REFERENCES

[1] G. Gonzalez, *Microwave Transistor Amplifier.* Englewood Cliffs, NJ: Prentice-Hall, 1984.
[2] J. C. Liu, S. S. Bor and P. C. Lu, *IEEE Microwave Theory Tech.,* vol. 41, no. 2, p. 363, Feb. 1993.
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Reply to "Comments on Optimum Noise Measure Terminations for Microwave Transistor Amplifiers"

D. K. Paul and P. Gardner

The commentators now assert that the stable region was calculated incorrectly in the paper. **This is not true.** It is perfectly valid to determine the stable region by plotting the input stability circle in the Γ_s plane and the output stability circle in the Γ_l plane, where Γ_l is the output load reflection coefficient. In Fig. 2 of the paper, both circles were plotted, for convenience and economy of journal space, on the same Smith chart. Stability was then verified by confirming that the proposed input and output terminations were in the stable regions in their respective planes.

In (1) and (2) of the latest comments, the commentators correctly reproduce the well known first lines in the derivation of the equations for the input and output stability circles. However, the meaning of their subsequent comments is obscured somewhat by poor English. They appear to be suggesting a method for determining the stable region in the Γ_s plane, in the special case where, for any input termination, the output termination is always adjusted to give a conjugate match. However, instead of following through this line of reasoning, they proceed to reproduce the input and output stability circles on the same chart. They assert, **incorrectly,** that the region **outside** the output stability circle is stable. This is **clearly not true,** because the origin of the Smith chart is {\mbi{inside}} the circle and $|S_{22}| < 1$. What their analysis does show is that if $\Gamma_s = 0$, and the output is conjugately matched, then $|\Gamma_{in}| > 1$. (**It should be pointed out, however, that they have calculated the actual value of** $|\Gamma_{in}|$ *incorrectly*). They then proceed to delineate a region between the two stability circles. **This is at best an obscure mathematical abstraction, since the two circles are in fact in two totally different spaces.**

We believe that what the commentators intended to do was to plot the locus of Γ_s for which a conjugate match on the output port would result in $|\Gamma_{in}|=1$. We calculate that this circle has its center at the point
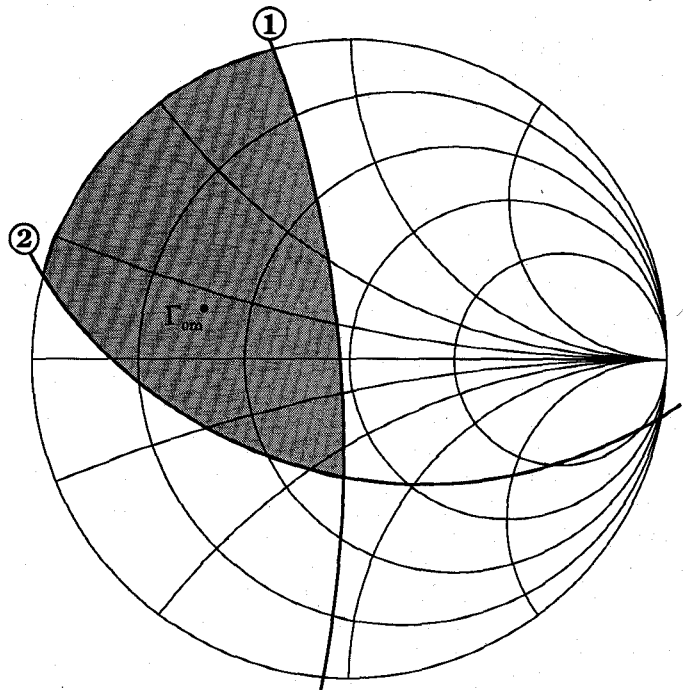
① Input stability circle

② Input stability circle, given a conjugate output match

Shaded area shows the stable region.

Fig. 1. Stable region in the source reflection coefficient plane.

with magnitude 3.65, angle $-175°$ and has radius 3.64, as shown in Fig. 1. Thus the origin of the Smith chart lies just outside the circle. Since we know from the preceding discussion that for $\Gamma_s = 0$, a conjugate match on the output gives $|\Gamma_{in}| > 1$, the stable region is **inside** this new circle.

The other boundary of the stable region is defined by the conventional input stability circle, as discussed in the original paper, and as shown in Fig. 1 of this reply. Then, given that the output is to be conjugately matched, the criterion for stability is that the reflection coefficient, Γ_{om}, of the input terminal should lie within the stable region, as indeed it does. Unlike the commentators, we do not concern ourselves with the position of Γ_{out} relative to this region, since the stable region has been plotted in the Γ_s plane.

This alternative method of analysis thus confirms the assertion in the original paper, that if the input is terminated in Γ_{om} and the output is conjugately matched, then the device **is stable at both ports.**

If Liu, Bor and Lu intend to make a career out of looking for errors in seven year old published papers, we would respectfully suggest that they take more care with their analysis and the presentation of their arguments. We would further suggest that they would be better employed in pursuing some new and forward looking research of their own.