SWRate User's Manual
v1.0.0

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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 738-2012. Data provided in the conductor tables and conductor calculations are based on ASTM 02.03-2020.

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 about 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
- 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 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 each conductor type, including conductor properties, resistance, and reactance (Pro version only)
- Calculation 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/AW
- ACSS
- ACSS/TW
- ACSS/AW
- ACSS/TW/AW
- MaxStorm™
- ACCS/TW/C7®-TS
- ZTACCR/TW/C7®-TS
- ACCS/TW/C7®-TP
- ZTACCR/TW/C7®-TP
- ACCR
- ACCR/TW

- AAC/VR2
- ACSR/VR2
- Al Bare
- Al Duplex
- Al Triplex
- Al Quadruplex
- HD Copper
- MHD Copper
- SD Copper
- Cu Duplex
- Cu Triplex
- Cu Quadruplex
- AAC Line Wire
- AAAC Line Wire
- ACSR Line Wire
- AAC Tree Wire/Spacer Cable
- ACSR Tree Wire/Spacer Cable
- C7® Tree Wire/Spacer Cable

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.

SWRate_install.msi

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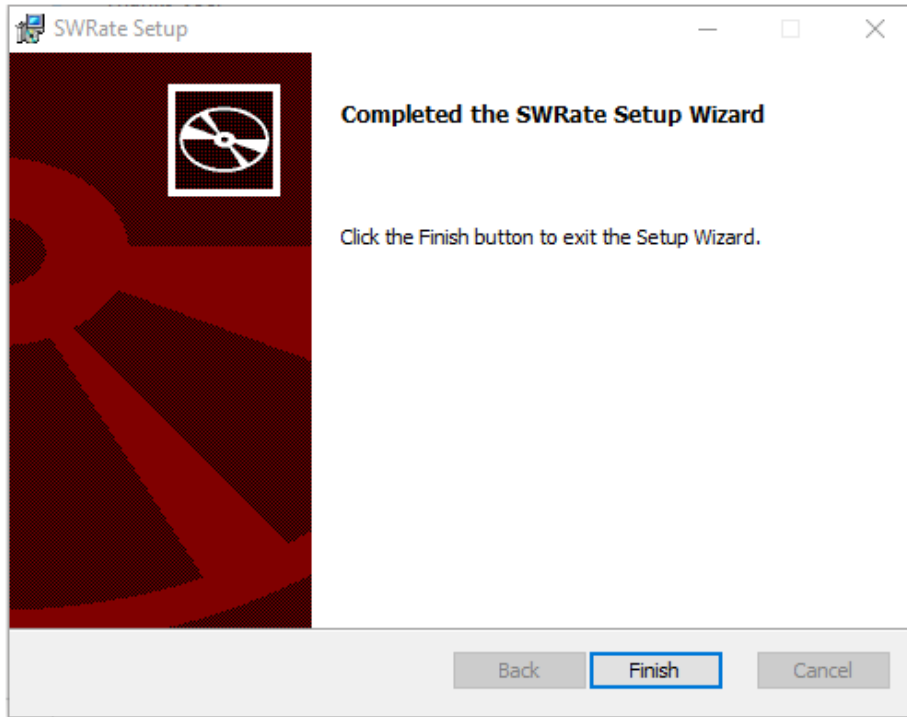
4. To launch the SWRate program, either double-click the Desktop shortcut or search "SWRate" in the Start menu.

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.

2. **License Type** should be *Network*. 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 <u>Configure Proxy Service</u>.

    Next, enter your proxy server address and click **Accept**.
    Finally, proceed to Step 3 below.
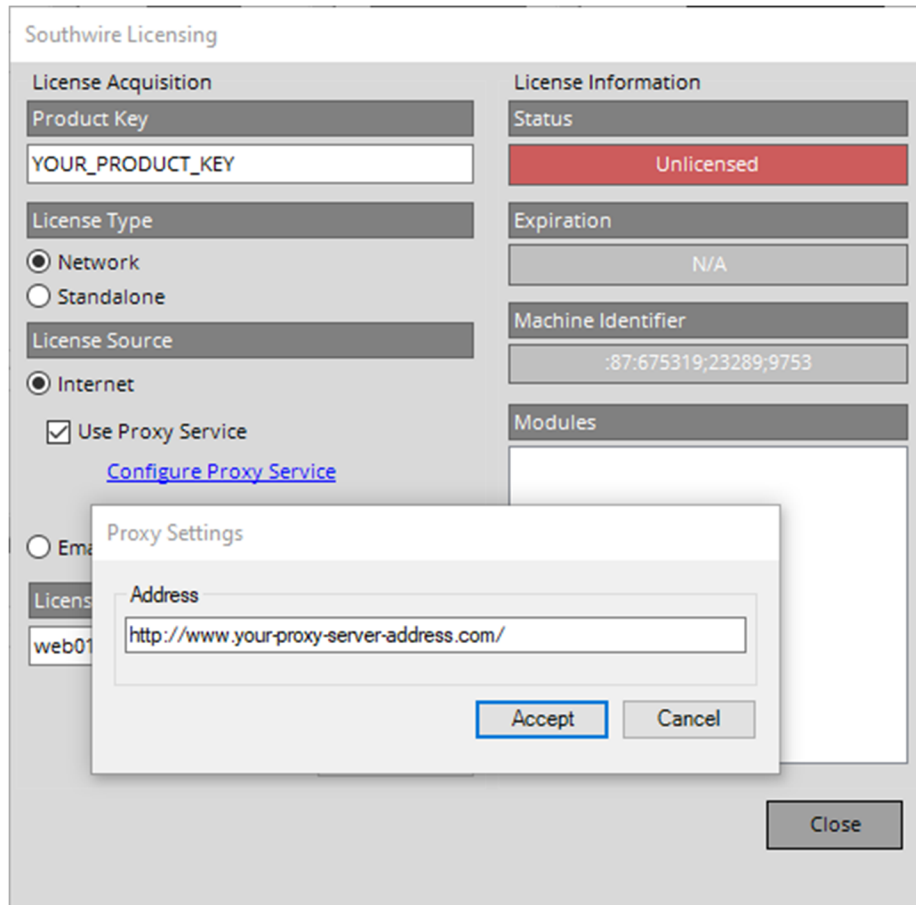
c) If you choose **Email**, you will need to request a license file.

    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.
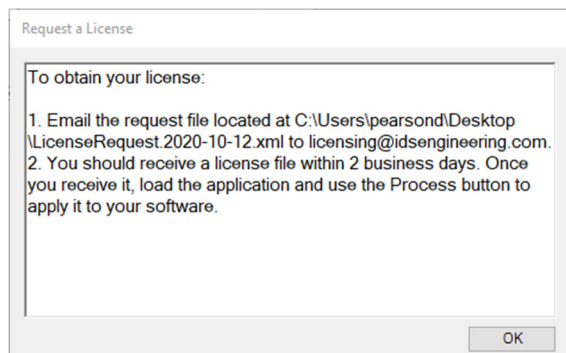
v.   When you receive the license file from Southwire, reopen the program and click **Upgrade to Pro** at the top of the **Main Menu** screen. Within the **Southwire Licensing** screen, again click *Email* under **License Source**, then click the **Process** button to apply the license file. You will 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.
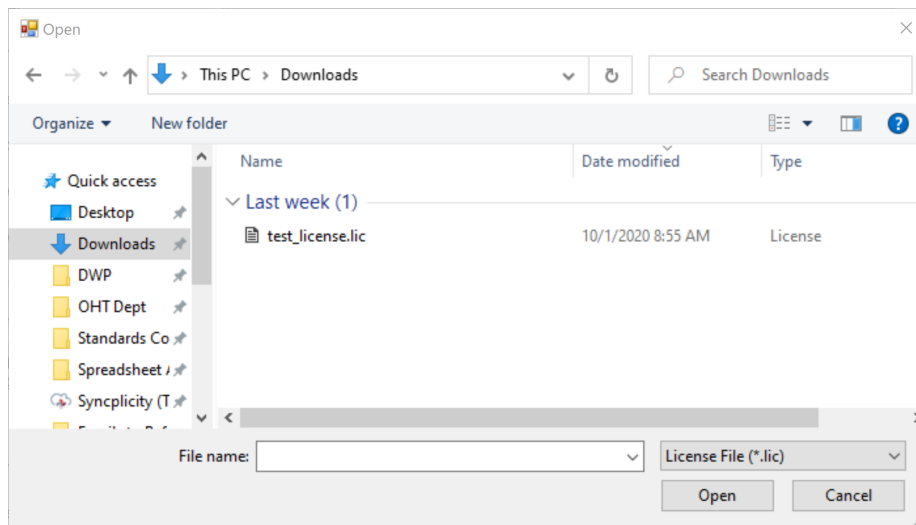
3. Click the **Checkout** button.
4. Once a license is successfully checked out, the *Status* section of License Information will be updated to say **Licensed** and will be visibly green.

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

Southwire License Agreement

License Terms

SWRate_EULA.rtf

Licensed Program End User License Agreement

IMPORTANT: THIS LICENSED PROGRAM END USER LICENSE AGREEMENT IS A LEGAL AGREEMENT BETWEEN THE LICENSEE AND SOUTHWIRE. READ IT CAREFULLY BEFORE COMPLETING THE INSTALLATION PROCESS AND USING THE LICENSED PROGRAM. IT PROVIDES A LICENSE TO USE THE LICENSED PROGRAM AND CONTAINS WARRANTY INFORMATION AND LIABILITY DISCLAIMERS. BY INSTALLING AND USING THE LICENSED PROGRAM, LICENSEE IS CONFIRMING TO SOUTHWIRE ACCEPTANCE OF THE LICENSED PROGRAM AND AGREEING TO BECOME BOUND BY THE TERMS OF THIS AGREEMENT. IF LICENSEE DOES NOT AGREE TO BE BOUND BY THESE TERMS, THEN SELECT THE "CANCEL" BUTTON TO NEGATE THE LICENSED PROGRAM INSTALL. LICENSEE MAY THEN CONTACT SOUTHWIRE FOR A FULL REFUND OF THE PURCHASE PRICE LICENSEE PAID FOR THE LICENSED PROGRAM.
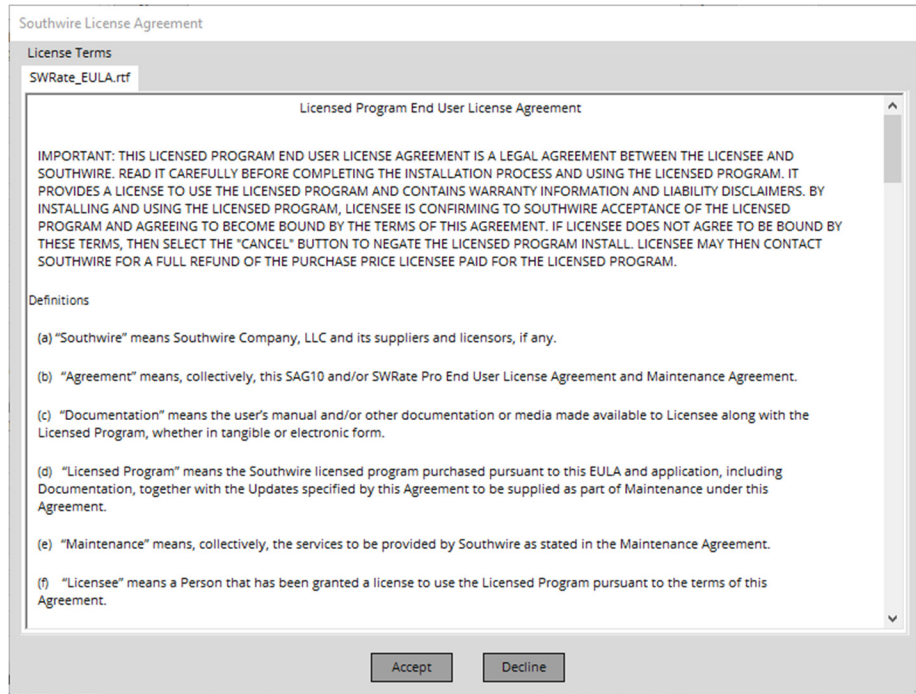
Definitions

(a) "Southwire" means Southwire Company, LLC and its suppliers and licensors, if any.

(b) "Agreement" means, collectively, this SAG10 and/or SWRate Pro End User License Agreement and Maintenance Agreement.

(c) "Documentation" means the user's manual and/or other documentation or media made available to Licensee along with the Licensed Program, whether in tangible or electronic form.

(d) "Licensed Program" means the Southwire licensed program purchased pursuant to this EULA and application, including Documentation, together with the Updates specified by this Agreement to be supplied as part of Maintenance under this Agreement.

(e) "Maintenance" means, collectively, the services to be provided by Southwire as stated in the Maintenance Agreement.

(f) "Licensee" means a Person that has been granted a license to use the Licensed Program pursuant to the terms of this Agreement.

Accept   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, including 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**:
    - Drop-down 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: Inputs used by the Sequence Impedance portion of the Calculate Ampacity calculation routine (*Pro* version only)
- **Printer**: Activates the printer selection and setup dialog box
- **Exit and Check-In License**: Closes the program and checks the license seat in for use by another user (Pro version only)

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 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 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.

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.
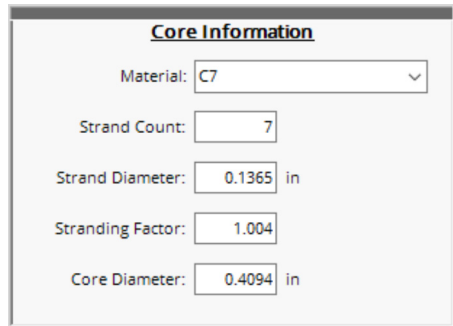
There are seven fields in this panel:

- **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 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).
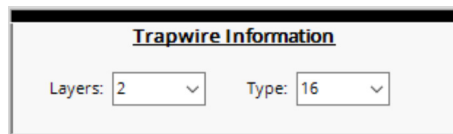
There are five fields in this panel:

- **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.
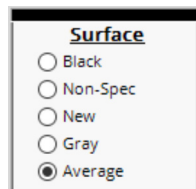

2.3.4 Surface (Pro version only)

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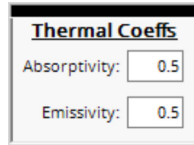

2.3.5 Thermal Coeffs

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.

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.
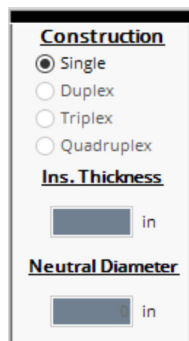
Absorptivity and emissivity values of approximately 0.2 for new conductors and 0.9 for weathered bare overhead conductors have been reported by House and Tuttle[3]. The exact rate of increase depends on the level of atmospheric pollution and the line's operating voltage. A value of 0.5 has been widely 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
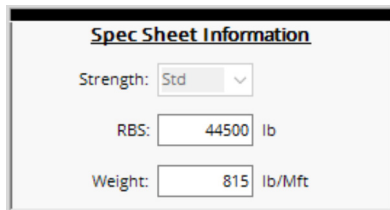
2.3.6   Construction (Pro Version Only)

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

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.
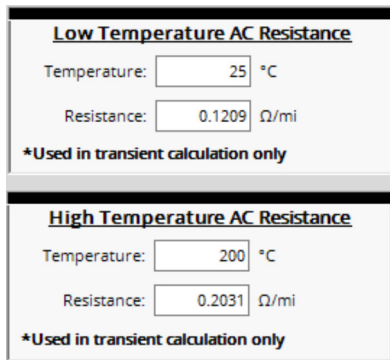
Spec Sheet Information	
Strength:	Std
RBS:	44500 lb
Weight:	815 lb/Mft

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 provided for reference only.

Low Temperature AC Resistance	
Temperature:	25 °C
Resistance:	0.1209 Ω/mi
*Used in transient calculation only	

High Temperature AC Resistance	
Temperature:	200 °C
Resistance:	0.2031 Ω/mi
*Used in transient calculation only	

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

- **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**: Solar heat flux or intensity, W/ft² (Pro version only). "Auto" calculates this value using other calculation conditions. SWRate Lite allows the "Auto" calculation, while SWRate Pro allows both input and "Auto".
- **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


- **Frequency**: Electrical frequency, Hz. Drop-down options are **50** Hz and **60** Hz.
- **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
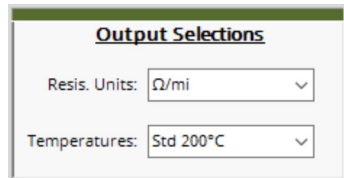
2.5.1 Resistance (Resis.) Units

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 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 MaxStorm™ 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).

- **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).
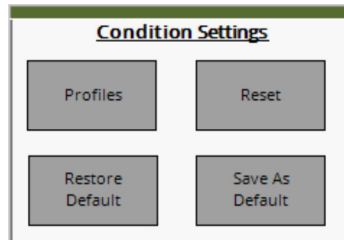
2.6 Condition Settings (Pro version only)

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 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.

2.6.2 Reset

Resets the calculation conditions to the default conditions

2.6.3 Restore Default
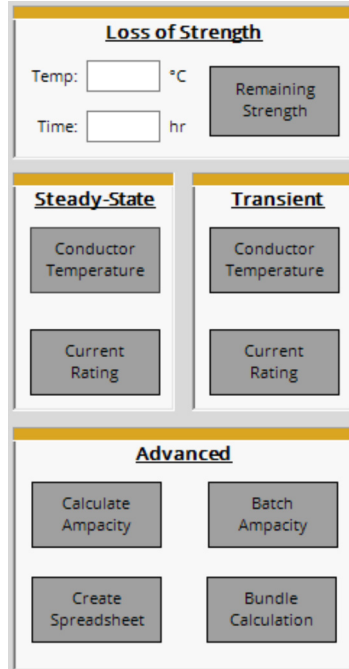
Restores the factory default calculation conditions

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 **Restore 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 *Steady-State* calculations, two are for *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).

Note that for single-layer steel core composite conductors, values above 75°C may be incorrect due to limited data for modeling.
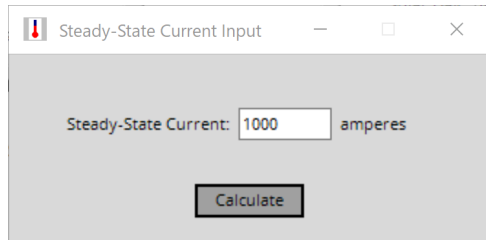
2.7.1 Loss of Strength

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, MaxStorm™ Overhead Conductors) have high normal operating temperatures and have very low risk of strength loss.

2.7.2 Steady-State Conductor Temperature
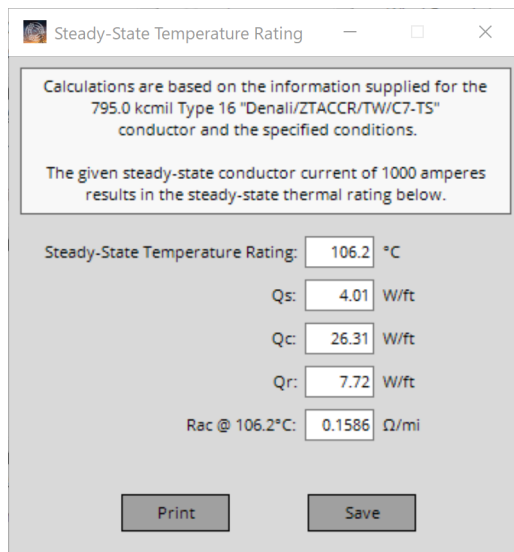
Selecting this option will calculate a steady-state conductor temperature based on an input current load. To run this calculation, first select a conductor and input the desired operating parameters (*Local Conditions* and *Location Conditions*). Click the **Conductor Temperature** button in the *Steady-State* 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$_r$**) and the ac resistance at the calculated conductor temperature (**Rac**).

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. To run this calculation, first select a conductor and input the desired operating parameters (*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 displayed 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 operating parameters (*Local Conditions* and *Location Conditions*). Click the **Conductor Temperature** button in the *Transient* panel and the **Transient Data Input** screen, shown below, will appear.

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 operating parameters (*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 ampacity results using the **Temperatures** defined in the *Output Selections* panel. To run this calculation, first select a conductor and input the desired operating parameters (*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 (**Xa/Xl**) & Capacitive Reactance (**X'a/Xc**) at 1-ft spacing (spacing is non-applicable for plexed covered conductors).

°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

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

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**: 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), **Xl** (positive sequence inductive reactance), **Xc** (positive sequence capacitive reactance), **R0** (zero sequence ac resistance), **Xl0** (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/Xl**) & Capacitive Reactance (**X'a/Xc**) at 1-ft spacing (spacing is non-applicable for plexed covered conductors).
- **Include Sequence Impedance Data with Printout**: 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
X'a @ 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 composite conductors, ac resistance is calculated at the highest current shown for each temperature. For single-layer steel core composite conductors, 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 operating parameters (*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.
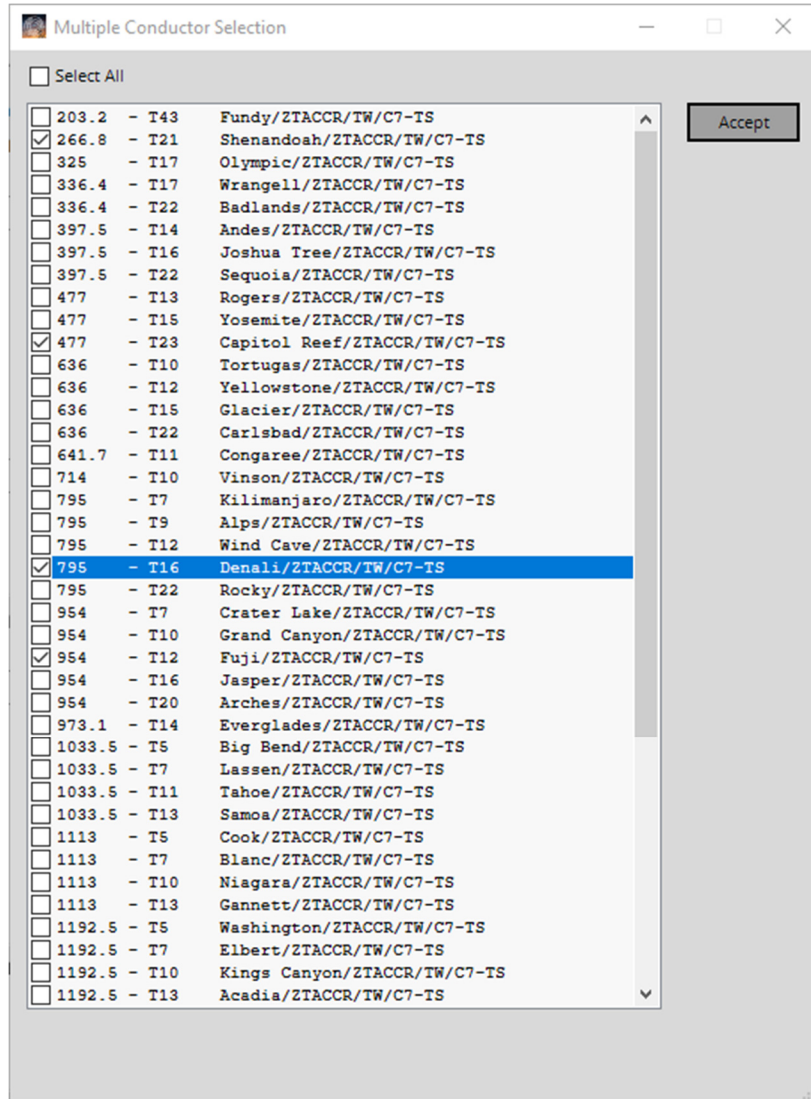
This screen displays the conductor options and allows you to select multiple conductors. Also note the **Select All** option at the top of the screen. Keep in mind that these calculations could take some time. Once you have made your selections, click **Accept**. A **Print** screen will appear to confirm your printer selection before proceeding with the calculations and printing.
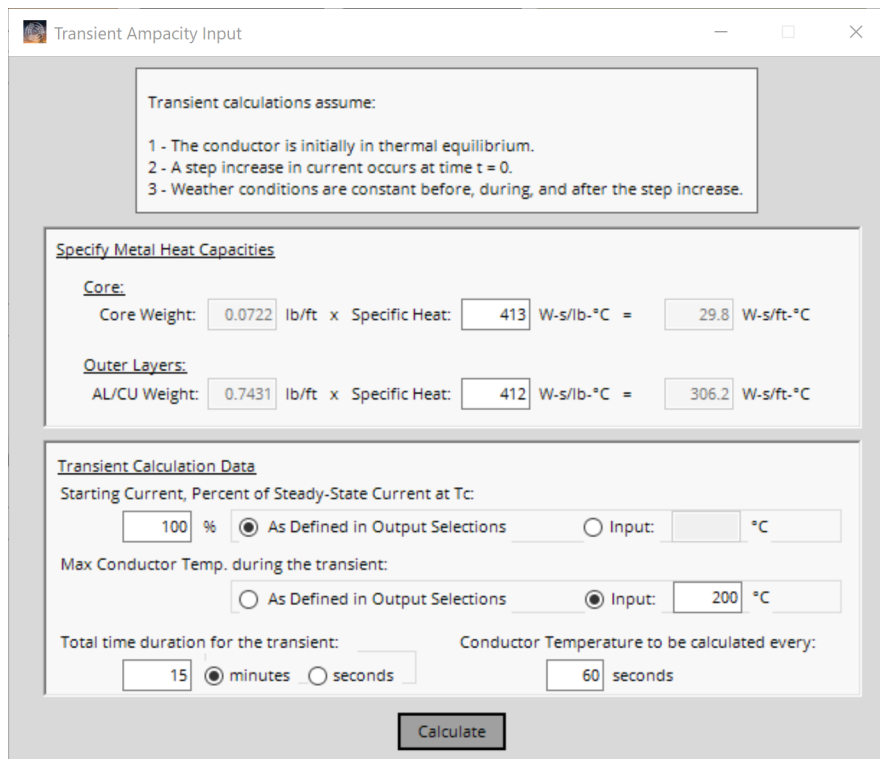
For single-layer steel core conductors, a **Calculating Single-Layer Values** screen will appear prior to the **Results** screen to track the progress of this complex calculation. Each printed report will contain the tabulated data as described in the Calculate Ampacity, Section 2.7.6.

Note that for single-layer and three-layer steel core composite conductors, ac resistance is calculated at the highest current shown for each temperature. For single-layer steel core composite conductors, 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, including conductor properties, resistance, and reactance. To run this calculation, first select a conductor **Type** and input the desired operating parameters (*Local Conditions* and *Location Conditions*). Click the **Create Spreadsheet** button in the *Advanced* panel and the **Multiple Conductor Selection** screen will appear as shown below. 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, especially if transient calculations are also chosen. Once you have made your selections, click **Accept**. A **Request Confirmation** screen will appear to confirm you want to proceed with the calculations. Upon clicking **Yes**, the program will ask 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.

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.

Click the **Calculate** button to proceed with **Create Spreadsheet** calculations. The **Input File Path and Name** screen, shown below, 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, and the .xlsx file will be saved to the specified destination on your computer.
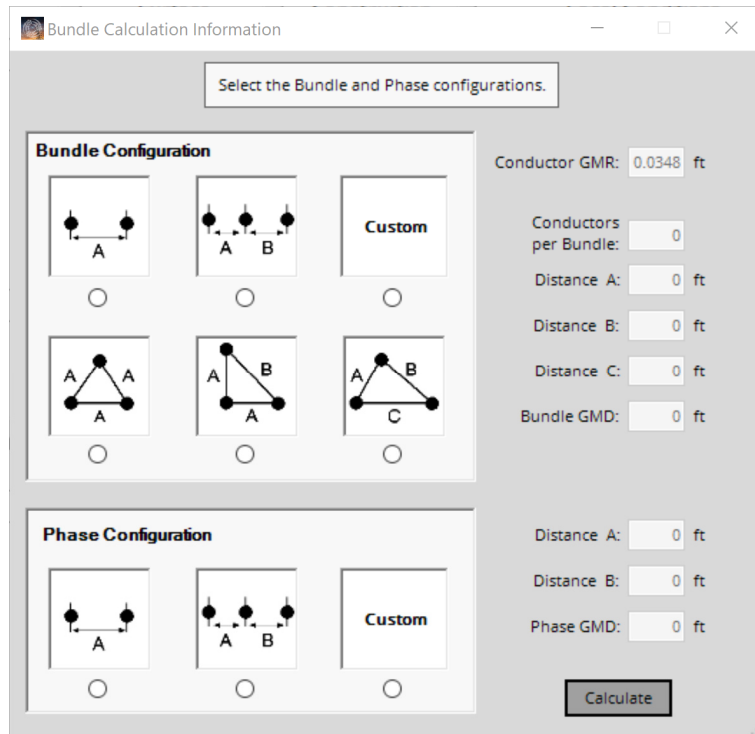
Note that transient calculations use interpolated resistance. This is because transient calculations require a complex, iterative process to calculate transient ratings. To ensure resistance interpolation and improve calculation accuracy, **Low** and **High Temperatures** and **Low** and **High Temperature AC Resistances** are recalculated for each transient calculation run based on calculation inputs.

Note that for single-layer and three-layer steel core composite conductors, ac resistance is calculated at the highest current shown for each temperature. For single-layer steel core composite conductors, 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. To run this calculation, first select a conductor and input the desired operating parameters (*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.
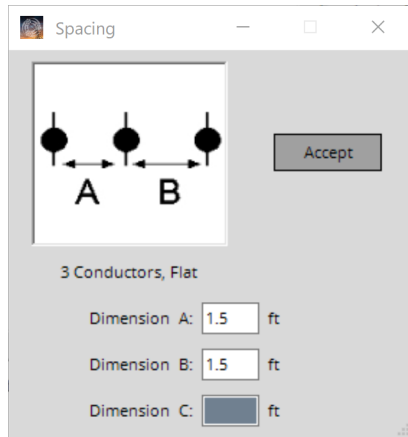
Click the **Calculate** button to run the bundle calculation. The **Bundle Calculation Results** screen, shown below, will be displayed. From this screen, you can **Print** the report. The report will contain the calculated data shown as well as the conductor information and calculation conditions from the **Main Menu**. Only calculation conditions that affect the calculation result will be shown in the printout.
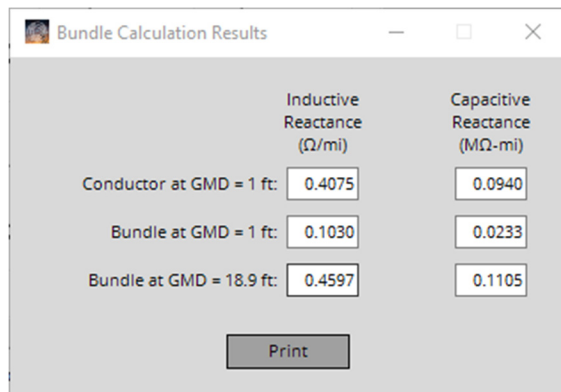
Appendix

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/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
MaxStorm™	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
ACCS/TW/C7®-TP	Shaped Wire Compact Aluminum Conductor, Thermoplastic Composite Supported
ZTACCR/TW/C7®-TP	Shaped Wire Compact Thermal-Resistant Aluminum Conductor, Thermoplastic 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
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
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	
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