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TECHNOTE

# A simple and essential method to verify the quality of Calibration of a vector-receiver load pull setup.

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## A simple and essential method to verify the quality of Calibration of a vector-receiver load pull setup.

Calibration of a vector-receiver load pull based measurement setup is a complex procedure. The components used must be well considered and connections must be secured. During the calibration procedure there is a chance something goes wrong. Verification of the complete setup is as important as calibration itself. A standard block diagram for a vector-receiver load pull measurement setup may look like fig.1. A simple method is discussed to verify the setup is accurate and repeatable.

After performing the vector receiver and power calibration procedure for example in IVCAD, use the THRU as the DUT and perform a power sweep with mismatched load, for instance at 0.8 load gamma, at every 45 degree separation.

When calibration is done correctly and the whole setup is stable, the measured operating power gain (GP) for the DUT (i.e the THRU) should ideally be 0dB and typically ±0.05dB for an optimum measurement system at 50 Ohms, See fig.2.

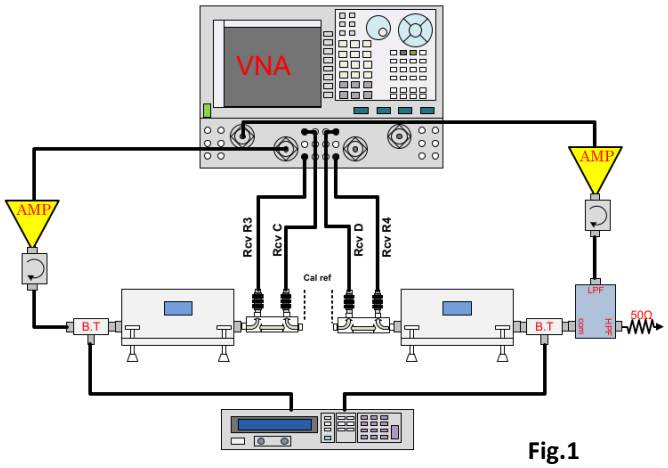



Fig.1

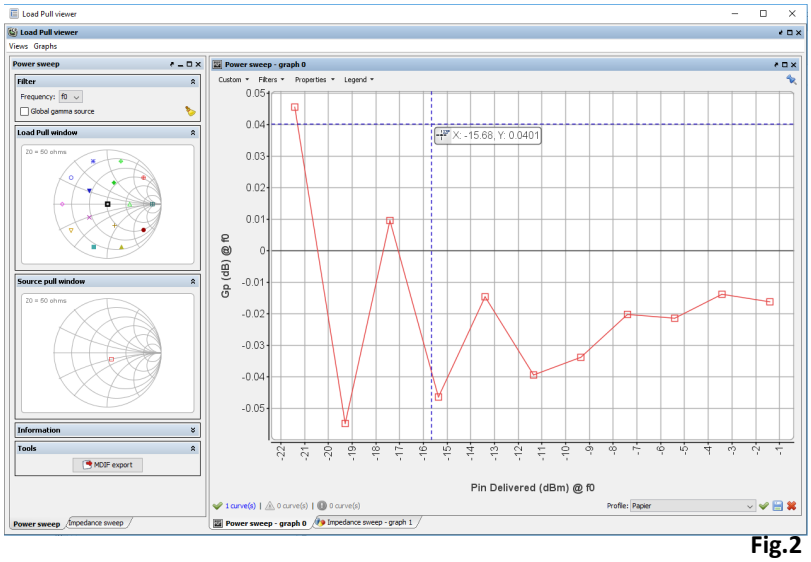



Fig.2

One should not proceed with any device characterization unless the following accuracy is achieved:

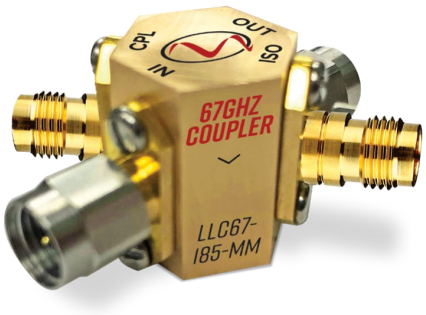
1. **The measured operating power gain ( GP) for the DUT (THRU) should be ≤ +/- 0.2 dB at gamma < 0.8 for frequencies < 18GHz and < +/-0.3 for frequencies higher than 18GHz.**

2. **The Power Gain error is extremely sensitive to cables, couplers, probes and substrate. Phase stable cables (+/- 0.08dB in amplitude and less than 5 degree in phase) need to be used.**

To achieve accurate system calibration it is highly recommended to:

1. Use a TRL calibration technique.
2. Use phase stable cables (at least +/- 0.08dB in amplitude and less than 5 degree in phase).
3. Use low loss couplers with high directivity.

Low insertion loss couplers used as part of a vector-receiver load pull setup directly maximize tuning range of an impedance tuner. Low insertion loss is critical for high-power applications in order to avoid power loss and eliminate drift due to heating. High directivity, the difference between coupling and isolation, enables highly-accurate measurements by isolating the direct and coupled measurement pathways. This is especially important in a calibrated system where changing coupler characteristics due to poor directivity can invalidate the calibration and result in erroneous measurements.




| Maury | LLC67-series | LLC34-series | LLC18-series |
|---|---|---|---|
| Frequency | 3-67GHz | 2-34GHz | 0.6-18GHz |
| Insertion loss | 0.4dB max | 0.35dB max | 0.25dB max |
| Directivity | 12dB | 14dB | 15dB |
| Coupling | 35dB | 30dB | 30dB |
| Power | 10W CW / 100W Peak | 150W CW / 500W Peak | 500W CW / 2KW Peak |
| Connector config | Multiple | Multiple | Multiple |

Non-repeatability can also be the result of bad connection or even due to vibration of the tuner itself at mmWave frequencies. The tuner is often connected directly onto the probe itself which is the best choice in terms of transmission.

**A tuner directly connected to a probe may cause vibrations and thus may result in a bad connection between probe and DUT.**

To ensure accurate load-pull results, it is essential to perform a verification of the system calibration.

With the MT985AL tuner, Maury offers since the mid 2000's , a proven vector-receiver load pull solution for mmWave frequencies up to 65GHz.

Example of a typical setup performance:

- MT985AL01 tuner has Gamma = 0.85 @ 30 GHz
- MT902C-series airline = 0.3dB insertion loss
- Probe = 0.4dB insertion loss
- Gamma at DUT = 0.72 with **Gp=0.17dB**

More information about Device Characterization can be found via:

https://www.maurymw.com/MW_RF/Sub_THz_Measurements.php

https://www.maurymw.com/MW_RF/Vector_Receiver_Load_Pull_Measurements.php

Phase stable cables and calibration solutions:

https://www.maurymw.com/Interconnect_Solutions/Stability_Plus.php

https://www.maurymw.com/Precision/

Low loss couplers:

https://www.maurymw.com/MW_RF/Low_Loss_Couplers.php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