Re: Matching source and input impedances in power amplifiers

Source: http://sci.tech−archive.net/Archive/sci.electronics.design/2006−06/msg05492.html

---

- *From*: rick H <rik_nntp@xxxxxxxxxxxxx>
- *Date*: Thu, 22 Jun 2006 07:51:00 GMT

---

theduder2005@xxxxxxxxx wrote:

> So the biggest reason to match is to prevent reflections?

No. Reflections are just fine; a quarter−wave transformer used to match two different resistances, for example, *relies* on reflections between the transmission line and the source and load to perform the match.

Nor does the OP's question relate to a typical scenario (maximising transducer power gain). Usually one looks at the load−pull data for the amplifier in question, then you match your source and load such that their impedances seen at the input and output ports of the amplifier give you the gain, noise−figure, IP3, efficiency and stability that you want.

> It makes sense why you'd want to match Zl to Zo (assuming everything is unilateral) to transfer the most power FROM the amplifier to the load.
>
> But why would you want to transfer the most power TO the amplifier? Aren't most amplifiers inherently voltage or current sensing?

Unless you perform some sort of match, which takes into account the length of the transmission line feeding the source to the amplifier, then you've potentially got no idea what the voltage will be at the input terminal of the amplifier. Of course this isn't the case when you've got a nice block diagram with 50 Ohm input/output impedances and 50 Ohm lines everywhere − but this isn't always the case in practice.

> If the amplifier had say a common gate structure, won't there be more output power (with a matched load) if you maximized the input voltage

(vgs) by making Zin >> Zs (given the frequency is low enough to
disregard reflections)?

If the frequency is "low enough to disregard reflections", then it ain't RF, and you default back to the low−frequency case of the voltage and current looking the same at all points along any given conductor.
Under those circumstances, a high input−impedance would indeed cause the input−voltage to look like the unloaded generator voltage.
In the RF case, however, this circumstance would just mean that the voltage *incident* on the amplifier's input will looks like the generator voltage, but refelections (which depend on the amplifier's input impedance loading the transmission line) would add to the incident voltage to create the composite terminal voltage. The phase of the reflected wave would be dependent on the capacitance Cgs and could produce a terminal voltage anywhere between zilch (high Cgs providing a low−impedance shunt) to nearly the same voltage as the unloaded generator.

rick H wrote:

theduder2005@xxxxxxxxx wrote:

Hi.

I have a question concerning impedance matching in RF
power amplifiers.

Given a power amplifier with input impedance Zin and
output impedance
Zo, a source with impedance Zs and a load Zl − does
conjugate matching
Zin and Zs give the highest output power?

Yes, if the amplifier is unilateral (S12=0).

In the more general case of a bilateral network (S12 is not 0) changing the output's load will change the impedance looking into the input of the amplifier, and changing the input's load will change the impedance looking into the output of the amplifier.

In terms of reflection coefficients and S−parameters, you end up with a set of two simultaneous equations:
conjugate(Gamma_source) = S11 +
(S12*S21*Gamma_load)/(1−S22*Gamma_load)
conjugate(Gamma_load) = S22 +

(S12*S21*Gamma_source)/(1−S11*Gamma_source)

which can be solved to give Gamma_source and Gamma_load required for maximum transducer power gain.

> I know that matching Zo to Zl will transfer the most power to the load,
> but shouldn't Zin be much greater than Zs so the amplifier "sees" the
> whole input signal? (ignoring reflections and noise performance)

You can't ignore reflections. If you make Zin very high, you will indeed maximise the voltage incident on the Zin terminal, but the magnitude of the reflection coefficient between the transmission line and Zin will be close to unity − i.e. almost all of the power incident on the PA's input will be reflected back to the source. If little of the power available from the source is absorbed by the amplifier, then whatever the power−gain of the amplifier, little will be available at its output for delivery to the load.

−−
Rick

.