Altium Designer

Advanced Training with Altium 365

Using Signal Harnesses

Software, documentation and related materials:

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Using Signal Harnesses

1 Purpose

A Signal Harness is a basic component in electrical design. It groups together different signals like buses and wires into one connection, making the design more flexible and organized. Although they are harder to create and manage, they make schematics simpler and easier to read.

2 Shortcuts

Shortcuts used when working with Using Signal Harnesses

F1	Help – Shortcut Key List
P » H » H	Place a Signal Harness
P » H » C	Place a Harness Connector
P » H » E	Place a Harness Entry
P » H » P	Open the Predefined Harness Connector Dialog
D » P	Synchronize Sheet Entries and Ports
V » F	View all Objects
V » D	View Document
CTRL + double-click	Navigate to next Level

3 Preparation

1. Close all existing projects and documents.
2. Next, create a copy of the Training Project: `Using Signal Harnesses.`
3. Select **File » Open Project...** to open the *Open Project* dialog.
4. Enable the folder view button  .
5. Navigate to the predefined Training Project `Using Signal Harnesses (Top\Projects\Altium Designer Advanced Training Course\...).`
6. Select **Open Project as Copy...**  .
7. In the new dialog *Create Project Copy:*
   a) Add your name to the project name: `Using Signal Harnesses – [Your Name].`
   b) Add a description: `Altium Advanced Training – [Your name].`
   c) Open the *Advanced* section.
   d) Select the **Ellipsis Button**  from the *Folder* configuration to open the *Choose Folder* dialog.
      i) Select the folder with your name: `Project\For Attendees\[Your name].`
      ii) Select **OK**.
   e) Change the **Local Storage** path if needed.
   f) Select **OK** to create the copy.
8. Wait until Altium Designer creates the copy of the project and opened the Project for you in the *Projects* panel, this may take up to 1 minute.

> Hint: For details how to copy the predefined training project, see module *Opening a Project*.

4 Overview

4.1 Working on the Top Sheet

9. Open the schematic `0_TOP_Sheet.SchDoc` from the *Projects* panel.
10. In this exercise, you'll finish the design by adding the missing harness information so that the final result looks similar to Figure 1.

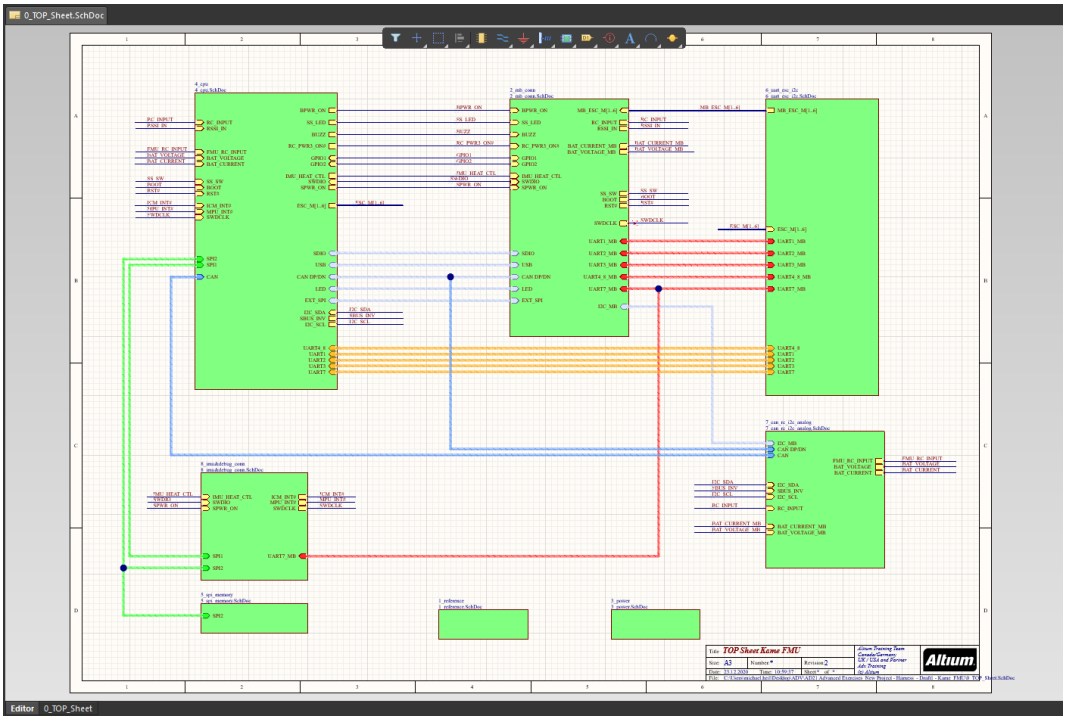


Figure 1. Final TOP Sheet

4.2 Schematic Navigation

11. In the schematic, hover over the existing `SPI2` harness connection to see the individual signals that are included in the harness. You will see the `SPI2` nets as shown in Figure 2.

Hint: You can adjust the design insight hover settings in the *Preferences* by going to the *System* section and selecting the *Design Insight* page.

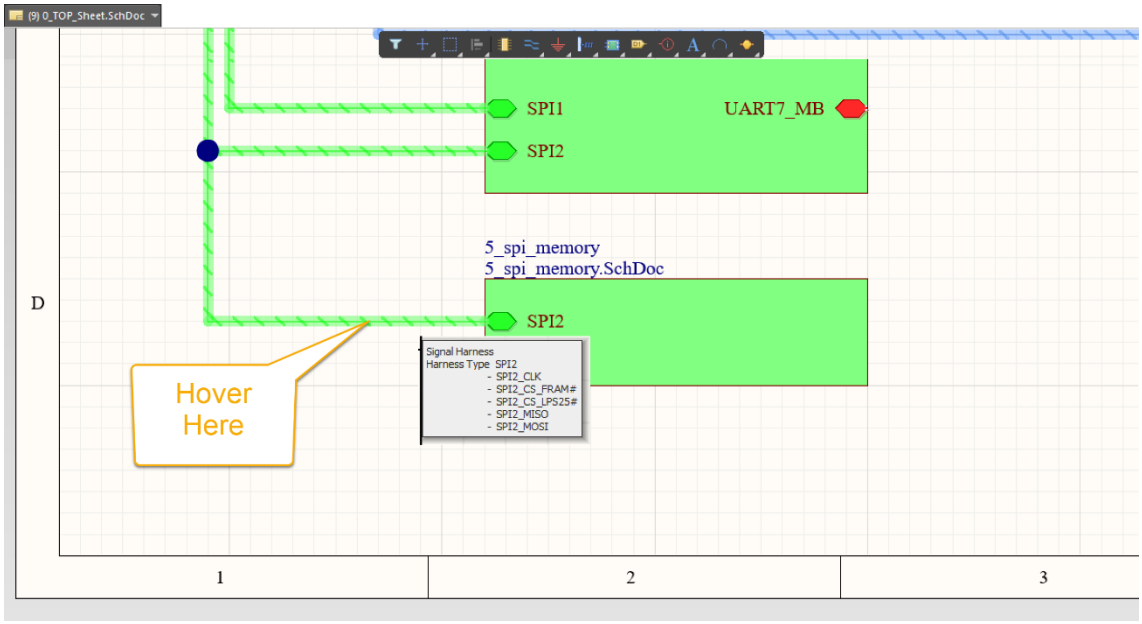


Figure 2. Signal Details inside of the Signal Harness

12. To jump to the signals in the `SPI2` harness, press and hold the **CTRL** key and double-click on the sheet entry, as shown in Figure 3.

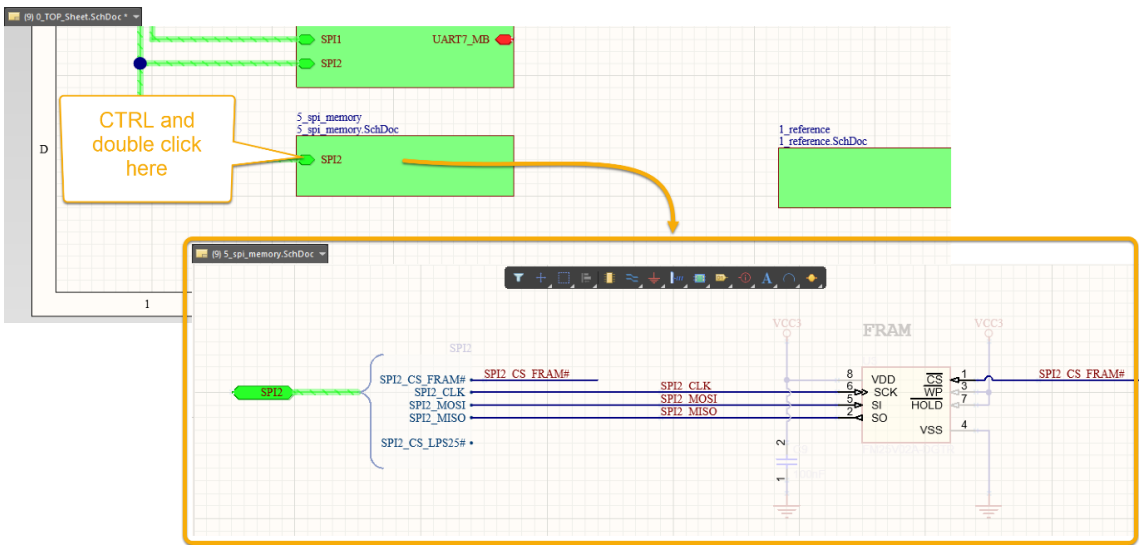


Figure 3. Navigating net connectivity between schematics

5 Creating a Signal Harness

5.1 Starting a Signal Harness from Scratch

A Signal Harness is made using several components like a harness connector, signal harness, harness entries, and ports. If there's already a signal harness in the design, you can reuse that setup. This will be covered later in this exercise.

5.1.1 Harness Connector

13. Open the `6_uart_esc_i2c` schematic document.
14. Navigate to the upper right corner of the schematic sheet, to the right-hand side of component `RN1`.
15. From the **Place** menu, select **Harness,** then **Harness Connector.** This command can also be accessed by right-clicking on the icon from the *ActiveBar*, as shown in Figure 4.

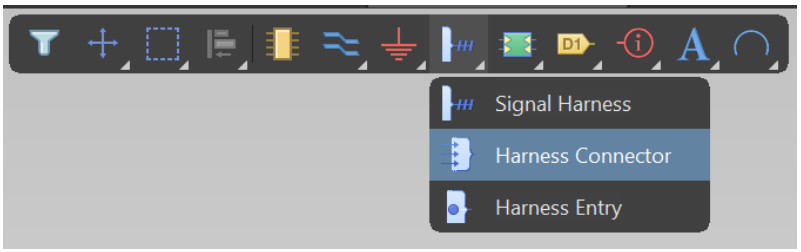


Figure 4. Placing a Harness Connector

16. Follow the steps below to place the Harness Connector:
    a) Left-click once to anchor to the left-side of the connector.
    b) Moving the mouse to the right will determine the width of the connector. Moving your cursor up or down will determine the overall height of the harness connector.
    c) Once you're satisfied with the size of the Harness Connector, left-click again to accept the size.
    d) Right-click to end the command. The Harness Connector should look similar to Figure 5 below. You can change the size anytime after it's placed.

> Hint: You can flip the harness connector with the shortcut key **X** after you placed it.

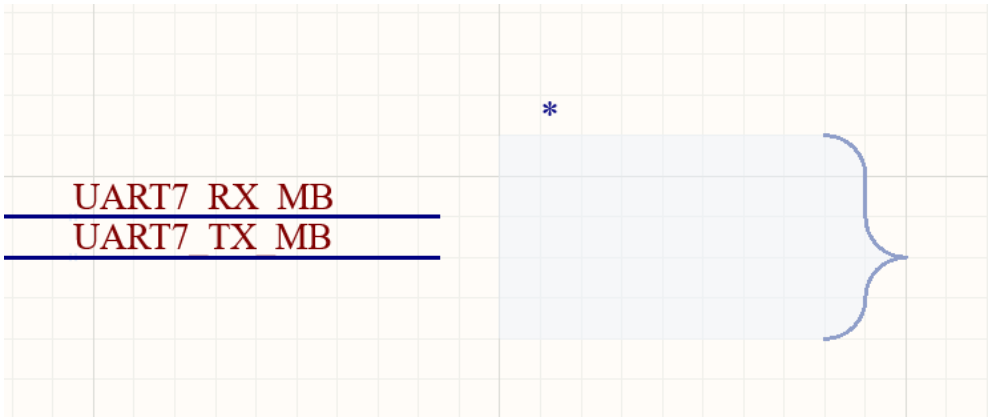


Figure 5. Placing Harness Connector

17. Double-click the Harness Connector to open the *Properties* panel.
18. In the *Harness Type* field, add the name of `UART7_MB` and hit **Enter**, as shown in Figure 6.

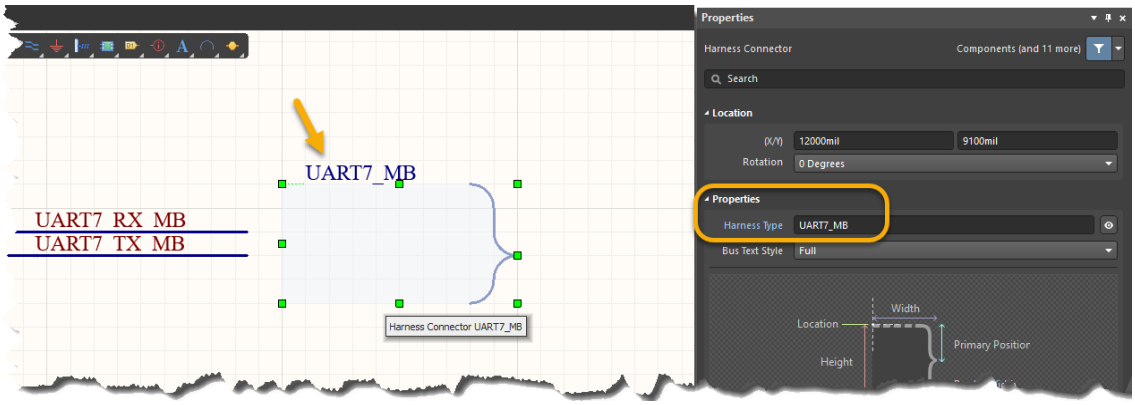


Figure 6. Harness Connector UART7_MB

> Note: When updating the *Harness Type* field, you may initially encounter the error message: "Conflicting Harness Definition." This error may remain valid until the entire task is completed.

5.1.2 Adding Harness Entries to the Harness Connector

Next, you'll add Harness Entries to the Harness Connector. These entries will be the nets grouped within the harness.

19. From the **Place** menu, select **Harness,** then **Harness Entry**, or use the *ActiveBar* to access it.
20. With the **Harness Entry** on your cursor:
    a) Move your cursor to the inside of the Harness Connector as shown in Figure 7.

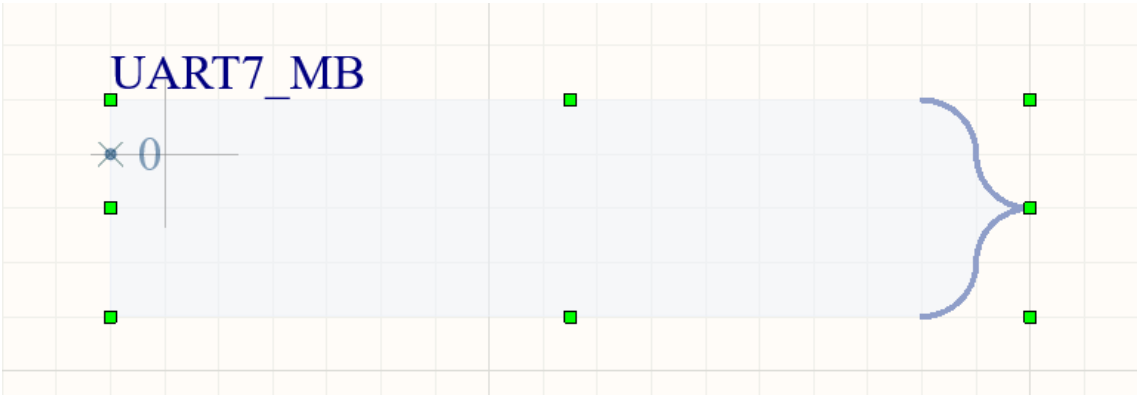


Figure 7. Place Harness Entry inside Harness Connector

    b) Before placing the entry, press the **TAB** key to open the *Properties* panel.
    c) In the *Harness Name* field, enter the name `UART7_RX_MB`.
    d) Hit **Enter**, or the **Pause** icon to continue the placement of the entry.
    e) Left-click to place the Harness Entry in the Harness Connector, like in Figure 7.
    f) With the Harness Entry command still active, place a second Harness Entry with the name of `UART7_TX_MB` and place it below of the first entry.
    g) Right-click to end the placement command.
    h) If needed, change the position and size of the Harness Connector by selecting and moving the vertices.

21. Left-click and drag the Harness Connector so that the Harness Entries are connected and aligned to their respective wires, Figure 8.

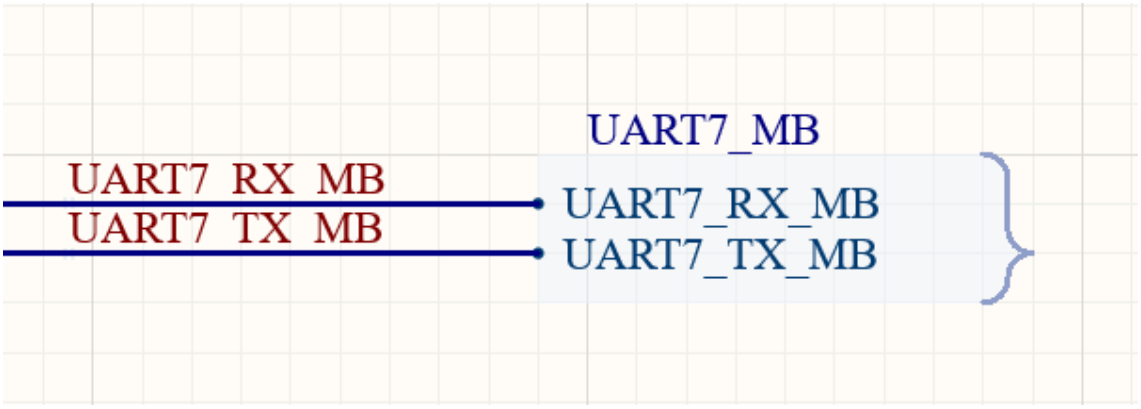


Figure 8. UART7_MB Harness Connector with two Entries

5.1.3 Adding a Signal Harness and Port

Let's add the Signal Harness and Port to transfer the group of signals to another schematic sheet. This is the most common use of harnesses in a hierarchical design.

22. From the **Place** menu, select **Harness,** then **Signal Harness**, or use the *ActiveBar* to access it.
    a) Left-click on the electrical hotspot of the Harness Connector to anchor the Signal Harness, as shown in Figure 9.

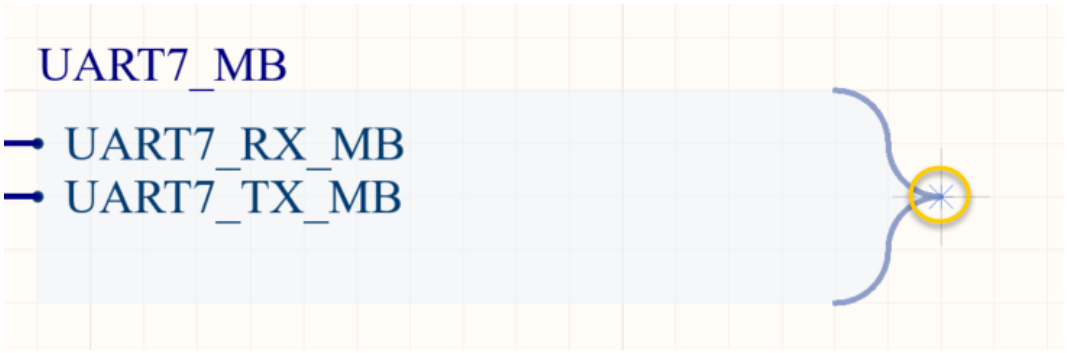


Figure 9. Place Signal Harness on Harness Connector

    b) Move your cursor to the right to expand the length of the Signal Harness.
    c) Left-click again to set the overall width of the Signal Harness.
    d) Right-click twice to exit the command. Your Signal Harness should look similar to what is shown in Figure 10.

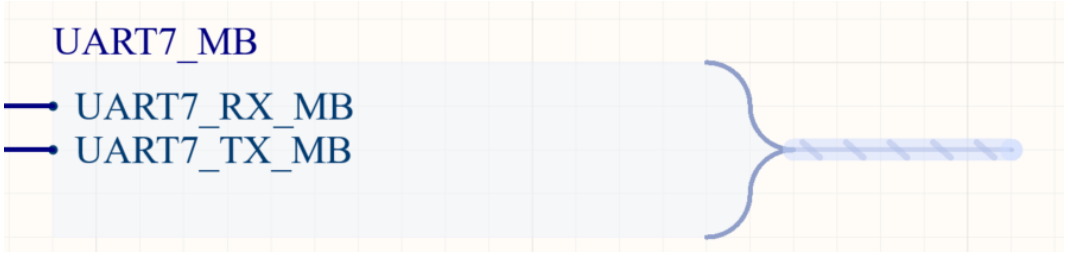


Figure 10. Signal Harness attached to the Harness Connector

23. From the **Place** menu, select **Port** or use the *ActiveBar* to access it.
24. Now that a Port is attached to your cursor, press the **TAB** key to open the *Properties* panel.
    a) Change the *Name* to `UART7_MB`.
    b) Leave the *I/O Type* as *Unspecified*.
    c) Leave the *Harness* Type empty as this will be automatically updated after placing the Port.
    d) Select the **Pause** icon to continue placing the Port.
    e) Left-click at the end of the Signal Harness to set the left side of the Port.
    f) Move your cursor to the right and left-click a second to define the length of the Port.
    g) Press the **ESC** key to cancel the placement command.
    h) Now that the Port is placed and attached to a Signal Harness, it will automatically be updated with the graphical information for the Harness and the correct Harness Type Information. Your result should be similar to Figure 11.

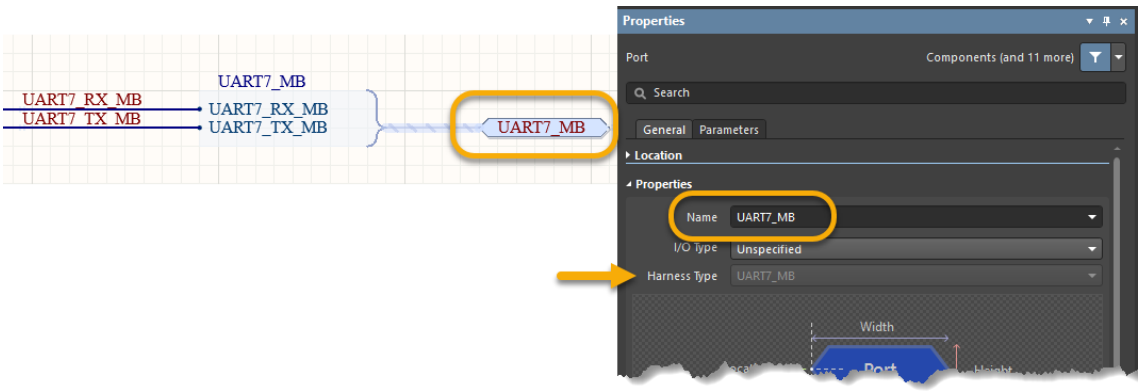


Figure 11. UART7_MB Harness structure (Connector, Entry, Signal and Port)

5.1.4 Creating the matching Harness for UART7_MB

Like Net Labels and Ports, Signal Harnesses need a matching connection for proper electrical connectivity. Let's define the other end of the Harness you've just created.

25. Select the entire group of the Harness Connector, Signal Harness, and Port you've just created, and hit **CTRL+C** to copy the selection.

> Hint: Instead of using Copy and Paste, you can also place Predefined Harness Connectors. It will be covered soon.

26. Open the `2_mb_conn` schematic document and navigate to the bottom-left of the sheet, near Zone 2-D in the title block.
27. Paste the copied harness using **CTRL+V**.
28. Before placing it, flip the orientation by hitting the **X** key.

29. Align the Harness Entries with the associated wires, as shown in Figure 12.
30. Left-click to place the harness so that it makes an electrical connection to the `UART7` wires.

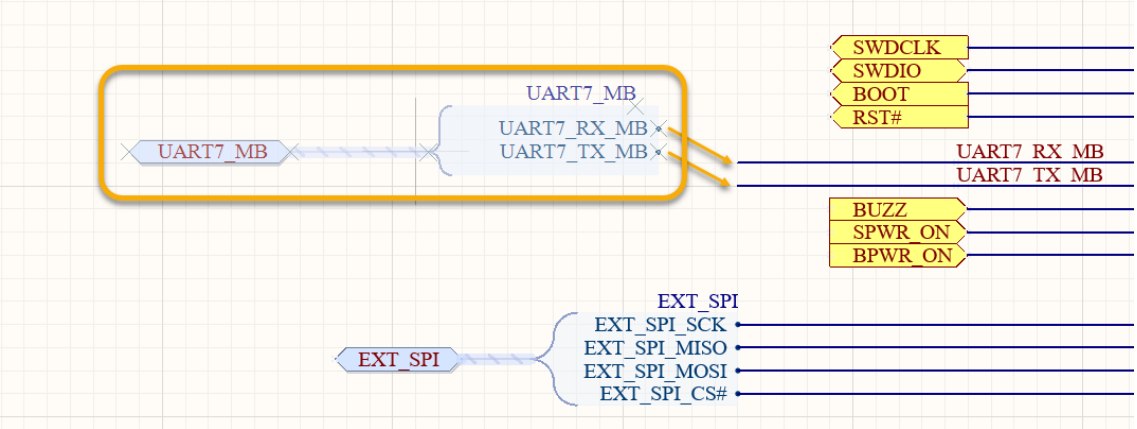


Figure 12. Matching UART7_MB Harness on Sheet 2_mb_conn.SchDoc

5.2 Using Predefined Harness Information

Let's place harnesses for the `UART4` and the `UART8` Signals. The matching Harness already exists in the design.

> Hint: Whenever a Harness Connector is created in a Project, the information is stored in a configuration file and can be reused later. You will find the `[SheetName].Harness` files on the hard disc. These files are linked in the Projects panel under the *Settings* folder.

31. Return to the `6_uart_esc_i2c` schematic document.
32. From the **Place** menu, select **Harness**, then place a **Predefined Harness Connector.** The *Predefined Harness Connector* interface will appear.
33. The list on the left side shows several Harness Connectors, such as the `UART7_MB` that you've just created.
    a) Scroll down the list and select the predefined Harness Connector named `UART4_8_MB`.
    b) As you want to transfer the signal to another schematic sheet, it's recommended to use the **Add Port option**. Enable this option, as shown in Figure 13.
    c) Enable the **Auto** option next to the port *Width*. This will set the size for us.
    d) Ensure that the **Add Signal Harness** option is enabled.
    e) Confirm that the option **Sort Harness Entries** is **disabled.**
    f) Select **OK** to start placement for the Predefined Harness Connector.

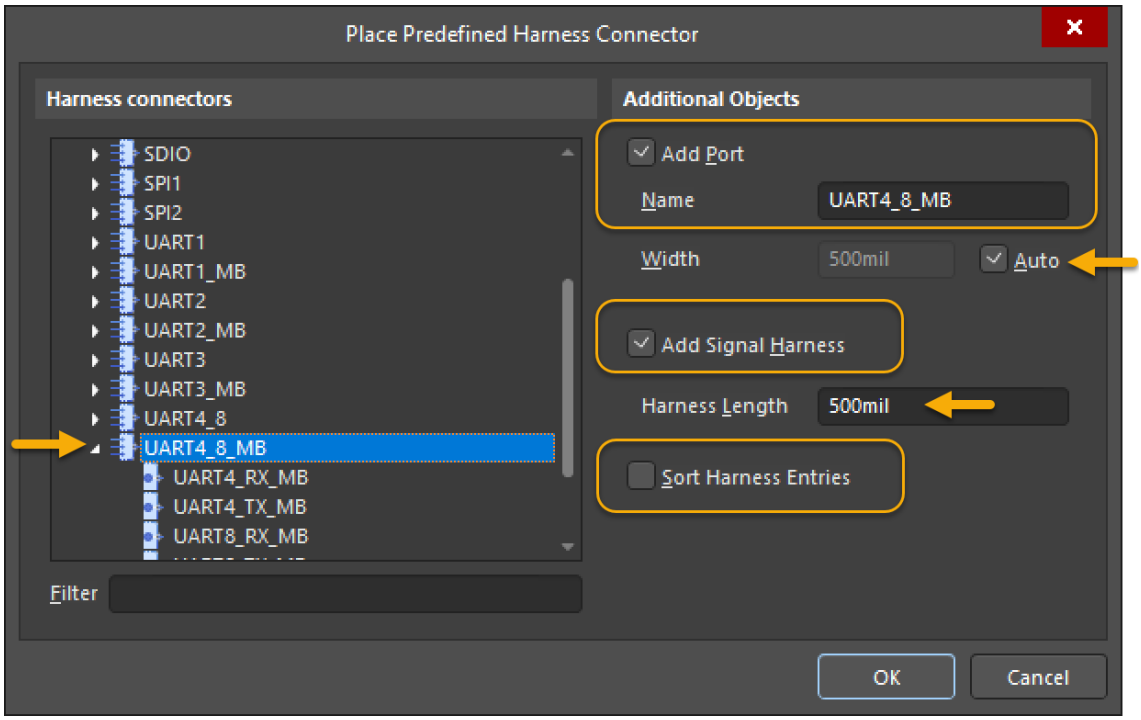


Figure 13. Select and Configure the Predefined UART4_8_MB

34. Place the predefined Harness Connector `UART4_8_MB` on the wires on the right-side of component `RN3`, as shown in Figure 14.

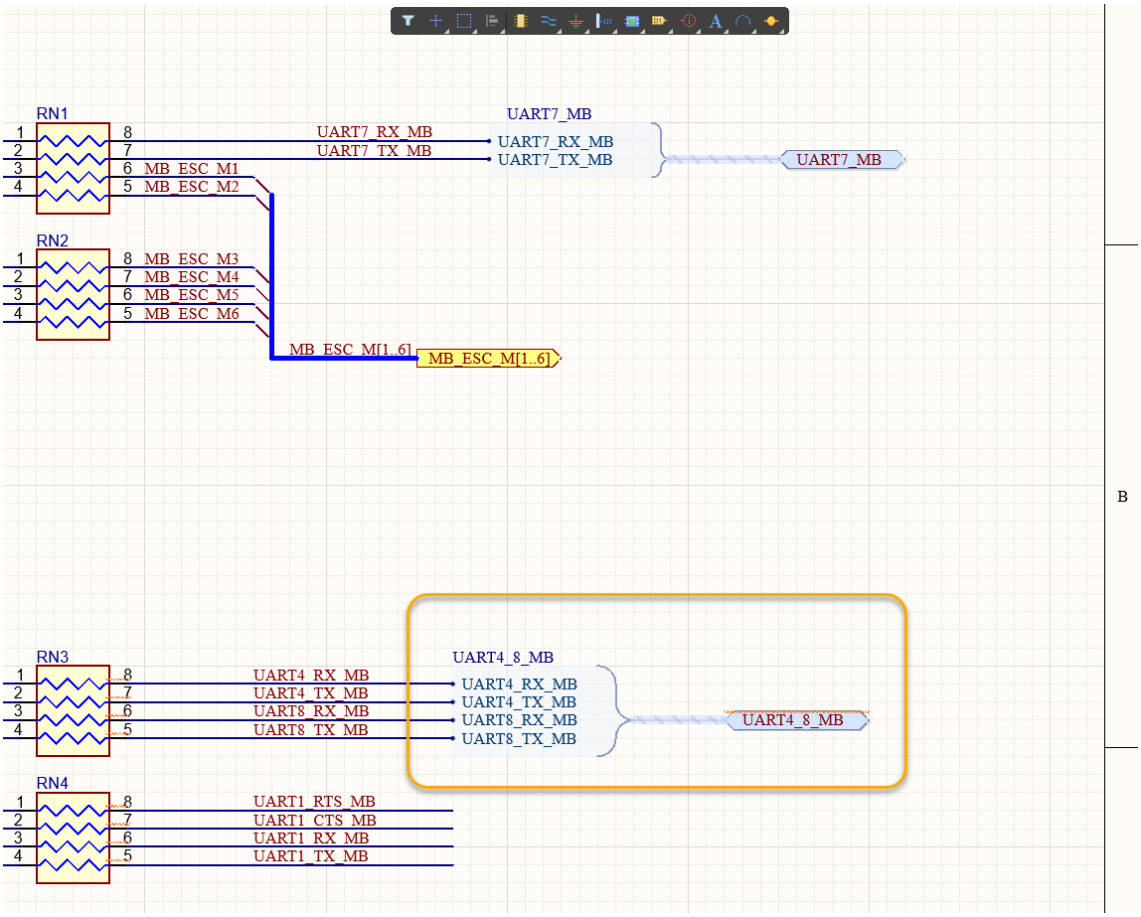


Figure 14. Place Predefined Harness connector UART4_8_MB

5.3 Smart Paste for Harness

Now, let's create the Harness `UART1_MB` using the **Smart Paste** function. This is an alternative for creating the harness from scratch if Net Labels are available in the design.

35. Using Figure 15 on the following page as a reference, select the following `UART1` Net Labels below component `RN3`:
    a) `UART1_RTS_MB`
    b) `UART1_CTS_MB`
    c) `UART1_RX_MB`
    d) `UART_TX_MB`
36. Copy the Net Labels using **CTRL+C.**
37. From the **Edit** menu, select **Smart Paste...**.
38. Using Figure 15 as a reference, change the following settings in the *Smart Paste* dialog:
    a) *Paste As*: **Harness Connector and Port**
    b) *Sort Order*: **By Location**
    c) *Signal Names*: **Keep**
    d) *Harness Type*: `UART1_MB`
    e) *Harness Wire Length*: `500mil`
    f) *Port Name*: `UART1_MB`

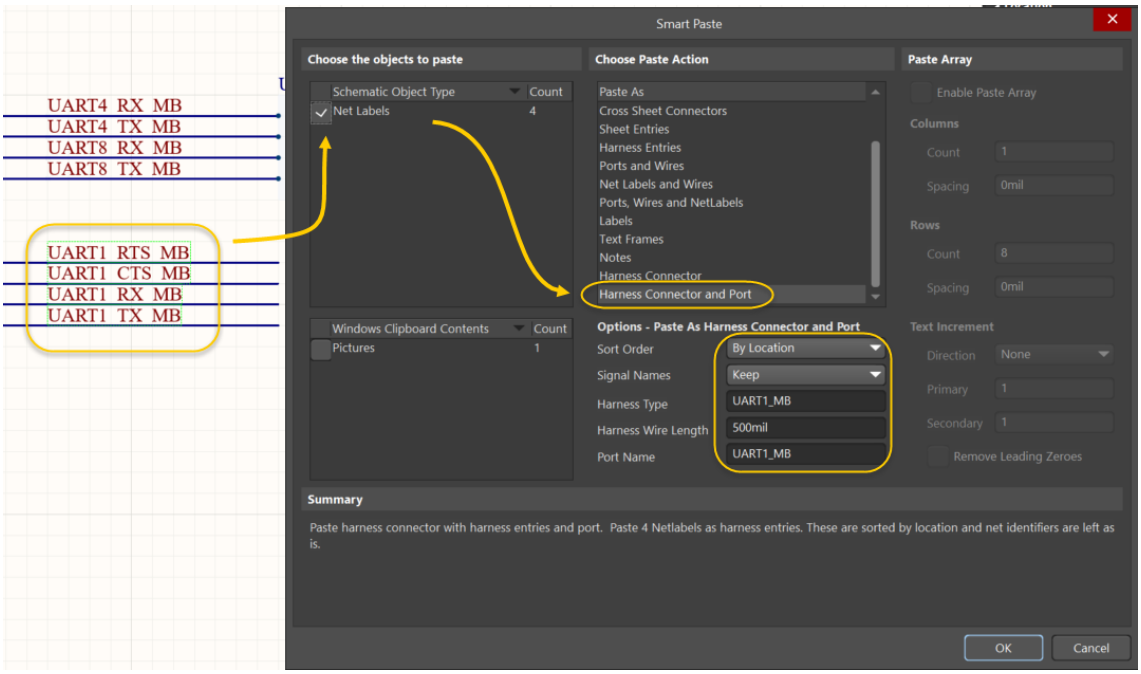


Figure 15. Harness creation based on netlabel

39. Select **OK** to see the Harness on your cursor.

40. Left-click to place it onto the UART1 wires, as shown in Figure 16.

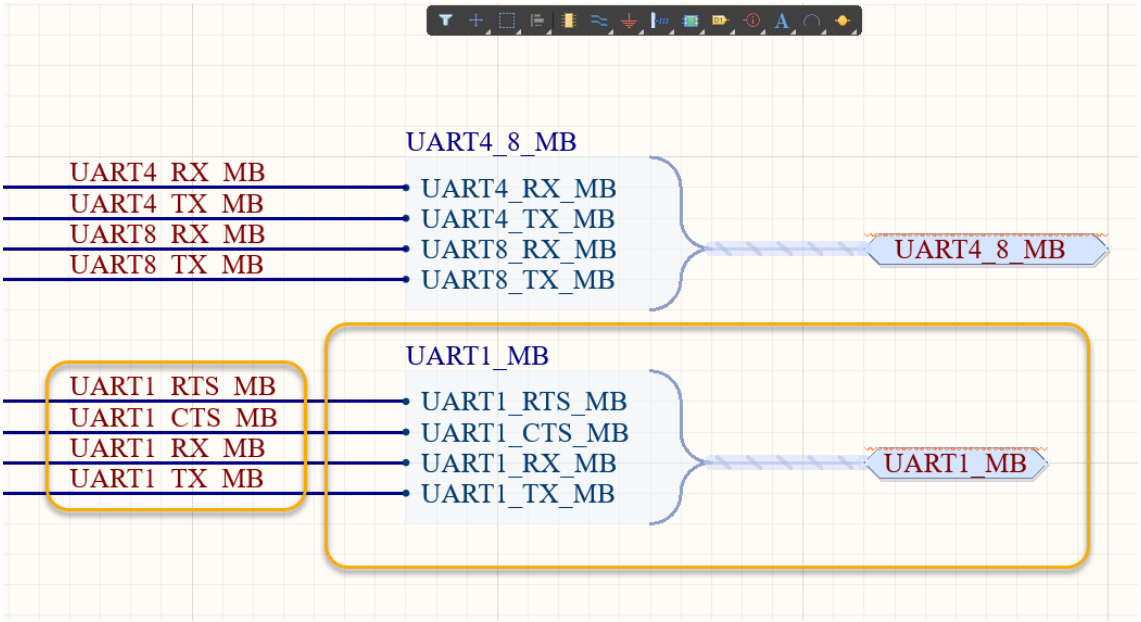


Figure 16. UART1_MB at 6_uart_esc_i2c.SchDoc

5.4 Nested Harness information

It's possible to define a high level harness that contains signals or other Harness definitions. Using a nested harness on lower level schematics minimizes the amount of harnesses on the top level sheet. In this example, you'll create a general CAN Harness that is built out of the `CAN1` and `CAN2` Harnesses.

41. Open the `7_can_rc_i2c_analog` schematic document.
42. Navigate to the *CAN driver* circuit on the left-hand side of component `U9`.
43. From the **Place** menu, select **Harness**, then **Predefined Harness Connector**.
44. When the *Predefined Harness Connector* window appears, use the information below, using Figure 17 as a reference, to assign the following settings:
    a) Select `CAN1` as the Harness Connector definition.
    b) Disable the **Add Port** option.
    c) Disable the **Add Signal Harness** option.
    d) Disable the **Sort Harness Entries** option.
    e) Select **OK** to continue.
45. With the Harness Connector your cursor, hit the **X** key to flip the harness.
46. Place it onto the respective `CAN1` wires as shown in Figure 17.
47. Repeat the process above to place the `CAN2` Harness Connector onto the `CAN2` wires below.

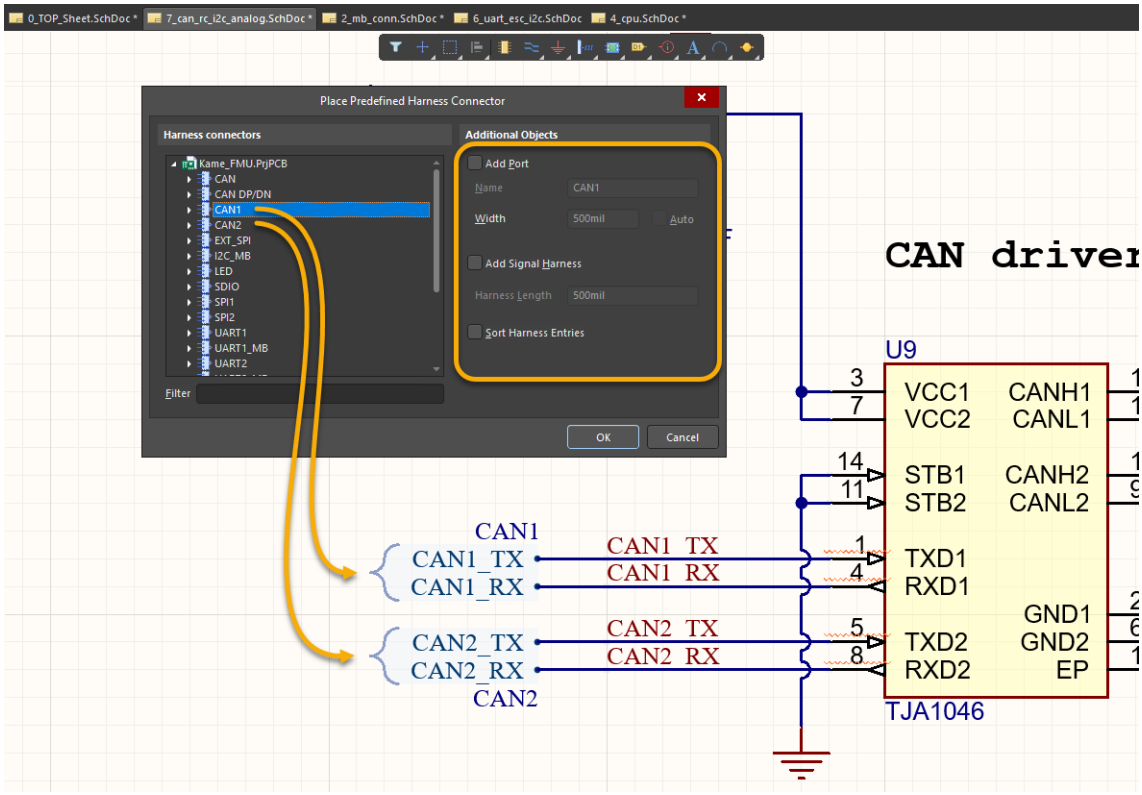


Figure 17. Page 7_can_rc_i2c_analog.SchDoc with two CAN harnesses

Creating a Nested Harness is the process of combining multiple signal harnessed into 1 main harness. You need to place another Harness Connector to complete this task.

48. From the **Place** menu, select **Harness**, then **Predefined Harness Connector**. Then, follow the information for the settings, using Figure 18 as a reference.
    a) Select `CAN` from the list of Harness Connectors.
    b) Enable the option to **Add Port.**
    c) Enable the option to **Add Signal Harness.**
    d) Select **OK** to create the Harness Connector.
    e) With the Harness Connector on your cursor, hit the **X** key to flip it.
    f) Left-click to place it to the left of the `CAN1` and `CAN2` Signal Harnesses, Figure 18.

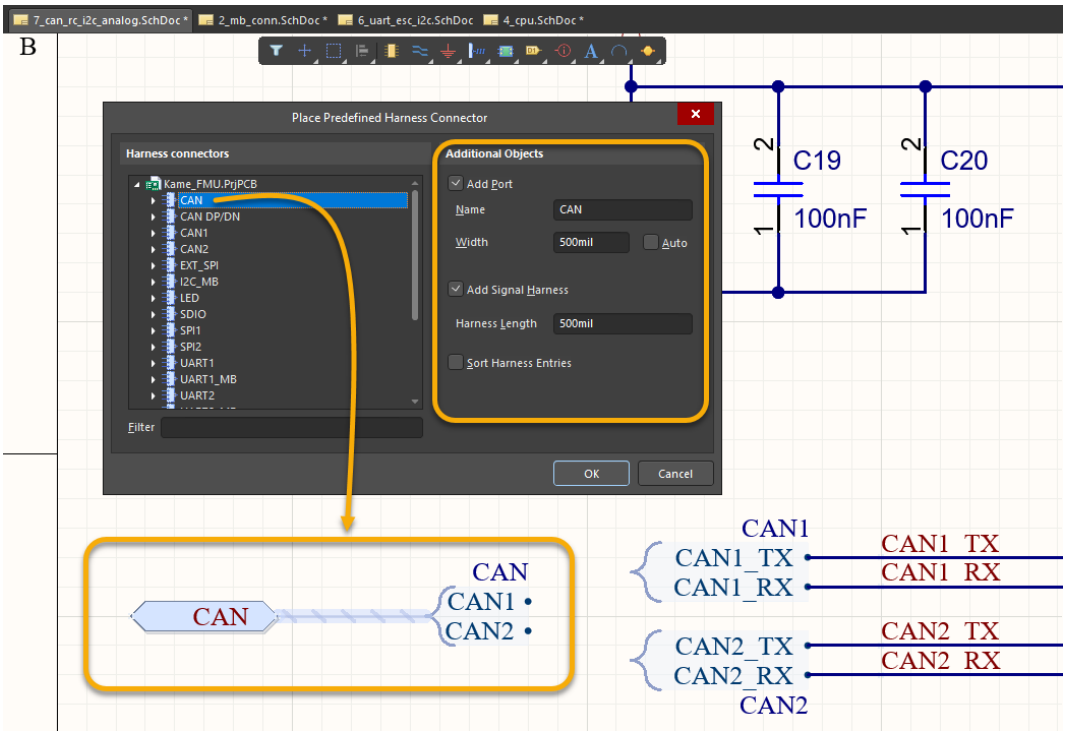


Figure 18. Page 7_can_rc_i2c_analog.SchDoc with three CAN harnesses

49. From the **Place** menu, or from the *ActiveBar*, place a **Signal Harness** to connect the new `CAN1` Harness Entry to the `CAN1` Signal Harness, as shown in Figure 19. Feel free to change the size of the Harness Connector CAN if needed.
50. Repeat the process above to connect the `CAN2` Harness Entry to the `CAN2` Signal Harness. Your end result should look similar to Figure 19.

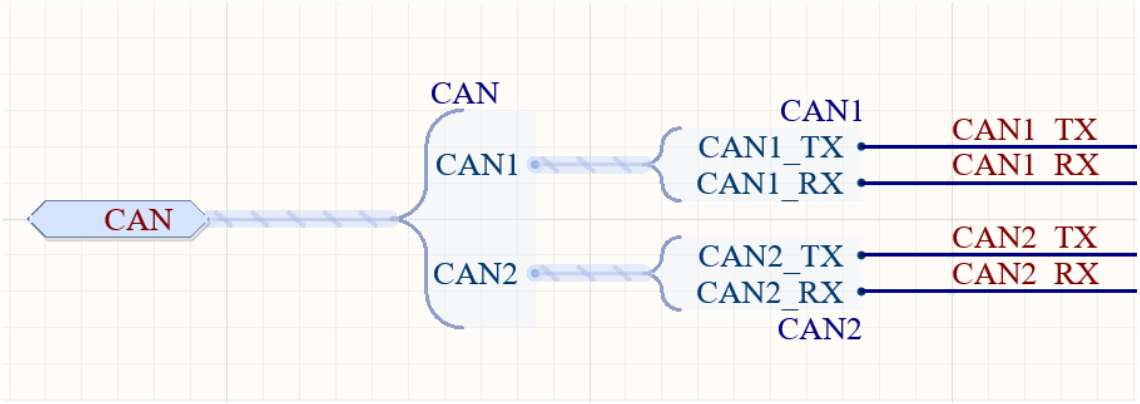


Figure 19. Page 7_can_rc_i2c_analog.SchDoc with nested CAN harness

5.5 Making the Harness Connection on Top Sheet

5.5.1 Creating the matching UART7_MB Harness on the Top Sheet

Next, you'll create the connection between the sheet symbols on the Top Sheet for the `6_uart_esc_i2c`, `2_mb_conn` and `8_imu&debug_conn` schematics.

51. Change the focus back to the `0_Top_Sheet` schematic sheet.
52. Open the *Preferences*. Navigate to the *Schematic* section and open the *Graphical Editing* page.
53. Confirm that the option to **Place Sheet Entries automatically** is enabled, as shown in Figure 20. This will automatically create the sheet entry after the Harness connection is created on the Top Level sheet.
54. Close **OK** to close the *Preferences* when finished.

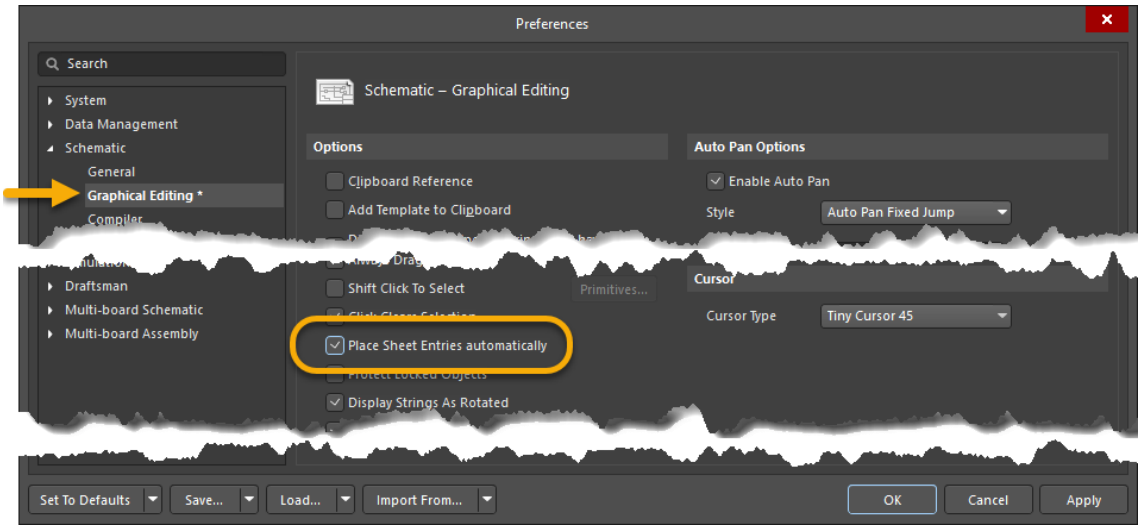


Figure 20. Option to Place Entries

55. From the **Place** menu, select **Harness,** then **Signal Harness**, or use the *ActiveBar* to access it.
    a) Start drawing the Signal Harness at the existing Sheet Entry `UART7_MB` from Sheet `Symbol 8_imu&debug_conn.SchDoc`, as shown in Figure 21.
    b) Draw the Signal Harness to sheet symbol `6_uart_esc_i2c` following the arrow, similar to what is shown in Figure 21.
    c) When you click on the edge of the Sheet Symbol `6_uart_esc_i2c` to complete the connection, the sheet entry for `UART7_MB` will be automatically generated.

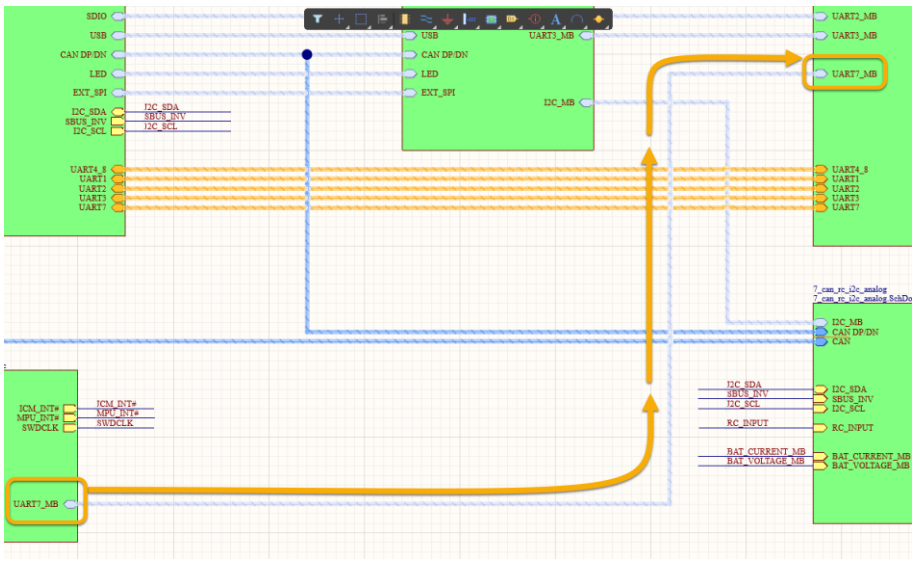


Figure 21. First part of Signal Harness

56. Like in the previous step, let's make another Signal Harness connection between the `2_mb_conn.SchDoc` and `6_uart_esc_i2c.SchDoc` sheet symbols, as seen in Figure 22.
    a) With the Signal Harness command still on your cursor, left-click on the corner of the `UART7_MB` Signal Harness you just created, as shown in Figure 22.
    b) Complete the connection to the edge of the `2_mb_conn.SchDoc` Sheet Symbol and the `UART7_MB` Sheet Entry will be automatically generated, as shown in Figure 22.
    c) Press **ESC** or right-click to exit the Signal Harness command when finished.

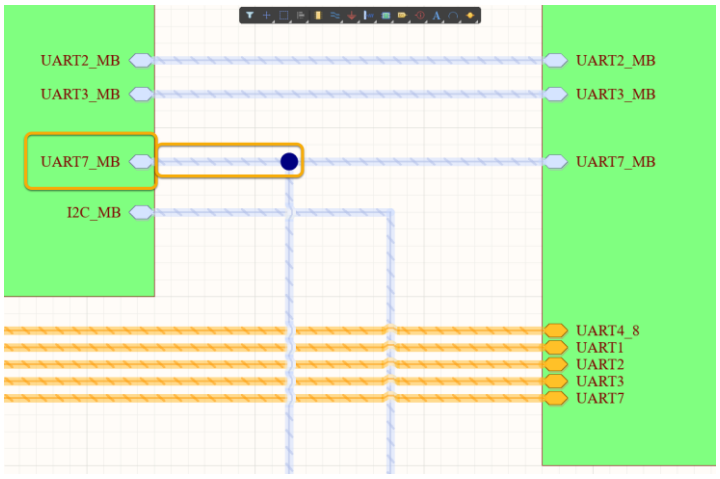


Figure 22. Final definition for Harness UART7_MB Top Sheet

57. At the moment, the new Sheet Entries have a name but no Harness Type information. Select one of the new `UART7_MB` Sheet Entries.

58. From the *Properties* panel, select `UART7_MB` from the *Harness Type* drop-down, as shown in Figure 23.
59. Repeat the step above to make the change to the other `UART7_MB` Sheet Entry.

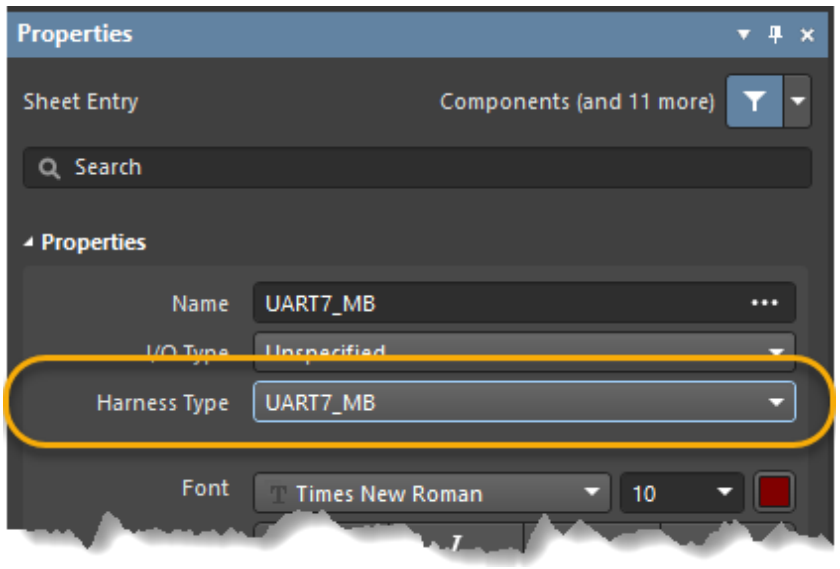


Figure 23. Sheet Entry Harness Type

60. You can change the color of a Signal Harness in the Properties panel to make it easier to identify. Select the Signal Harness that's connected between our `UART7_MB` Sheet Entries.
61. Change the color to red, as shown in Figure 24.

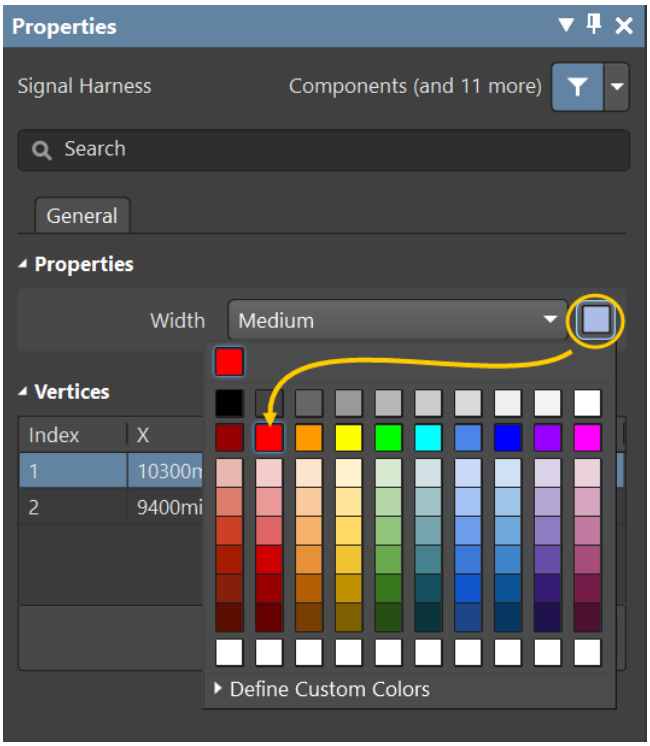


Figure 24. New Harness Color

62. The connected Sheet Entry and Harness will automatically be updated with the new color similar to Figure 25.
63. Only one of the connections will change. You will also need to select the second `UART7_MB` Harness connection and change it too red.

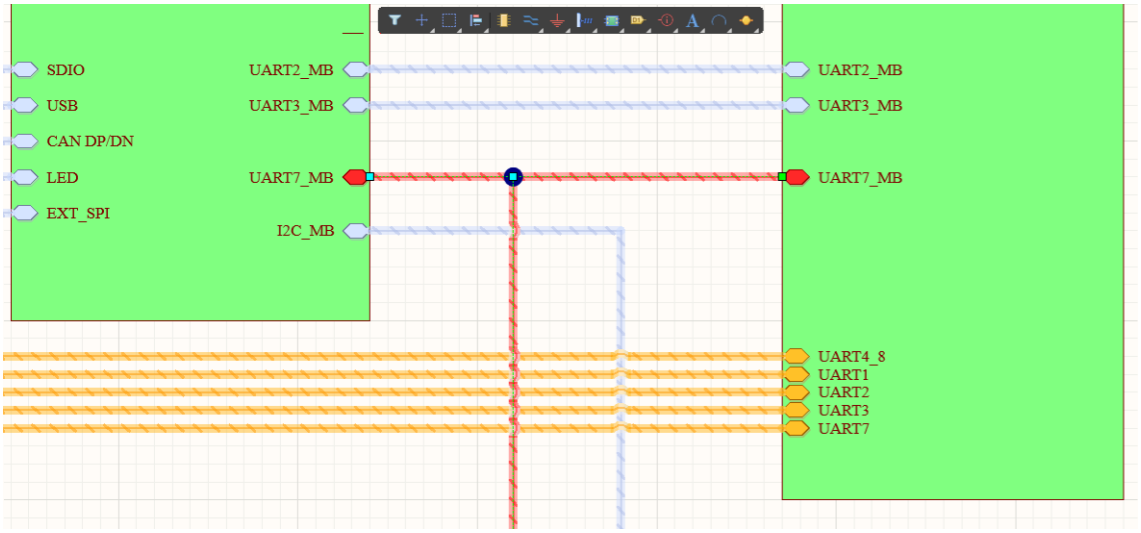


Figure 25. UART7_MB drawn in red

5.5.2 Synchronizing all Remaining Sheet Entries and Signal Harnesses

On the Top Level Sheet, you still need to create two connections for the other Harnesses. Instead of drawing a Signal Harness to the edge of the Sheet symbol to create Sheet Entries, you'll synchronize the Lower-Level sheets with the Top Sheet. Altium Designer provides a special interface to help you do this properly.

64. Open all of the schematic sheets in our design by right-clicking on the *Source Documents* folder of your project and select **Open All Schematic Documents**, as shown in Figure 26.

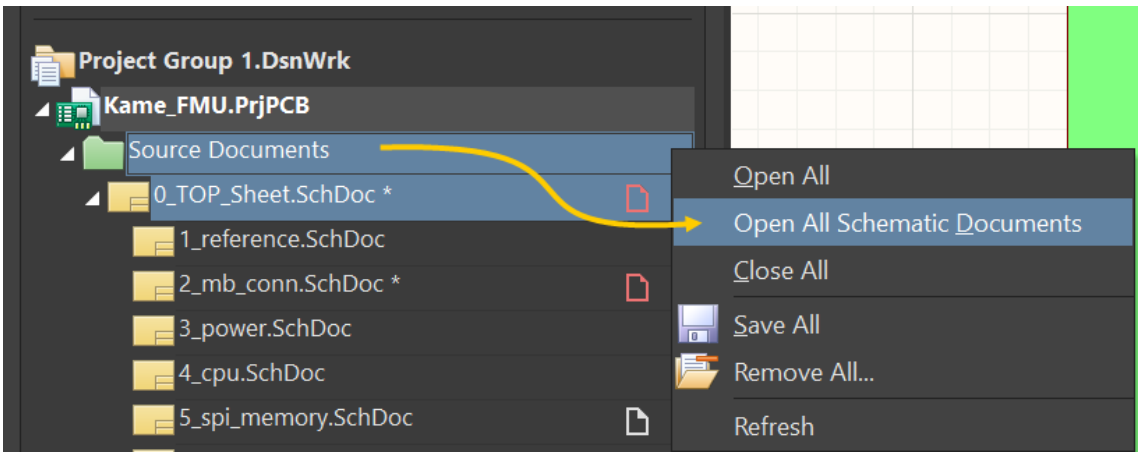


Figure 26. Opening all schematic documents

65. Ensure that the `0_TOP_Sheet.SchDoc` is the focused schematic.

66. From the **Design** menu, select **Synchronize Sheet Entries and Ports**. Use the instructions below and Figure 27 for reference:
    a) Near the top-left of the *Synchronize* window, select the `6_uart_esc_i2c` tab, Figure 27.
    b) From the `6_uart_esc_i2c.SchDoc` section, select the unmatched port `UART4_8_MB`.
    c) Select the command **Add Sheet Entries**. The focus will change to the schematic with a Sheet Entry on your cursor.
    d) Place the new Sheet Entry below the existing `UART3_MB` Sheet Entry on the `6_uart_esc_i2c` sheet symbol, as shown in Figure 27. Feel free to change your grid using the **G** key to place it.
67. Repeat the steps above to place the `UART1_MB` sheet entry above the `UART2_MB` sheet entry.

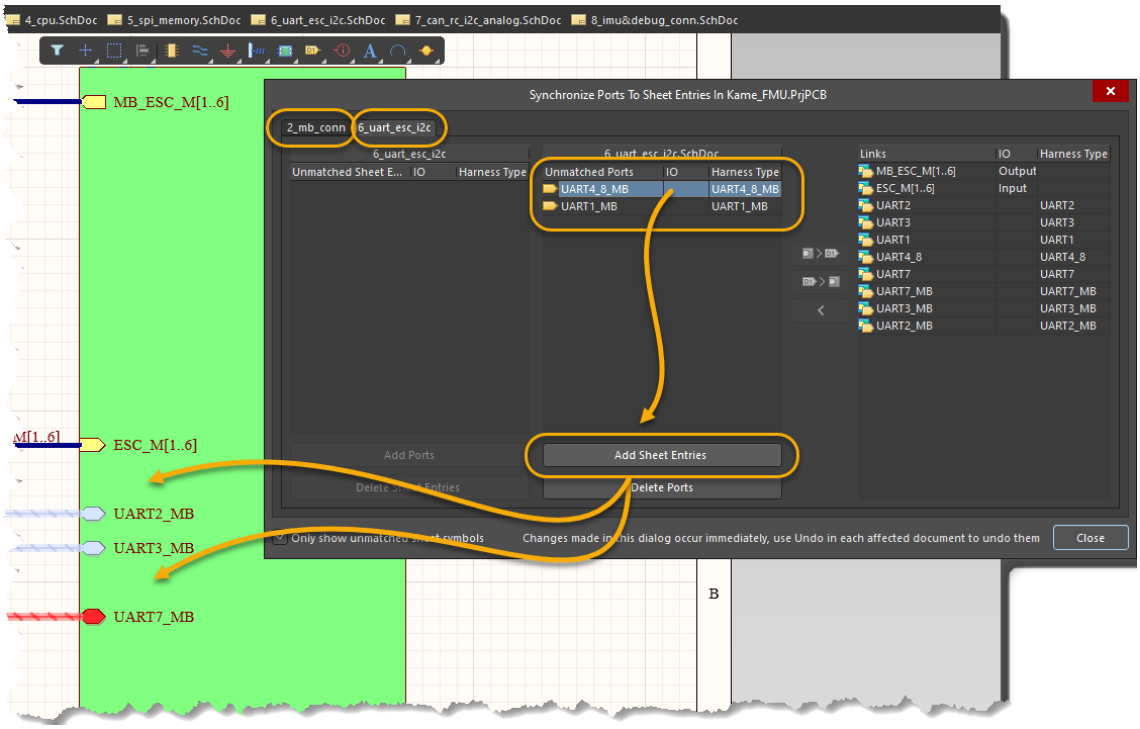


Figure 27. Synchronization for Hierarchical Designs

68. Select the `2_mb_conn` tab, as shown in Figure 28.

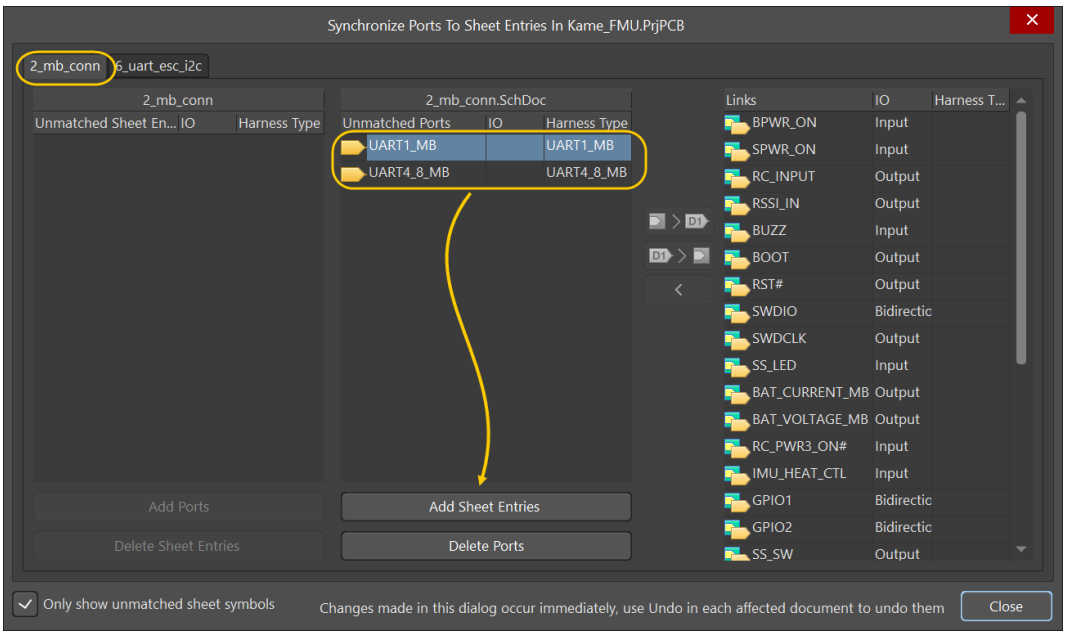


Figure 28. Placing Sheet Entries for 2_mb_conn

69. Repeat the process to **Add Sheet Entries** for the unmatched Ports onto the `2_mb_conn` sheet symbol. Close the *Synchronize Ports* interface.
70. Your final result should look similar to Figure 29 below.

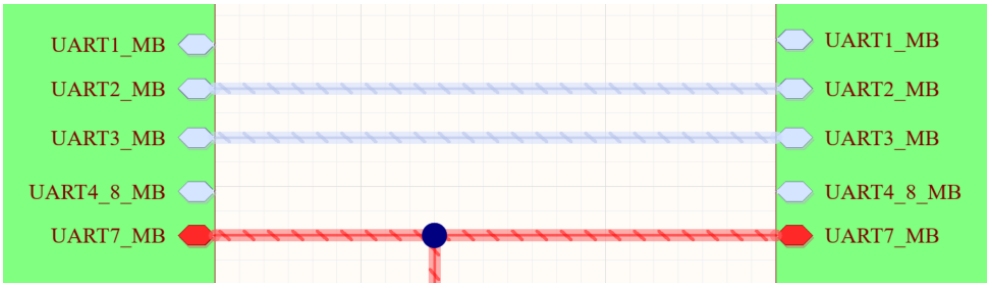


Figure 29. Synchronized sheet entries between sheet symbols

71. Create the connection between the two Sheet Symbols by placing Signal Harnesses to their respective Sheet Entries. Your final result should look similar to Figure 30.

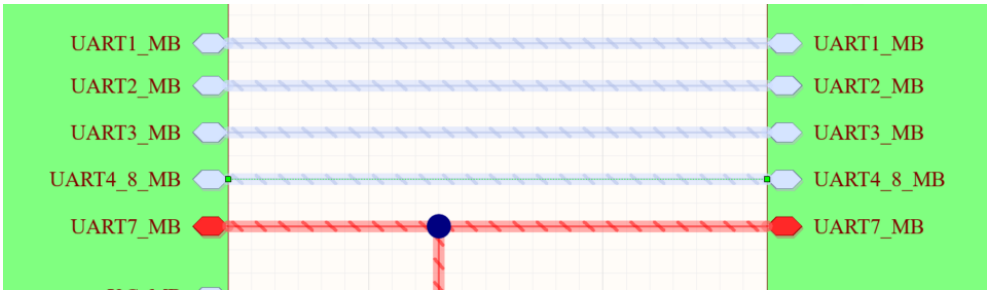
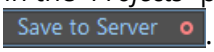


Figure 30. Signal Harnesses for the UART[number]_MB

72. Right-click to end the Signal Harness command.

73. Save all documents using **File » Save All**.
74. Save the modifications to the server:
    a) In the *Projects* panel, next to the Project name you find the command **Save to Server** 

.
    b) Select **Save to Server**.
    c) In the dialog *Save [Project Name]:*
        i) Add the comment `Using Signal Harnesses - [Add Your Name] - Finished`.
        ii) Select **OK**.
75. When ready, close the project and any open documents, **Window » Close All**.

Congratulations on completing the Module!

Using Signal Harnesses

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