

Maximize tuning range with Maury Microwave LLC67 low-loss couplers.



**A challenge with vector-receiver loadpull measurements is to keep losses as low as possible. Lower losses means closed contours on higher gamma of the Smith chart of the VNA. Within a Vector-receiver loadpull setup many components are of influence of VSWR and so on the max edge of the Smith chart.**

With a passive load pull system, the net magnitude of reflection achievable at the DUT reference plane can be calculated as:

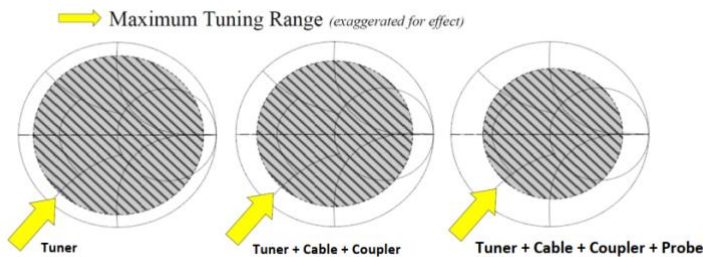
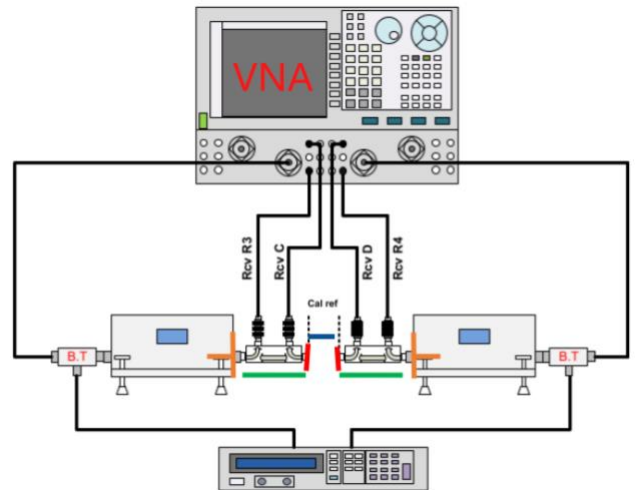
$$RL_{tuner} + RL_{coupler+cable+probe} = RL_{dut}$$

$$RL_{tuner} = -20 \text{Log} \left( \frac{VSWR_{tuner} - 1}{VSWR_{tuner} + 1} \right)$$

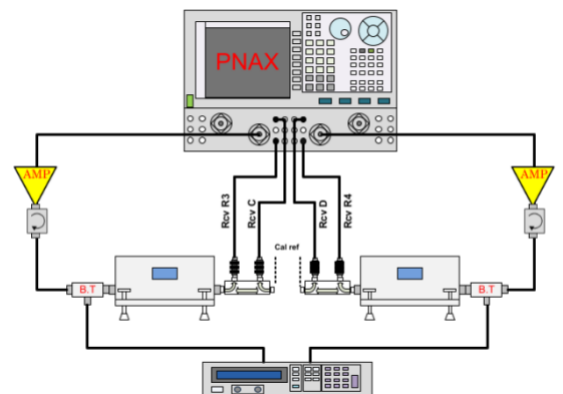
$$RL_{coupler+cable+probe} = 2(IL_{coupler+cable+probe})$$

$$\Gamma_{dut} = 10^{\left(\frac{-RL_{dut}}{20}\right)}$$

Assuming a typical tuner VSWR and coupler, cable and probe losses at 30 GHz,  $VSWR_{tuner} = 20:1$ ,  $IL_{Coupler+Cable+Probe}=2,5\text{dB}$ , the maximum achievable magnitude of reflection is reduced from  $\Gamma=0.9$  at the tuner reference plane to  $\Gamma=0.5$  at the DUT reference plane.



One solution to overcome these losses is to change the configuration from a passive- into a "hybrid-active" load pull configuration as shown in the diagram here on the right. Active power amplifiers compensate for losses but due to these amplifier this is quite often an expensive solution. Another solution is just decrease losses by selecting the best cables to be found in the market.



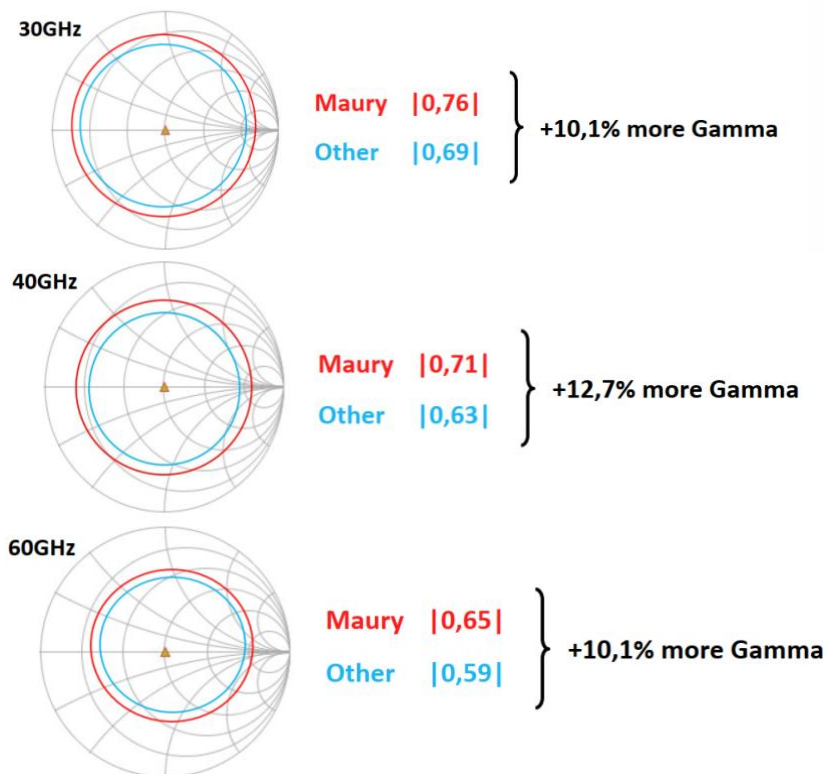
Also using low-loss couplers like Maury's LLC-Series maximizes tuning range as well. So let's take a look at Maury's new LLC67 low-loss couplers and compare them with other common used couplers.

Maury's new LLC67, 67GHz low loss coupler series have a lower insertion loss compared with other couplers in the market. the connector location is ideal for on wafer integration where IN and OUT connectors are aligned. CPL and ISO have instead an angle of 60 degree (from IN and OUT) allowing the user to use flexible cables for connections.



	<b>MAURY LLC67-SERIES</b>	<b>OTHER COMMON USED COUPLER</b>
<b>FREQUENCY</b>	3-67 GHz	2-65 GHz
<b>INSERTION LOSS</b>	0.4 dB max	0.7 dB typ / 1.4 dB max
<b>DIRECTIVITY</b>	12 dB	10 dB
<b>COUPLING</b>	35 dB	10 dB
<b>POWER</b>	10 W CW/ 100 W Peak	N/A
<b>CONNECTOR CONFIG</b>	Multiple	Fixed

To show the effect just by replacing couplers for Maury's LLC67 measurements are made on a vector-receiver loadpull setup on 30, 40 and 60GHz. Gamma presented by MT985 **at probe tip** in front of the tuner.

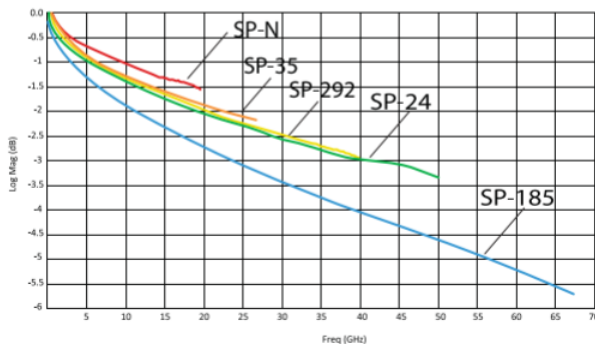
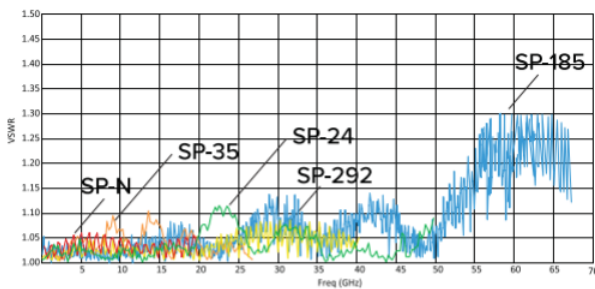


Overview Maury's LLC-Series low loss couplers:

	LLC67-SERIES	LLC34-SERIES	LLC18-SERIES
<b>FREQUENCY</b>	3-67 GHz	2-34 GHz	0.6-18GHz
<b>INSERTION LOSS</b>	0.4 dB max	0.35dB max	0.25dB max
<b>DIRECTIVITY</b>	12 dB	14 dB	15dB
<b>COUPLING</b>	35 dB	30 dB	30dB
<b>POWER</b>	10 W CW/ 100 W Peak	150W CW / 500W Peak	500W CW / 2KW Peak
<b>CONNECTOR CONF</b>	Multiple	Multiple	Multiple

Conclusion:

With the LLC67 Low loss coupler a positive impact on the tuning range will be achieved with more than 10%. It's easy to replace existing couplers and so improve the quality of an expensive measurement setup. Although not discussed, also the choice of used cables and probes do matter. Stability Plus™ Low Profile Microwave/RF Cable Assemblies minimizes losses with extreme low VSWR and Insertion loss. See tables here below.



Application note and datasheets as reference:

- [Overcoming the Challenges of On-Wafer Load Pull Measurements at Millimeter-Wave Frequencies for 5G Applications.](#)
- [Low-Loss Couplers](#)
- [StabilityPlus™ Microwave/RF Cable Assemblies](#)

More information can be found via: <https://www.maurymw.com/>

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