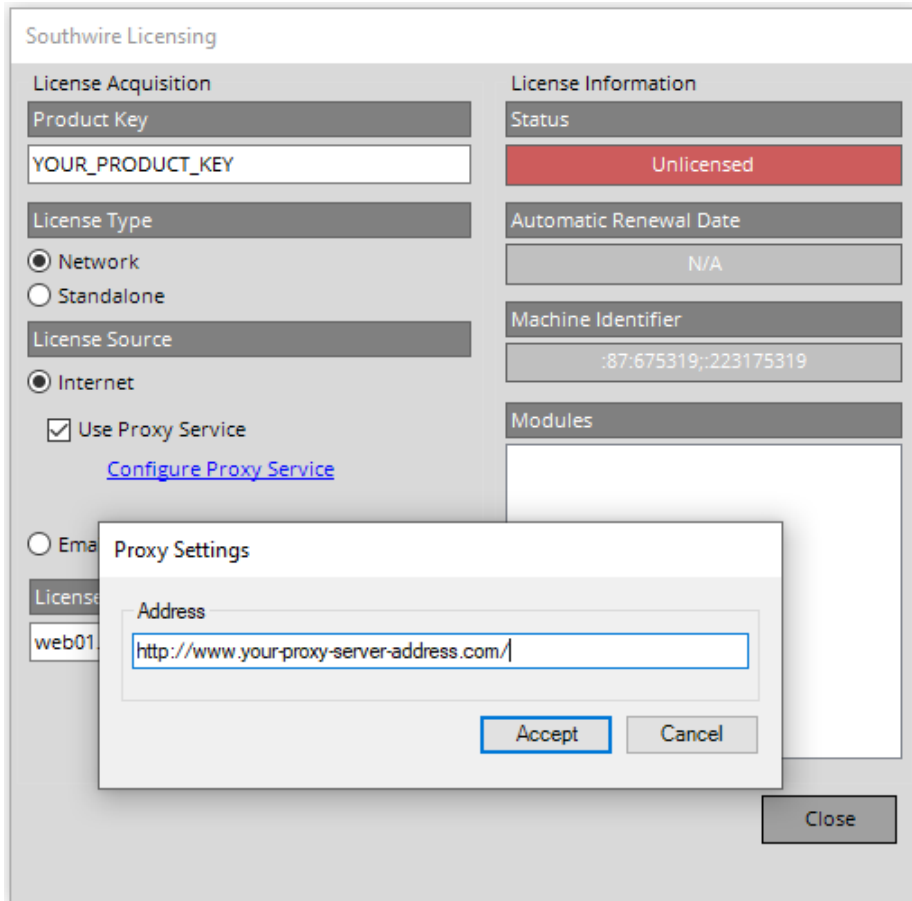
Southwire Licensing

License Acquisition	License Information
Product Key	Status
YOUR_PRODUCT_KEY	Unlicensed
License Type	Automatic Renewal Date
<input checked="" type="radio"/> Network	N/A
<input type="radio"/> Standalone	Machine Identifier
License Source	:87:675319;297:68642:
<input checked="" type="radio"/> Internet	Modules
<input type="checkbox"/> Use Proxy Service	
Configure Proxy Service	
<input type="radio"/> Email	
License Server	
web01.idsengineering.com	
<input type="button" value="Checkout"/>	<input type="button" value="Close"/>

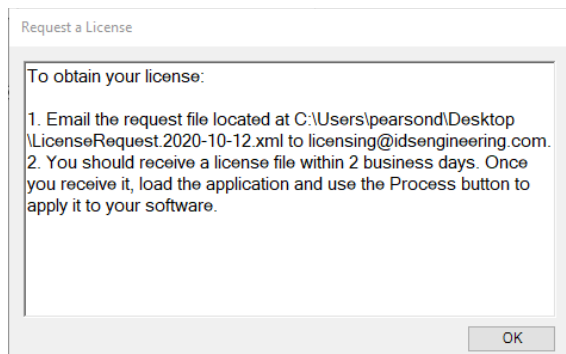
2. By default, the **License Source** will be set to **Internet**. If you do not have a valid internet connection, you may choose the **Email** option.
 - a) If you choose **Internet** and **DO NOT** use a proxy service, proceed to Step 3 below.
 - b) If you choose **Internet** and need to use a proxy service, check the box beside **Use Proxy Service** and click Configure Proxy Service.

Next, enter your proxy server address and click **Accept**.

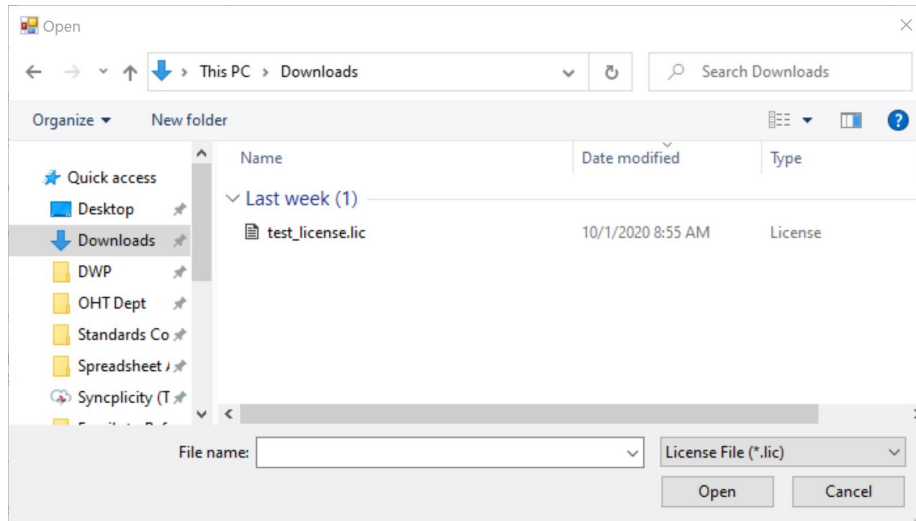
Finally, proceed to Step 3 below.



- c) If you choose **Email**, you will need to request a license file.
- i. Click the **Request** button.
 - ii. You will be prompted to select a folder under which to save the license request file (Ex: filename "LicenseRequest.YYYY-MM-DD.xml" will be generated).
 - iii. Click **OK**.
 - iv. A window will appear with instructions on where to email the previously generated license request file.



- v. When you receive the license file from Southwire, reopen the program and click **Upgrade to Pro** at the top of the **Main Menu** screen. Within the **Southwire Licensing** screen, again click **Email** under **License Source**, then click the **Process** button to apply the license file. You will need to navigate to the folder where the license file is located (Ex: “test_license.lic”) and click **Open**. If successful, proceed to Step 4.



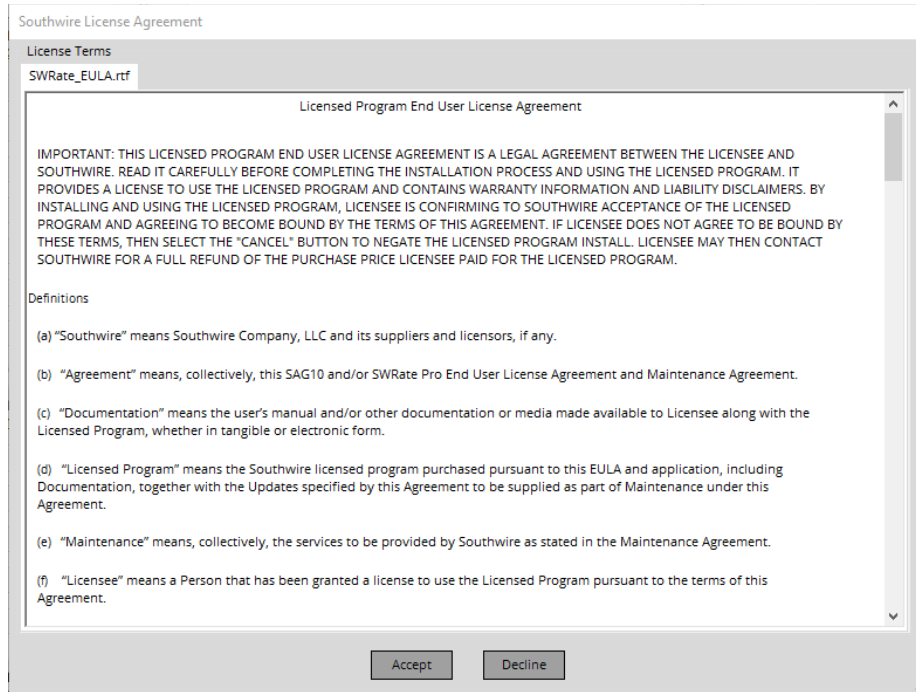
3. Click the **Checkout** button.
4. Once a license is successfully checked out, the **Status** section of License Information will be updated to say **Licensed** and will be visibly green.



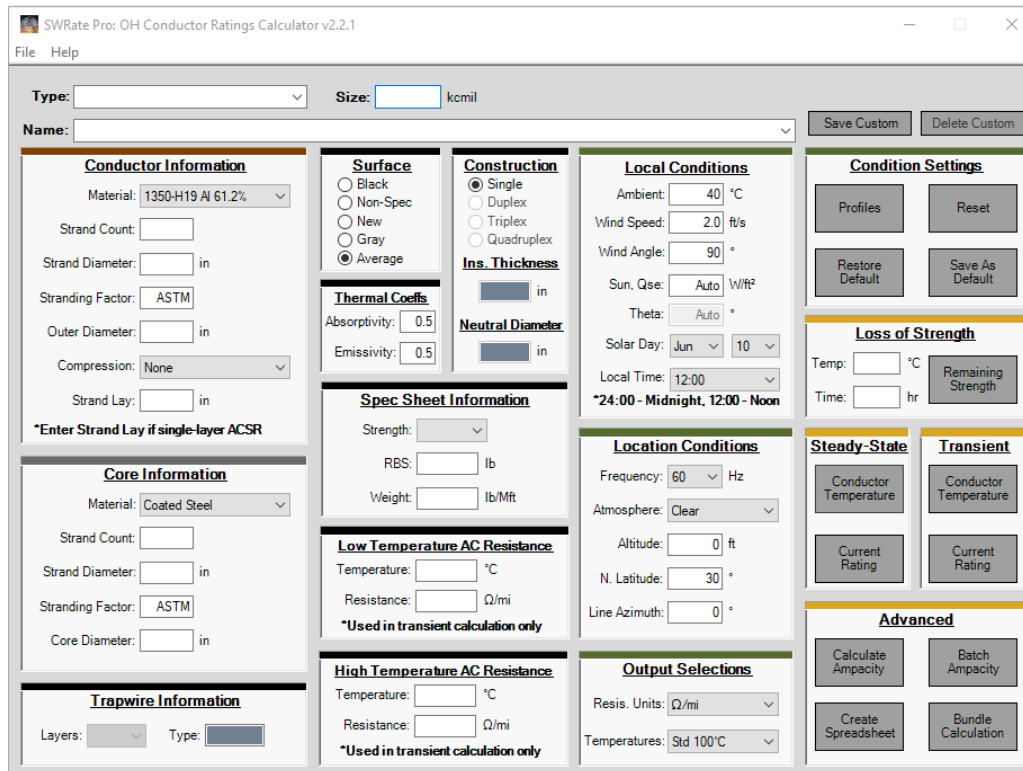
Southwire Licensing

License Acquisition	License Information
Product Key	Status
YOUR_PRODUCT_KEY	Licensed
License Type	Automatic Renewal Date
<input checked="" type="radio"/> Network <input type="radio"/> Standalone	10/26/2021
License Source	Machine Identifier
<input checked="" type="radio"/> Internet <input type="checkbox"/> Use Proxy Service Configure Proxy Service	:87:675319;;223175319
<input type="radio"/> Email	Modules
License Server	
web01.idsengineering.com	
Checkout	Close

5. Click **Close**.
6. You will be prompted with the SWRate End User License Agreement (EULA) and will need to click **Accept** or **Decline**.



7. Upon acceptance of the EULA, the program will reload, and you will be able to use the SWRate Pro program.



1.4.4 Automated Updating

If a software or data update is available for SWRate Pro, you will be prompted to incorporate the updates if: (1) you currently hold a maintenance contract and (2) the computer you are using is connected to the internet. The process for installing software updates will be similar to the installation process. Data updates will be automatic.

1.5 Technical Support

For assistance, contact SWRate technical support at 1-877-797-2410, OHT@southwire.com, or visit us at <https://overheadtransmission.southwire.com/swrate-software-support/>.

2 Main Menu Features

The **Main Menu** screen is divided into different sections, as shown below.

These sections are:

- **Main Menu Toolbar:** This toolbar contains the **Main Menu** tabs, which allow access to program **Options**, **Printer** options, and **Help**.
- **Conductor Selection:** **Type** and **Name** inputs for selecting a conductor
- **Primary Conductor Construction Information:** Two (2) panels, one for information on the selected conductor's



outer conducting strands (*Conductor Information*) and one for information on the core (*Core Information*), if applicable

- **Additional Conductor/Cable Information:** Seven (7) panels containing additional information used for calculations, including some used strictly for the specification sheet
- **Calculation Conditions:** Two (2) panels are available for specifying the *Local Conditions* and *Location Conditions*. An additional panel, the *Condition Settings* panel, allows saving and selection of calculation conditions.
- **Calculation Options:** Four (4) panels, one for *Loss of Strength* calculations, one for single *Steady-State* calculations, one for single *Transient* calculations, and one for *Advanced* calculations (Pro version only). The *Steady-State* and *Transient* panels contain two options, one to calculate a conductor temperature given a current input, and the second to calculate a current rating given a conductor temperature input. The *Advanced* panel (Pro version only) has button options for (1) creating a table of ampacities under given input conditions, (2) outputting a collection of ampacity calculation sheets for multiple conductors, (3) outputting a spreadsheet of steady-state and transient results for multiple conductors and multiple sets of calculation conditions, including columns for conductor properties, resistance, and reactance, and (4) reactance calculations for various bundle/phase configurations.

2.1 Main Menu Toolbar Controls

2.1.1 File Menu

The **File** tab on the **Main Menu** provides access to two options:

- **Options:**
 - **Dropdown Sorting:** The **Name** drop-down list can be sorted either alphabetically by code word (if applicable) or by conductor size. Regardless of sorting method, the code word (if applicable), conductor size, and stranding/type number will be shown.
 - **Sequence Impedance Info (Pro version only):** Inputs used by the Sequence Impedance portion of the Calculate Ampacity calculation routine
 - **Resistance Mode (Pro version only):** Select the mode for calculating ac resistance. **Calculate Resistance** calculates ac resistance for steady-state calculations considering the skin effect and hysteresis and eddy current effects [for single-layer and three-layer steel core conductors (aluminum-clad steel, AW, excluded)]. The skin effect is calculated per "Skin Effect in Tubular and Flat Conductors" by H.B. Dwight. Hysteresis and eddy current effects are calculated per "The Resistance and Reactance of Aluminum Conductors, Steel Reinforced" by Lewis and Tuttle and "The Magnetic Properties of ACSR Core Wire" by Matsch and Lewis for single-layer steel core conductors and per "AC Resistance of ACSR – Magnetic and Temperature Effects" by D.A. Douglass for three-layer steel core conductors. **Interpolate Resistance** interpolates between the **Low** and **High Temperature AC Resistance** values on the **Main Menu** for steady-state calculations. Regardless of *Resistance Mode* selection, transient calculations use



interpolated resistance. This is because transient calculations require a complex, iterative process to calculate transient ratings.

- **Core Temperature (Pro version only):** Check the **Calculate Core Temperature** checkbox and specify an **Effective Radial Thermal Conductivity (kr)** in $W/(m\text{-}^\circ\text{C})$ to enable single steady-state core temperature calculations using the **Conductor Temperature** or **Current Rating** button in the *Steady-State* panel. When these calculations are enabled, the surface temperature is distinct from the core temperature. When disabled, the surface temperature, average temperature of the aluminum wires, and core temperature are all assumed to be equal. To enable a core temperature input on the **Steady-State Temperature Input** screen, check the **Limit Core Temperature in Current Rating Calculations** checkbox.

At conventional current densities of less than 2 amperes per kcmil (corresponding with ratings less than 100°C), the radial temperature difference is typically less than 5°C and can be neglected. As current densities reach levels on the order of two or more amperes per kcmil, the radial temperature difference between core and surface may be 30°C or more. For homogeneous conductors or composite conductors below their knee-point temperature (i.e., nonzero tension in the aluminum strand layers), a kr value of $2\text{ W/m-}^\circ\text{C}$ appears to be reasonable. For composite conductors above their knee-point temperature, the use of an effective radial thermal conductivity equal to $1\text{ W/m-}^\circ\text{C}$ also appears to be reasonable.

- **Printer:** Activates the printer selection and setup dialog box
- **Exit and Check-In License:** Closes the application and checks in the license seat for use by another user

2.1.2 Help Menu

The **Help** tab on the **Main Menu** provides access to the following options:

- **About:** Displays the currently installed program version number, calculation method references, and contact information for technical support: OHT@southwire.com or **1-877-797-2410**
- **Help:** Contains instruction on how to activate context sensitive help for the input items on the **Main Menu**. When the cursor is placed into an input field either with the mouse or moved there using the **Tab** key, you can access help for the value to be entered, if available, by pressing the F1 key.
- **Revision History:** Details improvements to the software (Pro version only)
- **View Disclaimer:** Displays the disclaimer for the software (Lite version only)
- **User's Manual:** Opens this User's Manual

2.1.3 Upgrade to Pro Menu (Lite Version Only)

This toolbar option allows you to license your SWRate software to run SWRate Pro. Contact OHT@southwire.com to purchase an SWRate Pro license.

2.2 Conductor Selection

Conductor selection is done in two steps. First, select the **Type** of conductor to be used (AAC, ACSR, etc.) from the **Type** drop-down menu. The available conductor types are discussed in the Appendix. Detailed information on each type of conductor can be found in the Southwire Overhead Conductor Manual, which can be purchased at https://southwireocm.p3medialink.com/product_detail.php?id=71. Some conductor types, notably covered conductors, are not available in the Lite version.

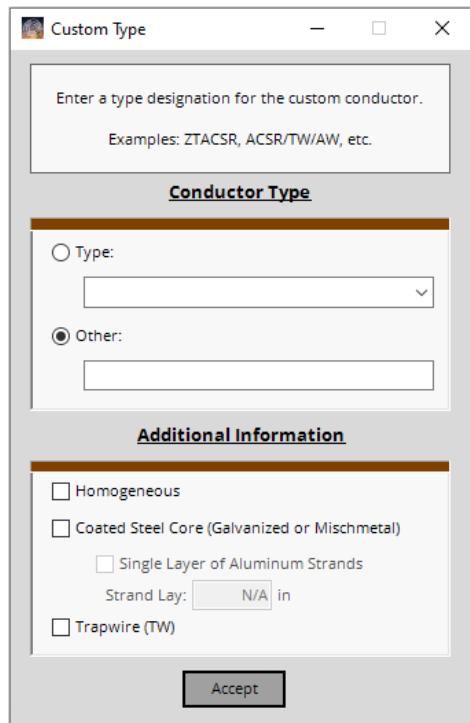
After selecting a conductor **Type**, the **Name** drop-down list will be populated with available conductor options. Select the desired conductor in this drop-down. After a selection has been made, the Conductor Construction Information will be automatically filled in, including the conductor **Size** in kcmil or AWG.

2.2.1 Custom (Pro Version Only)

This conductor **Type** contains all the custom conductors that you have saved. Custom conductors will also appear in the bottom of the **Name** drop-down when the custom conductor **Type** matches a conductor type in the **Type** drop-down list. Once selected, a custom conductor can be deleted by clicking the **Delete Custom** button.

2.2.2 Create Custom (Pro Version Only)

Select this conductor **Type** to enter the **Custom Type** screen.



The screenshot shows a dialog box titled "Custom Type" with a close button (X) in the top right corner. The dialog contains the following elements:

- A text input field with the placeholder text "Enter a type designation for the custom conductor." and examples: "Examples: ZTACSR, ACSR/TW/AW, etc."
- A section header "Conductor Type" with a horizontal line below it.
- Two radio button options: "Type:" (unselected) and "Other:" (selected).
- Under "Type:", there is a dropdown menu.
- Under "Other:", there is a text input field.
- A section header "Additional Information" with a horizontal line below it.
- Four checkboxes: "Homogeneous", "Coated Steel Core (Galvanized or Mischmetal)", "Single Layer of Aluminum Strands", and "Trapwire (TW)".
- Under "Single Layer of Aluminum Strands", there is a text input field for "Strand Lay:" with the value "N/A" and the unit "in".
- An "Accept" button at the bottom center.



The **Custom Type** screen assists in the creation of a custom conductor. There are several selection options available:

- **Conductor Type:** Select either a standard conductor **Type** or enter a custom conductor **Type** into the **Other** field. Selection of a standard conductor **Type** will automatically configure and lock each of the primary checkboxes within the *Additional Information* panel.
- **Additional Information:**
 - **Homogeneous:** Check if the custom conductor has individual strands of a single material. Do not check if the custom conductor consists of mixtures of wires of different materials.
 - **Coated Steel Core (Galvanized or Mischmetal):** Check if the custom conductor has a coated steel core, either galvanized (zinc-coated), mischmetal (zinc-5% aluminum-mischmetal alloy-coated), or aluminized (aluminum-coated). If the custom conductor has an aluminum-clad (AW) steel core, leave unchecked.
 - **Trapwire (TW):** Check if the custom conductor consists of one or more layers of trapezoidal-shaped wire helically wrapped over a round wire core. The core may consist of a single round wire for homogeneous aluminum conductors, a single wire or concentric-lay-stranded, same-size core strands for ACAR, ACSR, and ACSS conductors.

Once you have made your selections, click **Accept**. Fields will automatically populate based on your selections. To finish designing your custom conductor, enter the remaining conductor data per Section 2.3, *Conductor Construction Information*. Remember to also update the **Size** and **Name** as necessary. The custom conductor **Name** cannot match an existing conductor **Name**. When finished, click **Save Custom** to save the custom conductor to the Custom conductor database. Before the saving process is complete, the **Enter Conductor Weights** screen will appear and conductor weights will need to be entered for transient calculation purposes.

Custom conductors can also be created by editing/entering conductor data per Section 2.3, *Conductor Construction Information*, and clicking **Save Custom**.

Custom conductors will appear in the Custom conductor **Type** as well as the bottom of the **Name** drop-down when the custom conductor **Type** matches a conductor type in the **Type** drop-down list.

2.3 Conductor Construction Information

There are two panels on the main input form that contain the primary Conductor Construction information for the selected conductor. The first contains information on the outer conducting strands, and the second contains information on the core, if applicable.

2.3.1 Conductor Information

For purposes of the calculations in this program, the conducting strands are assumed to be the primary electrical conducting member of the construction. Conductor strands can be different types of aluminum, aluminum alloy, and

copper.

Conductor Information

Material:

Strand Count:

Strand Diameter: in

Stranding Factor:

Outer Diameter: in

Compression:

Strand Lay: in

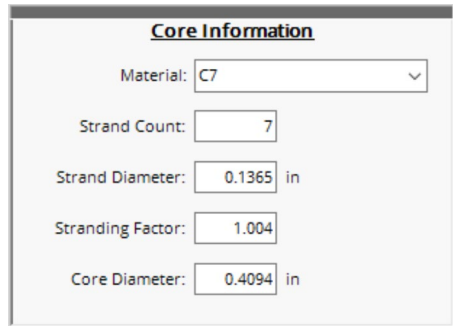
*Enter Strand Lay if single-layer ACSR

There are seven fields in this panel:

- **Material:** Material name for the outer conducting strands
- **Strand Count:** Number of outer conducting strands
- **Strand Diameter:** Diameter of each individual outer conducting strand, inches. Due to the irregular shape of Trapezoidal-shaped Wire (TW) strands, the outer conducting strand diameter is not input for TW constructions.
- **Stranding Factor:** Length increment due to stranding
- **Outer Diameter:** Overall diameter of the conductor, inches
- **Compression:** Choose **Compact** for designs with compact (TW) strands. Choose **Compressed** for designs with compressed outer strands. **Compressed** will be automatically selected for Al/Cu Duplex, Al/Cu Triplex, Al/Cu Quadruplex, and AAC Line Wire. For TW and other compact aluminum conductors not already in the database, each conductor layer diameter and number of strands per layer are required as inputs in the **Layer Information** screen after selecting **Compression => Compact** in order for GMR and inductive reactance to calculate.
- **Strand Lay [single-layer steel core conductors (aluminum-clad steel, AW, excluded) only]:** Length of lay of the outer strands

2.3.2 Core Information

For purposes of the calculations in this program, the core is defined as the mechanical support member of the conductor. The core can be composed of coated steel wire, aluminum-clad steel wire (AW), C7® stranded carbon fiber composite core, 3M® composite core, or aluminum alloy (when used as a core material in ACAR constructions).



Core Information

Material: C7

Strand Count: 7

Strand Diameter: 0.1365 in

Stranding Factor: 1.004

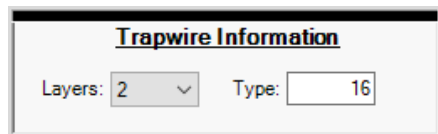
Core Diameter: 0.4094 in

There are five fields in this panel:

- **Material:** Material name for the core strands
- **Strand Count:** Number of core strands
- **Strand Diameter:** Diameter of each individual core strand, inches
- **Stranding Factor:** Length increment due to stranding
- **Core Diameter:** Overall diameter of the core, inches

2.3.3 Trapwire Information

When a TW construction (e.g., ACSS/TW) is selected, the number of **Layers** of aluminum strands and the **Type** number (core to aluminum area ratio in percent) will be automatically populated.



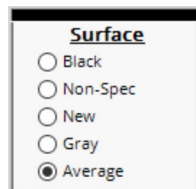
Trapwire Information

Layers: 2

Type: 16

2.3.4 Surface (Pro Version Only)

This selection will affect the thermal coefficients (*Thermal Coeffs*) and subsequent rating calculations. The **Black** and **Gray** options are intended for covered conductors.



Surface

Black

Non-Spec

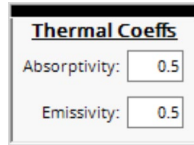
New

Gray

Average

2.3.5 Thermal Coeffs

Although the surface condition of the conductor/cable can be selected in the *Surface* panel, **Absorptivity** and **Emissivity** can also be custom defined in the *Thermal Coeffs* panel.



Thermal Coeffs
Absorptivity:
Emissivity:

Emissivity is defined as the ratio of heat radiated to the surrounding air by the conductor to the heat radiated to the surrounding air by a perfect “black body” radiator of the same dimensions.

Absorptivity is the ability of a conductor to absorb heat from its surroundings and is dependent upon conductor surface conditions. Although solar heat absorption occurs at a different frequency range than heat radiation, both the absorptivity and emissivity of an overhead conductor will increase over the life of the conductor, as a result of age and atmospheric pollution.

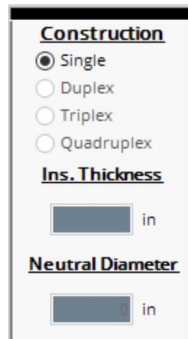
Absorptivity and emissivity values of approximately 0.2 for new conductors and 0.9 for weathered bare overhead conductors have been reported by House and Tuttle. The exact rate of increase depends on the level of atmospheric pollution and the line’s operating voltage. A value of 0.5 has been widely used when the actual conductor surface condition is unknown. The values entered here are subject to engineering judgment.

Surface condition and corresponding absorptivity and emissivity values are shown below.

- **Black:** 0.95/0.91
- **Non-Spec:** 0.42/0.42
- **New:** 0.23/0.23
- **Gray:** 0.5/0.5
- **Average:** 0.5/0.5

2.3.6 Construction (Pro Version Only)

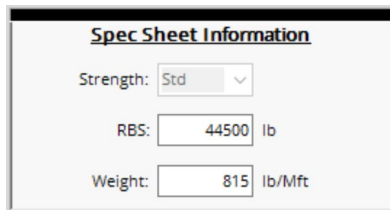
For plexed covered conductors, the applicable construction, including **Neutral Diameter**, should be specified. For any cable, **Insulation Thickness** should be entered.



Construction
 Single
 Duplex
 Triplex
 Quadruplex
Ins. Thickness
 in
Neutral Diameter
 in

2.3.7 Spec Sheet Information

This panel contains conductor information that has no effect on the calculation results but will be printed on calculation output files. Some conductor types, such as ACSS, allow selection of the applicable core strength; RBS changes accordingly.



Spec Sheet Information

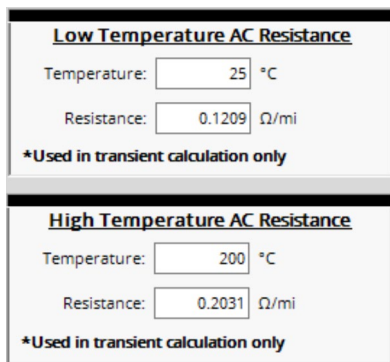
Strength: ▾

RBS: lb

Weight: lb/Mft

2.3.8 Low Temperature and High Temperature AC Resistance

Whereas steady-state calculations use calculated resistances, transient calculations use interpolated resistance. This is because transient calculations require a complex, iterative process to calculate transient ratings. To ensure resistance interpolation and improve calculation accuracy, **Low** and **High Temperatures** and **Low** and **High Temperature AC Resistances** are recalculated for each transient calculation run based on calculation inputs. The **Low** and **High Temperature AC Resistance** values on the **Main Menu** are used for steady-state calculations only when **Interpolate Resistance** mode (Section 2.1.1, *File Menu*) is selected but for transient calculations are provided for reference only.



Low Temperature AC Resistance

Temperature: °C

Resistance: Ω/mi

***Used in transient calculation only**

High Temperature AC Resistance

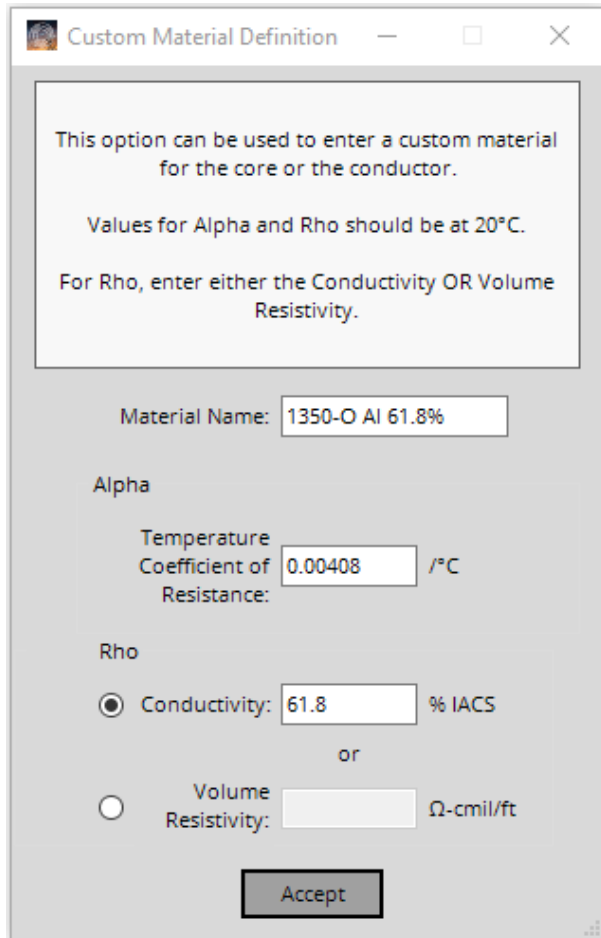
Temperature: °C

Resistance: Ω/mi

***Used in transient calculation only**

2.3.9 Custom Materials

A custom conductor or core **Material** may be selected from the **Material** drop-down. Once selected, the **Custom Material Definition** screen will appear.



There are three required input fields:

- **Material Name:** Enter the custom material name
- **Alpha:** Temperature Coefficient of Resistance, /°C
- **Rho:** Conductivity, % IACS, or Volume Resistivity, Ω -cmil/ft

2.4 Calculation Conditions

There are two panels on the **Main Menu** that contain the specific calculation condition information. The *Local Conditions* panel contains information on the local operating conditions, and the *Location Conditions* panel contains assumptions related to the location of the line. For more information on these inputs, see your applicable conductor ratings standard.



2.4.1 Local Conditions

Local Conditions	
Ambient:	<input type="text" value="40"/> °C
Wind Speed:	<input type="text" value="2.0"/> ft/s
Wind Angle:	<input type="text" value="90"/> °
Sun, Qse:	<input type="text" value="Auto"/> W/ft ²
Theta:	<input type="text" value="Auto"/> °
Solar Day:	<input type="text" value="Jun"/> <input type="text" value="10"/>
Local Time:	<input type="text" value="12:00"/>
*24:00 - Midnight, 12:00 - Noon	

- **Ambient:** Ambient air temperature, °C
- **Wind Speed:** Wind speed, feet per second (ft/s)
- **Wind Angle:** Angle between wind and axis of the conductor, degrees. A value of 90° indicates that the wind is blowing perpendicular to the conductor, providing maximum convection cooling.
- **Sun, Qse:** Total solar and sky radiated heat flux or intensity, corrected for elevation, W/ft² (Pro version only). “Auto” calculates this value using other calculation conditions. SWRate Lite allows only the “Auto” calculation, while SWRate Pro allows both input and “Auto”. When a value is input, the **Atmosphere** input is no longer necessary for the calculation and will be disabled.
- **Theta:** Effective angle of incidence of the sun’s rays, degrees (Pro version only). “Auto” calculates this value using other calculation conditions. SWRate Lite allows only the “Auto” calculation, while SWRate Pro allows both input (only when a Sun value is also input) and “Auto”. When a value is input, the **Solar Day, Local Time, N. Latitude, and Line Azimuth** inputs are no longer necessary for the calculation and will be disabled.
- **Solar Day:** Day of the year. The date chosen for the study impacts the position of the sun to the line, as does **Local Time**.
- **Local Time:** Local sun time. The time of day affects the angle of the sun to the line, thus affecting the amount of heat transferred. To calculate for a no-sun condition, input a value of **24:00**. For noon, input **12:00**.



2.4.2 Location Conditions

Location Conditions

Frequency: 60 Hz

Atmosphere: Clear

Altitude: 0 ft

N. Latitude: 30 °

Line Azimuth: 0 °

- **Frequency:** Electrical frequency, Hz. Drop-down options are **50 Hz**, **60 Hz**, and **dc** (Pro version only).
- **Atmosphere:** Relates to local air pollution levels. The type of **Atmosphere** affects the amount of solar radiation. The two available choices are **Clear** and **Industrial**.
- **Altitude:** Elevation of the line above sea level, feet
- **N. Latitude:** North latitude of the line, degrees
- **Line Azimuth:** Direction of the line, degrees. Values are 0° or 180° (line running North-South) and 90° or 270° (line running East-West).

2.5 Output Selections

Output Selections

Resis. Units: Ω/mi

Temperatures: Std 200°C

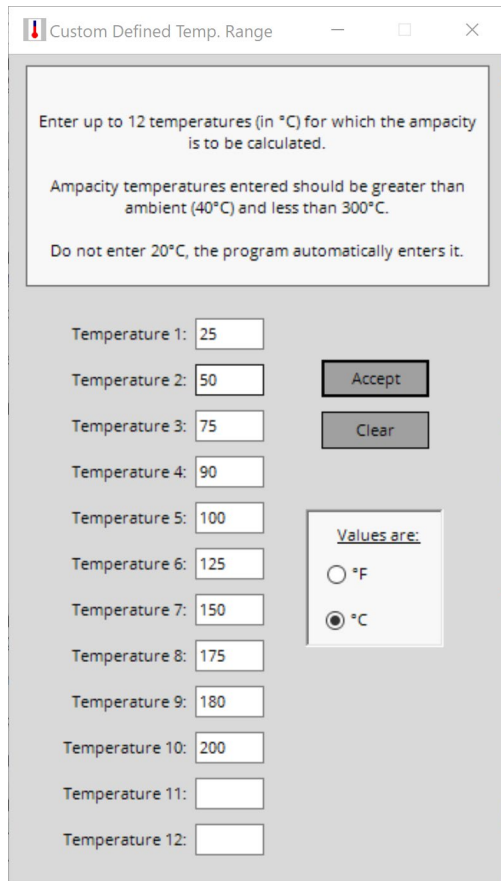
2.5.1 Resistance (Resis.) Units

A drop-down menu allows you to return calculation results in Ω/Mft (Pro version only), Ω/mi, or Ω/km units. If Ω/km is selected, additional values such as conductor information and calculation conditions will be converted to SI units when results are printed or saved.

2.5.2 Temperatures

A drop-down menu allows you to select a preset temperature range, enter a range of **Custom** temperatures, or enter a **Range** of evenly incremented temperatures. A preset temperature range is automatically selected based on the selected conductor **Type**. However, you can choose a different preset temperature range or select **Custom** or **Range**. Details on each are below.

- **Std 75°C:** default temperature range for copper and bronze conductor types; up to 75°C
- **Std 90°C:** temperature range up to 90°C
- **Std 100°C:** default temperature range for standard conductor types; up to 100°C
- **Std 130°C:** default temperature range for line wire and tree wire/spacer cable; up to 130°C
- **Std 200°C:** default temperature range for C7®-TS conductor types; up to 200°C
- **Std 225°C:** default temperature range for C7®-TP conductor types; up to 225°C
- **Std 240°C:** default temperature range for ACCR and Max Storm™ conductor types; up to 240°C
- **Std 250°C:** default temperature range for ACSS with mischmetal or AW core; up to 250°C
- **Custom:** You can custom input up to 12 temperatures. The preset range is loaded by default into the table. Entered values can be input in °C or °F units. Entered values must be greater than or equal to 25°C (77°F).



Custom Defined Temp. Range

Enter up to 12 temperatures (in °C) for which the ampacity is to be calculated.

Ampacity temperatures entered should be greater than ambient (40°C) and less than 300°C.

Do not enter 20°C, the program automatically enters it.

Temperature 1:

Temperature 2:

Temperature 3:

Temperature 4:

Temperature 5:

Temperature 6:

Temperature 7:

Temperature 8:

Temperature 9:

Temperature 10:

Temperature 11:

Temperature 12:

Accept

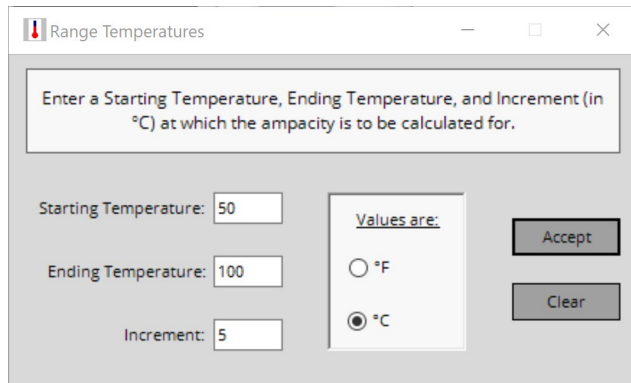
Clear

Values are:

°F

°C

- **Range:** You can define a **Starting Temperature**, **Ending Temperature**, and **Increment**. The software will then define a temperature range based on your inputs. For **Calculate Ampacity** and **Batch Ampacity** calculations, the temperature range should not be larger than 12. Entered values can be input in °C or °F units. Entered **Starting Temperature** and **Ending Temperature** values must be greater than or equal to 25°C (77°F).



Range Temperatures

Enter a Starting Temperature, Ending Temperature, and Increment (in °C) at which the ampacity is to be calculated for.

Starting Temperature: 50

Ending Temperature: 100

Increment: 5

Values are:

°F

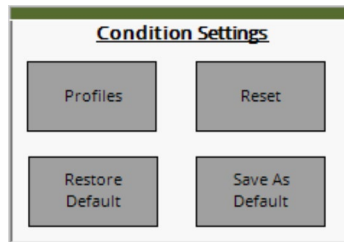
°C

Accept

Clear

2.6 Condition Settings (Pro Version Only)

Four (4) buttons allow saving and selection of calculation conditions.



- **Profiles:** Save various calculation conditions
- **Reset:** Resets the calculation conditions to the default conditions
- **Restore Default:** Restores the factory default calculation conditions
- **Save As Default:** Saves the currently input calculation conditions as your default conditions

The default conditions provided with the SWRate software do not constitute a recommendation by Southwire as to the appropriate conditions for your study, nor are they intended to replace engineering judgment, which you, the designer, should exercise in determining calculation conditions appropriate to your installation and operating conditions.

2.6.1 Profiles

Save various calculation conditions in tabular form to easily switch between rating assumptions. This is especially useful for consultants that work with many clients. Absorptivity and emissivity can also be included in Profiles. The **Import** button allows calculation conditions from the **Main Menu** to be imported into a new row in the **Profiles** screen.

2.6.2 Reset

Resets the calculation conditions to the factory default conditions

2.6.3 Restore Default

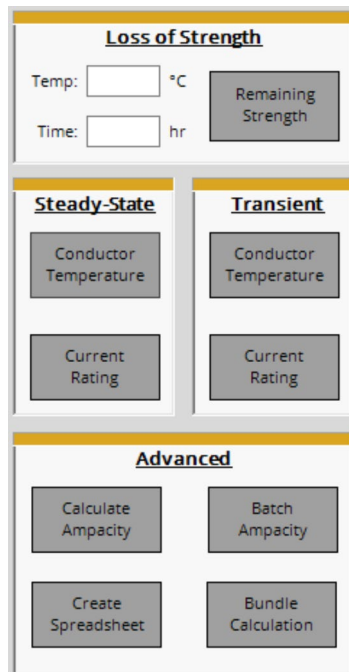
Restores the default calculation conditions

2.6.4 Save As Default

Saves the currently input calculation conditions as your default conditions. If the calculation conditions used for your studies are different from SWRate's default conditions, you may want to enter your specific conditions and save these as the defaults. Doing so will overwrite the defaults provided with SWRate software. These new defaults will then be loaded whenever the program is run. If at any time you want to reset the default conditions to their factory values, you can do so using the **Reset** button and then clicking the **Save As Default** button.

2.7 Calculation Options

There are nine (9) calculation options available in SWRate software: one is for *Loss of Strength* calculations, two are for single *Steady-State* calculations, two are for single *Transient* calculations, one is for calculating ampacity charts (Pro version only), one is for batch ampacity charts (Pro version only), one is for batch spreadsheet calculations (Pro version only), and the last is for Bundle Calculations (Pro version only).



The screenshot displays the SWRate software interface with three main sections:

- Loss of Strength:** Includes input fields for "Temp: [] °C" and "Time: [] hr", and a "Remaining Strength" button.
- Steady-State:** Includes buttons for "Conductor Temperature" and "Current Rating".
- Transient:** Includes buttons for "Conductor Temperature" and "Current Rating".
- Advanced:** Includes buttons for "Calculate Ampacity", "Batch Ampacity", "Create Spreadsheet", and "Bundle Calculation".

Note that for single-layer steel core conductors (aluminum-clad steel, AW, excluded), values above 75°C may be incorrect due to limited data for modeling.



2.7.1 Loss of Strength

Given a conductor operating temperature (**Temp**) in °C and cumulative time duration (**Time**) in hours, the program will calculate the **Remaining Strength** of the conductor in terms of the percent of the rated breaking strength (%RBS). This option is only available for the following standard conductor types: AAC-based conductor types (including covered conductors), AAAC-based conductor types (including covered conductors), ACAR, AACSR, and ACSR-based conductor types (including covered conductors). High-temperature low-sag (HTLS) conductors (e.g., ACSS, C7® Overhead Conductors, Max Storm™ Overhead Conductors) have high normal operating temperatures and have very low risk of strength loss. Loss-of-strength calculations should not be performed for Custom conductors.

Some degradation of tensile strength due to conductor heating is inevitable; however, a maximum 10% loss of strength over the life of the line is generally considered conductor end-of-life. **Remaining Strength** calculations in the program use the formulas presented in Harvey, J.R., “Effect of Elevated Temperature Operation on the Strength of Aluminum Conductors,” which are intended for approximations only.

Loss of Strength calculations can also be used to determine the **Remaining Strength** when several occurrences of high-temperature operation have occurred since the effects of each occurrence are cumulative. When various time-temperature exposures need to be considered, use the method below to determine the conductor remaining strength.

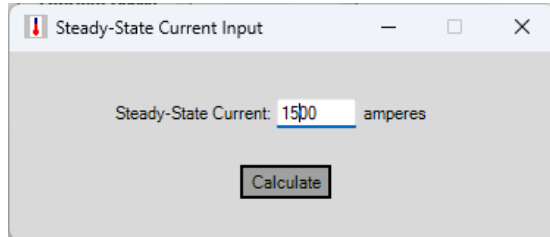
1. Calculate the **Remaining Strength** after the assumed exposure **Time** at the lowest **Temperature**.
2. Iteratively calculate the **Time** required at the next higher **Temperature** to yield the **Remaining Strength** calculated in Step 1.
3. Add the **Time** calculated in Step 2 to the exposure **Time** at the **Temperature** from Step 2.
4. Calculate the **Remaining Strength** using the total **Time** calculated in Step 3 and the **Temperature** from Step 2.
5. Repeat Steps 2-4 until the **Remaining Strength** at the highest **Temperature** is calculated. The total equivalent exposure **Time** will accumulate with each new, higher **Temperature** exposure considered. The final **Remaining Strength** calculation at the highest **Temperature** exposure will be the **Remaining Strength** of the conductor considering all the various time-temperature exposures.

Since consideration of the individual components separately is necessary, hand calculations are needed to calculate the remaining strength for ACAR and ACSR conductors after various time-temperature exposures. Refer to Harvey, J.R., “Effect of Elevated Temperature Operation on the Strength of Aluminum Conductors,” or to the Southwire Overhead Conductor Manual, 3rd Edition, for more information on performing these calculations by hand.

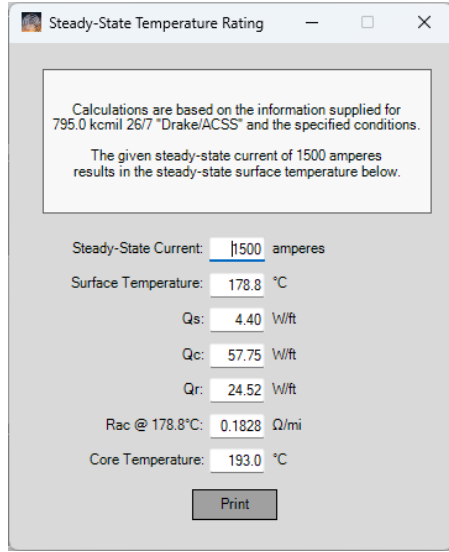
2.7.2 Steady-State Conductor Temperature

Selecting this option will calculate a steady-state conductor temperature based on an input current load. In the Pro version, distinct core and surface temperatures may also be calculated (see Section 2.1.1, *File menu*, for more

information). To run this calculation, first select a conductor and input the desired calculation conditions (*Local Conditions* and *Location Conditions*). Click the **Conductor Temperature** button in the *Steady-State* panel and the **Steady-State Current Input** screen, shown below, will appear.



Enter a value for the **Steady-State Current** in amperes. Click **Calculate** and the **Steady-State Temperature Rating** results screen, shown below, will be displayed.



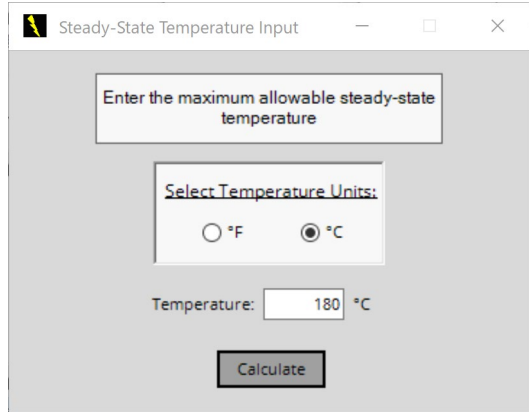
This screen displays the calculated **Steady-State Temperature Rating** for the **Steady-State Current** provided, the solar heat gain (Q_s), the convection heat loss (Q_c), the radiated heat loss (Q_r), the ac/dc resistance at the calculated conductor temperature (R_{ac}/R_{dc}), and the **Core Temperature**, if enabled (see Section 2.1.1).

From this screen, you can **Print** the report or **Save** it to a .doc file. The report will contain the calculated data shown as well as the conductor information and calculation conditions from the **Main Menu**.

2.7.3 Steady-State Current Rating

Selecting this option will calculate a steady-state current rating based on an input conductor temperature. In the Pro version, a core or surface temperature may also be entered (see Section 2.1.1, *File menu*, for more information). To run this calculation, first select a conductor and input the desired calculation conditions (*Local Conditions* and *Location*

Conditions). Click the **Current Rating** button in the *Steady-State* panel and the **Steady-State Temperature Input** screen, shown below, will appear.



Select the **Temperature Units** for the steady-state conductor temperature, and then enter a **Temperature** value. Click **Calculate** and the **Steady State Current Rating** results screen will be displayed. The only difference will be that the conductor current rating is calculated instead of a conductor temperature. The same output options are available.

2.7.4 Transient Conductor Temperature (Unavailable for Covered Conductors)

Selecting this option will calculate the maximum conductor temperature resulting from a temporary step increase in current, assuming no change in weather conditions and the conductor is at thermal equilibrium prior to the step increase in current. To run this calculation, first select a conductor and input the desired calculation conditions (*Local Conditions* and *Location Conditions*). Click the **Conductor Temperature** button in the *Transient* panel and the **Transient Data Input** screen, shown below, will appear.



Transient Data Input

Transient calculations assume:

- 1 - The conductor is initially in thermal equilibrium.
- 2 - A step increase in current occurs at time $t = 0$.
- 3 - Weather conditions are constant before, during, and after the step increase.

Specify Metal Heat Capacities

Core:
Core Weight: lb/ft x Specific Heat: W-s/lb-°C = W-s/ft-°C

Outer Layers:
AL/CU Weight: lb/ft x Specific Heat: W-s/lb-°C = W-s/ft-°C

Specify an Initial Steady-State Condition

Current: amperes

Temperature: °C

Specify Calculation Time Interval

Conductor Temperature to be calculated every:
 seconds

Transient Calculation Data

New Conductor Current, including step increase:
 amperes

Total time duration for the transient:
 seconds
 minutes

Calculate

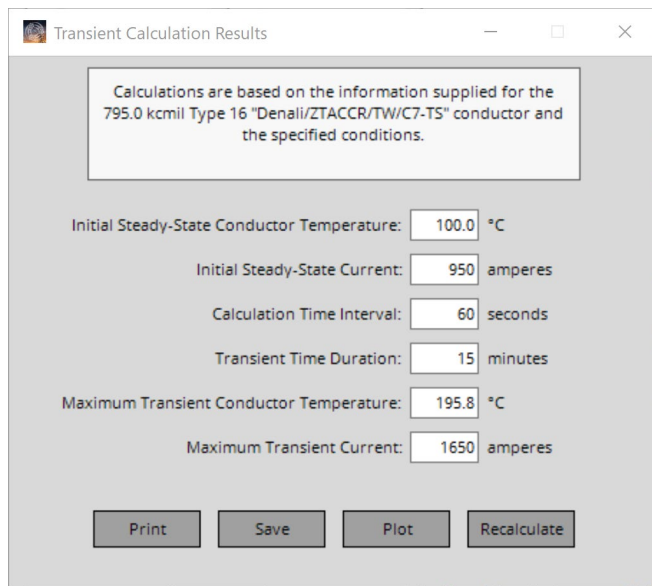
To perform a transient calculation, there are several inputs required:

- **Metal Heat Capacities**: This calculation is based on the material properties of the conductor. The program will load default **Weight** and **Specific Heat** values for the materials found in the selected conductor type (both **Core** and outer conducting (**AL/CU**) strands) and calculate the **Metal Heat Capacity** of the conductor. The values provided are defaults used in the industry, and you should verify that these values are appropriate for the conductor being used.
- **Specify an Initial Steady State**: An **Initial Steady-State Temperature** or **Current** must be specified. If a **Current** load is entered, the program will use the steady-state algorithm to calculate the conductor temperature prior to the application of the transient current load. Note that the **Initial Steady-State Temperature** should be (1) greater than the ambient temperature and (2) greater than 25°C (77°F). If an **Initial Steady-State Current** is specified and the resulting steady-state temperature is less than 25°C (77°F), the temperature will be elevated to 25°C (77°F) for the transient calculation to maintain calculation accuracy.
- **Specify Calculation Time Interval**: A **Time Interval** for calculating the transient condition must be entered. This will dictate how many calculations are run during the time the transient condition exists. This will also determine the time axis values for the transient temperature **Plot** option.
- **Transient Calculation Data**: In this panel, the **New Conductor Current, including step increase**, and the **Total**

time duration for the transient in minutes or seconds is entered.

Note that the same input screen is used for both the transient **Conductor Temperature** and **Current Rating** calculations. The only difference occurs in the *Transient Calculation Data* panel. For a transient **Conductor Temperature** calculation, the **New Conductor Current** is input, while the **Max Conductor Temp.** is input for a transient **Current Rating** calculation.

Click the **Calculate** button to run the transient calculation. The **Transient Calculation Results** screen, shown below, will be displayed.



The **Transient Calculations Results** screen displays the **Initial Steady-State Conductor Temperature** and **Current**, the conditions input for the transient, and in this case, the **Maximum Transient Conductor Temperature** resulting from the input **Maximum Transient Current** for the indicated **Transient Time Duration**.

From this screen, you can **Print** the report or **Save** it to a .doc file. The report will contain the calculated data shown as well as the **Metal Heat Capacities** and conductor information and calculation conditions from the **Main Menu**. Additionally, the **Recalculate** button will return the program to the previous screen to allow changes in the transient conditions. The **Plot** button will plot the temperature rise over time resulting from the transient step current, as shown below.



From this screen, a **Print** of the plot can be made.

Note that transient calculations use interpolated resistance. This is because transient calculations require a complex, iterative process to calculate transient ratings. To ensure resistance interpolation and improve calculation accuracy, **Low** and **High Temperatures** and **Low** and **High Temperature AC Resistances** are recalculated for each transient calculation run based on calculation inputs.

2.7.5 Transient Current Rating (Unavailable for Covered Conductors)

Selecting this option will calculate the **Maximum Transient Current** based on a **Maximum Transient Conductor Temperature**, assuming no change in weather conditions and the conductor is at thermal equilibrium prior to the step increase in current. To run this calculation, first select a conductor and input the desired calculation conditions (*Local Conditions* and *Location Conditions*). Click the **Current Rating** button in the *Transient* panel and the **Transient Data Input** screen will appear.

The only difference in this screen and the one provided for the transient conductor temperature option is a **Max Conductor Temp.** must be entered into the *Transient Calculation Data* panel instead of a **New Conductor Current**. The **Max Conductor Temp.** must be at least 10°C (18°F) higher than the ambient temperature. Also note that the **Initial Steady-State Temperature** should be (1) greater than the ambient temperature and (2) greater than 25°C (77°F). If an **Initial Steady-State Current** is specified and the resulting steady-state temperature is less than 25°C (77°F), the temperature will be elevated to 25°C (77°F) for the transient calculation to maintain calculation accuracy.



Click the **Calculate** button to run the transient calculation. The **Transient Calculation Results** screen will be displayed. The only difference in this screen and the one from the transient conductor temperature calculation is that the **Plot** option is unavailable.

Note that transient calculations use interpolated resistance. This is because transient calculations require a complex, iterative process to calculate transient ratings. To ensure resistance interpolation and improve calculation accuracy, **Low and High Temperatures** and **Low and High Temperature AC Resistances** are recalculated for each transient calculation run based on calculation inputs.

2.7.6 Calculate Ampacity (Pro Version Only)

This calculation creates tabulated steady-state ampacity results using the **Temperatures** defined in the *Output Selections* panel. To run this calculation, first select a conductor and input the desired calculation conditions (*Local Conditions* and *Location Conditions*). Confirm your **Temperatures** in the *Output Selections* panel or make changes as desired. Click the **Calculate Ampacity** button in the *Advanced* panel and the **Results** screen will appear. For single-layer steel core conductors, a **Calculating Single-Layer Values** screen will appear prior to the **Results** screen to track the progress of this complex calculation.

The **Results** screen includes operating temperatures in °C and °F (reflective of 20°C (68°F) and the defined **Temperatures**), **DC** and **AC Resistance**, ampacity under various **Sun** and **Wind** conditions, conductor **GMR**, and Inductive (**X_a/X_l**) & Capacitive Reactance (**X'_a/X_c**) at 1-ft spacing (spacing is non-applicable for plexed covered conductors). For **dc** calculations, **GMR** and Inductive & Capacitive Reactance are non-applicable.



Results

Print View Sequence Impedance Data Include Sequence Impedance Data with Printout

Save

GMR: 0.0348 ft
Xa @ 1ft: 0.4075 Ω/mi
X'a @ 1ft: 0.0940 MΩ-mi

°C	°F	DC Resistance	AC Resistance	Sun - No Wind	No Sun - No Wind	Sun - Wind	No Sun - Wind
20.0	68.0	0.1173					
25.0	77.0	0.1197	0.1209	****	****	****	****
50.0	122.0	0.1314	0.1325	****	298	186	441
75.0	167.0	0.1431	0.1441	461	599	702	800
90.0	194.0	0.1502	0.1511	622	726	862	940
100.0	212.0	0.1548	0.1558	710	800	950	1019
115.0	239.0	0.1619	0.1628	823	898	1064	1123
120.0	248.0	0.1642	0.1651	857	929	1098	1155
125.0	257.0	0.1666	0.1674	890	958	1131	1185
150.0	302.0	0.1783	0.1791	1037	1092	1277	1322
175.0	347.0	0.1900	0.1908	1164	1211	1401	1440
180.0	356.0	0.1924	0.1931	1188	1233	1425	1462
200.0	392.0	0.2017	0.2024	1278	1318	1512	1546

Available buttons and options on the **Results** screen:

- **Print:** Print the report. The report will contain the tabulated data shown as well as the conductor information and calculation conditions from the **Main Menu**.
- **Save:** Save the report to a .doc file. The report will contain the tabulated data shown as well as the conductor information and calculation conditions from the **Main Menu**.
- **View Sequence Impedance Data (non-applicable for dc calculations):** View the **Sequence Impedance Results** screen (see below). The screen includes operating temperatures in °C and °F (reflective of 20°C (68°F) and the defined **Temperatures**), **DC Resistance, R** (positive sequence ac resistance), **XI** (positive sequence inductive reactance), **Xc** (positive sequence capacitive reactance), **RO** (zero sequence ac resistance), **XIO** (zero sequence inductive reactance), **Xc0** (zero sequence capacitive reactance), **GMD** (as defined in **File => Options => Sequence Impedance Inputs**), **Line Height** (as defined in **File => Options => Sequence Impedance Inputs**), conductor **GMR**, and Inductive (**Xa/XI**) & Capacitive Reactance (**X'a/Xc**) at 1-ft spacing (spacing is non-applicable for plexed covered conductors).
- **Include Sequence Impedance Data with Printout (unavailable for dc calculations):** A separate printout that includes sequence impedance data will be printed prior to the ampacity results.



Sequence Impedances

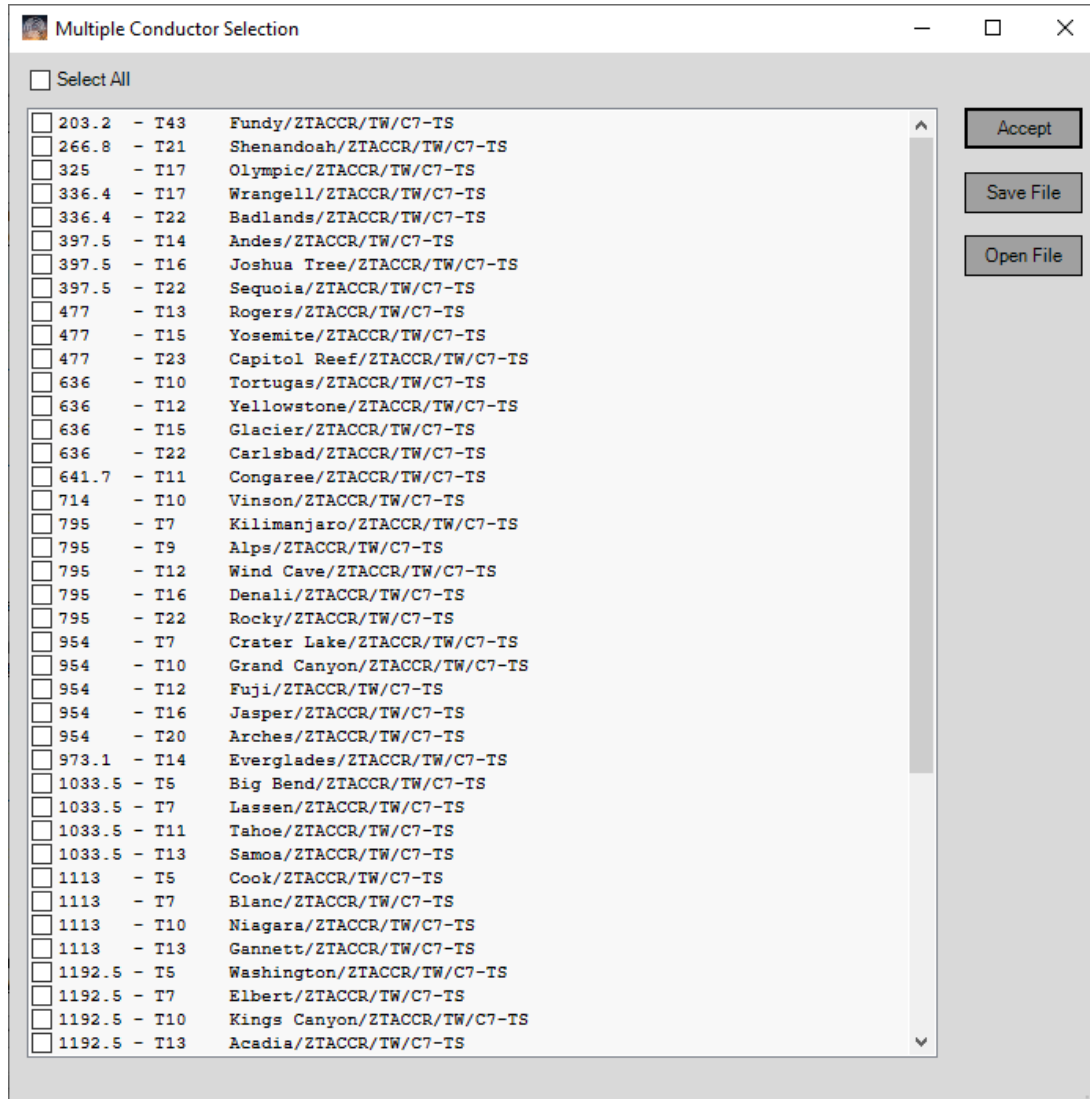
GMR: 0.0348 ft
 Xa @ 1ft: 0.4075 Ω/mi
 Xa @ 1ft: 0.0940 MΩ-mi
 Line GMD: 31.5 ft
 Line Height: 50 ft
 Earth Resistivity: 100 Ω-m

°C	°F	DC Resistance	R	Xl	Xc	R0	Xl0	Xc0
20.0	68.0	0.1173						
25.0	77.0	0.1197	0.1209	0.8262	0.1963	0.4067	2.4582	0.2993
50.0	122.0	0.1314	0.1325	0.8262	0.1963	0.4183	2.4582	0.2993
75.0	167.0	0.1431	0.1441	0.8262	0.1963	0.4299	2.4582	0.2993
90.0	194.0	0.1502	0.1511	0.8262	0.1963	0.4369	2.4582	0.2993
100.0	212.0	0.1548	0.1558	0.8262	0.1963	0.4416	2.4582	0.2993
115.0	239.0	0.1619	0.1628	0.8262	0.1963	0.4486	2.4582	0.2993
120.0	248.0	0.1642	0.1651	0.8262	0.1963	0.4509	2.4582	0.2993
125.0	257.0	0.1666	0.1674	0.8262	0.1963	0.4532	2.4582	0.2993
150.0	302.0	0.1783	0.1791	0.8262	0.1963	0.4649	2.4582	0.2993
175.0	347.0	0.1900	0.1908	0.8262	0.1963	0.4766	2.4582	0.2993
180.0	356.0	0.1924	0.1931	0.8262	0.1963	0.4789	2.4582	0.2993
200.0	392.0	0.2017	0.2024	0.8262	0.1963	0.4882	2.4582	0.2993

Note that for single-layer and three-layer steel core conductors (aluminum-clad steel, AW, excluded), ac resistance is calculated at the highest current shown for each temperature. For single-layer steel core conductors (aluminum-clad steel, AW, excluded), inductive reactance is calculated at the highest current at 75°C.

2.7.7 Batch Ampacity (Pro Version Only)

This calculation outputs a collection of tabulated ampacity calculation sheets using the **Temperatures** defined in *Output Selections*. To run this calculation, first select a conductor **Type** and input the desired calculation conditions (*Local Conditions* and *Location Conditions*). Confirm your **Temperatures** in the *Output Selections* panel or make changes as desired. Click the **Batch Ampacity** button in the *Advanced* panel and the **Multiple Conductor Selection** screen will appear.



This screen displays the conductor options and allows you to select multiple conductors. Also note the **Select All** option at the top of the screen. Keep in mind that these calculations could take some time. Once you have made your selections, you can save those selections into a file by clicking **Save File**. You can also open a saved file by clicking **Open File**. To proceed with the calculation, click **Accept**. A **Print** screen will appear to confirm your printer selection before proceeding with the calculations and printing.

For single-layer steel core conductors, a **Calculating Single-Layer Values** screen will appear prior to the **Results** screen to track the progress of this complex calculation. Each printed report will contain the tabulated data as described in Section 2.7.6, *Calculate Ampacity*.

Note that for single-layer and three-layer steel core conductors (aluminum-clad steel, AW, excluded), ac resistance is



calculated at the highest current shown for each temperature. For single-layer steel core conductors (aluminum-clad steel, AW, excluded), inductive reactance is calculated at the highest current at 75°C.

2.7.8 Create Spreadsheet (Pro Version Only)

The **Create Spreadsheet** calculation produces a spreadsheet of steady-state and transient results for multiple conductors and multiple sets of calculation conditions (up to 50), including columns for conductor properties, resistance, and reactance. To run this calculation, first select a conductor **Type** and input the desired calculation conditions (*Local Conditions* and *Location Conditions*). If multiple sets of ampacity calculations [e.g., ambient-adjusted ratings (AAR)] are desired, only *Location Conditions* need to be entered at this time. Click the **Create Spreadsheet** button in the *Advanced* panel and the **Multiple Conductor Selection** screen will appear as shown in Section 2.7.7. This screen displays the conductor options and allows you to select multiple conductors, or open a saved file. Also note the **Select All** option at the top of the screen. Keep in mind that these calculations could take some time if single-layer ACSR conductors and/or transient calculations are specified. Once you have made your selections, click **Accept**. A screen will appear asking if you would like to specify multiple sets of *Local Conditions* for your calculation.

Clicking **Yes** or **No** on the multiple sets of *Local Conditions* screen will yield a second screen asking if you want to calculate transient ratings as well (unavailable for covered conductors). If you click **Yes**, the **Transient Ampacity Input** screen will appear as shown below. Clicking **Yes** on the multiple sets of *Local Conditions* screen will cause the **Transient Ampacity Input** screen to appear after the **Local Conditions** screen.



Transient Ampacity Input

Transient calculations assume:

- 1 - The conductor is initially in thermal equilibrium.
- 2 - A step increase in current occurs at time $t = 0$.
- 3 - Weather conditions are constant before, during, and after the step increase.

Specify Metal Heat Capacities

Core:
Core Weight: lb/ft x Specific Heat: W-s/lb-°C = W-s/ft-°C

Outer Layers:
AL/CU Weight: lb/ft x Specific Heat: W-s/lb-°C = W-s/ft-°C

Transient Calculation Data

Starting Current, Percent of Steady-State Current at Tc:
 % As Defined in Output Selections Input: °C

Max Conductor Temp. during the transient:
 As Defined in Output Selections Input: °C

Total time duration for the transient: minutes seconds

Conductor Temperature to be calculated every: seconds

To calculate transient ratings within **Create Spreadsheet**, several inputs are required:

- **Metal Specific Heats:** Unlike the single transient calculation, **Weights** are not editable since the **Create Spreadsheet** calculation handles multiple conductors, all with different **Weights**. Transient rating calculations are based on the material properties of the conductor. The program will load default **Specific Heat** values for the materials found in the selected conductor type (both **Core** and outer conducting (**AL/CU**) strands). The values provided are defaults used in the industry, and you should verify that these values are appropriate for the conductor being used.
- **Transient Calculation Data:**
 - An initial steady-state **Starting Current** must be specified as a **Percent** of the calculated **Steady-State Current at Tc**. You must specify a **Percent** (default is 100%) and temperature. You may specify temperature **As Defined in Output Selections** (your temperature range) or by a single **Input** temperature.
 - A **Max Conductor Temp.** during the transient must be specified **As Defined in Output Selections** (your temperature range) or by a single **Input** temperature. If the **As Defined in Output Selections** radiobutton is selected, a **Percent** lower than 100% must be specified in the **Starting Current** section. The **Max Conductor Temp.** must be at least 10°C (18°F) higher than the ambient temperature. Also note that the initial steady-state temperature should be (1) greater than the ambient temperature and (2) greater than 25°C (77°F). If an initial steady-state current yields a steady-state temperature less than



25°C (77°F), the temperature will be elevated to 25°C (77°F) for the transient calculation to maintain calculation accuracy.

- **Total time duration for the transient** in **minutes** or **seconds** must be entered (15 **minutes** is default)
- **Conductor Temperature to be calculated every** – A time interval for calculating the transient condition must be entered. This will dictate how many calculations are run during the time the transient condition exists.

Clicking **Yes** on the multiple sets of *Local Conditions* screen will cause the **Local Conditions** screen to appear as shown below. Use the **Add Column** button to add your desired number of columns (up to 50). If Night calculations are desired, click the **Include Night calculations** checkbox before clicking **Add Column**. To update the values in a column, click on any value within a column, then use the *Local Conditions* panel on the left side of the screen to edit the column values before clicking **Update Table**. The calculation conditions specified in each column will be used to calculate steady-state ampacities for the temperature range. Once you have finished populating your table, you can save the table into a file by clicking **Save Table**. You can also open a saved table by clicking **Open Table**.

The screenshot shows the 'Local Conditions' software window. On the left is a control panel with input fields for Ambient Temp. Unit (°F selected), Ambient (60 °F), Wind Speed (2.0 ft/s), Wind Angle (90 °), Sun, Qse (Auto W/ft²), Theta (Auto °), Solar Day (Jun, 10), Local Time (12:00), and a checkbox for 'Include Night calculations'. Below this is a 'Night' section with Wind Speed (0 ft/s) and Wind Angle (90 °). At the bottom are buttons: Add Column, Delete Column, Clear Table, Update Table, Save Table, Open Table, and Calculate.

The main area contains a table with 15 columns and 15 rows. A text box above the table explains: 'Use this screen to specify up to 50 sets of Local Conditions. Use the Add Column button to add your desired number of columns. Click on any value within a column, then use the Local Conditions panel on the left side of the screen to edit the column values before clicking Update Table. Use the Save Table button to save the table in a text file for future use. When finished, click Accept.'

Conditions	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ambient:	-10	-5	0	5	10	15	20	25	30	35	40	45	50	55	60
Wind Speed:	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Wind Angle:	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
Sun, Qse:	Auto	Auto	Auto	Auto	Auto	Auto	Auto	Auto	Auto	Auto	Auto	Auto	Auto	Auto	Auto
Theta:	Auto	Auto	Auto	Auto	Auto	Auto	Auto	Auto	Auto	Auto	Auto	Auto	Auto	Auto	Auto
Solar Month:	Jun	Jun	Jun	Jun	Jun	Jun	Jun	Jun	Jun	Jun	Jun	Jun	Jun	Jun	Jun
Solar Day:	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Local Time:	12:00	12:00	12:00	12:00	12:00	12:00	12:00	12:00	12:00	12:00	12:00	12:00	12:00	12:00	12:00
Wind Speed, Night:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wind Angle, Night:	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90

Click the **Calculate** button to proceed with **Create Spreadsheet** calculations. The **Input File Path and Name** screen will be displayed.



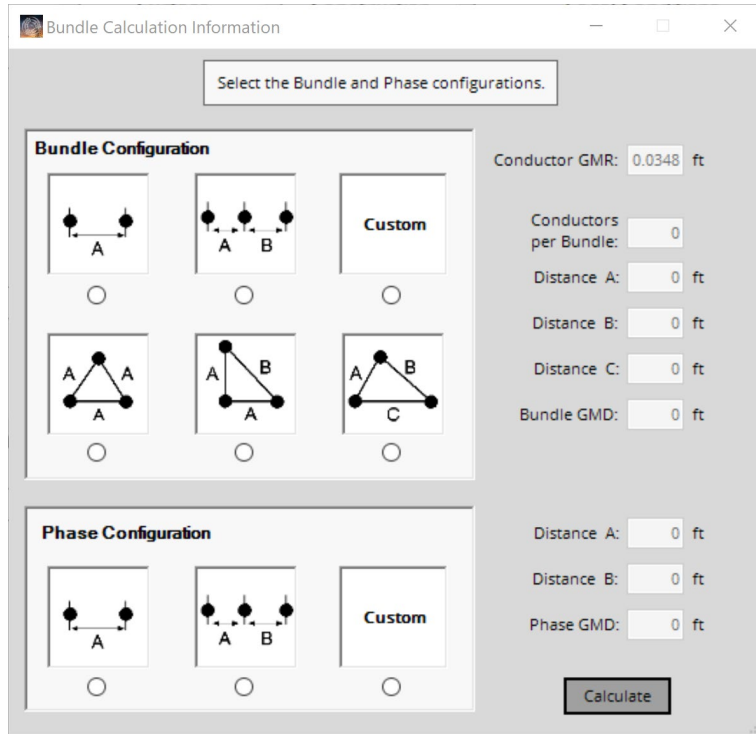
Click **Browse** to select a destination for your output .xlsx file. Also edit the **Filename** as needed. Click **Accept** when ready to initiate the calculations. For single-layer steel core conductors, a **Calculating Single-Layer Values** screen will appear to track the progress of this complex calculation. The **Building Excel File** screen will also appear to track the progress of the overall calculation. Once the calculation finishes, these screens will disappear, the .xlsx file will be saved to the specified destination on your computer, and a message box will appear, confirming successful spreadsheet creation. If multiple sets of calculation conditions were specified, the .xlsx file will include a worksheet for each set of conditions, including a unique worksheet for each Night calculation. If errors were encountered during the calculation, those will be summarized in a .txt file and saved (with a similar filename) in the same directory as the .xlsx file.

Note that transient calculations use interpolated resistance. This is because transient calculations require a complex, iterative process to calculate transient ratings. To ensure resistance interpolation and improve calculation accuracy, **Low and High Temperatures** and **Low and High Temperature AC Resistances** are recalculated for each transient calculation run based on calculation inputs.

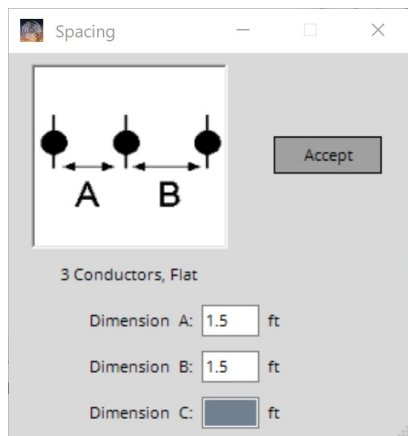
Note that for single-layer and three-layer steel core conductors (aluminum-clad steel, AW, excluded), ac resistance is calculated at the highest current shown for each temperature. For single-layer steel core conductors (aluminum-clad steel, AW, excluded), inductive reactance is calculated at the highest current at 75°C.

2.7.9 Bundled Calculation (Pro Version Only)

Calculate the inductive and capacitive reactances for a provided bundle and phase configuration (unavailable for **dc** calculations). To run this calculation, first select a conductor and input the desired calculation conditions (*Local Conditions* and *Location Conditions*). Click the **Bundle Calculation** button in the *Advanced* panel and the **Bundle Calculation Information** screen will appear.



Choose from various **Bundle Configurations** and **Phase Configurations**. When a radiobutton is selected, the **Bundle Info** screen will appear so that you can enter the applicable distances between conductors.



Click the **Calculate** button to run the bundle calculation. The **Bundle Calculation Results** screen, shown below, will be displayed. From this screen, you can **Print** the report. The report will contain the calculated data shown as well as the conductor information and calculation conditions from the **Main Menu**. Only calculation conditions that affect the calculation result will be shown in the printout.



Bundle Calculation Results

	Inductive Reactance (Ω /mi)	Capacitive Reactance (M Ω -mi)
Conductor at GMD = 1 ft:	0.4075	0.0940
Bundle at GMD = 1 ft:	0.1030	0.0233
Bundle at GMD = 18.9 ft:	0.4597	0.1105

Print



Appendix



Abbreviations

Conductor Types

AAC	All-Aluminum Conductor
AAC/TW	Shaped Wire Compact All-Aluminum Conductor
AAAC	All-Aluminum Alloy Conductor (6201-T81 Alloy)
ACAR	Aluminum Conductor, Aluminum Alloy Reinforced (1350/6201 Alloy)
AACSR	Aluminum Alloy Conductor, Steel Reinforced (6201-T81 Alloy)
ACSR	Aluminum Conductor, Steel Reinforced
ACSR/TW	Shaped Wire Compact Aluminum Conductor, Steel Reinforced
ACSR/MR	Motion-Resistant Aluminum Conductor, Steel Reinforced (also known as “Oval”)
ACSR/AW	Aluminum Conductor, Aluminum-Clad Steel Reinforced
ACSS	Aluminum Conductor, Steel Supported
ACSS/TW	Shaped Wire Compact Aluminum Conductor, Steel Supported
ACSS/AW	Aluminum Conductor, Aluminum-Clad Steel Supported
ACSS/TW/AW	Shaped Wire Compact Aluminum Conductor, Aluminum-Clad Steel Supported
Max Storm™	Shaped Wire Compact Thermal-Resistant Aluminum Conductor, UHS Steel Reinforced (ZTACSR/TW/MA5)
ACCS/TW/C7®-TS	Shaped Wire Compact Aluminum Conductor, Thermoset Composite Supported
ZTACCR/TW/C7®-TS	Shaped Wire Compact Thermal-Resistant Aluminum Conductor, Thermoset Composite Reinforced
ACCR	Thermal-Resistant Aluminum Conductor, Composite Reinforced
ACCR/TW	Shaped Wire Compact Thermal-Resistant Aluminum Conductor, Composite Reinforced
AAC/VR2®	Vibration-Resistant, Twisted Pair All-Aluminum Conductor
ACSR/VR2®	Vibration-Resistant, Twisted Pair Aluminum Conductor, Steel Reinforced
ZTACSR/VR2®	Vibration-Resistant, Twisted Pair Thermal-Resistant Aluminum Conductor, Steel Reinforced
Al	Aluminum
Cu	Copper
Duplex	Covered conductor plexed with a bare neutral
Triplex	Two covered conductors and a bare neutral, all plexed together
Quadruplex	Three covered conductors and a bare neutral, all plexed together
HD Copper	Hard-Drawn Copper
MHD Copper	Medium-Hard-Drawn Copper
SD Copper	Soft-Drawn Copper
HD Copper Contact Wire	Grooved, Figure 8, or Figure 9 Hard-Drawn Copper Contact/Trolley Wire
Bronze Alloy 55 Contact Wire	Grooved, Figure 8, or Figure 9 Bronze Alloy 55 (CuMg 0.5) Contact/Trolley Wire



Bronze Alloy 80 Contact Wire	Grooved, Figure 8, or Figure 9 Bronze Alloy 80 (CuMg 0.2) Contact/Trolley Wire
Line Wire	Single Covered Conductor
Tree Wire	Single Covered Conductor designed for momentary contact with trees
Spacer Cable	Single Covered Conductor designed for spacer cable systems

Other

AC	Alternating Current
DC	Direct Current
GA#	Galvanized Zinc Steel Core Coating (# equals strength rating)
GMD	Geometric Mean Distance, between conductors
GMR	Geometric Mean Radius, used in inductive reactance calculations
HS285®	Southwire proprietary Ultra-High Strength Steel Core
MA#	Mischmetal Steel Core Coating (# equals strength rating)
TW	Trapezoidal-Shaped Wire