

# Things to Know About New Load Pull

## Problem

What do I need to know about current (V12+) Load Pull?

## How is the current load pull simulation different than V11?

There are a couple of main differences. The first is support for swept load pull. This functionality also comes with a lot of [additional load pull graphing capability](#). The second is the use of [A/B waves](#) rather than columns of "derived" data such as gain, output power, PAE, etc. in the saved data set. This file storage format is more compact and versatile as it allows the user to plot data that they may not have considered when setting up the load pull simulation. As a result of both of these changes, the load pull DUT gets added to a load pull simulation template. This template is created automatically the first time the new load pull script runs ( **Scripts > Load Pull > Load\_Pull** ). Additional templates can also be created manually using **Scripts > Load Pull > Create\_Load\_Pull\_Template** ). Further detail are in the [AWR load pull simulation guide](#)

## Can I use the V11 simulated load pull script in new version of MWO?

Yes, please use this [version](#). This file should go in your ScriptsUser directory. The easiest way to get it there is to save it to disk, unzip it, and run **Scripts > Configuration > Import\_Global\_Script**.

## Do I have to use a Load Pull Template Schematic to do simulated load pull?

Yes, as it correctly defines power, gamma, and frequency sweeps as well as having the appropriate tuners and voltage and current meters for measuring the A/B waves.

## How can I sweep additional variables in my Load Pull Template Schematic?

Any variable can be swept, but there are some naming requirements. If it is possible to derive the swept quantity from the A/B waves or DC voltages /currents (e.g. power or bias), then the variable name must be prefixed with an "i." If it is not possible to derive the swept quantity from the A/B waves or DC voltages/currents (e.g. temperature), then the variable name must be prefixed with an "r." Note that power, gamma, and frequency sweep names must match the file standard exactly but that these names are already setup in the Load Pull Template Schematic. Please contact technical support [awr . support@ni.com](mailto:awr.support@ni.com) for additional details.

## There are a lot of load pull measurements. How do I know which to use?

Start by watching this video: [Load Pull Measurements](#)

Use this decoder for the measurement names.

- All the new, swept load pull measurements begin with "G\_."
- Measurements that align data to a specified value end in "A."
- Measurements that plot the intersection between contours contain "\_C2."
- Measurements that plot a single value contain "\_V."
- Measurements that plot a real value contain "\_R."
- Measurements that plot a complex value contain "\_C."
- Measurements that plot the response at any swept harmonic other than fundamental load (i.e. PAE vs. 2nd harmonic gamma sweep, source pull, etc.) contain "EX."
- Measurements that plot the interpolated maximum or minimum values contain "MAX" or "MIN."

So with that foundation in mind here's a phenomenological list of the most commonly used measurements

- If you want to plot contours
  - Load\_Pull > G\_LPCM plots contours
  - Load\_Pull > G\_LPCM\_A plots contours aligned to a specified value (like 1 dB compression)
  - Load\_Pull > G\_LPCM\_C2 plots the intersection between two contours
- If you want to plot contour interpolated min or max values
  - Load\_Pull > G\_LPCMMIN plots the contour min value
  - Load\_Pull > G\_LPCMMAX plots contour max value
- If you want to plot a single contour at a specified value
  - Load\_Pull > G\_LPCM\_V plots a single contour at a specified value
- If you want to see the gamma points in your file
  - Load\_Pull > G\_LPGPM plots gamma points for a swept load impedance
- If you want to plot swept data on a rectangular plot (like PAE vs. output power)
  - Data > PlotMD\_R plots real data with an x and y-axis chose in the measurement (like PAE vs. output power)

## I'm having a tough time plotting my data, how do I sanity check it?

1. Plot the "pulled" gamma points (G\_LPGPM)
  - a. Do they look right (you should be able to visually confirm what they expect)?
  - b. Are they the same for every independent variable value? (e.g. the gamma points are almost never a function of power, frequency, etc.)
  - c. If the gamma points are wrong there's no point and looking any further at the data
2. Plot the available input power vs. index for every independent variable value (PlotMD\_R)
  - a. Does it look correct (you should know the input power sweep range)?
  - b. Are they the same for every independent variable value (e.g. the available input power is usually not a function of gamma, frequency, etc.)
  - c. If the input power sweep is incorrect the source gamma data is probably incorrect and we can't properly compute anything that derives from input power (e.g. G\_Trans, PAE, etc.)
3. Plot the output power vs. index for each and every independent variable value (PlotMD\_R)
  - a. Does it look correct reasonable (e.g. physical and not fictional)?
4. Plot the gain compression vs. index for each and every independent variable value (PlotMD\_R)
  - a. Does it look correct reasonable (e.g. physical and not fictional)?
  - b. It's good to understand how hard the device was pushed so you have an idea of reasonable values for alignment

If all that looks good now you have a reasonable understanding of the gamma range over which the data was swept, the input power sweep, the output power of the device, and how hard the device was compressed.

## The new load pull simulation script doesn't seem to auto-generate Graphs for me. Is that intended?

Yes, that's by design. With the old load pull script the user had selected the measurements which they wanted to capture, and the only swept dimension was the load gamma. Therefore it was relatively easy to know what to plot. With the new load pull script the output data is A/B waves. Thus, there are a lot more degrees of freedom in what values to plot. Similarly, the swept load pull data adds dimensionality to the data which makes auto-plotting complex. For example, plotting all PAE contours at all swept power points would probably not be very useful. We're open to the idea of bringing auto-plotting back if we feel that there is consensus on what plots would be universally useful. If you have some thoughts on this please share them with the AWR [Product Marketing team](#).

## Are 2nd and 3rd harmonic load pull (including nested harmonic sweeps) and two-tone load pull supported?

Yes, in v12.01+. Please see [Swept\\_Load\\_Pull\\_Measurements\\_Complete](#) for example.

## Are 4th and 5th harmonic load and source pull supported?

Possibly, it depends on your application. For more information please contact the AWR [Product Marketing team](#).

## Is source pull supported?

Yes, in v13+. Please see [Swept\\_Load\\_Pull\\_Measurements\\_Complete](#) for example.

## Is System load pull (i.e. ACPR / EVM load pull) supported?

Yes, in v13+. Please see [System\\_Load\\_Pull](#) for example.

## Can I de-embed a package model from my load pull data?

Yes, as of v12.01. Please see the [de-embedding documentation](#) or the fully featured swept load pull as shown in [Swept\\_Load\\_Pull\\_Measurements\\_Complete](#) example.

## Is it also possible to plot contours with a network embedded, instead of de-embedded?

Yes, by using a NEG2 block to negate your embedding network in a schematic and then de-embedding the schematic the network will end up being embedded. Since that's a little confusing here's a link to an [example project](#).

## When doing simulated load pull can I record the load pull A/B waves at the device model intrinsic pins?

Yes, as of v12.01. If the model has exposed internal pins as top level pins then connecting the A/B wave voltage and current meters to those pins and performing a simulated load pull will accomplish this. If the internal device pins are only exposed inside a subcircuit model or as nodes that are only visible in the Measurement dialog then please contact technical support for detailed instructions.

## Is it possible to run the load pull without the having the dialog pop up every time?

Yes, there is a headless mode. Please contact the AWR [Product Marketing team](#) for more details.

## Is it possible to use different meters to record the DC information than the A/B wave information?

Yes, this is supported. This is common in the case where a device is biased internally or in the case that load pull is being done on a matched device. Please contact the AWR [Product Marketing team](#) for more details.

## **Can I generate more than one load pull data file from the Load Pull Template with a single simulation?**

Yes, this is supported. Please contact the AWR [Product Marketing team](#) for more details.

## **My model is converging poorly and that's creating bad load pull data (i.e. data with PAE > 100% or < 0%) which makes plotting contours and looking at min / max values difficult. Can you help with that?**

Yes, it's supported in a beta release of v12. Please contact the AWR [Product Marketing team](#) for more details.

## **Can I see how a metric at one harmonic plotted is impacted by the swept gamma at another harmonic? In other words, can I see the impact of 2nd and 3rd harmonic gammas on fundamental output power or PAE?**

Yes, as of v12.01. Please see the [G\\_LPCM\\_EX](#) measurement documentation for details or the fully featured swept load as shown in [Swept\\_Load\\_Pull\\_Measurements\\_Complete](#) example.

## **What is the difference between G\_Compress and Compress\_1dB?**

There is no difference if **Align to specify value** is set to 1 for **G\_Compress**. **Compress\_1dB** does not use the **Align to specify value**.

## **How is gain compression defined for G\_Compress, Compress\_1dB, and Compress\_2dB?**

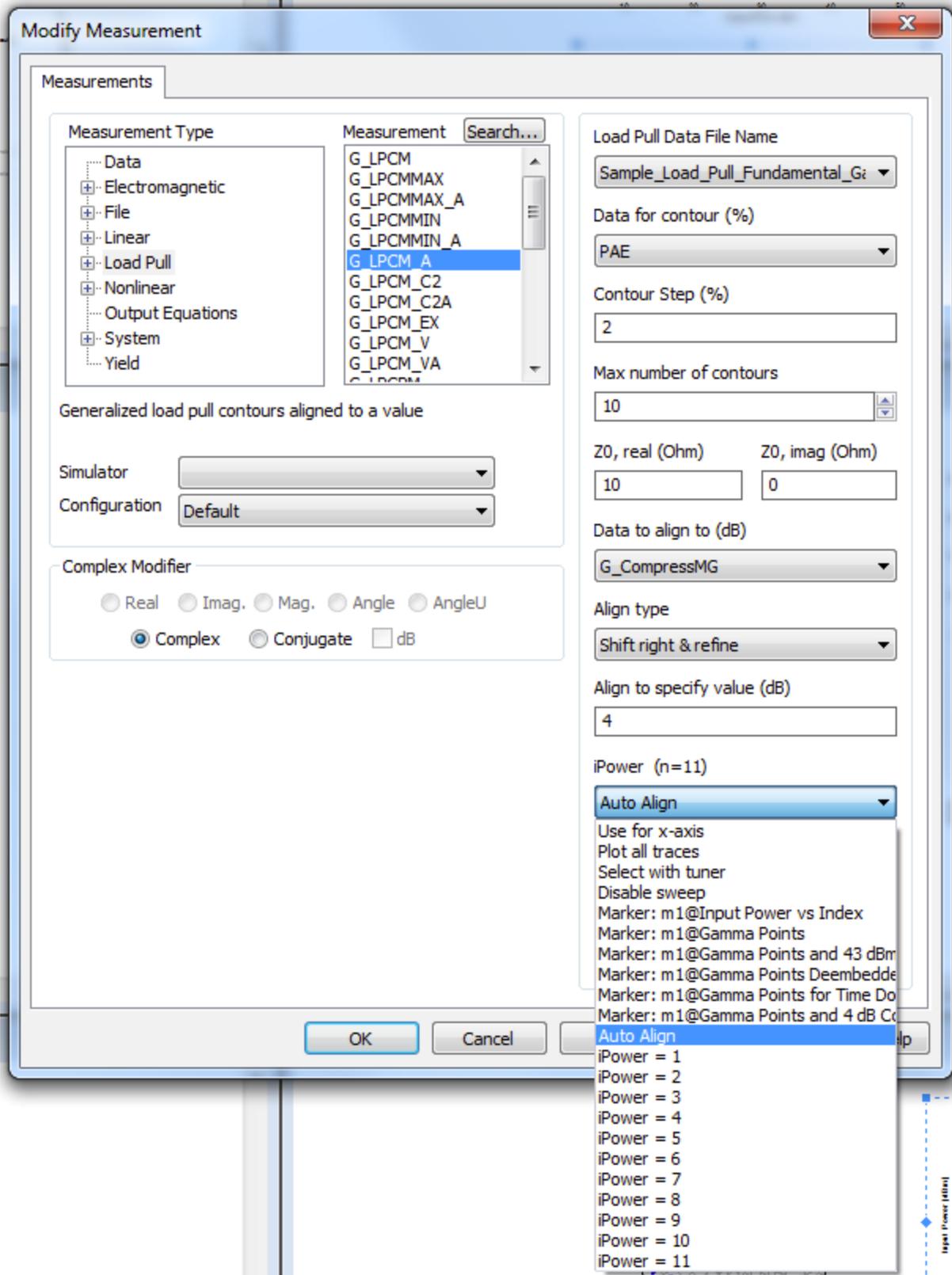
It is defined as compression from the first power point, which, ideally, is the linear gain. For gain compression defined from maximum gain use **G\_CompressMG**.

## **How is gain compression defined for G\_CompressMG?**

It is defined as compression from maximum gain. For gain compression defined from linear gain (or from the first input power point) use **G\_Compress**.

## **How do I set the iPower index when using aligned measurements? Since the data is aligned what does this index even mean?**

As of v12.01, the iPower index on aligned measurements is set automatically by choosing **Auto Align**.



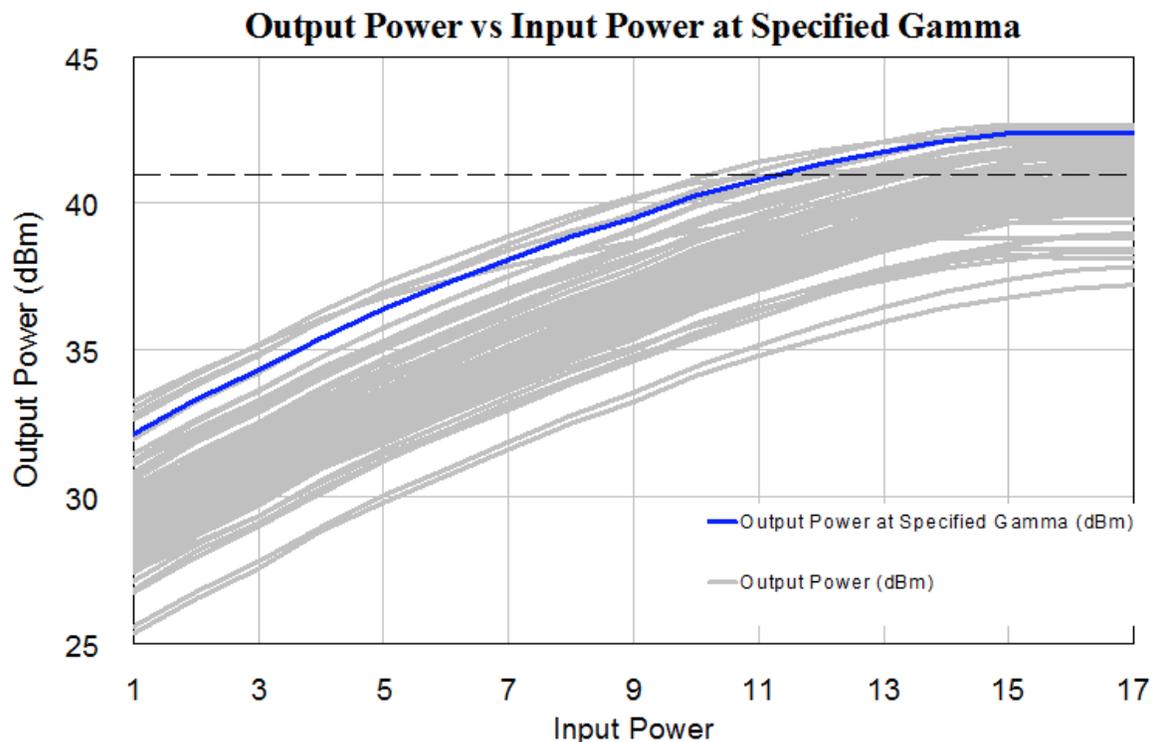
**Can you provide some additional insight into how the aligned Measurements work?**

When first simulating an aligned data measurement a simulation warning is generated that tells you the iPower index at which the data is aligned. It looks something like this

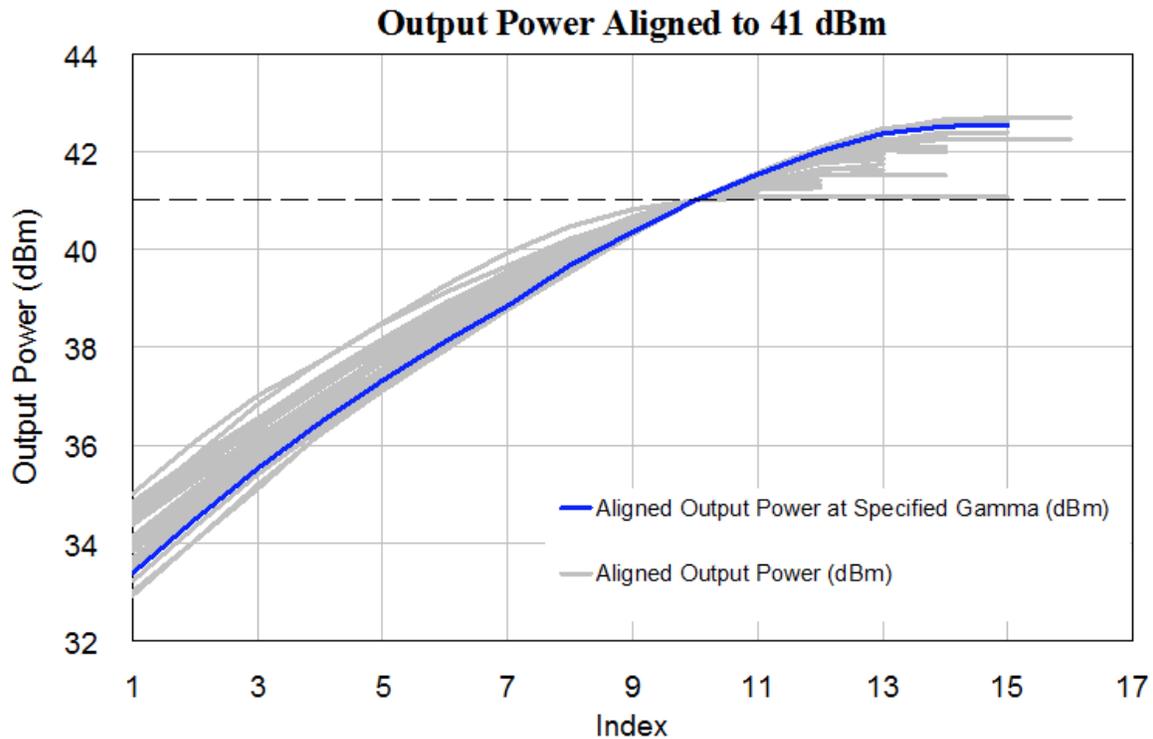
8:13:47 AM Measurement - Sample\_SPL\_New:PlotMD\_R\_A(PLoad,PLoad,2,11)[m1@Gamma Points and 41 dBm Output Power Contour,X,1]  
: Data is aligned at index 10 (49 of the traces were out of range for the alignment)

In this case, the warning tells you that at  $iPower = 10$  the data is aligned to the specified value. Visual inspection of the aligned data is always recommended as a sanity check and confirmation that the data alignment algorithms are doing a good job. This is done by plotting the data with "Data to align to" and "Data to plot" as the same value.

Some pictures might help explain what's going on. One way to picture what the data aligning is doing is "jiggling" the data along the x-axis to get everything to align at the specified value. After the alignment is complete the full data arrays are still present for all values of  $iPower > 0$  (i.e. if the data slides off the left side of the graph it is lost). For example, here's a plot of output power vs. input power index



Now here's the same data aligned to 41 dBm. Note that not all the traces achieve 41 dBm output power so there are less of them. Also, note that after the data is "jiggled" to get it to align it's clear from this graph that the alignment is at  $iPower = 10$  and that's the  $iPower$  value at which the contours should be plotted (which is the  $iPower$  index selected by **Auto Align**).



**Can you provide some additional insight into how to set the "Align Type" parameter on the aligned Measurements?**

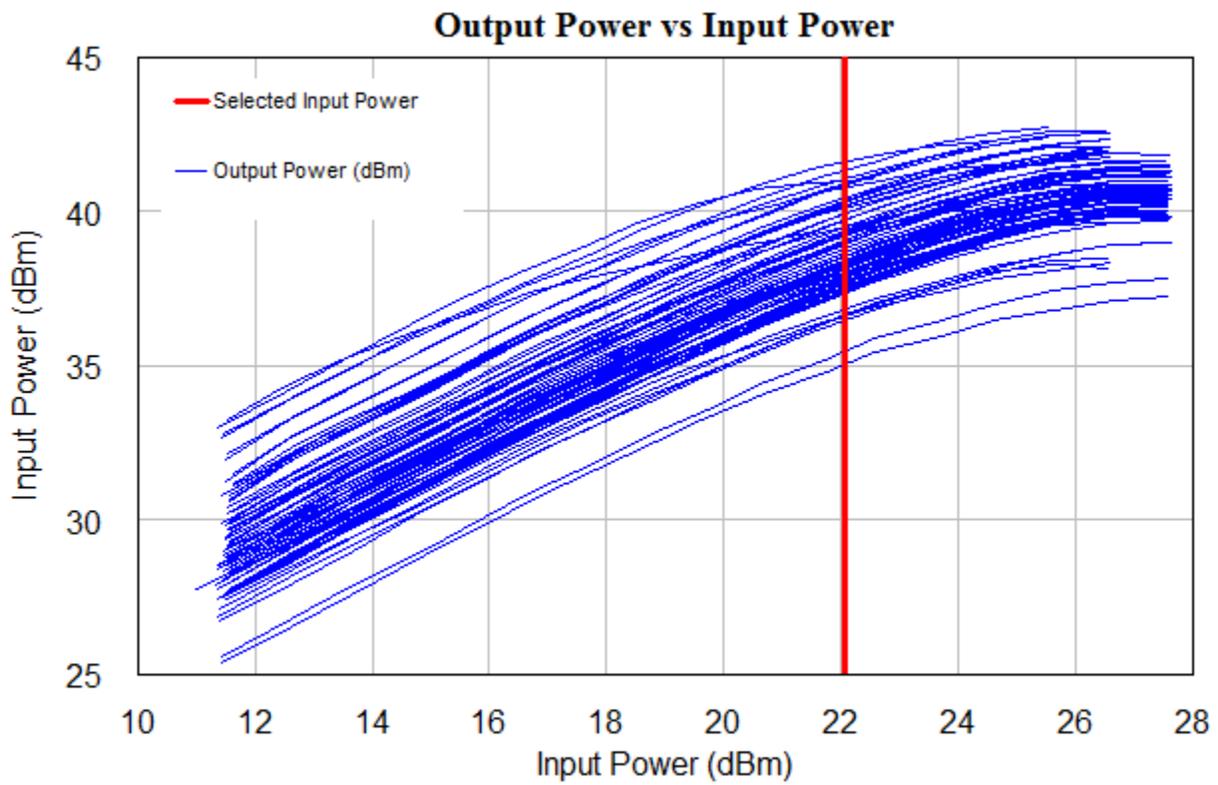
For v13+ the align type parameter has little impact on the aligned data. However, if you'd like view data at a power index above or below the aligned point the align type makes a difference since it discards data that fall off of the "shifted" direction. More detail on the align type can be found in the [G\\_LPCM\\_A Measurement documentation](#). For additional questions or discussion on this topic please contact technical support.

**Is it possible to view "backoff data" such as the PAE at 3 dB backoff from 1 dB Compression?**

Yes, this is supported by choosing the appropriate iPower index when working with aligned data. Please contact AWR Technical Support [awr.support@ni.com](mailto:awr.support@ni.com) for more information.

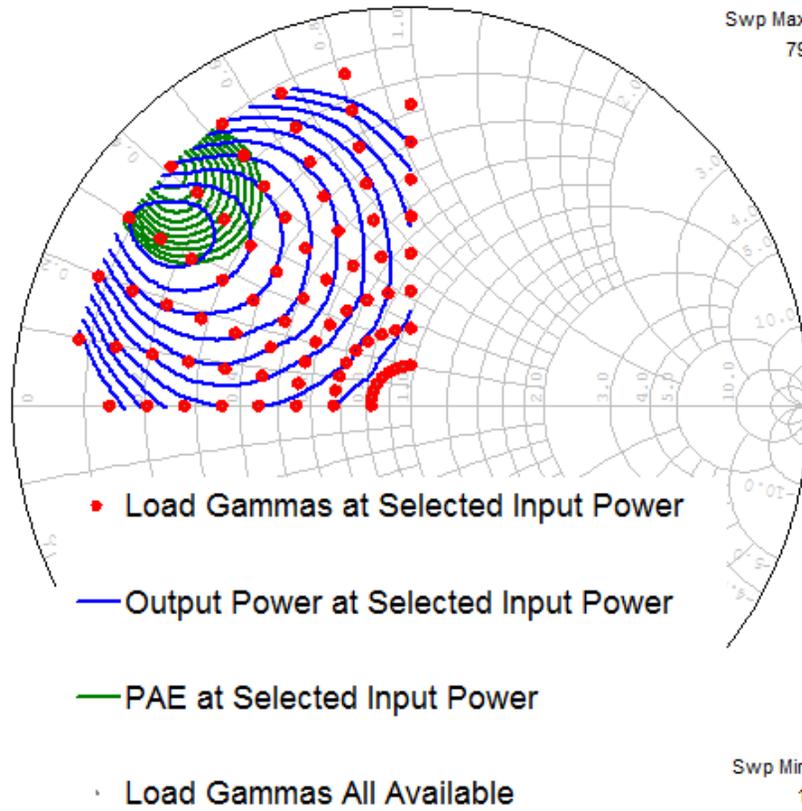
**Why do my contours cover a smaller area of the Smith Chart than the gamma sweep in my load pull file?**

Measured swept power load pull data often doesn't have a full power sweep at every gamma point. As a result, the contours plotted at a high input power point can look quite a bit different than the contours plotted at a low input power point because the number of gamma points over which the contours are plotting is different. For example, the traces below are show measured output power vs. input power for each gamma point. Note that not all traces are swept all the way to the highest input power.

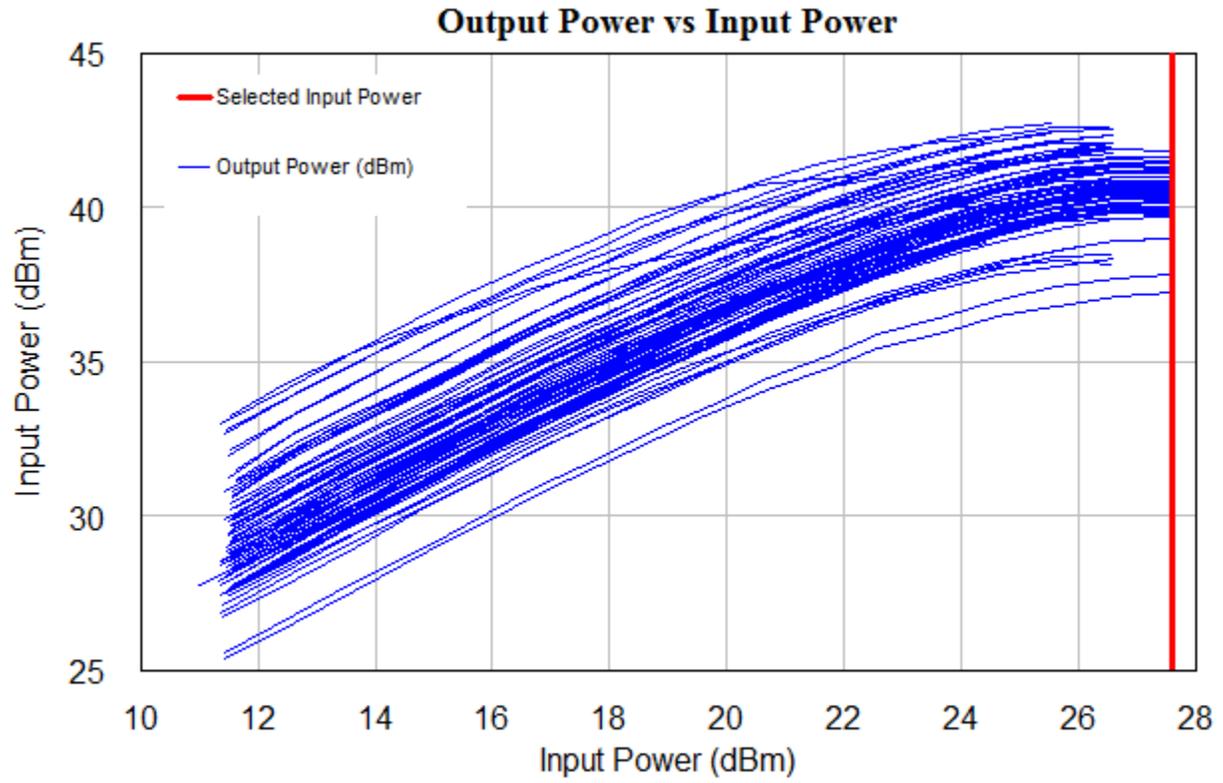


Contours plotted at the low input power level highlighted by the vertical red line cover the full gamma sweep in the data file because, as can be seen on the graph, all of the gamma points were swept to at least 21.7 dBm input power. The red circles on the contour graph below show the gamma points for the selected input power (i.e. the full sweep) and the contours cover the region highlighted by the red circles.

## Output Power and Efficiency Contours

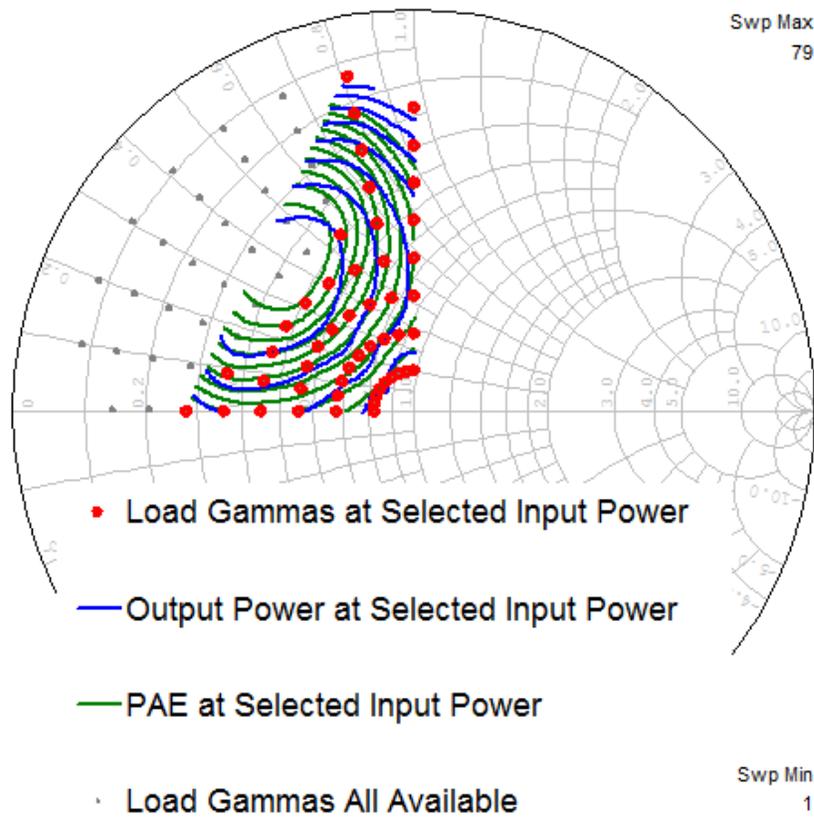


However, when the input power is shifted to the highest available input power there is only data at ~60% of the gamma points.



Thus, the resulting contours only plot over the region of the Smith Chart defined by the reduced number of gamma points. The red circles show the gamma points that were swept to the highest input power level while the grey circles show the gamma points which were not able to achieve the highest input power.

## Output Power and Efficiency Contours



The example that illustrates this issue can be downloaded [here](#)

### Why does my interpolated load pull data (LPINT) look strange at high power levels

If the LPINT measurement shows "bad" results the cause is often that the load pull data is not very complete at high drive levels and, thus, LPINT is extrapolating outside of the remaining gamma sweep range. This is an extension of the reduced contour area case described in the question above.

The above image has poor data above 49 dBm. If you plot Pload against its index you will notice that a lot of the traces are not converging for the higher input powers.

Another way to diagnose this is to plot the gamma grid (G\_LPGG) or convex hull (G\_LPCH) at those power levels to see the reduced grid and that the matching network is now outside of the network, or simply use G\_LPGPM and tune the power levels. For the above case look at the below gamma points low and high power levels and the subsequent match.

**Low Power Level Gamma Points**

**High Power Levels**

**I love all this new load pull stuff but have some feedback; what's the best way to provide that?**

Please contact the AWR [Product Marketing team](#).