Fwd: Feedback >> PA Compression Test Version 1.5

Nick.Lalic to me 12:43

- Nick

Sent from my iPhone

Begin forwarded message:

> **From:** "Greg Bonaguide" <Greg.Bonaguide@rsa.rohde-schwarz.com>
> **Date:** December 1, 2015 at 7:08:12 AM PST
> **To:** "Nick Lalic" <Nick.Lalic@rsa.rohde-schwarz.com>
> **Cc:** "Mike Leffel" <Mike.Leffel@rsa.rohde-schwarz.com>, "Wayde Marshall" <Wayde.Marshall@rsa.rohde-schwarz.com>
> **Subject: Re: Feedback >> PA Compression Test Version 1.5 /cr/**
>
> Hi Nick,
>
> Here's the information you requested. I've got the "settings" folder, Exported data, my setup file (gb002.zvx), and the command log:
>
> *(See attached file: PA Compression Test.zip)*
>
> I've gone through your comments below to answer some of your questions. (My replies are in BLUE.) Things are looking better in the light of a new day…
>
> Regards,
>
> **Gregory M. Bonaguide**
> ***Senior Product Line Engineer - Spectrum Analyzers and Vector Network Analyzers***
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> Product and Application Information: http://www.rohde-schwarz.com/
> Service hotline: 888-TEST-RSA (888-837-8772) - Option 2 (technical support)
> Nick Lalic---11/30/2015 08:57:15 PM---Greg, Thanks for your feedback. It sounds like you had a rough time with PA Compression Test. Sorry
>
> From: Nick Lalic/RSA
> To: Greg Bonaguide/RSA@RSA,
> Cc: Mike Leffel/RSA@RSA, Wayde Marshall/RSA@RSA
> Date: 11/30/2015 08:57 PM
> Subject: Re: Feedback >> PA Compression Test Version 1.5 /cr/
>
> ---
>
> Greg,
>
> Thanks for your feedback. It sounds like you had a rough time with PA Compression Test. Sorry about that. Hopefully this reaches you in time for your visit with M/A-COM.
>
> I'll try to reply to your feedback inline.

2. The dialogs are a bit too large for the ZVA screen.
I'll see if I can make it a little smaller for the ZVA screen.
Yes, please check all your dialog boxes to make sure they'll fit within the ZVA viewing area.

3. It takes quite a few seconds before the "Max Gain" trace appears on the Compression Test...
The application waits for the first sweep to complete, then it displays the gain from that sweep as the Max Gain (at least so far). Similarly, the Pin at Compression trace is initially populated with the Pin value of this sweep. You don't see it because it is a flat line that overlaps the Pin-Ymin value of the plot. I also update this Pin trace with the actual compression values as I find them.

How long do you expect a frequency sweep to take with your settings? It sounds like it might be taking about 30-35 seconds? If it is confusing to the user to see an empty initial plot, I can display something else and/or wait to transition to the plot. What would you rather see?
Could you just display intermediate values as they become available?

4. How is the "Max Gain" determined? Actually point-by-point increase of power to find the max gain at each frequency? Also, when the first few Pin points appear, they look like a sawtooth. Why? What is the algorithm actually doing? And why does it seem to break the sweep up into segment "chunks"?

The first sweep sets the initial Max Gain values. If the Gain Expansion option is included, these values are compared to subsequent sweeps and updated if a higher gain is found. As such, for a Gain Expansion sweep, you may see this trace increase as more sweeps are performed. So, yes, this is a point-by-point, (freq, Pin) max gain value. These maximum gains do not necessarily all occur at the same Pin value.

Similarly, the Pin at compression trace initially contains the Pin value of the first successful sweep. As compression points are found for particular frequency points, those points are updated in the plot. So, you should see individual frequency points increase as compression is found for them.

Perhaps this isn't the best way to illustrate Pin compression values being found. What might be a better display method is to have the Pin at compression line increase with each sweep across the entire line, UNLESS compression has been reached for a particular point, at which point that particular point is frozen in place. This way you'd be able to watch the Pin values "ramp up" to compression for each frequency point.

Does that make sense, and does that sound better? Feel free to suggest something completely different for this progress plot. This is just an initial guess on my part.
I understand (now) how it currently works (thanks for the explanation), but I think it would be more "intuitive" to the user to have the "Pin at compression line increase with each sweep across the entire line," as you suggest above.

5a. ...why isn't the Pin (Compression) trace smooth? Why so choppy?

So, as I described above, I am increasing Pin, checking S21 (gain) and comparing it to Max Gain to see whether or not I have reached compression. By reached compression, I mean found a gain that is compressed by AT LEAST the desired compression value. Of course, the values of Pin that I am using are set by the user's power settings (start power, stop power, power points). This means that, more likely than not, I will overshoot Pin at compression by some amount not exceeding the user's power spacing.

This Pin value, at or just past compression, is what I am displaying on the progress screen. Because the measured power values are not exactly the actual compression values, I then perform a linear interpolation. I perform this interpolation after all sweeps are complete. These interpolated values are what I write to the VNA when I am done.
I'm not sure that linear interpolation is the best method to arrive at values for this non-linear compression characteristic, which is more parabolic. Could be a problem with larger power steps, larger compression values, and/or tighter customer requirements.

This explanation should answer two of your questions:

a) The Pin progress plot is choppy because the compression test has not completed yet (and so some of the frequency points are not at compression), and because they are not interpolated. Using the algorithm described at the end of question #4 above, and perhaps also adding on-the-fly interpolation, should help improve this.

b) The compression values displayed on the VNA have been linearly interpolated. As such, some of the values may come out to be close to the desired compression value, but not exact. The markers on the VNA are actually doing the same thing unless you happen to place them exactly on a measurement point. If you want to verify the value of a marker with an actual measurement,

you'd have to change your measurement grid to include that point. It will probably be a little different in this case.

5b. There are a few parts to this:

This value is off by 20.88 dB. I think your algorithm is not properly taking into account my use of 20-dB attenuation on Source Port 1
It looks like the measurement data used by the application takes into account the 20 dB attenuator, but the a1(P1s) plot on the VNA does not. I come to this conclusion based on the fact that b2(P1s) is not off by 20 dB, or missing altogether.
The b2 value in diagram area 1 is correct. The b2 value shown for trace "Pout compression" is way off -- showing gain rather than output power.

I assumed the VNA's representation of a1(P1s) would take into account the source attenuation? Or am I missing something? How should I compensate for this? Simply add the value of the attenuation (20 dB)?

I chose to display the power as "Port 1 Source" rather than "Channel Base Pb ".
I'm not sure I follow. Can you clarify?
Channel > Mode > Port config > "Stimulus..." > Power: "Enter and Display" > "Port 1 Source" rather than the default "Channel Base Pb"

...shouldn't I expect the Compressed Gain to be at least 1 dB less than the Max Gain?... 31.98 * Seems 1.5 dB higher than for my power sweep results. Why?**
I'm not sure why it isn't. I wonder if it is because the measurements taken by PA Compression Test to generate these Max Gain and compression estimates use different segmented sweep settings than the final, displayed traces?

For example, PA Compression Test is increasing the channel power while also removing the frequencies in the segmented sweep that have reached compression. The results displayed on the VNA, however, are segmented sweeps with individual (freq, power) points. Maybe this changes the behavior of the amplifier and/or the value of the measurement?

In this vein, I would also expect your power sweeps to yield slightly different max gain and compression values than frequency sweeps would. For this reason, M/A-COM wants us specifically to perform frequency sweeps at a set power level, rather than power sweeps for a particular frequency, presumably because the values are different and their use case is closer to the former than the latter.

6. It would be nice if you could show multiple progress bars of the inner loop progress and outer loop progress.
I can do this. The inner loop progress bar will be an estimate based on the reported sweep time from the VNA, but it will still at least give the user an idea of where each sweep is at.

7. But the bigger issue is that it took 25 minutes to complete a single run.
Because it took 30-35 seconds for the Max Gain trace to display on the progress plot, I'm guessing this is roughly how long each sweep takes? If all the sweeps took around 25 minutes, that would mean that roughly 43 sweeps were performed (25 * 60 / 35 ~= 43, ie 43 sweeps performed). Does this sound roughly in line with the settings you used in the PA Compression Test application, or do you think something else is awry in PA Compression Test itself?

At any rate, to investigate further (specifically testing time and integrity of the values), I'd like to take a look at both the exported data and the SCPI command log. You should be able to export the data from the last measurement from the GUI via the "Export" button. The SCPI command log can be found from the start menu.

I tried a different test scenario today, whereby I:

1. Changed the Attenuator value from 20 dB to 10 dB, and
2. Turned ALC OFF.

#1 eliminated the "clicking" by using a fixed attenuator setting that better centered the power sweep range.

#2 really sped up all measurements!! When I repeated yesterday's measurement with ALC off, I got the "Max Gain" trace in 5 seconds and the entire procedure completed in 3 minutes 19 seconds!

Please do the following:
0. Set up your test
1. Start PA Compression Test
2. Confirm the settings

3. Start the test
4. After the test completes, click the "Export" button to save the raw data
5. Close the application
6. Navigate to the following in the start menu:

Start -> Programs -> R&S PA Compression Test -> Logs

I'll comb through this manually to try to get an idea of what, exactly, is going on.

Thanks again for the feedback. Looking forward to more insight from M/A-COM.

Best Regards,
Nick Lalic

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R&S®ZNB and R&S®ZNC: General Purpose Network Analyzers

Greg Bonaguide---11/30/2015 02:56:50 PM---Hi Nick, I was able to load and run the 1.5 beta today. A few quick feedback points:

From: Greg Bonaguide/RSA
To: Nick Lalic/RSA@RSA,
Cc: Mike Leffel/RSA@RSA, Wayde Marshall/RSA@RSA
Date: 11/30/2015 02:56 PM
Subject: Re: Feedback >> PA Compression Test Version 1.5 /cr/

Hi Nick,

I was able to load and run the 1.5 beta today. A few quick feedback points:

1. It ran right off, without any dickering with connectivity/compatibility! (Nice.) My DUT is a very small amplifier/LNA.

2. The dialogs are a bit too large for the ZVA screen. An example is shown below, where I had to move the main panel up a bit to be able to access the buttons at the bottom. What you see here is what I saw on the ZVA screen:

3. It takes quite a few seconds before the "Max Gain" trace appears on the Compression Test, and much longer (several minutes) before the first Pin (Compression) results appear. I can hear an attenuator switching internally every few seconds, but nothing is displayed. Why so long?

4. How is the "Max Gain" determined? Actually point-by-point increase of power to find the max gain at each frequency?
Also, when the first few Pin points appear, they look like a sawtooth. Why? What is the algorithm actually doing? And why does it seem to break the sweep up into segment "chunks"?

5. Referring to the graph below, why isn't the Pin (Compression) trace smooth? Why so choppy?

5. The first 3 diagram areas (below) I had defined before running "PA Comp Test." Diagram area 4 was created by "PA Comp Test." I created Diagram area 5 after running "PA Compression Test" to see if I could make sense of the results. It represents a power sweep at one frequency: 2.534 GHz (the same frequency as the Marker in all the other windows). I tend to trust the marker values shown in this window: input power of (approx) -17.8 dB leads to a 1-dB compression value of 30.55 dB, and a corresponding output power of (-17.8 dBm + 30.55 dB = +12.75 dBm).

PA Compression Test Gives (for this same frequency point):
Max Gain = 31.8
Compressed Gain = 31.98 * Here, shouldn't I expect the Compressed Gain to be at least 1 dB less than the Max Gain?
Pin_Compression = -38.76 ** This value is off by 20.88 dB. I think your algorithm is not properly taking into account my use of 20-dB attenuation on Source Port 1. Also, I chose to display the power as "Port 1 Source" rather
than "Channel Base Pb ".
Pout_Compression = 31.98 *** Seems 1.5 dB higher than for my power sweep results. Why?

6. The progress bar is OK, but doesn't tell me much beyond "This is progressing very slowly, and judging by the position, I have a lot longer to wait for this sweep to complete." It would be nice if you could show multiple progress bars of the inner loop progress and outer loop progress. If showing/updating the Inner loop progress impacts sweep performance, then perhaps updating every n iterations might be an acceptable compromise.

7. I guess my biggest fear is that the time to complete a measurement cycle will be unacceptable. It took 35 seconds from initiation until the Max Gain trace appeared (and then saw some activity on the progress bar.) A less patient user would think something was wrong after not seeing anything on the screen for 30 seconds. **But the bigger issue is that it took 25 minutes to complete a single run.** Ugh!

I do have ALC ON for my channel.

Let me know if I can provide more information or settings. I'll be demonstrating this for the customer tomorrow.

Regards,

Gregory M. Bonaguide
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Nick Lalic---11/21/2015 04:59:07 AM---Greg, Mike, Here is a beta version of PA Compression Test. There are some things you'll need to know

From: Nick Lalic/RSA
To: Greg Bonaguide/RSA@RSA,
Cc: Mike Leffel/RSA@RSA, Wayde Marshall/RSA@RSA
Date: 11/21/2015 04:59 AM
Subject: PA Compression Test Version 1.5 /cr/

Greg, Mike,

Here is a beta version of PA Compression Test. There are some things you'll need to know to use it.

Launch the application
The application is installed on-instrument, and can be accessed from the External Tools menu.

GUI, Settings
When you launch the application, you get the following interface:

Any settings that are not explicitly called out in this interface are inherited from a reference channel (see Miscellaneous: Channel). This includes calibration, attenuation and settings for pulsed measurements. I expect the user to set this extraneous stuff up, if necessary, before running my application.

Most of the settings are self-explanatory. The Post-Condition can either be None or RF Off. The sweep type refers to the measurement setting used on the VNA. So, when Sweep Type is set to Frequency the VNA will be set up for a (segmented) frequency sweep, and the power level will be incremented between sweeps.

Another option that I will add later is Sweep Type: Power. This will set a single frequency, then perform a power sweep. M/A-COM is specifically interested in Frequency sweep, so I have put this off for now.

Measure, Progress screen
Once you click Measure, the measurements begin and the GUI transforms to a progress plot. The progress plot displays the maximum gain and Pin at Compression. If "Include Gain Expansion" is checked, the maximum gain will be updated as the measurement progresses. Pin at compression also updates as compression points are found.

This is the progress plot (without data).

While the measurement is running, the user has the option to cancel. Canceling the measurement brings you back to the settings screen. No results are available if the user cancels prematurely. Also, if any compression points are not found, the application will return to the settings screen and display a warning.

One important note: the Pin, gain, and Pout at compression values are linearly interpolated between the two nearest measured values.

Results Loaded into VNA
Once the measurements complete successfully, the results are plotted on the VNA as follows:

Two channels are created: max_gain and compression. Each channel is a segmented sweep consisting of individual (frequency, power) points set to the appropriate values for maximum gain and compression, respectively.

In practice, the segmented sweep looks something like this:

In addition to the max_gain and compression channels, a diagram is created with the following traces:
- max_gain
- compressed_gain
- Pin_compression
- Pout_compression

Subsequent PA compression measurements will update the max_gain and compression channel with the latest values. M/A-COM has expressed a strong interest in setting up their own diagrams and traces. To this end, I do not touch any of the preexisting diagrams or traces. Also, on subsequent PA compression measurements, I do not regenerate these traces. This way, the user can move, modify, place markers on, or completely delete these traces as they wish. Subsequent PA compression measurements will respect their graphical setup and only update the maximum gain and compression points in the channel.

I do this by looking for the existence of either the max_gain or compression channel. If either of these channels exists beforehand, I assume that the user has already ran the application at least once, and I respect their setup. If they want to regenerate the channels, diagrams and traces of PA Compression Test, they should delete both these channels to force the application to recreate the initial configuration.

Export Data
And, finally, M/A-COM wants to export the measurement data. The "Export Data" button allows the user to save the results in a ZIP file. The file contains a Settings.txt file with a summary of the measurement settings, a Compression.csv file with the maximum gain (pin, gain, pout) and compression (pin, gain, pout) data. And it also contains a folder of touchstone files that, collectively, contain all the raw measurement data.

Power Cal?
I talked to Volker about PA Compression Test while he was visiting San Jose. He said that he worked extensively on a PA compression testing tool with M/A-COM Belgrade, Serbia. He said that they were interested in getting very accurate measurements, to within 10ths of a dB/dBm. He said that for this level of accuracy, we would need to perform a 2D (vs both frequency and power) power cal.

The firmware currently supports a "1D" power cal. If you set up a frequency sweep, you can power cal it (vs frequency). Conversely, if you set up a power sweep, you can power cal that (vs power). But PA Compression Test will be changing both frequency and power as it measures. Volker implemented a 2D power cal tool to handle this. Apparently the Agilent/Keysight solution includes this. He said that M/A-COM in Massachusetts may be expecting it, but may not have thought to ask specifically.

Something to think about.

Let me know if any of this needs clarification. I plan on including formal documentation with the application, but I wanted to give you guys this information in the meantime. Also let me know if any of this should be modified. I'm open to suggestions.

Here is the download link.

PA Compression Test version 1.5
https://cloud.rs-us.net/public.php?service=files&t=3c03208dd55e174d396ac891e399be5e

Best Regards,
Nick Lalic

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