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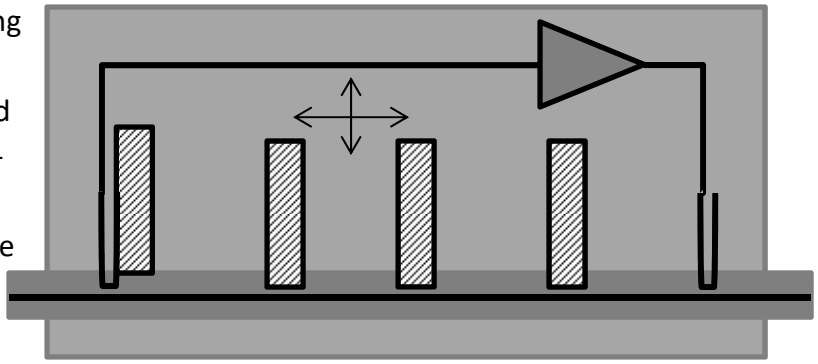
Product note 91

Active Harmonic 5G Tuners

Summary

Harmonic multi-probe tuners control independently two (MPT-Lite) and three (MPT) harmonic frequencies. However insertion loss between the tuner and the DUT, especially at 5G (28-36GHz) frequencies, limit the tuning range and the capacity of the tuners to test some devices.

This shortcoming is reversed using the Hybrid Harmonic Tuner concept* (MPT+). A feed-forward active loop is added to the multi-carriage tuner and allows reflection factor at DUT reference plane $|\Gamma_{DUT}| = 1$.



Impedance tuners use a slotted airline (slabline) and metallic (reflective) probes. The slabline has two vertical sidewalls and a round center conductor. The probes (slugs) have a concave bottom matching the radius of the center conductor (CC). A set of mobile directional couplers allows sampling the signal delivered by the DUT, amplify, phase-correct and re-inject it backwards towards the DUT where it is vector-added to the signal reflected by the passive tuner probes. Whereas the passive tuner reflects Fo, 2Fo and 3Fo signals independently, the coherent feedback signal is added only to the Fo component. This allows complete harmonic impedance control at Fo, 2Fo and 3Fo and simultaneous reduction of injected power due to pre-matching by the passive tuner at Fo.

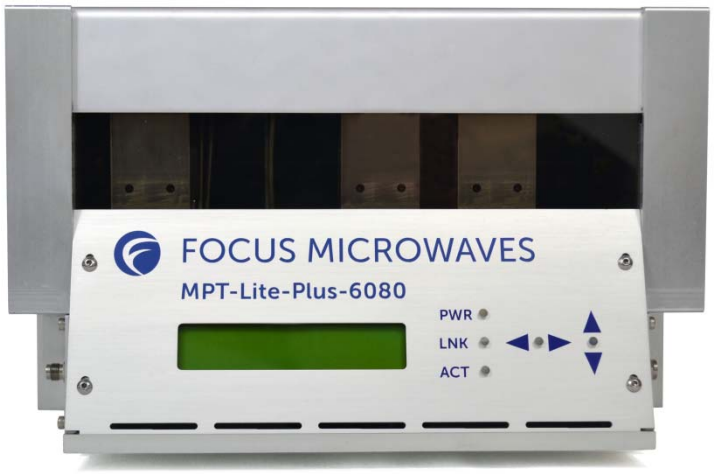


Fig. 2: Frequency 8-60GHz; active @Fo=28-30GHz; passive 2Fo=56-60GHz

**patent pending*

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Figure 3 shows calibration points of passive harmonic tuning at 28GHz using the tuner of Figure 2. The impedance at 56GHz is fixed, as shown by the red dots. The tuning range is obviously reduced due to insertion loss between tuner and DUT.

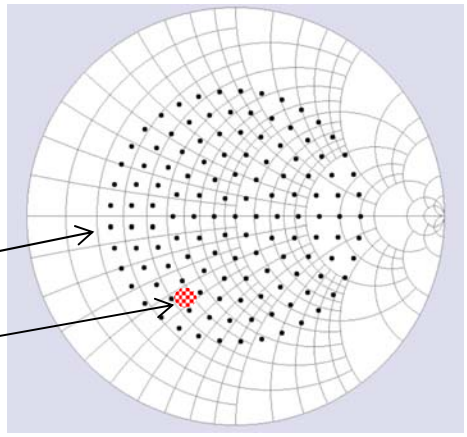

Figure 3: Passive tuning at 28GHz

Figure 4 shows calibration points of hybrid harmonic tuning at 28Ghz using the tuner of Figure 2.
Active injection is phase adjusted to allow |Γ|=1 at DUT
Reference plane towards small impedances (Z_{out} -> 0Ω)
The harmonic impedance (red dots) remains at the same position as before.

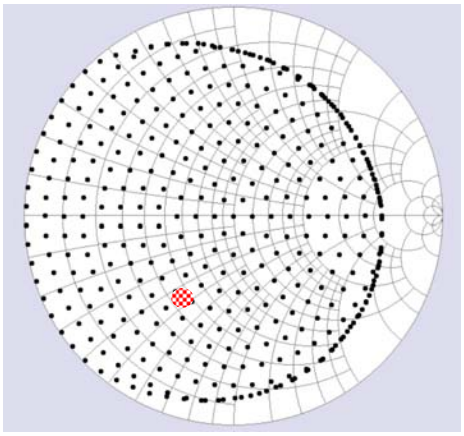

Figure 4: Hybrid tuning at 28GHz

System Verification

The simplest way for verifying the accuracy of an active system is to compare with a passive system on the same DUT. This has been done in this case. Two setups have been used, one using a passive harmonic tuner MPT-6710 (10 to 67GHz) and the second one using the MPT-Lite-Plus 6080, shown in Figure 2. The proof of accuracy is self evident, as shown in Figures 5 and 6.

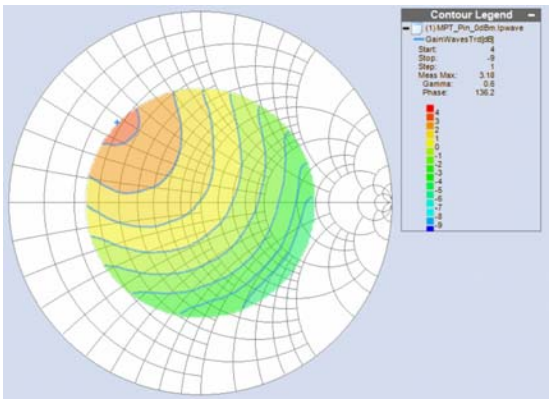

Figure 5: Passive Load Pull

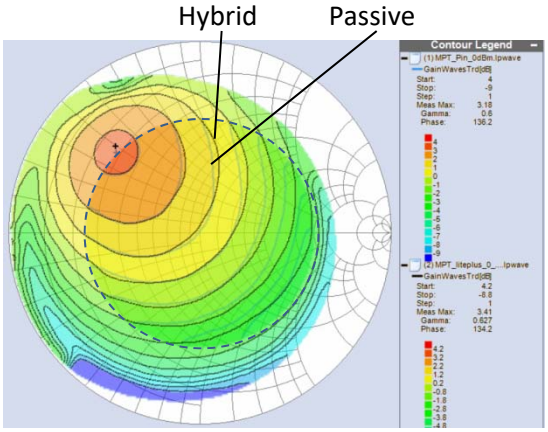

Figure 6: Hybrid & passive Load Pull -Superimposed