Subject: About the RF System Budget Analysis Tool

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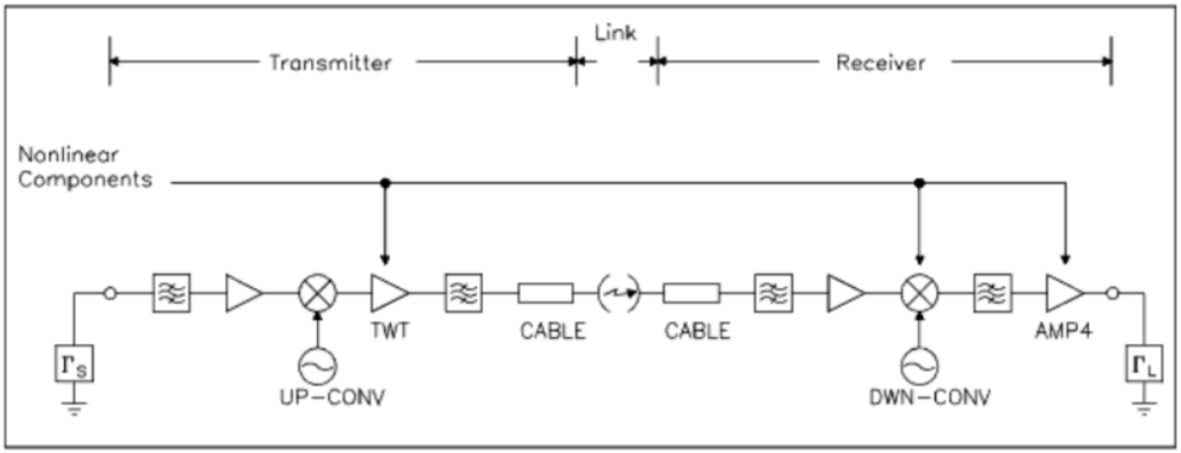
This paper discusses features on the web site: **https://www.serdesdesign.com/home/rf-system-budget-tool/**

The RF System Budget Analysis Tool analyzes an RF system that has a typical structure shown in this figure.



Where the RF system is defined by the cascade of two-port RF components, The components may be defined as S-Parameter data, filters, RF cables, gain or mixer components, Terrestrial links, or Satellite links,

I originally developed this tool in 1987 with the EEsof company which was a pioneering company in Electronic Design Automation (EDA) software founded in 1984. The original RF System Budget Analysis tool in 1987, part of the EEsof OmniSys suite of tools defined and developed by me along with my coworker Niranan Kanaglekar who created the associated S-Parameter/Noise Parameter engine.

About_the_RF_System_Budget_Analysis_Tool

The RF system budget analysis tool has been part of the Keysight Technologies EEsof product line, in ADS (Advanced Design System), until 2023 (for over 35 years). This tool that I created was the first RF system budget tool to incorporate RF components defined with S-parameters and noise parameters. This tool was removed from the Keysight ADS product in 2023 and instead Keysight ADS now relies on use of their newer SpecraSys tool for RF system budget analysis. The cost to Keysight is that ADS is now missing this much easier to use tool that I created.

Since this tool was removed from the Keysight ADS product, I decided to recreate it from first principles and make it available for free on my web site.

See the Keysight documentation on the RF System Budget Analysis Tool, which John Baprawski wrote, at this Keysight web site:

- https://edadownload.software.keysight.com/eedl/ads/2011_01/pdf/rfsysbudget.pdf
- Or, see the documentation at this alternate web site:
- https://mosses.pbworks.com/f/rfsysbudget.pdf
- Thanks to Blake Gray Ph.D., Director of Engineering /Silicon Creations LLC for the use of their Keysight Advanced Design System (ADS RF Budget System Analysis Tool for testing my current copy of this tool against the ADS copy.

See the history of the EEsof OmniSys suite of tools at this link 'EEsof_OmniSys_History

The key Keysight features that are missing from my current tool are as follows:

- Co-simulation with ADS RF circuit designs which extracts the circuit associated S-parameters and large signal transfer function.
    - Instead, my tool supports power dependent S-parameter models (p2d files) exported from ADS.
- ADS specific models (Amplifier, Amplifier 2, FDD1P, SDD1P, RF_PA_Ckt
    - Instead, my tool supports many alternate nonlinear models, many are equivalent to the ADS models.
- Filter models for Raised Cosine filters, filter models defined with arbitrary polynomials and poles-zeros.
    - Instead, my tool supports standard models (as does ADS) for Butterworth, Chebyshev, Bessel, Gaussian and Elliptical filters with LPF, BPF, BRF and HPF characteristics
- Use with the ADS equations, sweeps, optimization, and data display.
    - Instead, my tool supports analysis and data displays for the many ADS defined Budget measurements with ability to include frequency sweeps and power sweeps.

All other features essentially exist in my current tool.

Additionally, my current tool is faster, more accurate, and more robust than the tool I create which was in the Keysight product line for over 35 years.

To use the RF System Budget Analysis Tool, follow the steps on the web page.

0. Define the analysis name

Analysis name: RF_	SystemTest	✓	Alpha-numeric characters or underbar - case sensitive - start with alpha character	Recall

- All analyses are named with the prefix 'RF_'. The entry field can be uniquely named by the user.
- After a successful 'Run', the named analysis can be recalled by selecting the 'Recall' button.
- When 'Recall' is selected, the previously run user analysis will be loaded into the web page.

2. Define the RF system

- Up to 20 cascaded RF blocks can be defined.

Name	Description	Entry Value(s)	Status	Type	Limits	Comment	Action
RF1Type	RF model 1	2	✓	Integer	[0, 5]	0 = None; 1 = SParam; 2 = Filter; 3 = Amplifier,Mixer; 4 = Coaxial cable; 5 = Link	Open...

- Set 'Entry Value' to enable a block.
- Select 'Open' to open the model dialog box.
- See separate documentations for the models:
  - RF_Budget_SParam.pdf
  - RF_Budget_Filter.pdf
  - RF_Budget_AmplifierMixer.pdf

- RF_Budget_CoaxialCable.pdf
- RF_Budget_Link.pdf

5. Setup the analysis.

Name	Description	Entry Value(s)	Status	Type	Limits	Comment	Action
FreqS	RF system input source frequency in Hz	2.0E+9		Real	> 0		
PwrS_dBm	RF system input source power in dBm	-30		Integer	[100, 100]		
NumComp	Number of components in the RF system	13		Integer	[0, 20]		
UserMeas1	User selected measurement 1	NULL		String		Copy/paste string from the Meas...	Meas...
UserMeas2	User selected measurement 2	NULL		String		Copy/paste string from the Meas...	Meas...
UserMeas3	User selected measurement 3	NULL		String		Copy/paste string from the Meas...	Meas...
SetupOptionsBudget	Setup analysis options	1		Integer	[1]		Open...

-
- Define the input frequency FreqS in Hz.

- Define the input power level PwrS_dBm in dBm.
- Defined the number of RF components NumComp used (the count of RF models that are enabled).
- Up to 3 user defined measurements, UserMeas1/2/3, selected from **Meas...**
  - These measurements are as defined in the above referenced rfssbudget.pdf.
- Set SetupOptions = 1 to 'Open' its dialog box.
  - See detail documentation at: **Setup Budget Options**

6. Run the analysis.

Select to run analysis	Run

7. Display results.

Display	Action
Analysis log file	Open
0. Budget: Power gain in dB to component output	Open
1. Budget: Power in dBm at component output	Open
2. Budget: Noise figure in dB to component output	Open
3. Budget: UserMeas1	Open
4. Budget: UserMeas2	Open
5. Budget: UserMeas3	Open

- Observe RF Budget power gain in dB, power in dBm, noise figure in dB, or any of the three user defined measurements selected.

- If the Setup Options has EnableFSweep = 1, then these displays are available.

FSweep	
6. FSweep: Output power gain in dB vs. output frequency	Open
7. FSweep: Output voltage phase in deg vs. output frequency	Open
8. FSweep: Input reflection in dB vs. input frequency	Open
9. FSweep: Input reflection in deg vs. input frequency	Open
10. FSweep: FSweepMeas1	Open
11. FSweep: FSweepMeas2	Open
12. FSweep: FSweepMeas3	Open

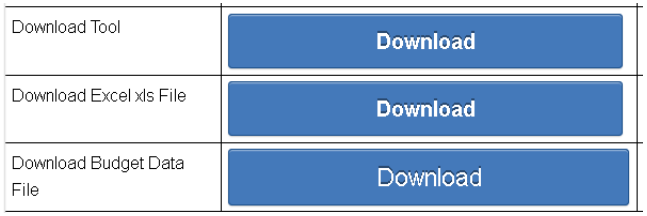
- Observe the swept frequency response for RF Budget power gain in dB, input reflection coefficient in dB, or any of the three user defined measurements selected.
- If the Setup Options has EnablePSweep = 1, then these displays are available.

PSweep:	
13. PSweep: Output power in dBm vs. input power	Open
14. PSweep: PSweepMeas1	Open
15. PSweep: PSweepMeas2	Open
16. PSweep: PSweepMeas3	Open

- Observe the swept power response for RF Budget power in dBm or any of the three user defined measurements selected
- After the Analysis is Run, the Analysis Log file is displayed.

- Look at the bottom of the file to see that the analysis was successful.

Additional options.

- 

- One has the option to download this RF System Budget Analysis Tool for use local on a Windows 6 bit PC.
- One can download the RF Budget analysis data and use it with the Excel file download to display all available data plots, not just the ones listed for display on the Linux website.

See additional detail: **Typical RF System Budget Characteristics and Displays**

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