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Creating Bundled Cable files for PLS-CADD and PLS-CADD/LITE

In PLS-CADD and PLS-CADD/LITE, cables arranged in a bundled configuration can easily be modeled. These multi-wire bundle configurations can be modeled as a single cable by creating a cable (*.WIR) file using **Sections/Cable Files/Create Bundled Cable File...** based on configurations shown in Figure 1 below. These configurations include a) two identical conductors twisted in a pair, b) a cable lashed onto a messenger, and c) two or more insulated cables supported by a messenger. This Technical Note will provide a brief overview of these common configurations and describe how to input some easily determined properties to create a single *.WIR file. This topic is also covered in section 9.2.1 of the PLS-CADD User's Manual, and additional PLS resources are also provided throughout this Technical Note.

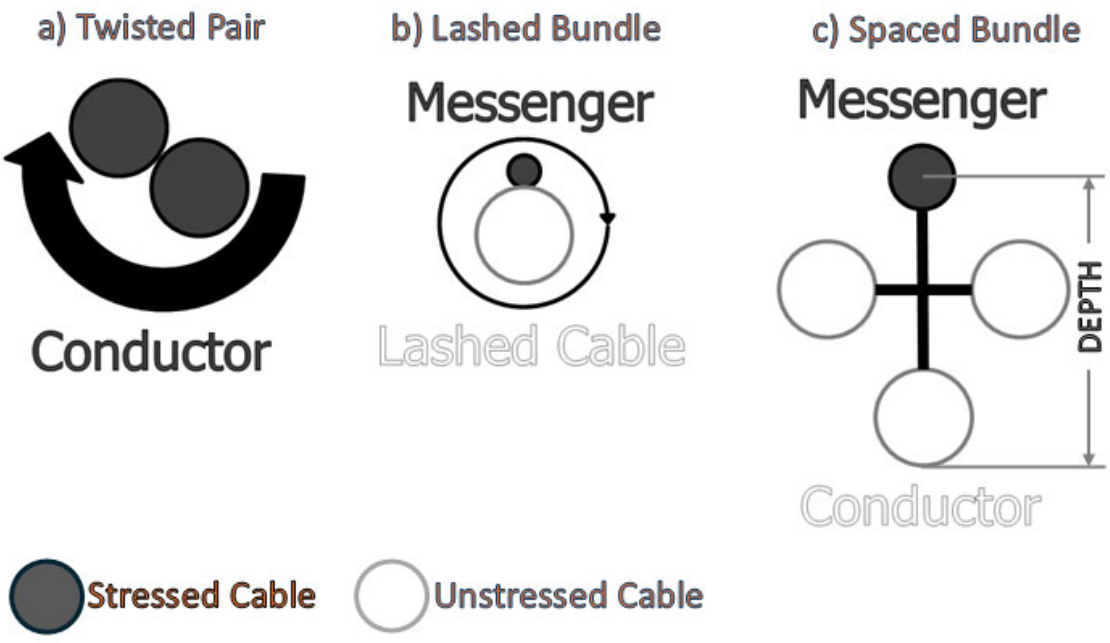

Figure 1: Cables in Bundles

Introduction

It helps to think of the cable bundles in Figure 1 as a system with stressed cables, unstressed cables or a combination of the two. Depending on the configuration of the cable bundle, there may be only stressed cables (a) or unstressed cables supported by a stressed cable (b and c).

- Unstressed cable(s) contribute weight, wind and ice loads to the system, but they are not subject to tension.
- Stressed cable(s) carry their own weight plus any weight from ice and are also subject to wind loads and tension. When supporting an unstressed cable(s), PLS-CADD uses the stressed cable to determine sag and tension.

Before creating a bundled cable, start with an existing *.WIR file for the subconductor of the twisted pair, or start with the messenger *.WIR file for lashed or spaced cables. Many *.WIR files can be downloaded exclusively from within the PLS-CADD. Please visit the Cable Models section of our website for a list of cable files provided by various manufacturers and instructions for downloading within the software. If needed, a *.WIR file can be created as discussed beginning in section 9.2 of the PLS-CADD User's Manual.

In the following sections, we will demonstrate how to use the preferred method, **Sections/Cable Files/Create Bundled Cable File...,** to build the various cable bundles. The same results can be achieved in the **Sections/Cable Files/Edit Existing Cable File...** menu (or **Sections/Edit Existing Cable File...** in PLS-CADD/LITE) by modifying the appropriate properties. Refer to section 9.2.1 of the PLS-CADD User's Manual for guidance using that method.

For all configurations in Figure 1, the number of "conductors per phase" in **Sections/Modify** should be left at "1" since this is representing an equivalent single stressed cable in the case of Figure 1a and the single stressed messenger cable in Figures 1b and 1c. Likewise, the rendered conductor in PLS-CADD when it is strung does not look like the bundle, but it will behave like the bundle for the purposes of sag-tension and structure loading.

Twisted Pair

First, go to **Sections/Cable Files/Create Bundled Cable File...** and select the single subconductor (source *.WIR file) for the Twisted Pair conductor. We will use Drake.WIR (795 kcmil ACSR 26/7 Drake). From there, PLS-CADD will populate the Diameter (D), Unit Weight (UW), Cross Section Area (AT) and Ultimate Tension (ULT) from the source *.WIR file and apply modifiers as shown in Table 1 to obtain properties for the Twisted Pair bundle as shown in Figure 2.

A description, manufacturer, stock number and size label can be typed into the fields, and a cable type can be selected from the drop-down menu. Press OK and PLS-CADD will save a new *.WIR file with the information in the description field.

If the source *.WIR file contains thermal and electrical properties, PLS-CADD will ask whether to clear these properties (Yes) or leave them unmodified (No). Regardless of the selection, the thermal and electrical properties can always be modified in the **Sections/Cable Files/Edit Existing Cable File...** menu. If thermal properties are being used, reduce the resistance values by half the resistance of a single subconductor, and multiply the heat capacity values by twice the heat capacity of a single subconductor.

Table 1: Twisted Pair Conductor Physical Properties	
Cross section area, AT:	Twice cross section area of single subconductor
Outside diameter, D:	Because the diameter exposed to the wind changes continuously along the conductor, an average equivalent circular diameter equal to 1.64 times the subconductor diameter can be used (Roche, J.B. et al., "T2 Wind Motion Resistant Conductor", IEEE Transactions on Power Apparatus and Systems, Vol. PAS-104, No. 10, Oct. 1985). According to the reference, the equivalent diameter will also provide a good estimate of ice load based on ice thickness.
Unit weight, UW:	Twice unit weight of single subconductor
Ultimate tension, ULT:	Twice ultimate tension of single subconductor
Number of independent cables, N:	One
Stress-strain and other properties:	Same as those for single subconductor
Number of conductors per phase:	One or select ● (single wire) for Bundle Geometry

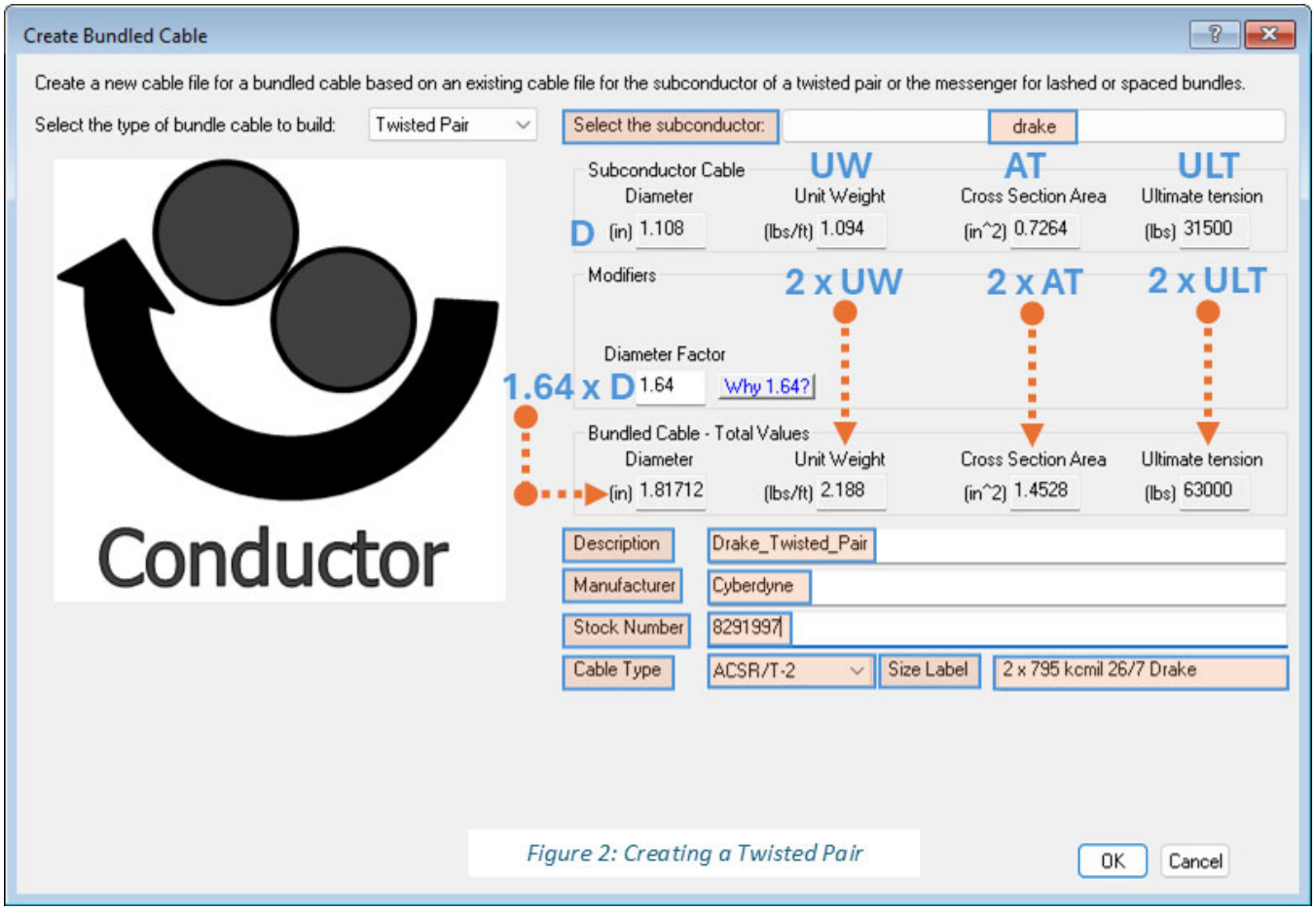

Figure 2: Creating a Twisted Pair

Cable Lashed onto a Messenger

One or more cables can be bundled with a messenger and secured with a lashing wire. These are commonly installed at low to medium distribution voltages and in telecommunication applications. The messenger is the stressed cable, and the lashed cable is the unstressed cable. To create a lashed cable bundle, we need the physical properties of the messenger and lashed cable as noted in Table 2. We will use 3_8EHS.WIR (3/8" EHS Steel) as the messenger and Paw-Paw_Poly_CLW.WIR (556.5 kcmil covered AAC conductor) as the lashed cable.

As shown in Figure 3, in the **Sections/Cable Files/Create Bundled Cable File...** menu, select "Lashed Bundle" from the drop-down menu, then select 3/8" EHS Steel for the messenger. Next, enter the appropriate Paw Paw modifiers for additional diameter and additional unit weight. Once these values are entered, PLS-CADD will calculate the total values for the lashed bundle.

Table 2: Lashed Bundle Physical Properties	
Cross section area, AT:	Cross section area of messenger
Outside diameter, D:	Because the diameter exposed to the wind changes continuously along the conductor, an equivalent circular diameter should be used. That equivalent diameter will be used to determine the ice load based on ice thickness.
Unit weight, UW:	Total unit weight of messenger plus supported cable
Ultimate tension, ULT:	Ultimate tension of messenger
Number of independent cables, N:	One
Stress-strain and other properties:	Properties of messenger
Number of conductors per phase:	One or select ● (single wire) for Bundle Geometry

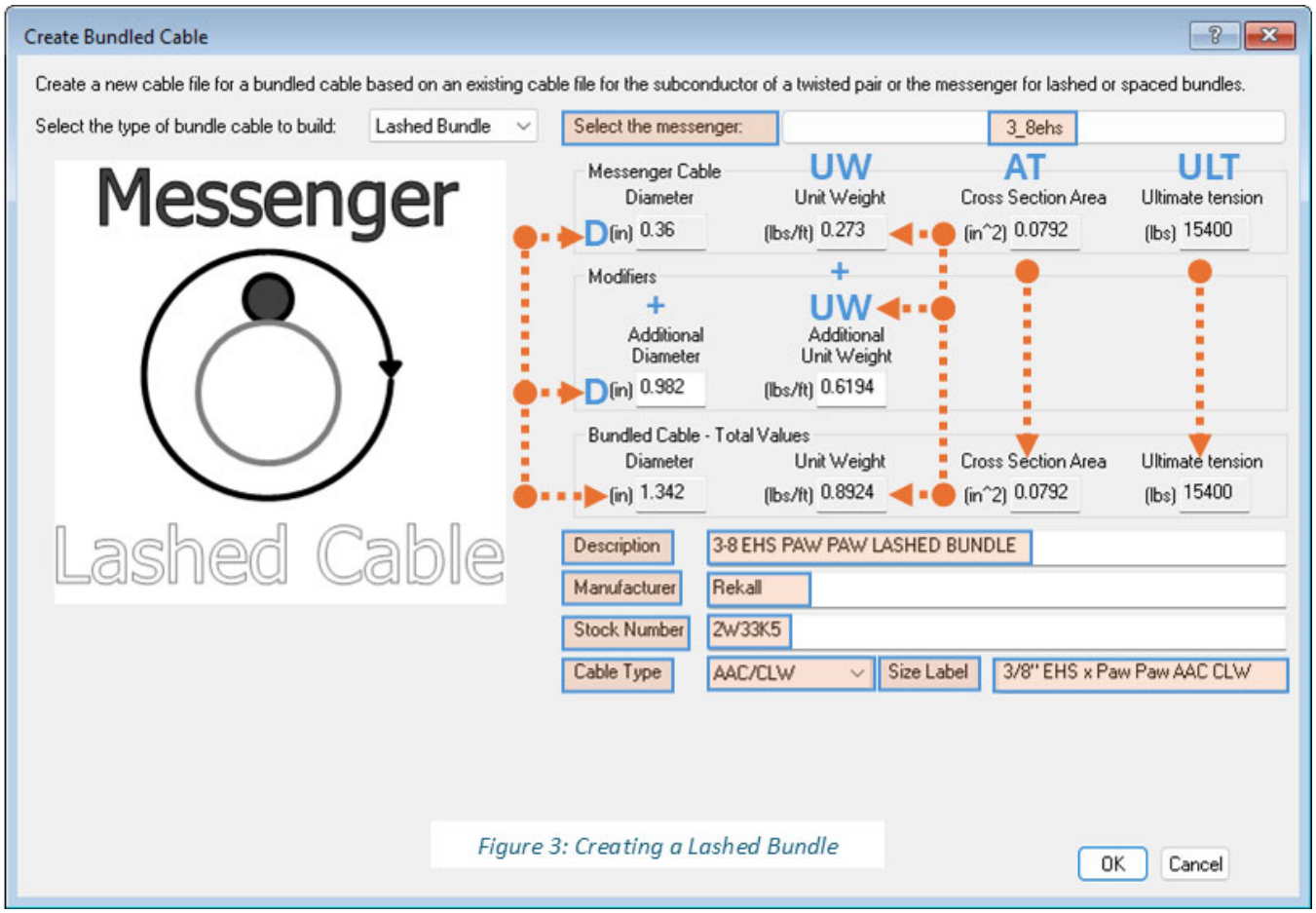

Figure 3: Creating a Lashed Bundle

Cable(s) Supported by a Messenger

A messenger wire can support one or more cables in what is commonly referred to as a spacer cable system. The messenger cable is attached to the structure, and spacers are used throughout the span to suspend the cables and maintain separation distance.

To create a spaced cable bundle, we need the physical properties of the messenger and conductor as noted in Table 3 on the following page. We will use 3_8EHS.wir (3/8" EHS Steel) as the messenger and Paw-Paw_Poly_CLW.wir (556.5 kcmil covered AAC conductor) as the lashed cable.

As shown in Figure 4 on the following page, in the **Sections/Cable Files/Create Bundled Cable File...** menu, select "Spaced Bundle" from the drop-down menu, then select 3/8" EHS Steel for the messenger. Next, enter the appropriate Paw Paw modifiers for additional diameter, additional unit weight and, if known, distributed unit weight for the spacer hardware. Once these values are entered, PLS-CADD will calculate the total values for the spaced bundle cable.

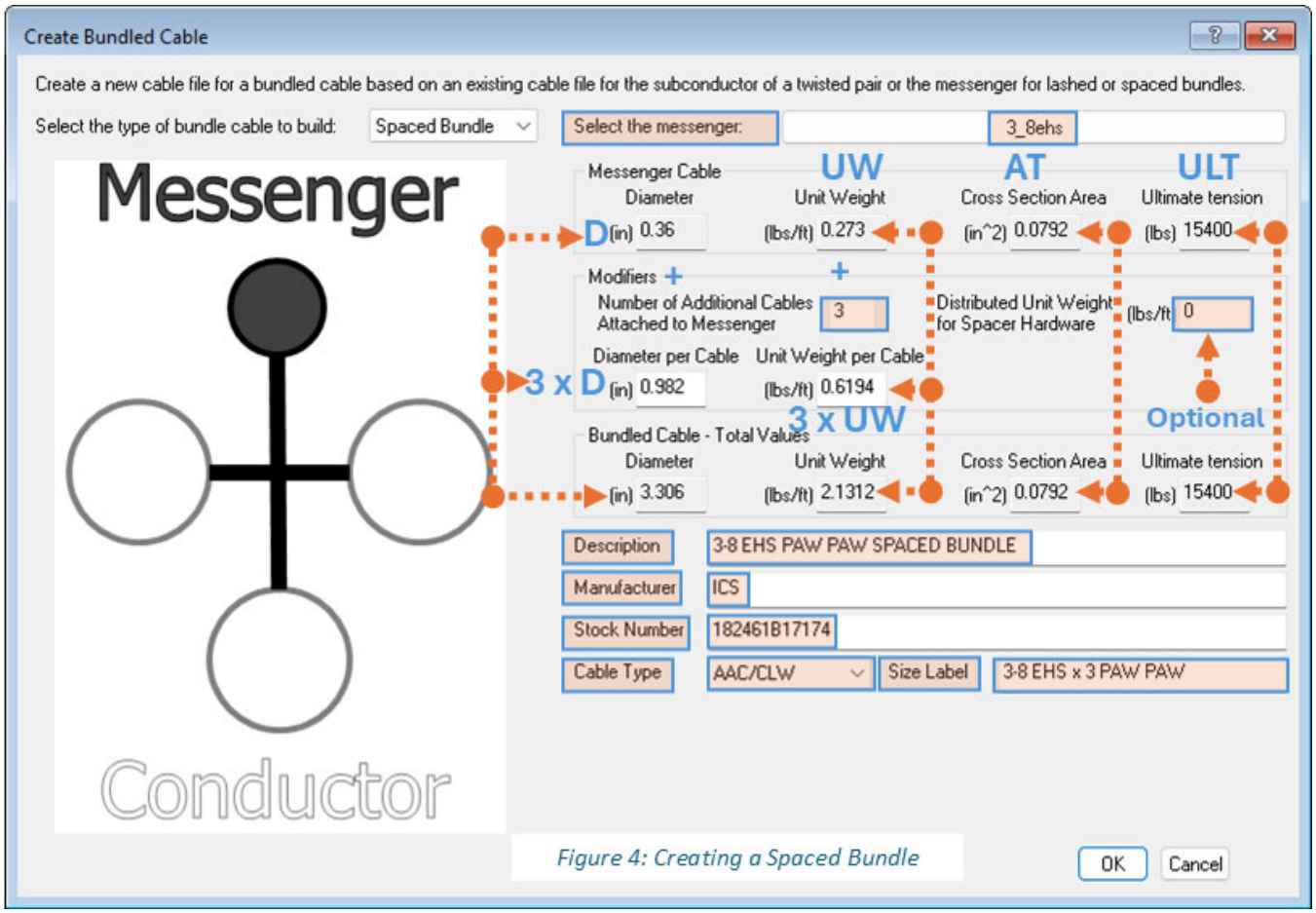

Figure 4: Creating a Spaced Bundle

Table 3: Cables Supported by a Messenger Physical Properties	
Cross section area, AT:	Cross section area of messenger
Outside diameter, D:	Equivalent diameter equal to the sum of the diameters of all the cables in the bundle (diameter of messenger plus 3 times diameter of conductors for the situation in Figure 1c).
Unit weight, UW:	Total unit weight of messenger plus supported conductors and, optionally, the distributed weight for the spacer hardware
Ultimate tension, ULT:	Ultimate tension of messenger
Number of independent cables, N:	Number of spaced cables in bundle (4 for situation in Figure 1c). This number is used internally for the calculation of ice and wind-on-ice loads which take into account the fact that each cable in the bundle is subjected to a coating of uniform ice thickness
Stress-strain and other properties:	Properties of messenger
Number of conductors per phase:	One or select ● (single wire) for Bundle Geometry
Special consideration for depth of bundle:	You should take into account the vertical dimension of the bundle (DEPTH in Figure 1c) when checking vertical clearances. This can be done by lowering the bundle attachment point by the length DEPTH (for example by using longer suspension insulators) or increasing the required vertical clearance by that amount.