Ansys 2025 R1

POWERING INNOVATION THAT DRIVES HUMAN ADVANCEMENT

Getting Started with EMIT - Tutorial 2

Ansys

ANSYS, Inc.
Southpointe
2600 Ansys Drive
Canonsburg, PA 15317
ansysinfo@ansys.com
https://www.ansys.com
(T) 724-746-3304
(F) 724-514-9494

Release 2025 R1
January 2025

Conventions Used in this Guide

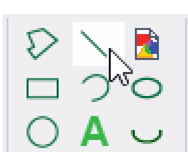
Please take a moment to review how instructions and other useful information are presented in this documentation.

- Procedures are presented as numbered lists. A single bullet indicates that the procedure has only one step.
- Bold type is used for the following:
    - Keyboard entries that should be typed in their entirety exactly as shown. For example, “**copy file1**” means you must type the word **copy**, then type a space, and then type **file1**.
    - On-screen prompts and messages, names of options and text boxes, and menu commands. Menu commands are often separated by greater than signs (>). For example, “click **HFSS** > **Excitations** > **Assign** > **Wave Port**.”
    - Labeled keys on the computer keyboard. For example, “Press **Enter**” means to press the key labeled **Enter**.
- Italic type is used for the following:
    - Emphasis.
    - The titles of publications.
    - Keyboard entries when a name or a variable must be typed in place of the words in italics. For example, “**copy** *filename*” means you must type the word **copy**, then type a space, and then type the name of the file.
- The plus sign (+) is used between keyboard keys to indicate that you should press the keys at the same time. For example, “Press Shift+F1” means to press the **Shift** key and, while holding it down, press the **F1** key also. You should always depress the modifier key or keys first (for example, Shift, Ctrl, Alt, or Ctrl+Shift), continue to hold it/them down, and then press the last key in the instruction.

Accessing Commands: *Ribbons, menu bars,* and *shortcut menus* are three methods that can be used to see what commands are available in the application.

- The *Ribbon* occupies the rectangular area at the top of the application window and contains multiple tabs. Each tab has relevant commands that are organized, grouped, and labeled. An example of a typical user interaction is as follows:

  "Click **Schematic** > **Line**"

This instruction means that you should click the **Line** command on the **Schematic** ribbon tab. An image of the command icon, or a partial view of the ribbon, is often included with the instruction.

- The *menu bar* (located above the ribbon) is a group of the main commands of an application arranged by category such File, Edit, View, Project, etc. An example of a typical user interaction is as follows:

  "On the **File** menu, click the **Open Examples** command" means you can click the **File** menu and then click **Open Examples** to launch the dialog box.

- Another alternative is to use the *shortcut menu* that appears when you click the right-mouse button. An example of a typical user interaction is as follows:

  “Right-click and select **Assign Excitation> Wave Port**” means when you click the right-mouse button with an object face selected, you can execute the excitation commands from the shortcut menu (and the corresponding sub-menus).

Getting Help: Ansys Technical Support

For information about Ansys Technical Support, go to the Ansys corporate Support website, http://www.ansys.com/Support. You can also contact your Ansys account manager in order to obtain this information.

All Ansys software files are ASCII text and can be sent conveniently by e-mail. When reporting difficulties, it is extremely helpful to include very specific information about what steps were taken or what stages the simulation reached, including software files as applicable. This allows more rapid and effective debugging.

Help Menu

To access help from the Help menu, click **Help** and select from the menu:

- **[product name] Help** - opens the contents of the help. This help includes the help for the product and its *Getting Started Guides*.
- **[product name] Scripting Help** - opens the contents of the *Scripting Guide*.
- **[product name] Getting Started Guides** - opens a topic that contains links to Getting Started Guides in the help system.

Context-Sensitive Help

To access help from the user interface, press **F1**. The help specific to the active product (design type) opens.

You can press **F1** while the cursor is pointing at a menu command or while a particular dialog box or dialog box tab is open. In this case, the help page associated with the command or open dialog box is displayed automatically.

Table of Contents

1 - Introduction

This tutorial builds on the project developed in Tutorial 1 to introduce additional modeling concepts and features in EMIT. You can load a completed version of the Tutorial 1 project archive from “C:\Program Files\ANSYS Inc\v251\AnsysEM\Win64\Examples\EMIT\Tutorials\Tutorial 1 – Completed”, or you can work with your own version of the Tutorial 1 project.

Key Concepts

- Samplings with multiple channels
- Explore results and "drill-down" into Scenario Details
- Frequency Hopping with random sampling and EMIT's availability metric

Project Configuration

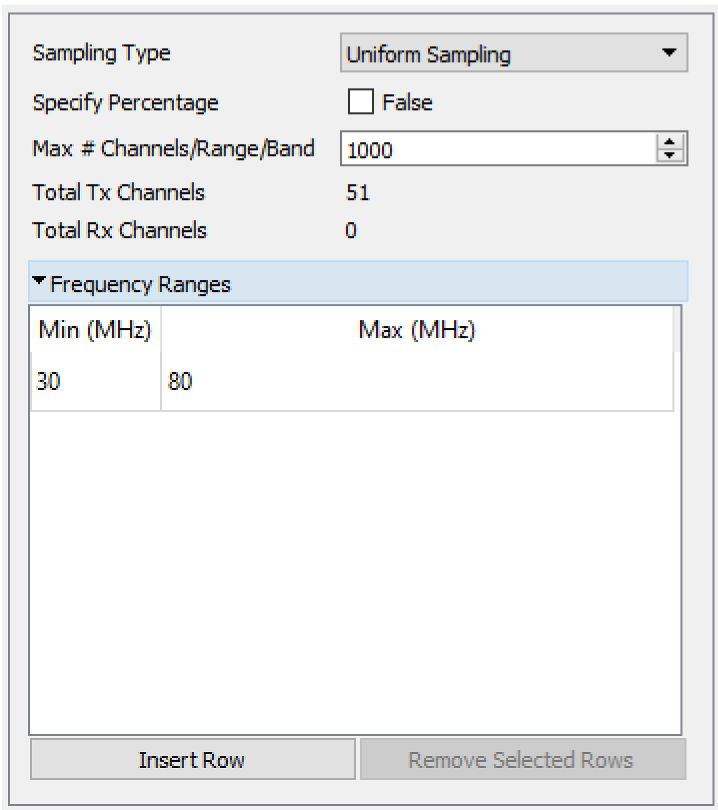
For this tutorial, we will modify the project built in Tutorial 1. Load that project into Electronics Desktop and save it as "Tutorial 2" by selecting Save As from the main File menu.

Delete the low pass filter on the Tx by right clicking the Filter in the EMIT Design’s Schematic Diagram and selecting Delete. Reconnect the Antenna to the Tx-1 (Lo-VHF) radio.

2 - Modify the Tx and Rx Samplings

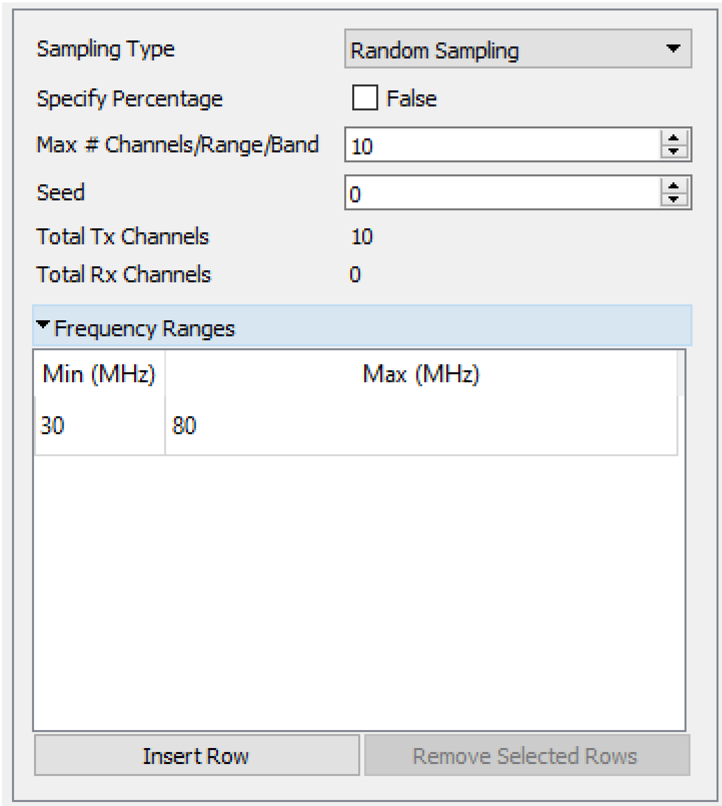
We want to modify the Tx and Rx radios so that we can explore the use of EMIT when a design contains multiple radios and multiple channels within a sampling.

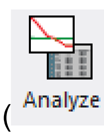
To begin, open the Tx-1 (Lo-VHF) Radio's Configuration dialog and select the Sampling node. In the property panel, edit the Frequency Ranges table to have a single range from 30 MHz to 80 MHz. Since the Tx is defined with 1 MHz channel spacing, 51 separate Tx channels will be simulated.



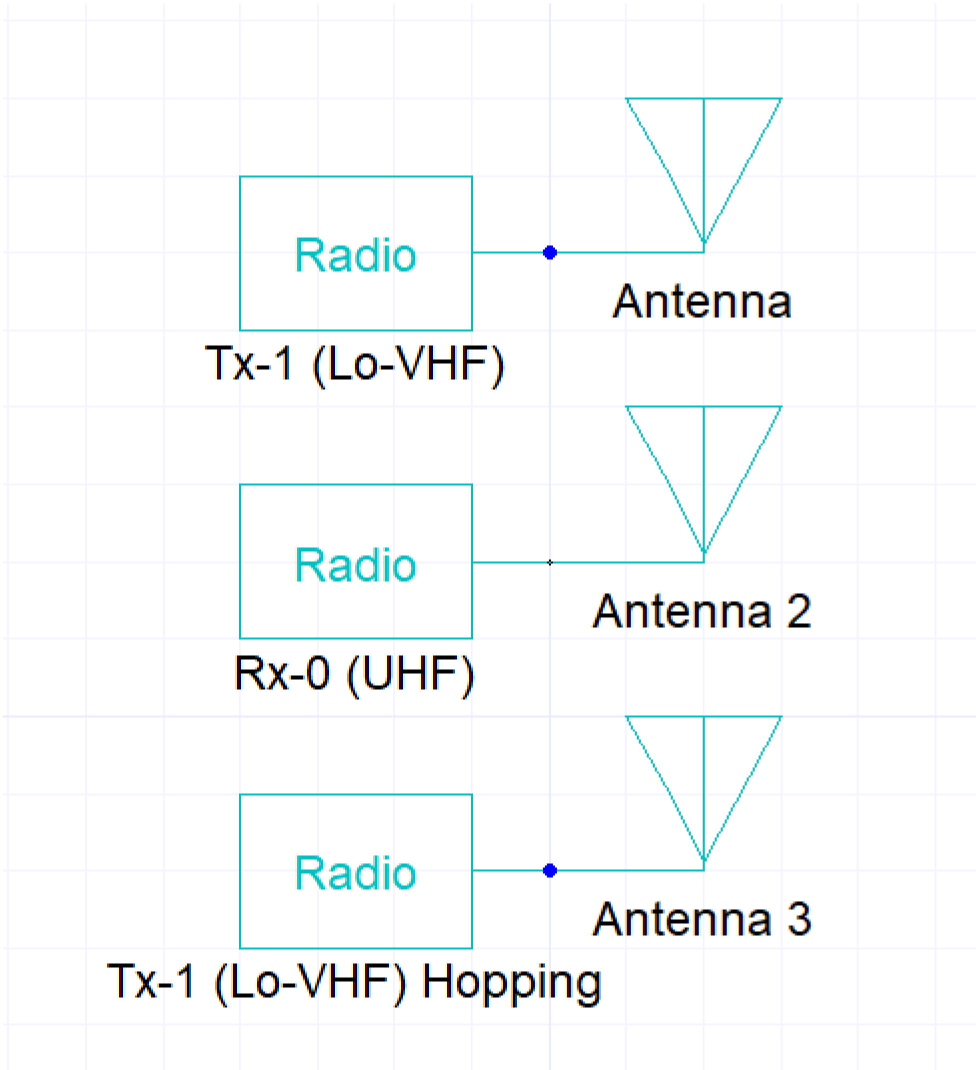
EMIT can model radios that are operating in a frequency hopping mode by setting the Sampling Type to Random Sampling, which uses a pseudorandom number generator to randomly select a channel within the Frequency Range(s) defined for the Band. An EMIT design may contain any number of Radios and each radio can have unique sampling parameters.

To create a second radio for the Tx so that we can simulate its frequency hopping mode, right-click on the Tx-1 (Lo-VHF) radio in the schematic and select **Copy**. Paste the Radio into the schematic and rename it to *Tx-1 (Lo-VHF) Hopping*. In the property panel of its Sampling node, set the parameters as shown below. The radio will randomly "hop'" on 10 of the available frequencies between 30 and 80 MHz, inclusive. If desired, multiple rows can be included in the table to allow a radio to hop in non-contiguous segments of a band.

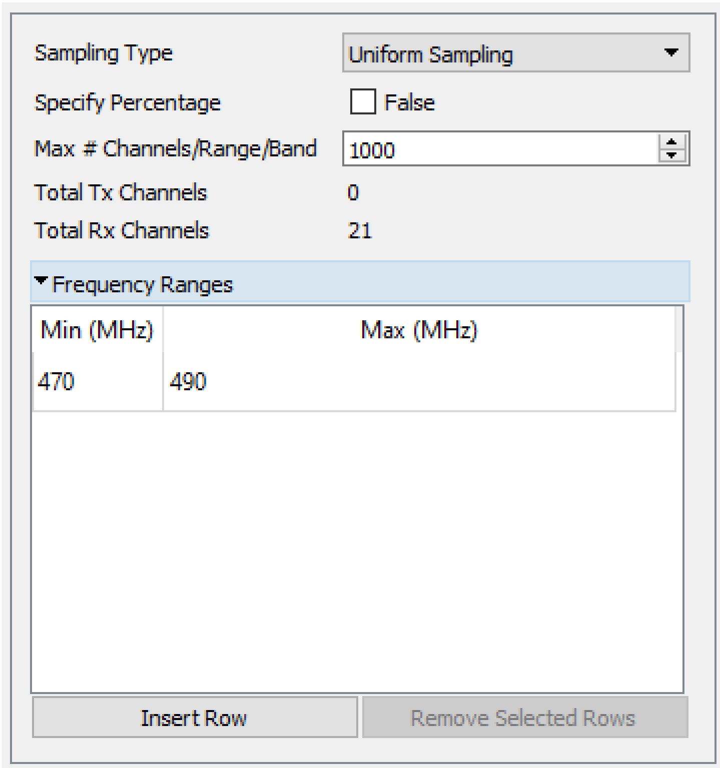


In the Simulation ribbon tab, click the Analyze button (

) to open the results dialog. Note that if you look at the Scenario Matrix in the top-left of the results dialog, Total Channel Combinations = 51 which is the number of channels in the Tx-1 (Lo-VHF) radio alone. That is because we have not yet connected this new radio (Tx-1 (Lo-VHF) Hopping) to an Antenna, and it will not be simulated. In the Schematic ribbon menu, click the Antenna button () to connect an antenna to the Tx-1 (Lo-VHF) Hopping radio.

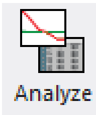


Next, we will modify the Rx radio's sampling. Open the Rx-0 (UHF) Radio’s Configuration dialog and select the Sampling node. In the Sampling node's property panel, set the parameters as shown below.


Sampling Type
Uniform Sampling
Specify Percentage
False
Max # Channels/Range/Band
1000
Total Tx Channels
0
Total Rx Channels
21
Frequency Ranges
Min (MHz)
Max (MHz)
470
490
Insert Row
Remove Selected Rows

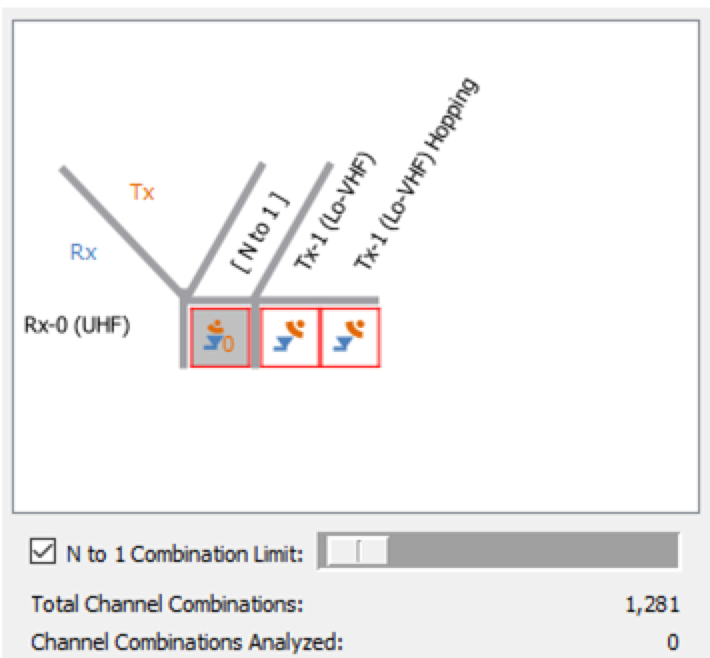
3 - Run the Simulation

From the **Simulation** ribbon, click the **Analyze** button.



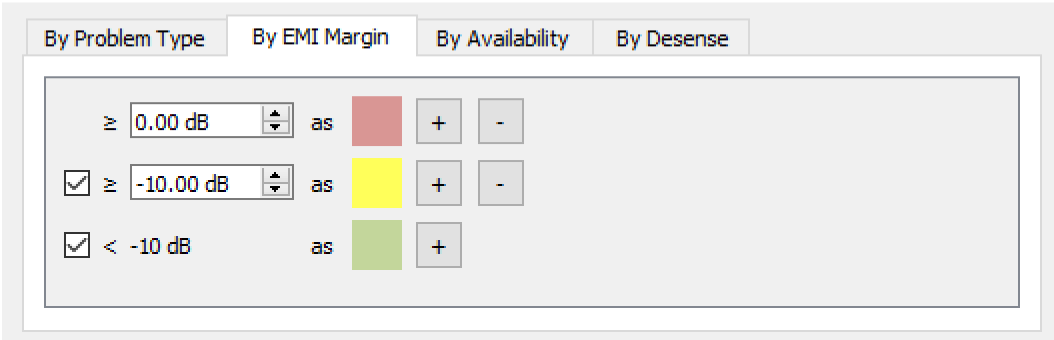
Before we run the simulation, let's view the Scenario Matrix. The project now contains 1281 Tx/Rx channel combinations, as shown below the Scenario Matrix.

> **Note:** The [N to 1] column for the Rx-0 (UHF) receiver is still disabled because the N to 1 channel combination limit is currently too low for any N-1 analyses to occur. Moving the slider to the right will enable the [N to 1] analysis, though that is not the subject of this Tutorial. See Tutorial 3 for details on running N-1 analyses in EMIT.

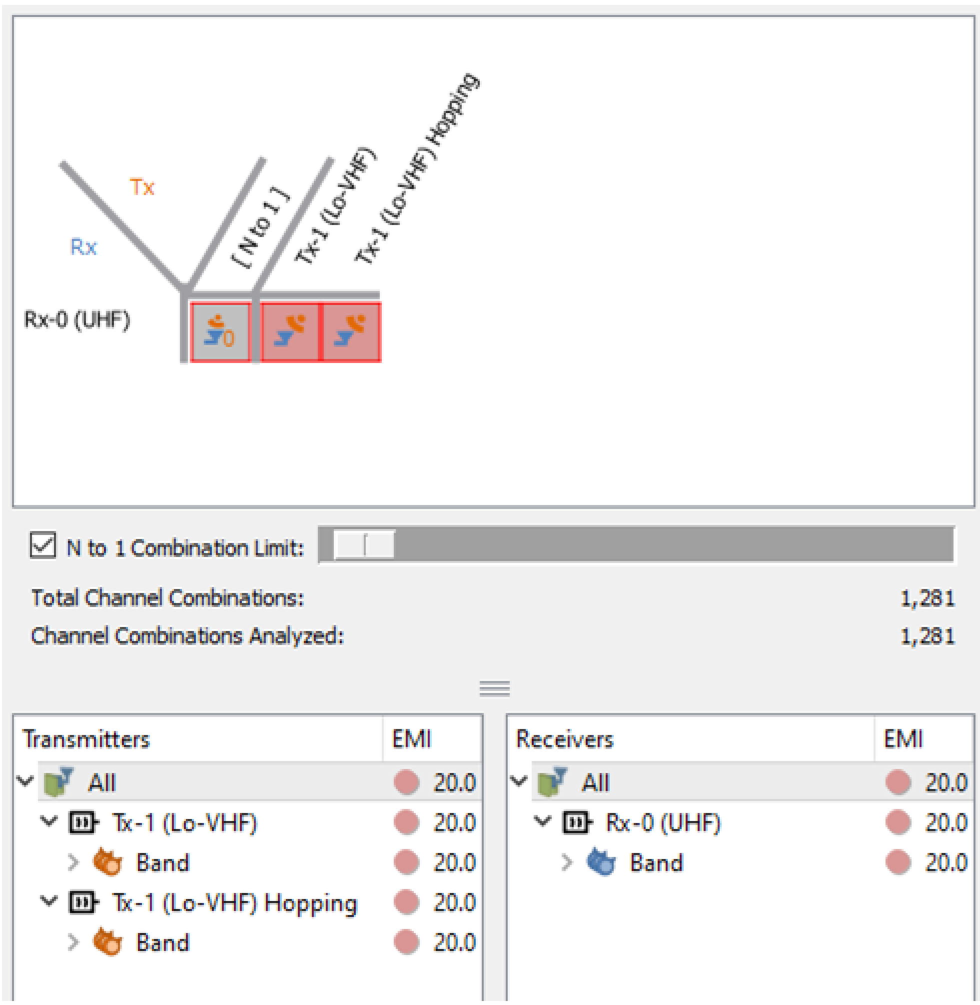


We are ready to run the analysis by selecting the Run icon () above the Scenario Matrix.

The thresholds for color-coding results can be defined by the user in the Result Categorization property panel. The settings used for this example are shown below. If your settings don't match those shown below, change them now. For this scenario, we wish to flag as interference any EMI margins greater than 0 dB and any EMI margins greater than -10 dB as marginal.



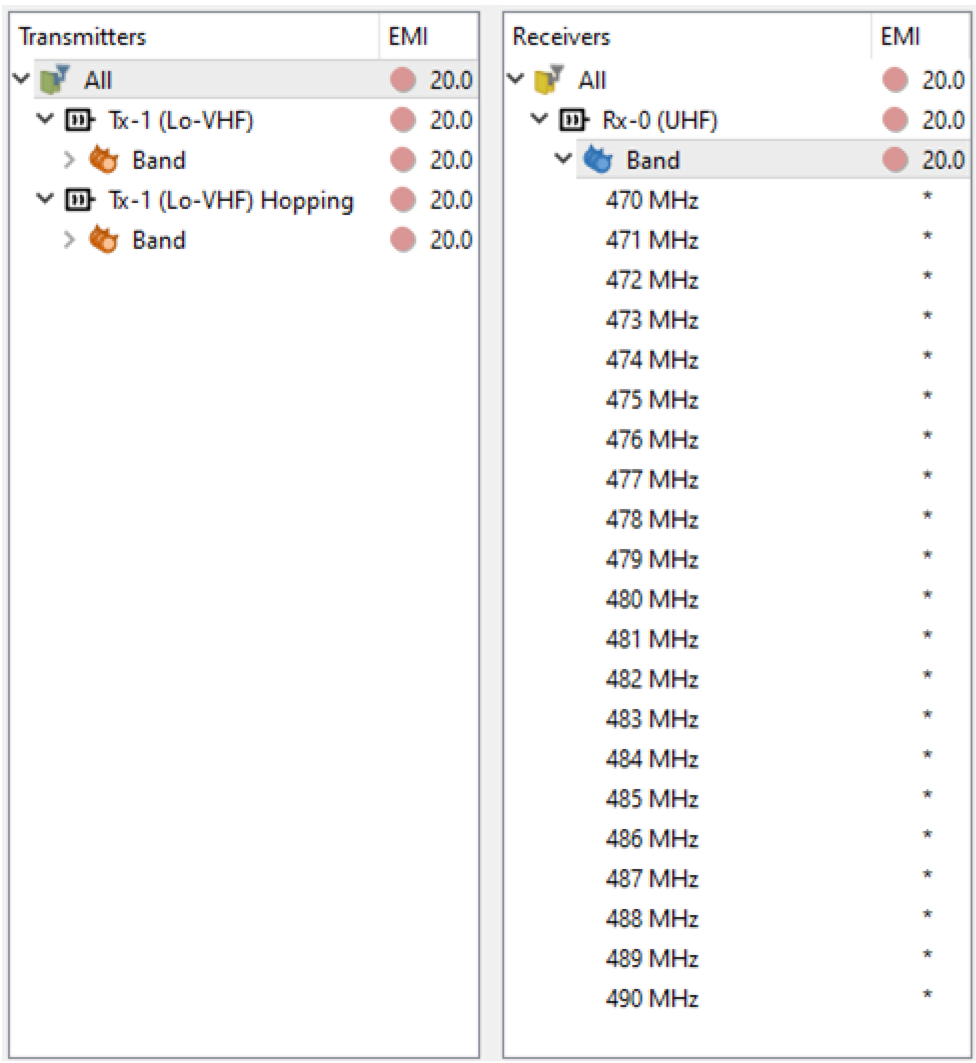
After the simulation completes, the Scenario Matrix and Scenario Details will indicate potential interference problems with a red color.



The Scenario Details display a list of the transmitters and receivers in the scenario and the worst-case interference result for each node. Although we only have a single Rx in this example, we can still explore the Scenario Details without loss of generality.

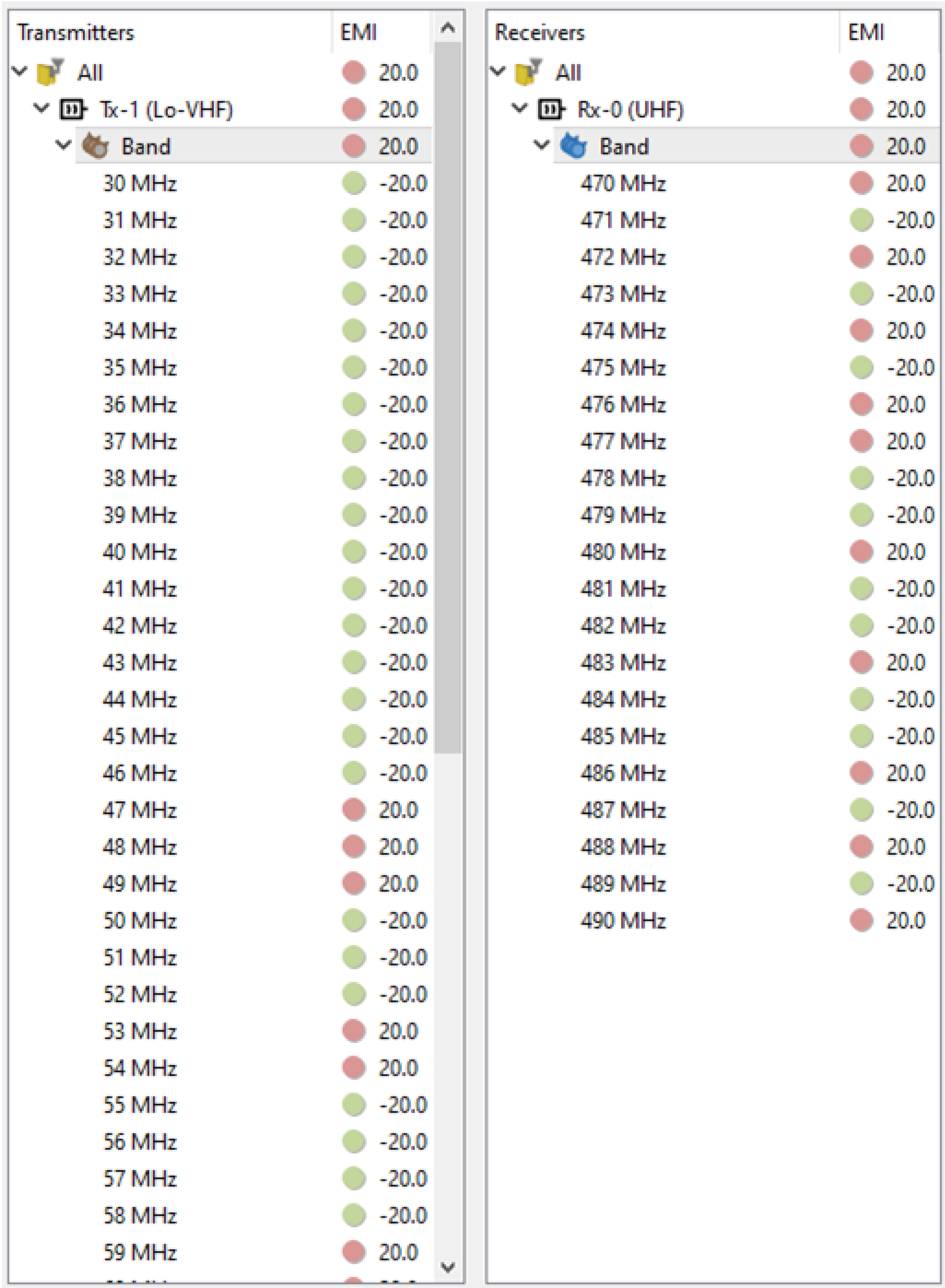
The first step is to select the Rx we wish to explore further. In this case, we have only one Rx. At this level of the Scenario Details, we see that for fixed channel operation, there is a 20 dB EMI margin indicating an interference problem. At this level, we know that there is an interference issue with this Rx, but we don't know which Tx is causing it (for multi-Tx scenarios) or what Tx/Rx channel pairs are problematic. We only know that there is at least one issue causing interference in the Rx.

Expand the Rx-0 (UHF) row in the Scenario Details to drill-down to the next level. At this level, we see a list of all the Bands defined for the radio (in this example, there is only one band). Finally, expand the Band node to display a list of all the Rx channels and the maximum EMI margins for each Rx channel.

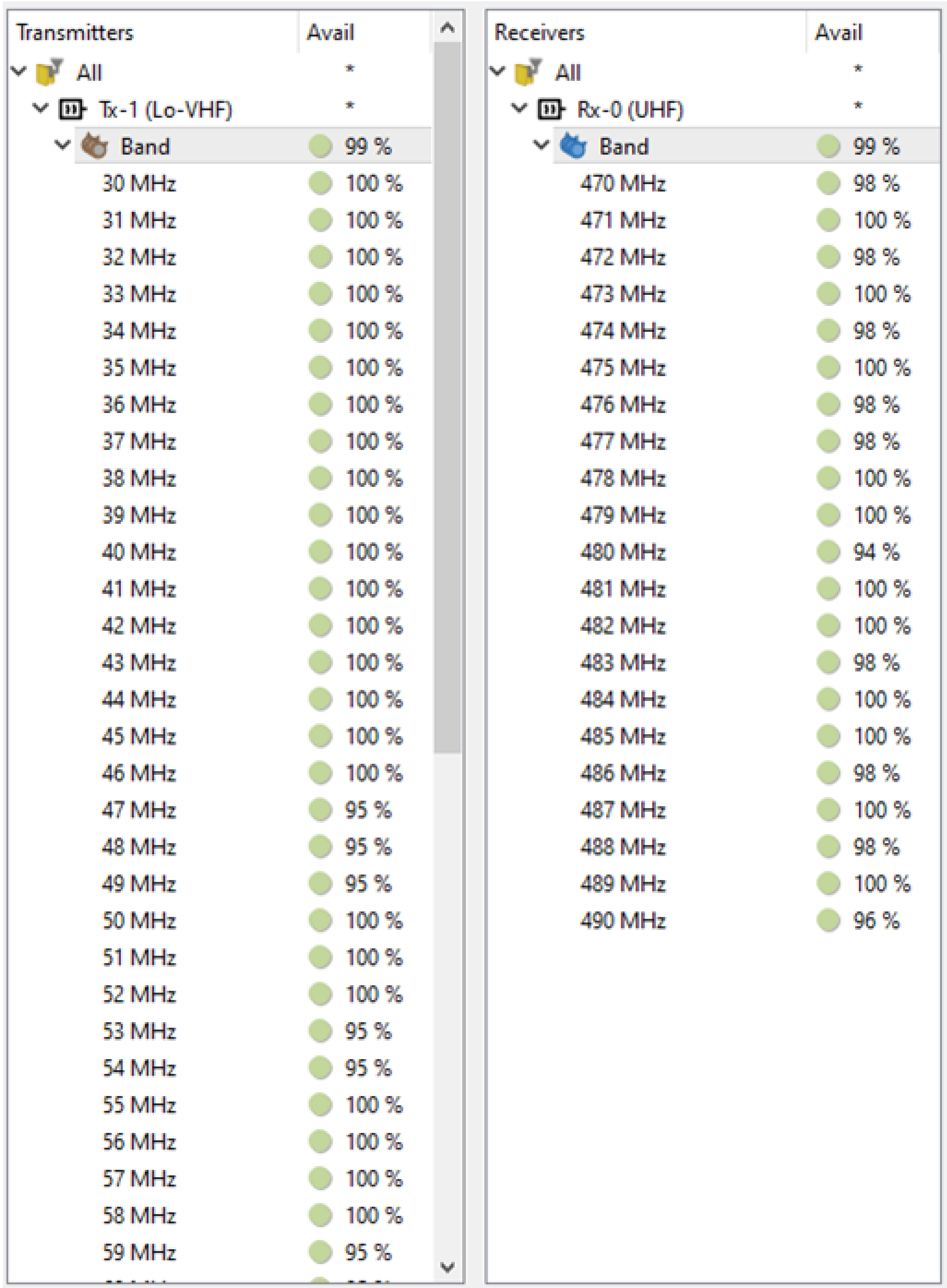


> **Note:**
>
> EMIT does not permanently store the EMI margin for the individual channels, so these may temporarily appear with an asterisk in the EMI column. If a band pair is selected in the Scenario Details, EMIT will compute and cache the channel level results until the Result Cache limit is reached.

To display the channel level EMI margins, you must also select a Tx Band or Channel in the Scenario Details. Drill-down on the transmitter side of the Scenario Details and select the Band for the Tx-1 (Lo- VHF) radio. After the band is selected, the Receivers side of the Scenario Details will update to show the channel level EMI margins for the two bands selected.



The Scenario Details clearly shows that quite a few of the Rx channels experience interference (e.g. 470, 472, 474, 480 MHz, etc) and we can use EMIT's availability metric to determine the percentage of channels without interference. In the Analysis dialog, select the Availability icon () to toggle the availability metric. The Scenario Details will automatically update to show a percentage next to each Band or Channel. This quickly shows that while the max EMI margin for the Band is +20 dB, only 1% of the channel combinations result in interference.

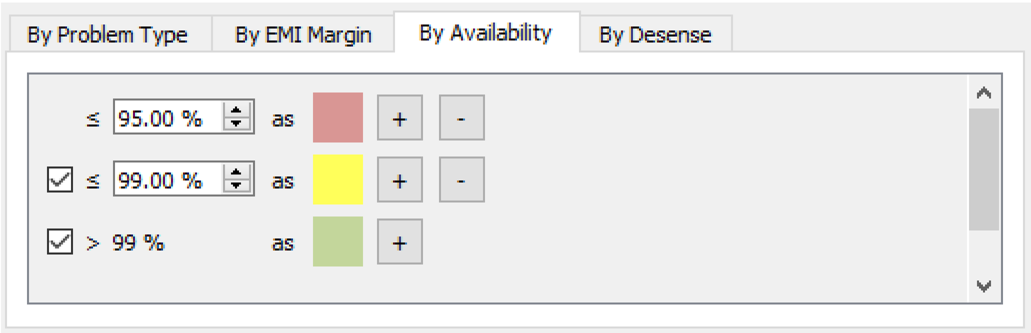


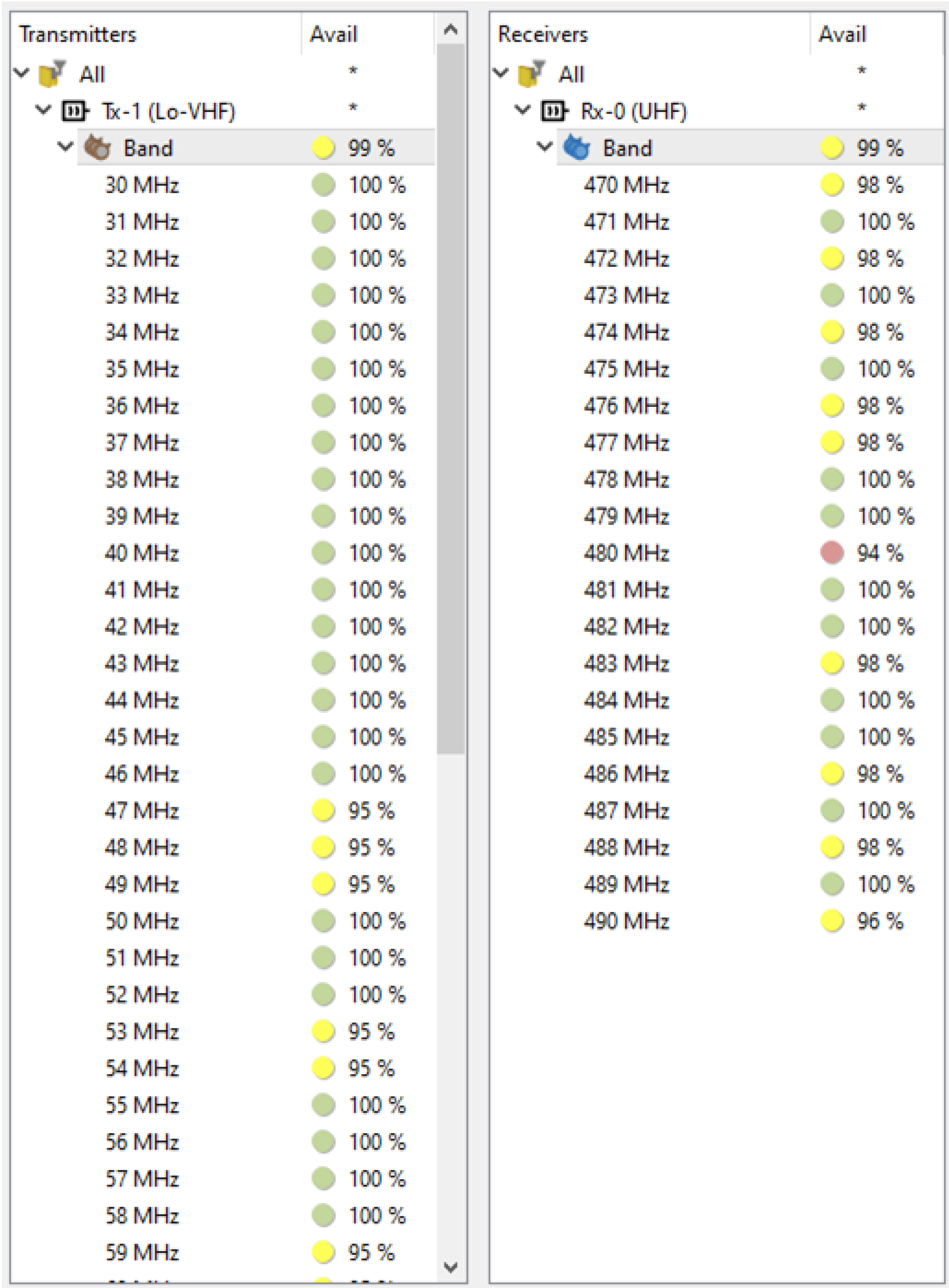
The availability metric is extremely useful for developing frequency plans. Scrolling through the list of transmit channels in the Scenario Details shows that many of the Tx Channels have 100%

availability, i.e., they do not cause interference. Thus, to eliminate the interference, one could simply develop a frequency plan that only operates on the channels with 100% availability.

You'll also notice that all availabilities (even those <100%) are green. This is because we are still using EMIT's default thresholds. If you go to the **By Availability** tab of the Result Categorization window, you can modify these thresholds. Let's say this is a high priority link and requires virtually no interference.

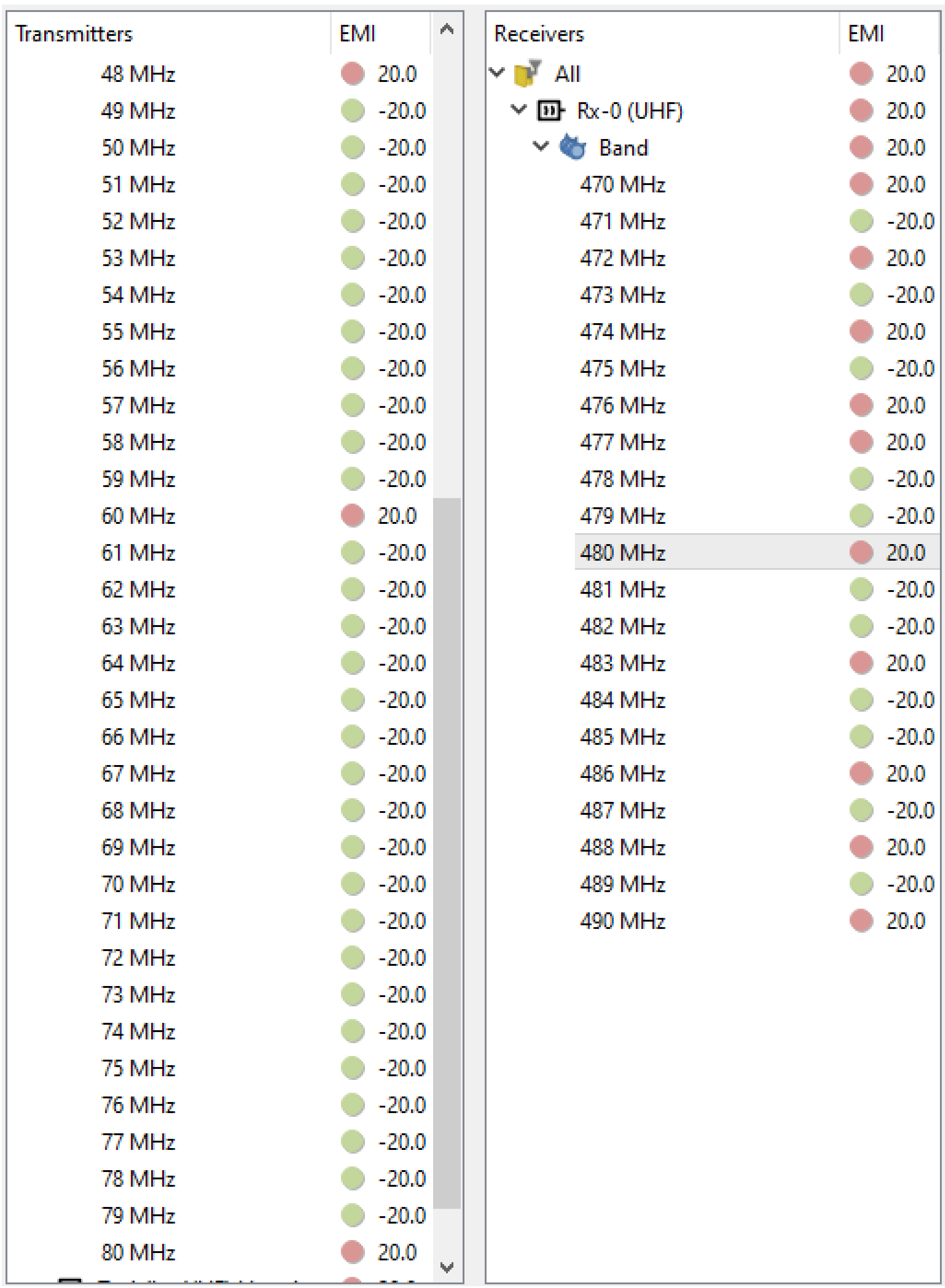
We can set the thresholds below and flag channels with even the slightest bit of interference.





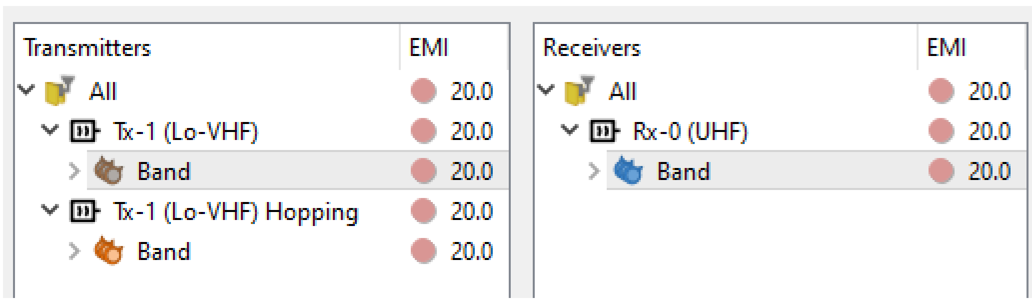
If you select one of the Rx channels (e.g. 470 MHz) with availability = 98% and then toggle back to the EMI Margin metric (click the), you'll notice that only one of the Tx channels (47 MHz) interferes with that channel. Simply avoiding operating on that channel combination would eliminate the interference.

While we now have an acceptable mitigation strategy, let's continue to investigate the specific cause(s) of the interference problems. Toggle the Scenario Details back to the EMI Margin results by clicking the icon and select the 480 MHz Rx channel. The EMI margins on the Tx side of the Scenario Details will instantly update to reflect the EMI margin that each specific Tx channel causes for the specific 480 MHz Rx channel. Scrolling through the list, we see that there are 3 Tx channels that cause interference for the 480 MHz Rx Channel: 48 MHz, 60 MHz, and 80 MHz.

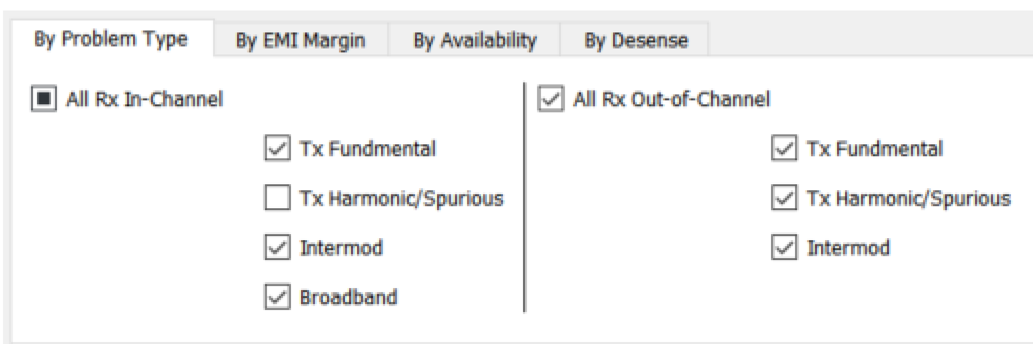


Select the row in the Scenario Details corresponding to the 60 MHz Tx channel. The plot marker and label in the Result Plot quickly identify that the interference is due to the 8th harmonic of the Tx falling in the Rx channel of 480 MHz (8 x 60 = 480 MHz).

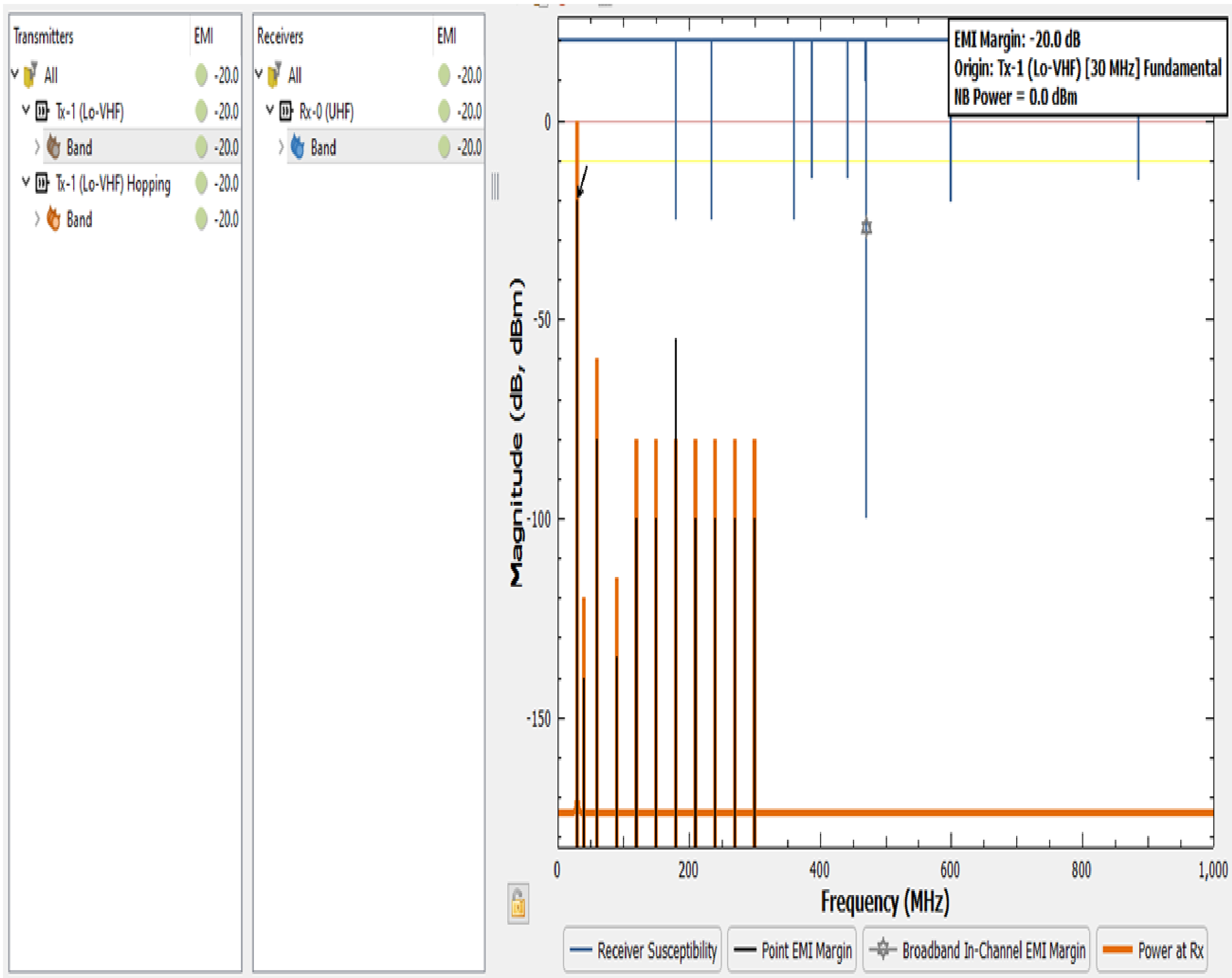
Similarly, selecting the 48 MHz and 80 MHz Tx channels in the Scenario Details will show that the interference due to those channels is also due to harmonics that fall within the 480 MHz Rx channel. To quickly see if there is any interference in this Rx Band that is not due to harmonics, select the Rx Band in the Scenario Details.



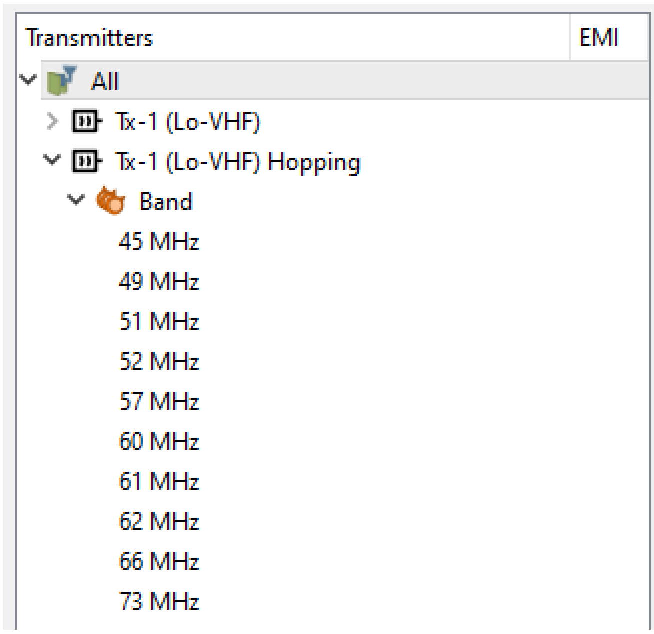
Next, in the upper-right corner of the Analysis dialog, select the **By Problem Type** tab.. Under the Rx In-Channel category, deselect the **Tx Harmonics/Spurious** option. This will remove (via post-processing) any interference that is due to transmitter harmonics or spurs falling in the Rx's tuned channel from the results views (Scenario Matrix, Scenario Details, Result Plots, and Interaction Diagram).



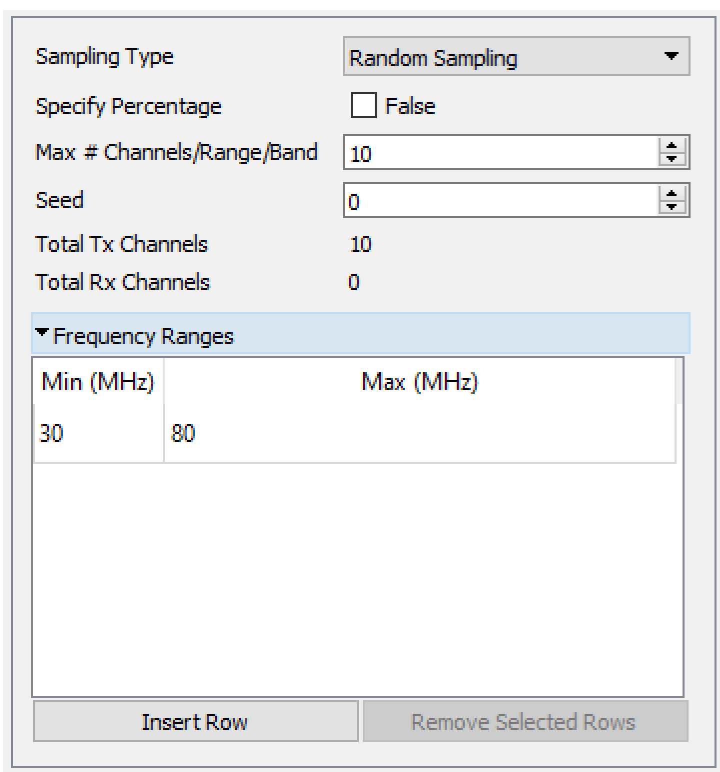
The worst-case EMI margin is now -20 dB and is due to the out-of-band fundamental.



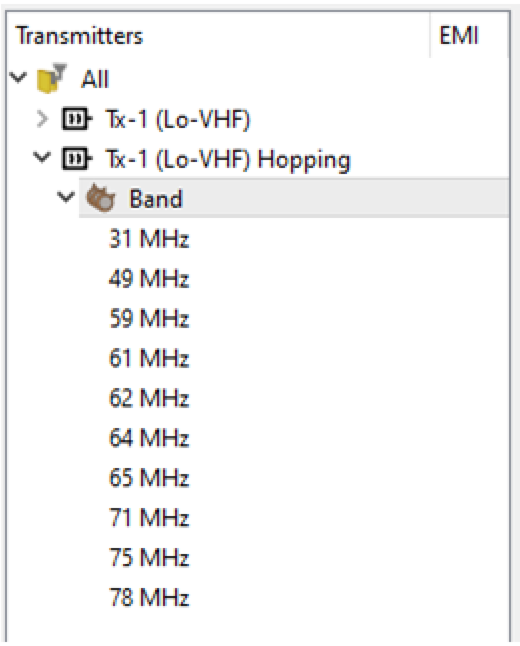
Finally, let’s look at the results for our "Frequency Hopping" radio (toggle the Tx/Harmonic/Spurious problems back on). In the Scenario Details, select the Tx-1 (Lo-VHF) Hopping radio. Drill-down to display its channels so we can inspect them more thoroughly. Note that the Band contains a random list of frequencies, as seen below.



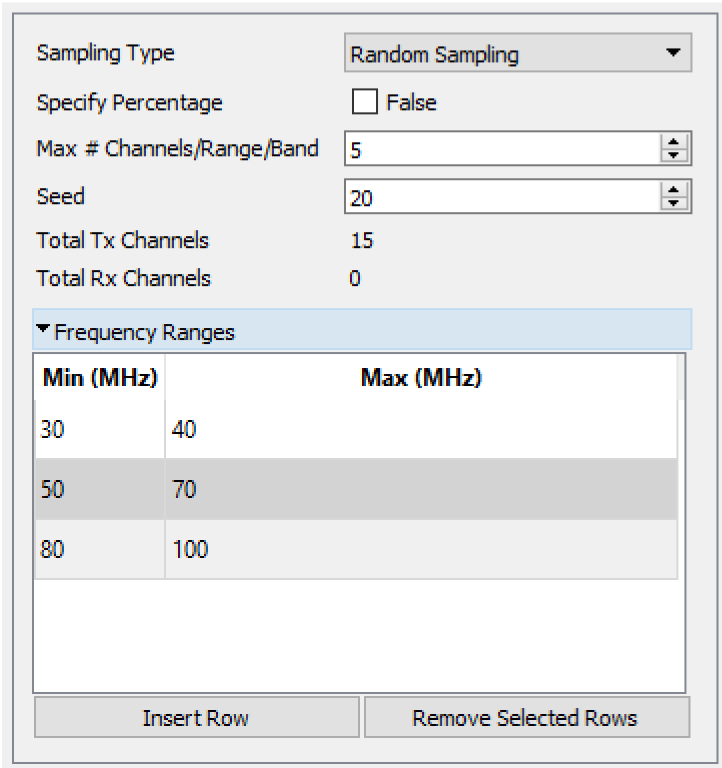
The parameters of the random list of frequencies are set by the Sampling properties of the radio. The frequency range limits the possible channels to the 30-80 MHz subrange (remember, the Band is defined to operate from 30-100 MHz) and the Max # Channels/Band specifies that we want 10 channels for each range. The last parameter here is the Seed, which allows the random simulation to be repeated since the same seed will always result in the same channels selected.



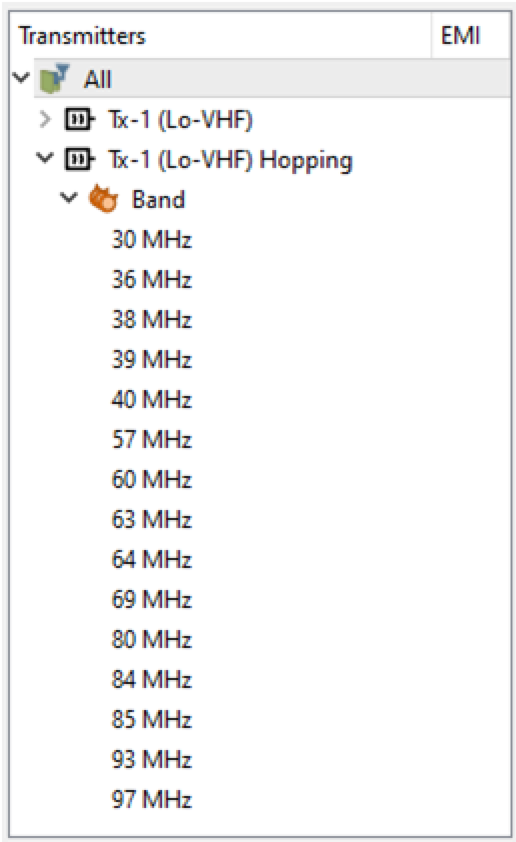
Close the Analysis window to return to the schematic view. Open the Configuration dialog for the Tx-01 (Lo-VHF) Hopping radio and select the Sampling node. Change the seed to 20 and click OK to close the dialog. Click the Analyze button in the ribbon to reopen the results dialog. In the Scenario Details, select the Tx-1 (Lo-VHF) Hopping radio and expand the Band node. The channel list should appear as below.



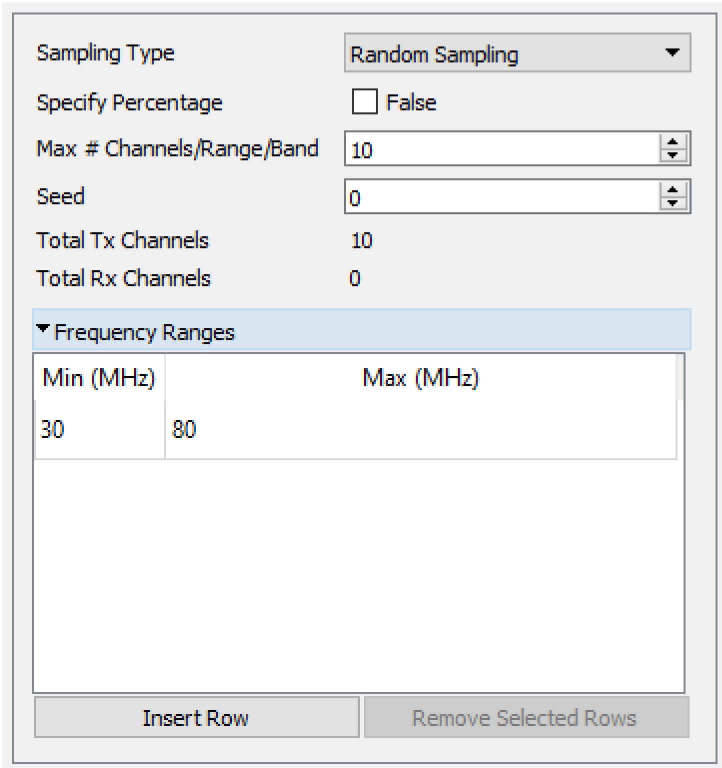
Next, let's further modify our Tx-1 (Lo-VHF) Hopping Sampling by setting multiple ranges for the random channel selection. Again, close the Analysis window, open the Configuration dialog for the Tx-1 (Lo-VHF) Hopping radio, and set the parameters as shown below.



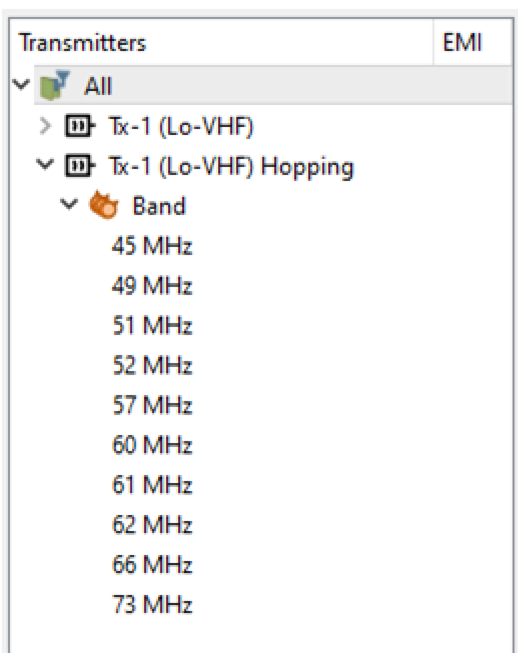
Reopen the Analysis dialog and note the changes in the Scenario Details. There should be 3 ranges, each with 5 random channels in each range.



Finally, to show the reproducibility of the random analysis mode, set the Tx-1 (Lo-VHF) Hopping Sampling's properties back to their initial settings as shown below.



Again, reopen the Analysis window, select the Tx-1 (Lo-VHF) Hopping radio in the Scenario Details list, and expand the Band node. The original frequency list that produced the green results above should now be displayed in the Scenario Details.



At this point, save your project and experiment a bit with the Results Categorization filters to examine other Tx/Rx channel pairs in the various hopping and non-hopping samplings to get a feel for operation of this important EMIT feature.