

# 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<sup>™</sup>
- ACCS/TW/C7®-TS
- ZTACCR/TW/C7®-TS
- ACCS/TW/C7®-TP
- ZTACCR/TW/C7®-TP
- ACCR
- ACCR/TW

### 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.

- 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<sup>®</sup> Tree Wire/Spacer Cable





SWRate\_install.msi

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

🔀 SWRate Setup	- 🗆 🗙
Ś	Welcome to the SWRate Setup Wizard
	The Setup Wizard will install SWRate on your computer. Click Next to continue or Cancel to exit the Setup Wizard.
	Back Next Cancel

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



🛃 SWRate Setup	- 🗆 X
S	Completed the SWRate Setup Wizard
	Click the Finish button to exit the Setup Wizard.
	Back Finish Cancel

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 <u>OHT@southwire.com</u> 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	Expiration
Network	N/A
O Standalone	Machine Identifier
License Source	:87:675319;23289;9753
Internet	
Use Proxy Service	Modules
Configure Proxy Service	
O Email License Server web01.idsengineering.com	
Checkout	Close

- 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.



Southwire Licensing			
License Acquisition	License Information		
Product Key	Status		
YOUR_PRODUCT_KEY	Unlicensed		
License Type	Expiration		
Network	N/A		
O Standalone	Machine Identifier		
License Source	:87:675319:23289:9753		
Internet			
Use Proxy Service	Modules		
Configure Proxy Service			
O Ema			
Address			
http://www.your-proxy-server-address.com	/		
webbi			
	Accept Cancel		
	Close		
	Close		

- 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.

Request a License	
To obtain your license: 1. Email the request file located at C:\Users\pearsond\D \LicenseRequest.2020-10-12.xml to licensing@idsengin 2. You should receive a license file within 2 business da you receive it, load the application and use the Process apply it to your software.	eering.com. ys. Once button to
,	ОК



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.

🖳 Open			×
$\leftarrow$ $\rightarrow$ $\checkmark$ $\Uparrow$ $\clubsuit$ > This PC > Download	ds 🗸 🗸	ව 🔎 Search	Downloads
Organize 🔻 New folder			= • • •
↑ Name	1)	Date modified	Туре
Downloads	slic	10/1/2020 8:55 AM	License
OHT Dept 🖈			
Spreadsheet / *			
Syncplicity (T * V			>
File name:		<ul><li>✓ License File (</li><li>Open</li></ul>	*.lic) V Cancel

- 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	Expiration	
Network	2020-10-29	
O Standalone	Machine Identifier	
License Source	·87:675319-23289:9753	
Internet		
Use Proxy Service	Modules	
Configure Proxy Service	Overamp, 2018 DATAUPDATE, NEVER	
◯ Email		
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**.



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.

Help						
ype:	→ Name:			✓ Size:		
<u>Conductor I</u>	nformation_	Surface	Construction	Local Conditions	Condition	n Settings
Material: 1350-	H19 AI 61.2%	O Black	Single     Duplex	Ambient: 40 °C	Profiles	Reset
Strand Count:		O New	Oriplex	Wind Speed: 2.0 ft/s		
Strand Diameter:	in	Average	Ins. Thickness	Wind Angle: 90 °	Restore	Save As
Stranding Factor: A	STM	Thermal Coeffs	in	Sun: Auto W/ft <sup>2</sup>	Default	Default
Outer Diameter:	in	Absorptivity: 0.5	Neutral Diameter	Solar Day: Jun 🗸 10 🗸	Loss of S	<u>strength</u>
Compression: None	~	Emissivity: 0.5	in	Local Time: 12:00 V	Temp: C	Remainin
Strand Lay:	N/A in	Spec Sheet I	nformation	*24:00 - Midnight, 12:00 - Noon	Time: hr	Strength
Enter Strand Lay if single-I	ayer ACSR	Strength:	~		Charle Charles	
Caralafa	mation	RBS:	Ib		<u>steady-state</u>	Iransier
	in Steel	Weight:	lb/Mft	Frequency: 60 V Hz	Conductor Temperature	Conductor
Material: Coate				Atmosphere: Clear V		
Strand Count:		Low Temperatu	re AC Resistance	Altitude: 0 ft	Current	Current
Strand Diameter:	in	Temperature:	°C	N. Latitude: 30 °	Rating	Rating
Stranding Factor: A	STM	Resistance:	Ω/mi	Line Azimuth: 0 °		
Core Diameter:	in	*Used in transient calcul	lation only		Adva	nced
		High Temperatu	re AC Resistance	Output Selections	Calculate	Batch Ampacity
Trapuise la	formation	Temperature:	°C			, and the starty
<u>Trapwire in</u>	normation	Resistance:	Q/mi	Resis. Units: Ω/mi	Create	Bundle
Layers: 🗸	Туре: 🗸			Temperatures: Std 100°C V	Spreadsheet	Calculation



#### 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, <u>OHT@southwire.com</u>, or visit us at <u>https://overheadtransmission.southwire.com/swrate-software-support/</u>.

# 2 Main Menu Features

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

SWRate Pro: OH Conductor Ratings Calculator v1.0.0			- 🗆 ×
Type: ZTACCR/TW/C7-TS V Name: 73	5 - T16 Denali/ZTACCR/TW/C7-TS	✓ Size: 795	]
Conductor Information Material: AI-2r 60% Strand Count: 20 Strand Diameter: in Stranding Factor: ASTM	Surface     Construction       Black     Single       Non-Spec     Duplex       Gray     Triplex       Average     Ins. Thickness       Thermal Coeffs     in       Absorptivity:     0.5	Local Conditions Ambient: 40 °C Wind Speed: 2.0 ft/s Wind Angle: 90 ° Sun: Auto W/ft <sup>2</sup>	Condition Settings       Profiles     Reset       Restore     Save As       Default     Default
Outer Diameter: 1.01 in Compression: None   Strand Lay: N/A in  *Enter Strand Lay if single-layer ACSR	Emissivity:     0.5       Spec Sheet Information       Strength:       Std	Solar Day: Jun v 10 v Local Time: 12:00 v *24:00 - Midnight, 12:00 - Noon	Loss of Strength Temp: ^C Remaining Time: hr Strength Steady-State Transient
Core Information Material: C7 ~	RBS: 44500 lb Weight: 815 lb/Mft	Frequency: 60 V Hz Atmosphere: Clear V	Conductor Temperature
Strand Diameter: 0.1365 in Stranding Factor: ASTM	Low Temperature AC Resistance           Temperature:         25           *C         Resistance:           0.1209         Ω/mi           *Used in transient calculation only	Altitude: 0 ft N. Latitude: 30 * Line Azimuth: 0 *	Current Rating Advanced
Core Diameter: 0.4094 in           Trapwire Information           Layers: 2         Type: 16	High Temperature AC Resistance           Temperature:         200         *C           Resistance:         0.2031         Ω/mi           *Used in transient calculation only         *	Output Selections           Resis. Units:         Ω/mi         ✓           Temperatures:         Std 200*C         ✓	Calculate Batch Ampacity Ampacity Create Bundle Spreadsheet Calculation

These sections are:

- <u>Main Menu Toolbar</u>: 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

- <u>Additional Conductor/Cable Information</u>: Seven (7) panels containing additional information used for calculations, including some used strictly for the specification sheet
- <u>Calculation Conditions</u>: 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.
- <u>Calculation Options</u>: 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:
  - <u>Drop-down Sorting</u>: 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.
  - <u>Sequence Impedance Info</u>: Inputs used by the Sequence Impedance portion of the Calculate Ampacity calculation routine (*Pro* version only)
- **<u>Printer</u>**: 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:

- <u>About</u>: Displays the currently installed program version number, calculation method references, and contact information for technical support: <u>OHT@southwire.com</u> or *1-877-797-2410*
- <u>Help</u>: 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.

- <u>Revision History</u>: Details improvements to the software (Pro version only)
- <u>View Disclaimer</u>: 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 <u>OHT@southwire.com</u> 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 <a href="https://southwireocm.p3medialink.com/product\_detail.php?id=71">https://southwireocm.p3medialink.com/product\_detail.php?id=71</a>. 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.



<u>Condu</u>	Conductor Information				
Material:	Al-Zr 60% 🗸				
Strand Count:	20				
Strand Diameter:	in				
Stranding Factor:	1.0225				
Outer Diameter:	1.01 in				
Compression:	None ~				
Strand Lay:	N/A in				
*Enter Strand Lay if single-layer ACSR					

There are seven fields in this panel:

- <u>Material</u>: Material name for the outer conducting strands
- <u>Strand Count</u>: Number of outer conducting strands
- <u>Strand Diameter</u>: 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
- **<u>Outer Diameter</u>**: Overall diameter of the conductor, inches
- <u>Compression</u>: 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<sup>®</sup> stranded carbon fiber composite core, 3M<sup>®</sup> composite core, or aluminum alloy (when used as a core material in ACAR constructions).



<u>Core Information</u>	
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:

- <u>Material</u>: Material name for the core strands
- <u>Strand Count</u>: 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 ~	Туре:	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		
O 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 C	oeffs
Absorptivity:	0.5
Emissivity:	0.5

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.

- <u>Black</u>: 0.95/0.91
- <u>Non-Spec</u>: 0.42/0.42
- <u>New</u>: 0.23/0.23
- <u>Gray</u>: 0.5/0.5
- <u>Average</u>: 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 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

Local Conditions			
Ambient: 40 °C			
Wind Speed: 2.0 ft/s			
Wind Angle: 90 °			
Sun: Auto W/ft <sup>2</sup>			
Solar Day: Jun 🗸 10 🗸			
Local Time: 12:00 🗸			
*24:00 - Midnight, 12:00 - Noon			

- **<u>Ambient</u>**: Ambient air temperature, °C
- <u>Wind Speed</u>: Wind speed, feet per second (ft/s)
- <u>Wind Angle</u>: 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.
- <u>Sun</u>: Solar heat flux or intensity, W/ft<sup>2</sup> (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".
- <u>Solar Day</u>: 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 V			
Altitude:	0 ft			
N. Latitude:	30 °			
Line Azimuth:	•			

- **Frequency**: Electrical frequency, Hz. Drop-down options are **50** Hz and **60** Hz.
- <u>Atmosphere</u>: 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



- <u>N. Latitude</u>: 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  $\Omega$ /Mft (Pro version only),  $\Omega$ /mi, or  $\Omega$ /km units. If  $\Omega$ /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.

- <u>Std 75°C</u>: default temperature range for copper conductor types; up to 75°C
- <u>Std 90°C</u>: temperature range up to 90°C
- <u>Std 100°C</u>: 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
- <u>Std 200°C</u>: default temperature range for C7®-TS conductor types; up to 200°C
- <u>Std 225°C</u>: default temperature range for C7<sup>®</sup>-TP conductor types; up to 225°C
- <u>Std 240°C</u>: default temperature range for ACCR and MaxStorm<sup>™</sup> conductor types; up to 240°C
- Std 250°C: default temperature range for ACSS with mischmetal or AW core; up to 250°C
- <u>Custom</u>: 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: 25				
Temperature 2: 50	Accept			
Temperature 3: 75	Clear			
Temperature 4: 90				
Temperature 5: 100	Values are:			
Temperature 6: 125	O °F			
Temperature 7: 150	● °C			
Temperature 8: 175	,			
Temperature 9: 180				
Temperature 10: 200				
Temperature 11:				
Temperature 12:				

<u>Range</u>: 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, Endir °C) at which the ampacit	ng Temperature, a y is to be calculate	and Increi ed for.	ment (in
Starting Temperature: 50 Ending Temperature: 100 Increment: 5	<u>Values are:</u> ○ °F ● °C		Accept Clear



# 2.6 Condition Settings (Pro version only)

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



- **<u>Profiles</u>**: Save various calculation conditions
- **<u>Reset</u>**: Resets the calculation conditions to the default conditions
- <u>Restore Default</u>: 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<sup>®</sup> Overhead Conductors, MaxStorm<sup>™</sup> 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.

Steady-State Current Input —	×
Steady-State Current: 1000 amperes	
Calculate	

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.

Steady-State Temperature Rating - 🗆 🗙
Calculations are based on the information supplied for the 795.0 kcmil Type 16 "Denali/ZTACCR/TW/C7-TS" conductor and the specified conditions.
The given steady-state conductor current of 1000 amperes results in the steady-state thermal rating below.
Steady-State Temperature Rating: 106.2 °C
Qs: 4.01 W/ft
Qc: 26.31 W/ft
Qr: 7.72 W/ft
Rac @ 106.2°C: 0.1586 Ω/mi
Print Save

This screen displays the calculated **Steady-State Temperature Rating** for the **Steady-State Current** provided, the solar heat gain (**Q**<sub>s</sub>), the convection heat loss (**Q**<sub>c</sub>), the radiated heat loss (**Q**<sub>r</sub>) 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.

Steady-Stat	e Temperature Input —	
Enter	the maximum allowable steady-stat temperature	te
	Select Temperature Units:	
	Temperature: 180 °C	
	Calculate	

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.



Transient Data Input	- 🗆 X
Transient calculations assume: 1 - The conductor is initially in thermal equ 2 - A step increase in current occurs at time 3 - Weather conditions are constant before	ilibrium. t = 0. , during, and after the step increase.
Spacify Matal Hast Canacities	
Core: Core Weight: 0.0722 lb/ft x Specific Heat:	413 W-s/lb-°C = 29.8 W-s/ft-°C
Outer Layers: AL/CU Weight: 0.7431 lb/ft x Specific Heat:	412 W-s/lb-°C = 306.2 W-s/ft-°C
Specify an Initial Steady-State Condition	Transient Calculation Data
O     Current:     amperes       Image: Temperature:     100     °C	New Conductor Current, including step increase:
Specify Calculation Time Interval Conductor Temperature to be calculated every: 60 seconds	Total time duration for the transient: 15 O seconds () minutes
Calcula	te

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

- <u>Metal Heat Capacities</u>: 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.
- <u>Specify an Initial Steady State</u>: 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.
- <u>Specify Calculation Time Interval</u>: 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.
- <u>Transient Calculation Data</u>: 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/XI**) & Capacitive Reactance (**X'a/Xc**) at 1-ft spacing (spacing is non-applicable for plexed covered conductors).



🗿 Resul	ts						- 🗆 X
Prir Sav	nt e	View Seque Impedance	ence Data	Include Sequence Ir Data with Printout	mpedance	GMR: 0.034 Xa @ 1ft: 0. X'a @ 1ft: 0.	8 ft 4075 Ω/mi 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**.
- <u>Save</u>: 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**.
- <u>View Sequence Impedance Data</u>: 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), R0 (zero sequence ac resistance), XI0 (zero sequence inductive reactance), Xc (positive 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).
- <u>Include Sequence Impedance Data with Printout</u>: A separate printout that includes sequence impedance data will be printed prior to the ampacity results.



GMR: ( Xa @ 1 X'a @ 1 Line GI Line He Earth R	uence Im 0.0348 ft ft: 0.407 ft: 0.094 MD: 31.5 eight: 50 Resistivity	pedances 5 Ω/mi 9 MΩ-mi 5 ft 9 ft γ: 100 Ω-m						- 0	×
°C	°F	DC Resistance	R	XI	Xc	R0	XIO	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.



Multiple	Conducto	or Selection	_		$\times$
Select Al	1				
203.2	- T43	Fundy/ZTACCR/TW/C7-TS	^	Acce	eot
266.8	- T21	Shenandoah/ZTACCR/TW/C7-TS			1.5
325	- T17	Olympic/ZTACCR/TW/C7-TS			
336.4	- T17	Wrangell/ZTACCR/TW/C7-TS			
336.4	- T22	Badlands/ZTACCR/TW/C7-TS			
397.5	- T14	Andes/ZTACCR/TW/C7-TS			
397.5	- T16	Joshua Tree/ZTACCR/TW/C7-TS			
397.5	- T22	Sequoia/ZTACCR/TW/C7-TS			
477	- T13	Rogers/ZTACCR/TW/C7-TS			
477	- T15	Yosemite/ZTACCR/TW/C7-TS			
477	- T23	Capitol Reef/ZTACCR/TW/C7-TS			
636	- T10	Tortugas/ZTACCR/TW/C7-TS			
636	- T12	Yellowstone/ZTACCR/TW/C7-TS			
636	- T15	Glacier/ZTACCR/TW/C7-TS			
636	- T22	Carlsbad/ZTACCR/TW/C7-TS			
641.7	- T11	Congaree/ZTACCR/TW/C7-TS			
714	- T10	Vinson/ZTACCR/TW/C7-TS			
795	- T7	Kilimanjaro/ZTACCR/TW/C7-TS			
795	- T9	Alps/ZTACCR/TW/C7-TS			
795	- T12	Wind Cave/ZTACCR/TW/C7-TS			
/ 795	- T16	Denali/2TACCR/TW/C7-TS			
795	- T22	Rocky/ZTACCR/TW/C7-TS			
954	- T7	Crater Lake/ZTACCR/TW/C7-TS			
954	- T10	Grand Canyon/ZTACCR/TW/C7-TS			
954	- T12	Fuji/ZTACCR/TW/C7-TS			
954	- T16	Jasper/ZTACCR/TW/C7-TS			
954	- T20	Arches/ZTACCR/TW/C7-TS			
973.1	- T14	Everglades/ZTACCR/TW/C7-TS			
	- T5	Big Bend/2TACCR/TW/C7-TS			
1033.5					
1033.5	- T7	Lassen/ZTACCR/TW/C7-TS			
] 1033.5 ] 1033.5 ] 1033.5	- T7 - T11	Lassen/ZTACCR/TW/C7-TS Tahoe/ZTACCR/TW/C7-TS			
1033.5 1033.5 1033.5 1033.5	- T7 - T11 - T13	Lassen/ZTACCR/TW/C7-TS Tahoe/ZTACCR/TW/C7-TS Samoa/ZTACCR/TW/C7-TS			
1033.5 1033.5 1033.5 1033.5 1113	- T7 - T11 - T13 - T5	Lassen/ZTACCR/TW/C7-TS Tahoe/ZTACCR/TW/C7-TS Samoa/ZTACCR/TW/C7-TS Cook/ZTACCR/TW/C7-TS			
] 1033.5 ] 1033.5 ] 1033.5 ] 1033.5 ] 1113 ] 1113	- T7 - T11 - T13 - T5 - T7	Lassen/ZTACCR/TW/C7-TS Tahoe/ZTACCR/TW/C7-TS Samoa/ZTACCR/TW/C7-TS Cook/ZTACCR/TW/C7-TS Blanc/ZTACCR/TW/C7-TS			
] 1033.5 ] 1033.5 ] 1033.5 ] 1033.5 ] 1113 ] 1113 ] 1113	- T7 - T11 - T13 - T5 - T7 - T10	Lassen/ZTACCR/TW/C7-TS Tahoe/ZTACCR/TW/C7-TS Samoa/ZTACCR/TW/C7-TS Cook/ZTACCR/TW/C7-TS Blanc/ZTACCR/TW/C7-TS Niagara/ZTACCR/TW/C7-TS			
] 1033.5 ] 1033.5 ] 1033.5 ] 1033.5 ] 1113 ] 1113 ] 1113 ] 1113	- T7 - T11 - T13 - T5 - T7 - T10 - T13	Lassen/ZTACCR/TW/C7-TS Tahoe/ZTACCR/TW/C7-TS Samoa/ZTACCR/TW/C7-TS Cock/ZTACCR/TW/C7-TS Blanc/ZTACCR/TW/C7-TS Niagara/ZTACCR/TW/C7-TS Gannett/ZTACCR/TW/C7-TS Hackington/GTACR/TW/C7-TS			
1033.5 1033.5 1033.5 1113 1113 1113 1113 1113 1113	- T7 - T11 - T13 - T5 - T7 - T10 - T13 - T5 - T2	Lassen/ZTACCR/TW/C7-TS Tahoe/ZTACCR/TW/C7-TS Samoa/ZTACCR/TW/C7-TS Blanc/ZTACCR/TW/C7-TS Niagara/ZTACCR/TW/C7-TS Gannett/ZTACCR/TW/C7-TS Washington/ZTACCR/TW/C7-TS Fibers (ZTACCR/TW/C7-TS			
1033.5 1033.5 1033.5 1113 1113 1113 1113 1113 1192.5 1192.5	- T7 - T11 - T13 - T5 - T7 - T10 - T13 - T5 - T7 - T10	Lassen/ZTACCR/TW/C7-TS Tahoe/ZTACCR/TW/C7-TS Samoa/ZTACCR/TW/C7-TS Blanc/ZTACCR/TW/C7-TS Niagara/ZTACCR/TW/C7-TS Gannett/ZTACCR/TW/C7-TS Washington/ZTACCR/TW/C7-TS Elbert/ZTACCR/TW/C7-TS			
] 1033.5 ] 1033.5 ] 1033.5 ] 1033.5 ] 1113 ] 1113 ] 1113 ] 1113 ] 1113 ] 1192.5 ] 1192.5 ] 1192.5	- T7 - T11 - T13 - T5 - T7 - T10 - T13 - T5 - T7 - T10 - T10 - T12	Lassen/ZTACCR/TW/C7-TS Tahoe/ZTACCR/TW/C7-TS Samoa/ZTACCR/TW/C7-TS Dianc/ZTACCR/TW/C7-TS Blanc/ZTACCR/TW/C7-TS Miagara/ZTACCR/TW/C7-TS Gannett/ZTACCR/TW/C7-TS Elbert/ZTACCR/TW/C7-TS Elbert/ZTACCR/TW/C7-TS Kings Canyon/ZTACCR/TW/C7-TS			

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.

Marka Transient Ampacity Input -		$\times$
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:         0.0722         Ib/ft x Specific Heat:         413         W-s/lb-°C =         29.8	W-s/ft-°C	
Outer Layers:     AL/CU Weight:     0.7431     Ib/ft x Specific Heat:     412     W-s/lb-°C =     306.2	W-s/ft-°C	
<u>Transient Calculation Data</u> Starting Current, Percent of Steady-State Current at Tc:		
100 % ( As Defined in Output Selections ) Input:	°C	
Max Conductor Temp. during the transient:		
As Defined in Output Selections Input: 200	°C	
Total time duration for the transient:     Conductor Temperature to be calcula       15     Image: Conductor Temperature to be calcula       60     seconds	ted every:	
Calculate		

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

 <u>Metal Specific Heats</u>: 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.



Spacing	_		×
♦ A B		Accep	t
3 Conductors, Flat			
Dimension A: 1.5	5 ft		
Dimension B: 1.5	5 ft		
Dimension C:	ft		

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	-		$\times$
Inductive Reactance (Ω/mi)		Capacit Reactar (MΩ-n	ive nce ni)
Conductor at GMD = 1 ft: 0.4075		0.09	40
Bundle at GMD = 1 ft: 0.1030		0.02	33
Bundle at GMD = 18.9 ft: 0.4597		0.11	05
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/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/MAS) Shaped Wire Compact Aluminum Conductor, Thermosot Composite Supported
	Shaped Wire Compact Aluminum Conductor, Mermoset Composite Supported
ZTACCR/100/C7 -13	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 <sup>®</sup>	Vibration-Resistant, Twisted Pair All-Aluminum Conductor
ACSR/VR2 <sup>®</sup>	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 Other	Single Covered Conductor designed for spacer cable systems
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 <sup>®</sup>	Southwire proprietary Ultra-High Strength Steel Core
MA#	Mischmetal Steel Core Coating (# equals strength rating)
TW	Trapezoidal-Shaped Wire