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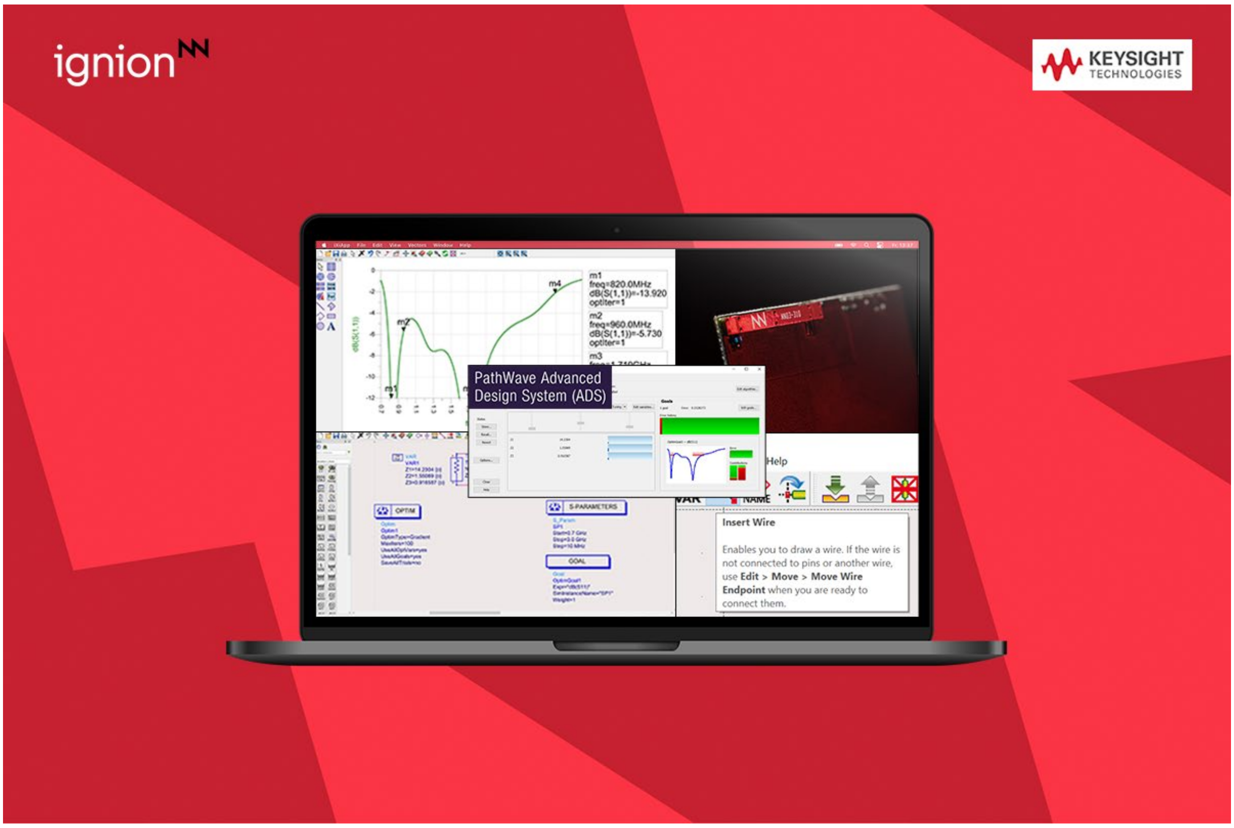
Librarie[S] for Keysight Advanced Design System (ADS)

USER MANUAL

KEYSIGHT TECHNOLOGIES

Librarie[S] for Keysight Advanced Design System (ADS)



Ignion's Virtual Antenna™ Librarie[S] are now available on the Keysight ADS software and ready for you to use when integrating the antenna into your next wireless device. It's very easy, just select your PCB size and the Virtual Antenna™ component, download the library file from our website and import it into the Advanced Design System (ADS) software.

Based on our Virtual Antenna™ technology, all files in the Librarie[S] form a group of [S] parameters for several wireless platforms, with different PCB/ground plane form factors and clearance area dimensions and using different Virtual Antenna™ components. The Librarie[S] is composed of three sets of [S] parameters, one set for 1-port platforms, one set for 9-port platforms, and a set for 5-port platforms using the TRIO mXTEND™ in particular, containing one port, nine ports and five ports, respectively, for implementing a matching network for adapting your design. By choosing the file with the specs closest to those of your device you can implement your matching network quickly and easily in just a few clicks. In this case, we will use the set of 1-port platforms.

Last Update: November 2021

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1. WHAT IS A LIBRARY FILE?

1.1. LIBRARY FILE DEFINITION

The Librarie[S] provides a collection of [S]-parameter files for each Virtual Antenna™ component as mounted on a variety of wireless platforms with different form factors and printed circuit board (PCB) sizes. Each library file is associated to a different PCB size and recommended clearance area, so you can choose the one most suitable for your needs depending on the form factor of your wireless device. For the Advanced Design System software, we will use a set of 1-port library files, from the Librarie[S], containing the [S]-parameters for 1 port for matching your device. Uploading a library file into the Advanced Design System software allows you to implement a matching network to match the device to its desired frequency or frequencies of operation and then complete all the antenna integration work. By using ADS, embedding an antenna component into a new wireless device becomes as simple as including any other electronic part into a circuit design.

1.2. LIBRARY FILE PLATFORM

In *Figure* 2, below you can find an example of a basic platform like that used in any file within the Librarie[S]. It includes a PCB ground plane layer mounted on an FR4 dielectric substrate of 1mm thickness and a Virtual Antenna™ component located in a clearance area, that is, the area on the ground plane layer surrounding the antenna component where the ground plane conductor is removed. In some platforms the antenna component is placed at a corner of the PCB in the clearance area, as shown in the picture on the left in *Figure 2,* and in other platforms, the component is placed at some distance from the corner as on the platform on the right in *Figure 2*.

In general, the antenna component is connected to a matching network by a feeding line, as indicated in *Figure 2*. This feeding line is L-shaped for platforms where the component is not placed at the PCB corner (*image on the right).* The feeding line from the matching network to the corner of the PCB (*image on the right*) or to the antenna component (*image on the left*) is 2 mm in width and in the case that the feeding line is L-shaped it measures 5mm from the corner of the PCB to the antenna component (*image on the right*).

Figure 2 also shows the dimensions of the platform, being *AxC* the board dimensions and *wxh* the clearance area dimensions. The antenna component is connected to one matching network, as previously described.

The platforms available in the Librarie[S] give you the possibility of using a simplified feeding area with one single port. One-single port platforms simplify the matching network design process. Accordingly, to provide an easiest matching network optimization process our Librarie[S] provides you a set of 1-port library files. For more details about the different feeding area layouts available in the Librarie[S] see section 4.

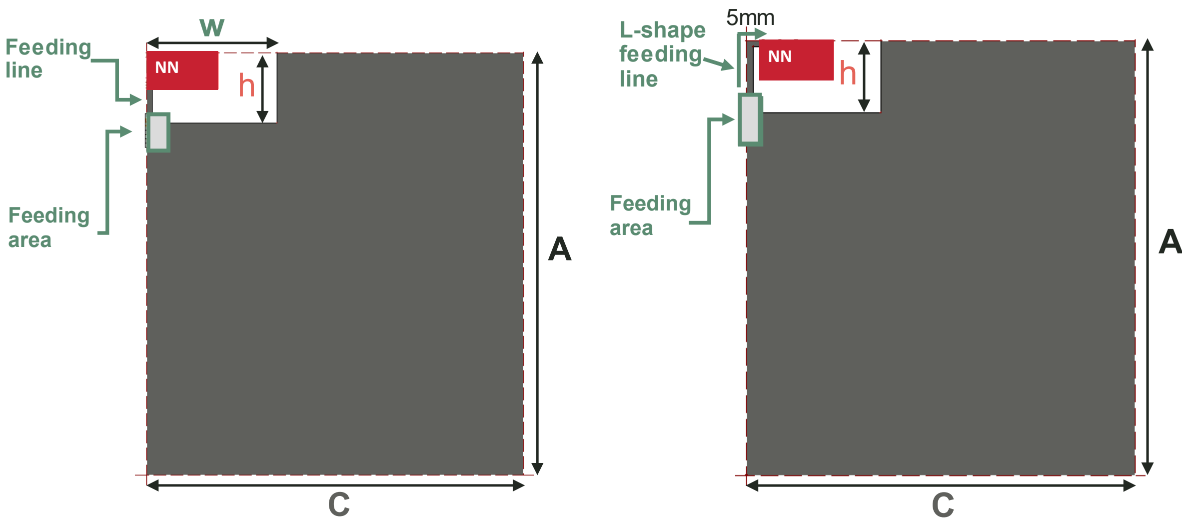


Figure 2 – Example of a platform used for creating a library file.

1.3. LIBRARY FILE NAMING

Now we´ll look at the naming convention for each library file. For easy and convenient identification, every file is individually named using the following general rule: ***NN_Virtual Antenna™ Component_BAxC_Cwxh.s*p,*** where the ***** relates to the number of ports used in the feeding area of the platform related to that library file. Our Librarie[S] provides you with a set of 1-port library files, a set of 9-port library files for cases with a full-layout feeding areas, and a set of 5-port library files for Virtual Antenna™ TRIO mXTEND™ platforms. For the examples provided in this user manual we will only use the set of 1-port files so, in this document we will only use the **.s1p** extension.

Each name helps identify the file content as each part of the name corresponds to a specific piece of information related to the simulated platform. This information is provided in the following table, *Table 1*.

Library File Name				
NN	**Virtual Antenna™ Component**	**BAxC**	**Cwxh**	**.s1p**
Ignion's Logo	Antenna component name	B: Board	C: Clearance	File extension
		AxC: board dimensions	wxh: clearance dimensions	

Table 1 – Library file name by parts.

For instance, if the platform has the following characteristics:

Library File Name				
NN	**Virtual Antenna™ Component**	**BAxC**	**Cwxh**	**.s1p**
NN	**RUN**	**B**: Board	**C**: Clearance	**.s1p**
		AxC: **120X60**	wxh: **60X11**	

Table 1.1. – Example of a library file name by parts.

The file name will be: **NN_RUN_B120x60_C60x11.s1p**

File Name Example

NN_RUN_B120x60_C60x11.s1p contains the [S] params corresponding to an Ignion platform using a RUN mXTEND™ Virtual Antenna™ integrated in a board with dimensions of 120mm x 60mm featuring a clearance of 60mm x 11mm for allocating the RUN mXTEND™ Virtual Antenna™.

1.4. LIBRARY FILE CONTENT

Each library file contains the information described below and structured as follows.

Example of Library File Content: Header Information, Parameters Information

An example is provided below, corresponding to the file NN_RUN_B120x60_C60x11.s1p file introduced on the previous page.

It is worth noting that the ! character at the beginning of a line indicates a comment line that is normally not interpreted by matching-circuits design software that typically read these types of files

1.4.1. HEADER INFORMATION

- The name of the library file.
- The name, reference, and size of the Virtual Antenna™ component used in the Ignion platform associated with the library file.
- A link to Ignion´s website providing more information about the Virtual Antenna™ component specified in the previous line.
- Board dimensions.
- Clearance area dimensions.
- Feeding line shape and dimensions: the first dimension is for the line from the ground plane edge to the board corner, and second dimension which is only for L-shape lines, is for the line from the board corner to the Virtual Antenna™ component.
- Possible applications for which the platform associated with the library file can be used.
- Frequency range at which the [S] params included in this library file are calculated.
- The number of ports defined in the platform and for which the [S] parameters are calculated.
- A paragraph related to the Ignion´s patents and/or patents applications that protect this platform and the Virtual Antenna™ component as an Ignion product and their use.
- A paragraph related to Ignion's FastTrack service in case the user needs more assistance in designing their device.
- Some additional information preceded by the word "*Touchstone*" about the platform ports. These lines are sometimes interpreted by some of the matching-circuit softwares which able to import and use the library file.

```
! IGNION VIRTUAL ANTENNA LIBRARY
!
! NN_RUN_B120x60_C60x11
! Virtual Antenna™ RUN mXTEND™: NN02-224 5.0 mm x 5.0 mm x 5.0 mm
! https://ignion.io/product/run-mxtend/
! Board: 120 mm x 60 mm
! Clearance Area: 60 mm x 11 mm
! Feeding line: L-shape; 11mm x 2mm and 5mm x 2mm
! Applications: Smartphone, Fleet management, IoT
! Frequency range 0.65GHz to 6GHz, step 10MHz
! Number of ports 1
!
! This product and its use is protected by at least one or more of the following patents and patent
! applications US 8,203,492 B2; US 8,237,615 B2; PCT/EP2013/064692; WO 2014/012842 A1; US
2019/190122 A1.
! US 62/072,671; and other domestic and international patents pending. Additional information about
! patents related to this product is available at https://ignion.io/files/Patent-list-NN.pdf, all
! rights reserved. Copyright, Ignion 2021.
!
! Need more help? Your platform is much different than these examples in the manual? Use our
! Fast Track service (https://ignion.io/fast-track/), for free, and get a personalized antenna design in
! just 24 hours.
!
! Touchstone port 1 = "Series Port"
!
```

Example: Header information of a single-port library file, specifically the NN_RUN_B120x60_C60x11.s1p.

1.4.2. PARAMETERS

1.4.2.1. Parameters general information

Following the header, the lines concern the representation of the [S] parameters. They are calculated by an EM CAD software at the 1 port defined in the platform associated with the library file for each frequency included in the simulation. This is because each platform in the Librarie[S] enables implementing a matching network, as shown in section 4.

For each frequency, provided in GHz, the [S] params related to the ports defined in the platform related to the file are shown at the beginning of each line of [S] params for 1-port library files. Each [S] parameter is represented by its magnitude and angle, as indicated by the “M” and the “A” found in the following examples. The “R 50” text from the examples provided below indicates that the [S] params are calculated regarding an impedance Z=50Ω (only resistance component).

```
! IE3D S-Parameters Output Version 2.0
# GHZ S MA R 50
! Nport = 9
!
```

Example: Parameters general information of a 1-port library file.

1.4.2.2. Frequency, magnitude and angle

The last information provided is the **frequency**, the **magnitude** and the **angle** representing each [S] parameter related to the port of the structure for 1-port library files.

For the 1-port library files, a line of [S] params includes 1 [S] parameter related to the structure port calculated for the corresponding frequency, indicated at the beginning of the line. Then, in 1-port library files, there is as many numbers of lines of [S] parameters as number of computed frequencies.

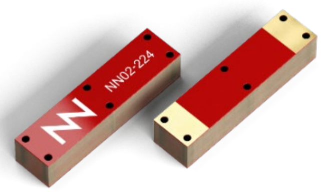
```
6.5000000000e-001  9.9154595539e-001 -1.6113757198e+001
```

Example: Line of text with frequency, magnitude and angle for the [S] parameter related to a 1-port library file.

2. AVAILABLE VIRTUAL ANTENNA™ COMPONENTS

The range of Ignion products are called Virtual Antenna™ components. You can find below the whole available range of Ignion's Virtual Antenna™ components, used in the wireless platforms included in our Librarie[S]. You can also find their part number and dimensions along with the bands that it is possible to cover in solutions already implemented with each piece. Notice that the acronym standing out in bold and capital letters is the name of the Virtual Antenna™ component used to create the library file names, as explained in section 1.3.

Virtual Antenna™ **ALL** mXTEND™
Part number: NN02-220
Bands: 698 – 2690 MHz
24.0 mm x 12.0 mm x 2.0 mm



Virtual Antenna™ **RUN** mXTEND™
Part number: NN02-224
Bands: 698 – 3800 MHz
12.0 mm x 3.0 mm x 2.4 mm

Virtual Antenna™ **TRIO** mXTEND™
Part Number: NN03-210
Bands: 698 – 2690 MHz
30.0 mm x 3.0 mm x 1.0 mm

Figure 3 – Virtual Antenna™ components available in the Librarie[S].

3. CHOOSE THE RIGHT LIBRARY FILE FOR YOUR APPLICATION

The table below provides the different platforms available for direct download. The .s1p file extensions indicate that the number of ports used in the feeding area of the platform related to the file is 1. The dimensions of the board along with those of the clearance area available in the board for allocating the Virtual Antenna™ component are included in the third and fourth columns. Once you´ve decided which library platform best fits your device requirements you must choose to work with 1 port for designing your matching network. The use of just one port simplifies the matching network design and optimization process.

Choose the right file: Size, Space and Clearance

With a quick look at the table below you can choose a library file depending on your platform requirements, especially in terms of size and the available space for allocating the Virtual Antenna™ Component, that is, the clearance area.

Application	Virtual Antenna™ Component	Board Size AxC mm^2	Clearance Size wxh mm^2	Library File Name
Smart meter	RUN	145x130	45x24	NN_RUN_B145x130_C45x24.s1p
	ALL	145x130	45x24	NN_ALL_B145x130_C45x24.s1p
Smartphone	RUN	130x60	20x11	NN_RUN_B130x60_C20x11.s1p
Fleet Management Module	RUN	120x60	60x11	NN_RUN_B120x60_C60x11.s1p
	RUN	105x45	45x11	NN_RUN_B105x45_C45x11.s1p
	RUN	70x40	40x11	NN_RUN_B70x40_C40x11.s1p
IoT	RUN	90x90	90x11	NN_RUN_B90x90_C90x11.s1p
	RUN	90x70	70x11	NN_RUN_B90x70_C70x11.s1p
	RUN	85x55	55x11	NN_RUN_B85x55_C55x11.s1p
	RUN	70x55	55x11	NN_RUN_B70x55_C55x11.s1p
	RUN	50x55	55x11	NN_RUN_B50x55_C55x11.s1p
	RUN	50x40	40x11	NN_RUN_B50x40_C40x11.s1p
	RUN	50x20	20x11	NN_RUN_B50x20_C20x11.s1p
Wearable	RUN	30x30	14x5	NN_RUN_B30x30_C14x5.s1p
Routers/ Repeaters	RUN	140x120	120x11	NN_RUN_B140x120_C120x11.s1p

Table 2 – Platforms available in the Librarie[S].

4. PLATFORM PADS AND PORTS

The port configuration used for implementing the feeding area of all platforms associated with a 1-port library files is shown below (*Figure 4*). One single port is defined for allocating the matching network that you will design for matching your device. The port is defined in a gap between a feeding line that is connected on its end to the Virtual Antenna™ component and the platform ground plane.

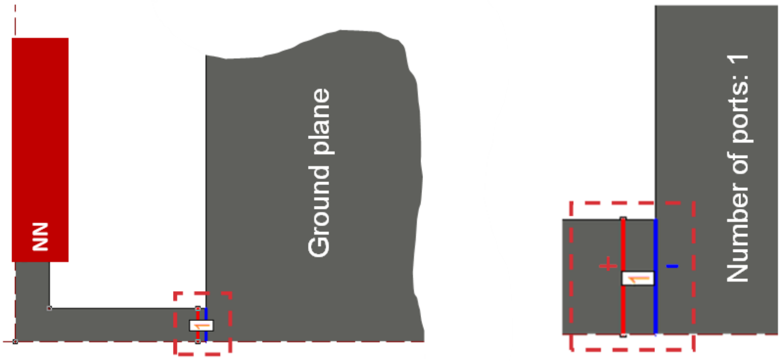


Figure 4 – Ignion's platform port configuration defined for 1-port library files.

It is worth noting that for the platforms included in the set of 1-port library files, where the matching network can also be implemented, as is shown in *Figure 5*. Any matching network topology can be designed within this port configuration.

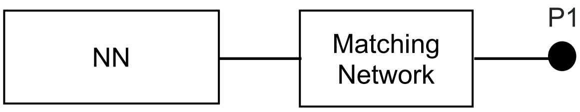


Figure 5 – Generic matching network allocated in the port defined in an Ignion platform with a feeding area composed of just 1 port.

5. HOW TO USE A LIBRARY FILE IN ADS: EXAMPLES

5.1. IoT – SMART METER

5.1.1. STEP 1: LIBRARY FILE SELECTION

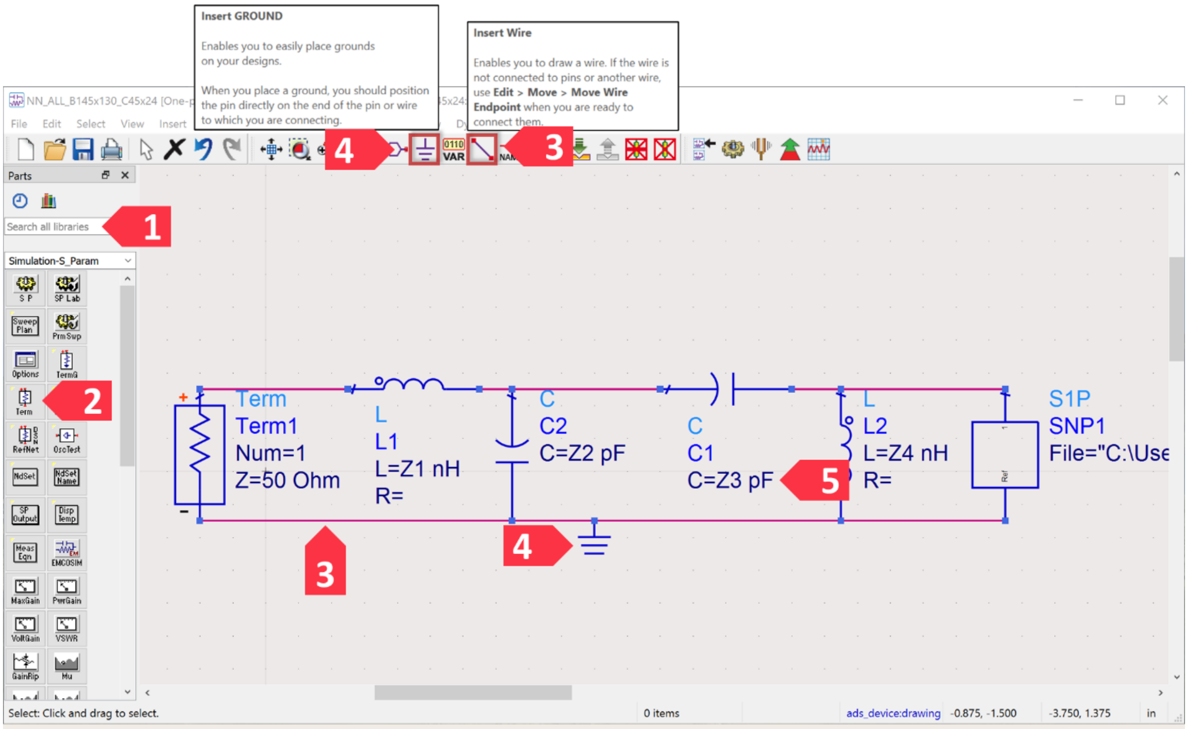
Let´s say you have a new project, and you need to design a new smart meter application within a frequency range from 698 MHz to 960 MHz and/or from 1.71 GHz to 2.17 GHz. You also know the platform used features a 142 x 129 mm^2 board with a clearance of 45 x 25 mm^2.

The information above is the only data you need to in order to choose the most suitable library file. Use Table 2 to see available files and choose the one closest in specs to your specific project.

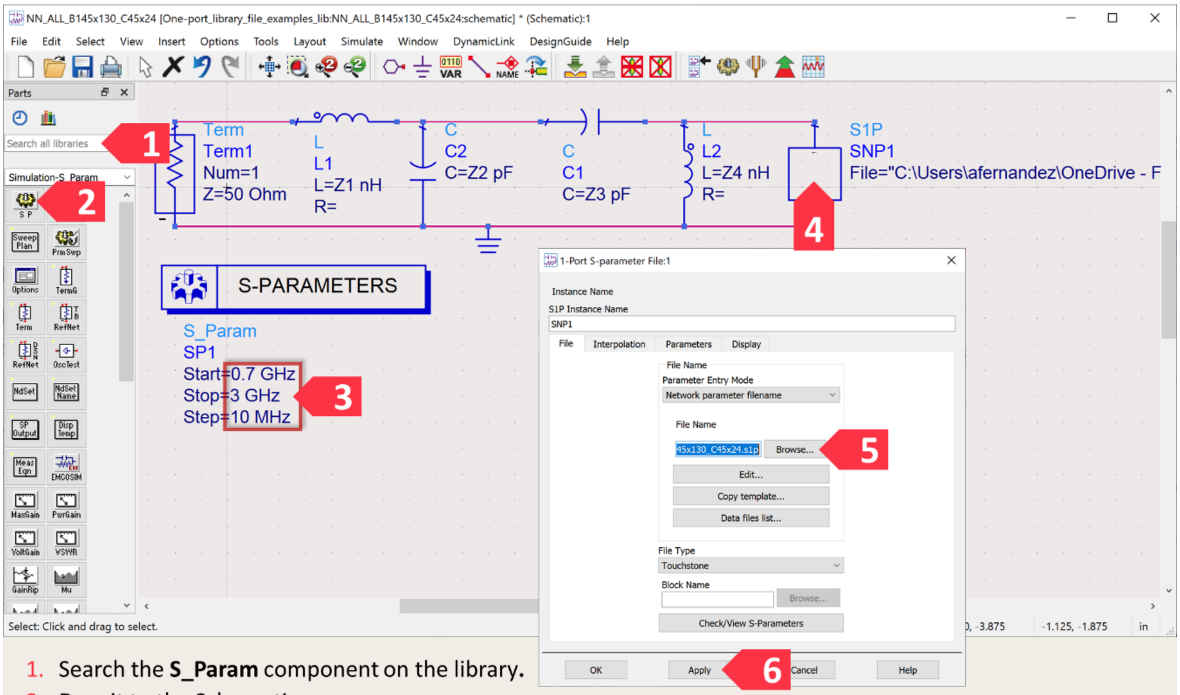
In this case the most suitable 1-port library file is NN_ALL_B145x130_C45x24.s1p. The antenna is a Virtual Antenna™ ALL mXTEND™ (see section 2 of this manual) placed at the corner of the PCB.

5.1.2. STEP 2: MATCHING NETWORK OPTIMITZATION

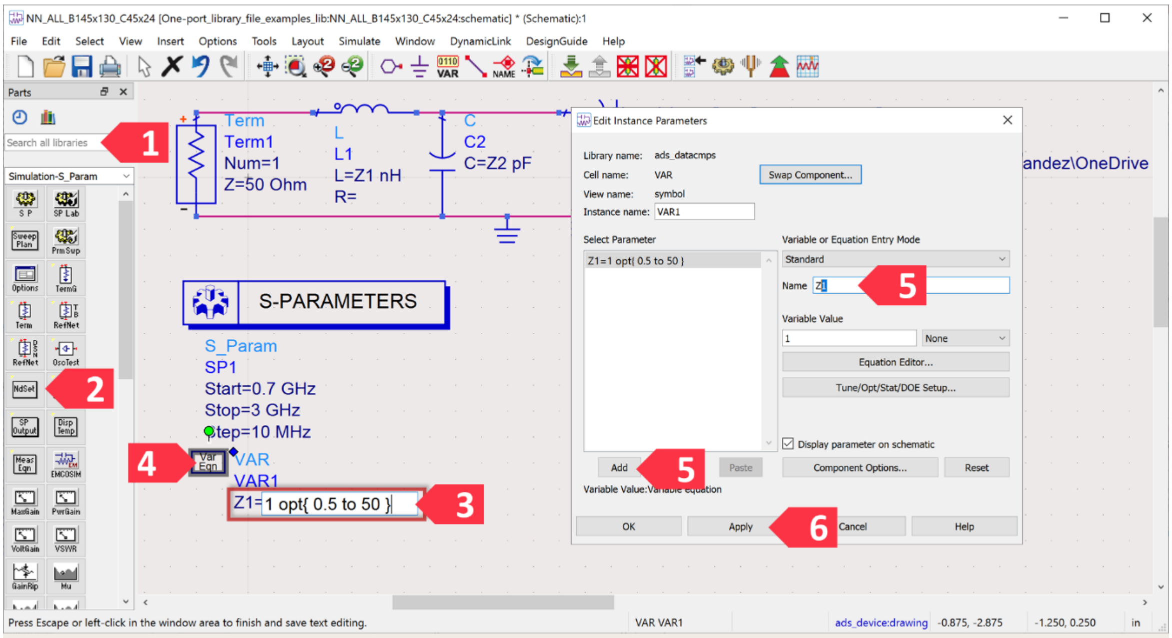
The Advanced Design System software can be used for optimizing a suitable matching network for the previously chosen platform. Below, you can find the steps to follow.



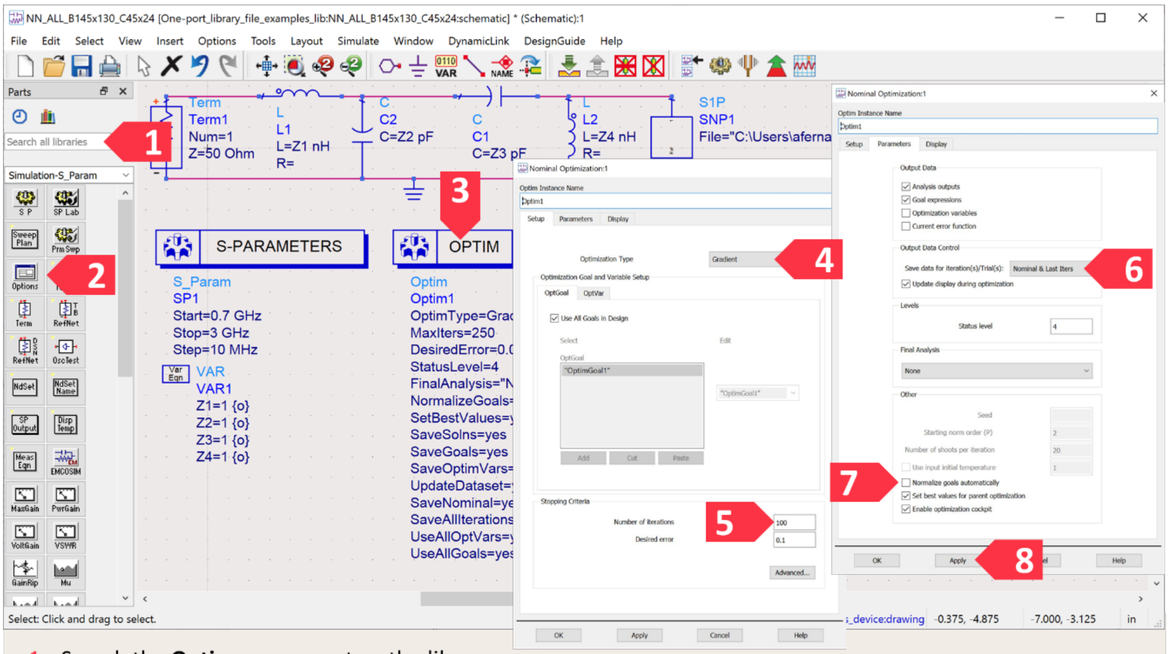
1. Search the components on the library: **Term, L, C & S1P.**
2. Drag them to the Schematic.
3. Connect them with wires.
4. Insert the ground.
5. Change the value of the components to variables Z1, Z2…



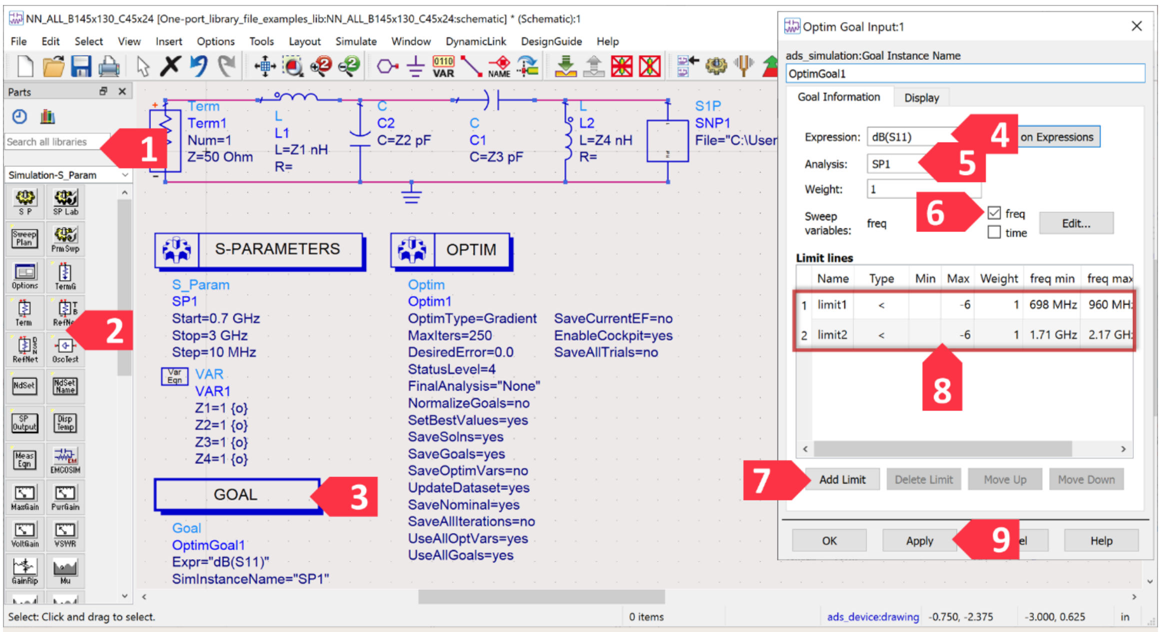
1. Search the **S_Param** component on the library.
2. Drag it to the Schematic.
3. Doble click on the frequency values, and rewrite them to the ones you can see here.
4. Double click on the S1P component to open the setup wizard.
5. Browse the .s1p file.
6. Apply the changes.



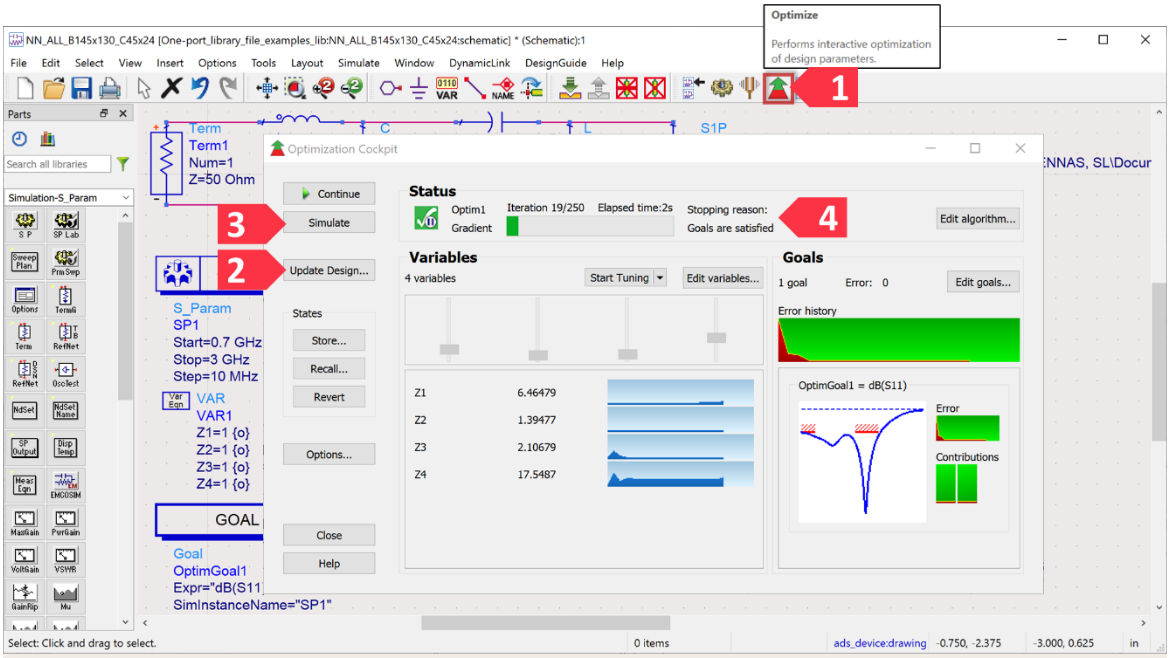
1. Search the **VAR** component on the library.
2. Drag it to the Schematic.
3. Doble click and rewrite the name and value of the variable to the one you can see here.
4. Double click on the VAR component to open the setup wizard.
5. **Rename** the name of the variable to Z2, Z3 & Z4, and **add** the new variable.
6. Apply the changes.



1. Search the **Optim** component on the library.
2. Drag it to the Schematic.
3. Double click on the OPTIM component to open the setup wizard.
4. Change the optimization type to **Gradient**.
5. Change the number of iteration to **100** or more.
6. Change the save data for iteration to **Nominal & Last Iters.**
7. Unselect **Normalize goals automatically.**
8. Apply the changes.

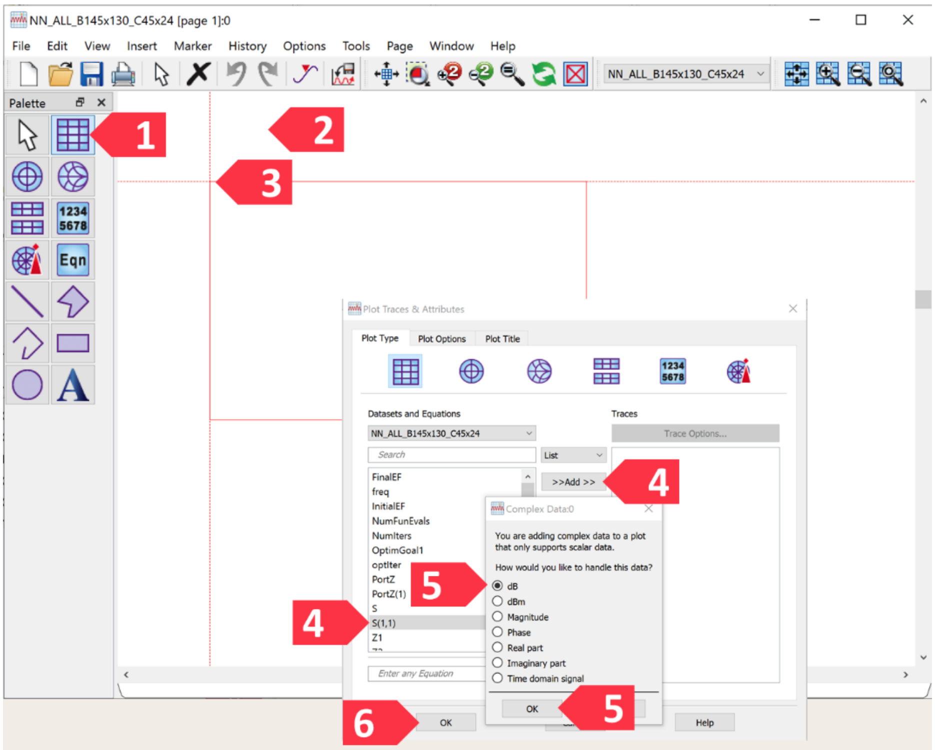


1. Search the **Goal** component on the library.
2. Drag it to the Schematic.
3. Double click on the GOAL component to open the setup wizard.
4. Insert the expression **dB(S11)** .
5. Insert the analysis **SP1.**
6. Select **freq.**
7. Add a second band limit, by pressing the button **Add limit.**
8. Fill the limit lines, ass the ones you can see here.
9. Apply the changes.

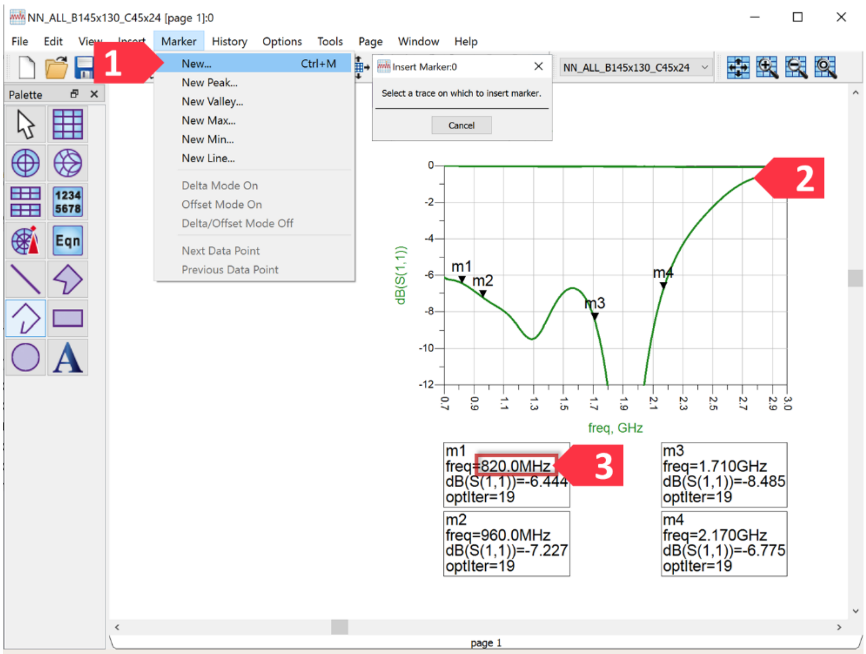


1. Optimize the schematic values.
2. The optimization will start and finish automatically. Once is finished, **update the design**.
3. Simulate the design.
4. Once the simulation is finished, a new data display window will appear.

It is important to remark that the values obtained for the matching network components with the Network Synthesis Wizard presented above are optimized values that need to be adjusted to real values (if you want to implement the obtained matching network). After designing the matching network, you can plot the reflection coefficient obtained.



1. Select the chart type, by clicking at it.
2. Move the mouse and a red square, representing the chart, will appear.
3. Click again to fix the red square and a setup wizard will appear.
4. Select **S(1,1)** and press **Add**.
5. Select **dB** and press **OK**.
6. Press OK and the plot will appear.



1. Click on Marker > New... And Insert Marker window will appear.
2. Select the trace and the marker will appear.
3. Rewrite the frequency value of the marker in order to move it to the desired value.

Figure 6 provides a zoom of the platform to show the antenna component and the feeding area (red dashed square) of the Ignion platform used for this smart meter example, and to show how the antenna component, which is placed at the PCB corner, is connected to the feeding area. In this case the feeding area is composed of just 1-port and it is connected to the antenna component by means of a straight feeding line of 2mm in width. The matching network design is connected to the port of the platform as shown in the last steps shown in the matching network optimization section of this user manual

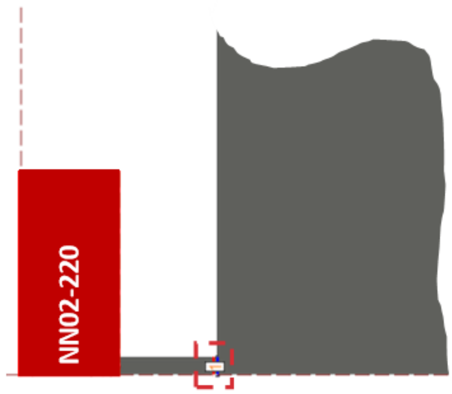


Figure 6 – Zoom of the antenna component and the feeding area of the Ignion platform used in the example here provided for modelling an IoT/smart meter device. Platform uses an ALL mXTEND™ Virtual Antenna™.

5.1.3. STEP 3: RESULTS

The matching obtained with the matching network designed above is shown in the following *Figure 7*. This figure shows the input reflection coefficient for this smart metering example. The design is matched below -6dB in the frequency bands of interest, ranging from 698MHz to 960MHz and from 1.71GHz to 2.17GHz.

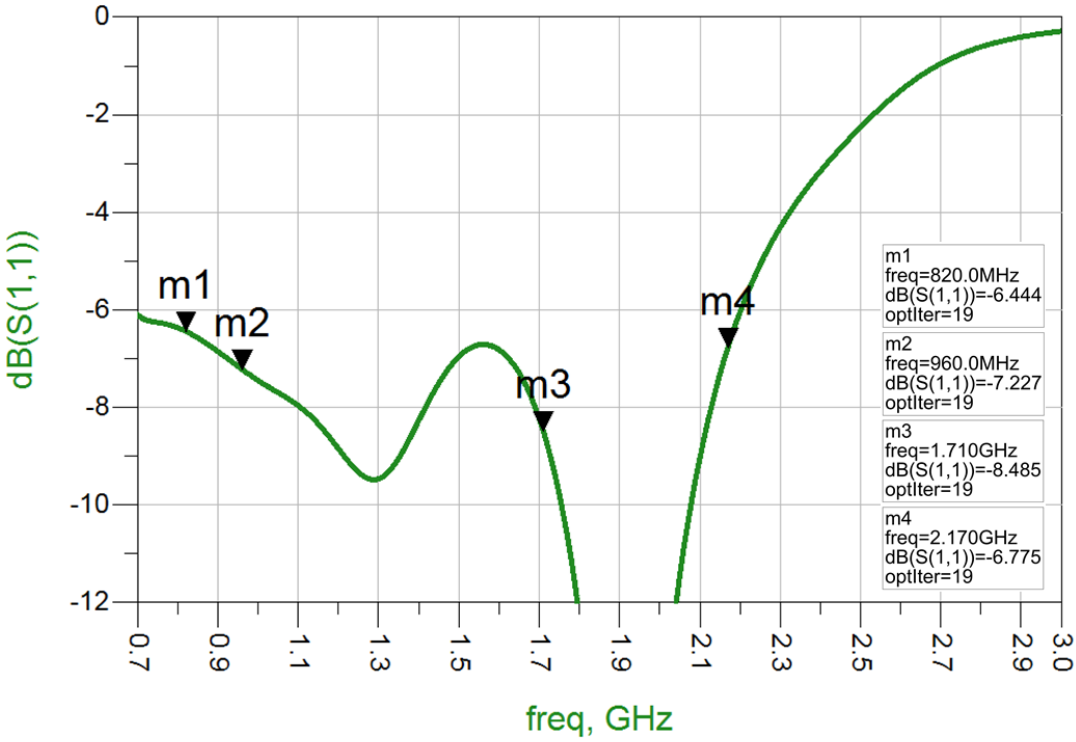


Figure 7 – Input reflection coefficient related to the IoT/smart meter example shown in this user manual.

5.2. MOBILE – FLEET MANAGEMENT MODULE

5.2.1. STEP 1: LIBRARY FILE SELECTION

Imagine you need to design the antenna for a new fleet management application module, and you need connectivity within a frequency range going from 824 MHz to 960 MHz and/or from 1.71 GHz to 2.17 GHz. The module features a 125 x 60 mm^2 board with a clearance of 61 x 13 mm^2.

The information above is the only data you need to choose the most suitable library file. Use Table 2 to see available files and choose the one closest in specs to your specific project.

The most suitable library file providing the [S] params related to a 1-port platform is the NN_RUN_B120x60_C60x11.s1p. In this plaftform the RUN mXTEND™ Virtual Antenna™ (see section 2 of this manual) is placed at 5 mm from the corner of the PCB. The RUN mXTEND™ Virtual Antenna™ is connected to the feeding area, where the matching network is allocated, by an L-shape feeding line of 2mm width as seen in *Figure 8*.

5.2.2. STEP 2: MATCHING NETWORK OPTIMIZATION

Ignion's team proposes the following matching network for the Ignion platform chosen in the section above. For more details about how to optimize a matching network with ADS you can have a look at the steps provided in the smart meter example (see Section 5.1.2) for creating the matching network. The following image shows the matching network connected to the Ignion 1-port library (NN_RUN_B120x60_C60x11.s1p) from the Librarie[S].

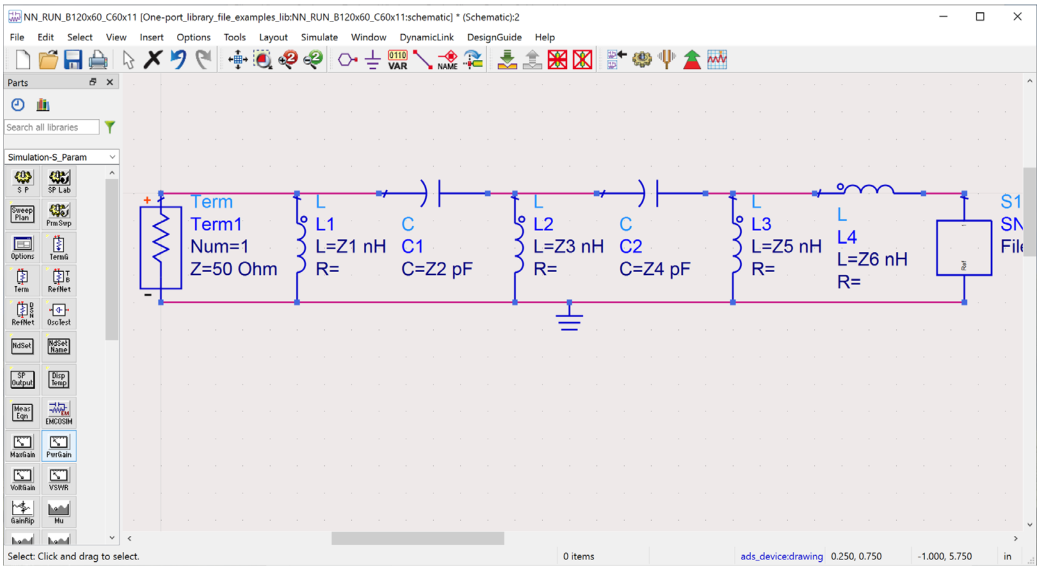


Figure 8 – Matching network proposed by the Network Synthesis Wizard for matching the fleet management example provided here.

Figure 9 provides a zoom of the platform to show the antenna component and the feeding area on the Ignion platform used for this fleet management example, and to show how the antenna component, which is placed at 5mm from the corner, is connected to the feeding area. The feeding area in this case is composed of just 1-port and it is connected to the antenna component by means of an L-shape feeding line of 2mm width. The matching network design is connected to the port '1' of the platform as shown in *Figure 8*.

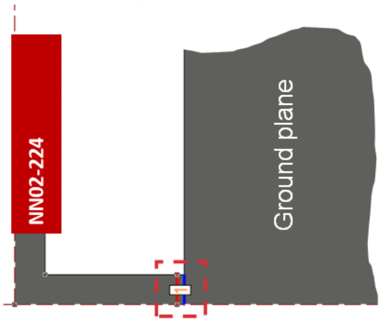


Figure 9 – Zoom of the antenna component and the feeding area on the Ignion platform used in the fleet management example provided here. Platform uses a RUN mXTEND™ Virtual Antenna™.

5.2.3. STEP 3: RESULTS

The matching performance resulting from using the matching network (*Figure 8*) proposed in the previous section 5.2.2. is shown in the following *Figure 10*. It shows the input reflection coefficient for this fleet management example. The design is matched below -6dB in the frequency bands of interest, ranging from 824MHz to 960MHz and from 1.71GHz to 2.17GHz.

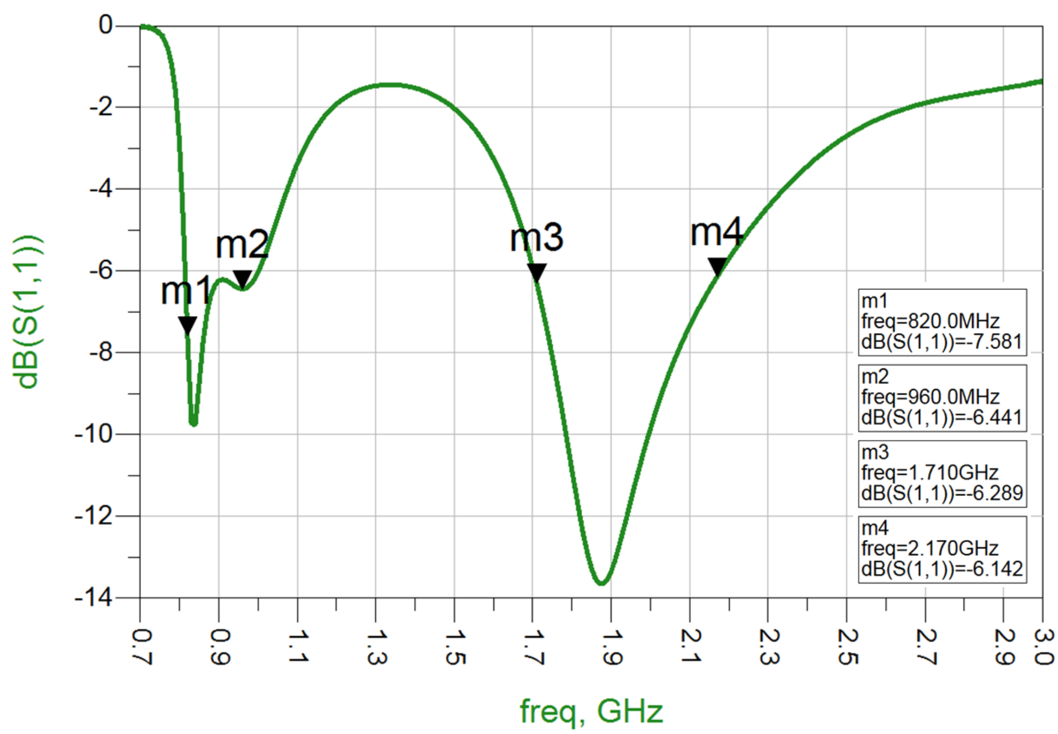


Figure 10 – Input reflection coefficient related to the fleet management example provided in this User Manual.

5.3. ISM – WEARABLES

5.3.1. STEP 1: LIBRARY FILE SELECTION

If you need to cover ISM bands operating within the 2.4 GHz to 2.5 GHz range, this is the example for you. This might be the case in something like a wearable device that needs to establish a short-range wireless link with a computer or mobile device. In this example, we´ll imagine that the platform used features a 32 x 32 mm^2 board with a clearance of 14 x 4 mm^2.

The information above is the only data you need in order to choose the most suitable library file. Use Table 2 to see available files and you choose the one closest in specs to your specific project.

In this case the library file that should be chosen is NN_RUN_B30x30_C14x5.s1p, as its specs are the closest to the ones of the hypothetical device used in this example.

5.3.2. STEP 2: MATCHING NETWORK OPTIMIZATION

Ignion's team proposes the following matching network for the Ignion platform chosen previously to model your device. For more detail on how to optimize a matching network with ADS you can have a look at the steps for creating the matching network provided in the smart meter example (see Section 5.1.2). The following image, *Figure 11,* shows the matching network design, connected to the Ignion's 1-port library platform previously chosen from the Librarie[S].

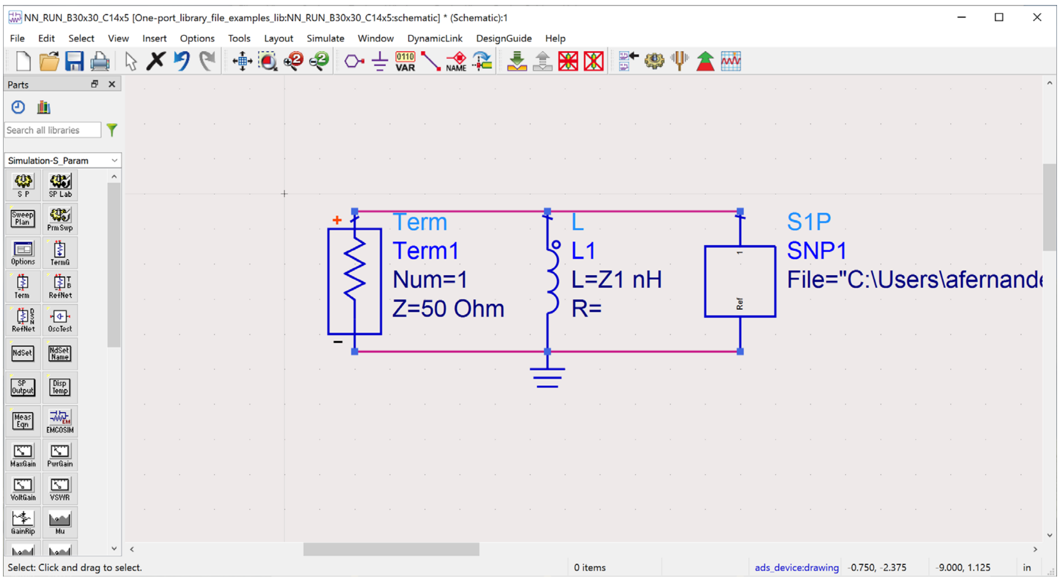


Figure 11 – Matching network proposed by the Network Synthesis Wizard for matching the wearables example provided here.

Figure 12 provides a zoom of the platform to show the antenna component and the feeding area (dashed red square) of the Ignion platform used for this wearable example, and shows how the antenna component, which is placed at the corner, is connected to the feeding area. The feeding area is in this case composed of just 1-port, and it is connected to the antenna component by means of a straight feeding line of 2mm width. The matching network design is connected to the port '1' of the platform as shown in *Figure 11*.

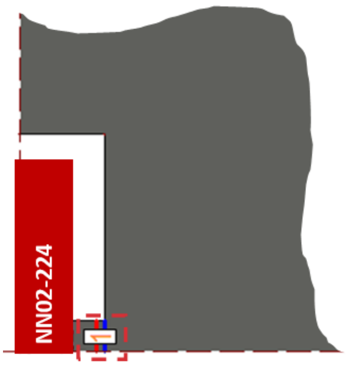


Figure 12 – Zoom of the antenna component and the feeding area of the Ignion platform used in the wearable example provided in this User Manual. Platform uses a RUN mXTEND™ Virtual Antenna™.

5.3.3. STEP 3: RESULTS

The matching performance resulting from using the matching network proposed in the previous section 5.3.2 is shown in the following *Figure 13*. This figure shows the input reflection coefficient for this wearable example. The design is matched below -6dB in the frequency bands of interest, ranging from 2.4 GHz to 2.5 GHz.

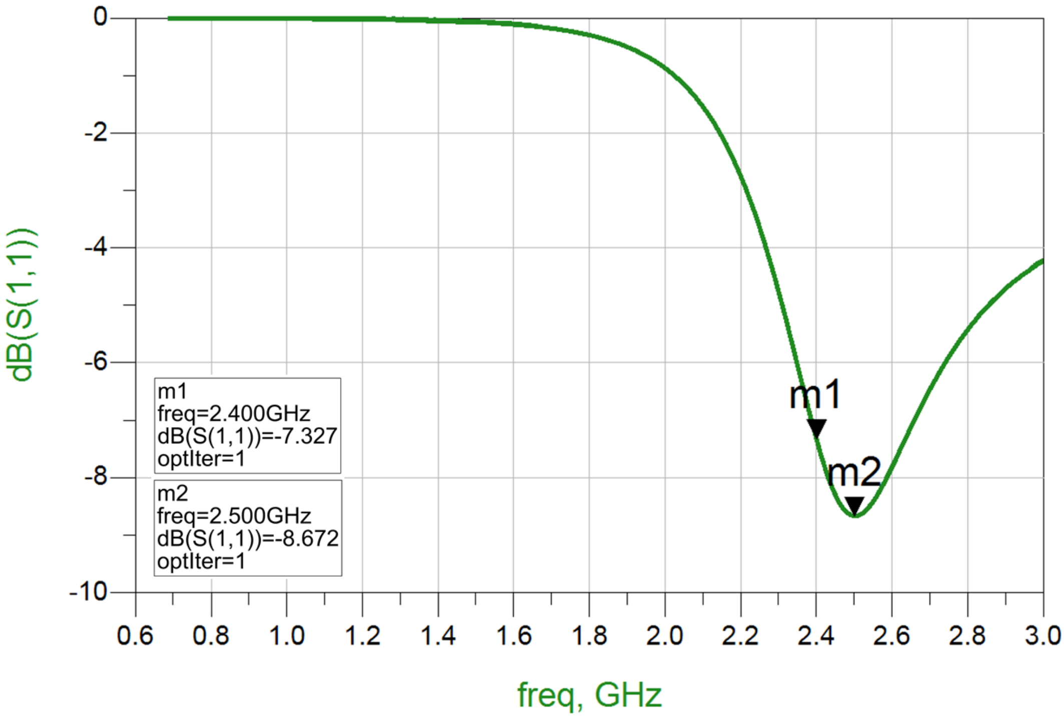


Figure 13 – Input reflection coefficient related to the wearable example here provided.

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