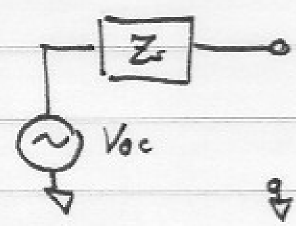
ECE 202A 10/30/89

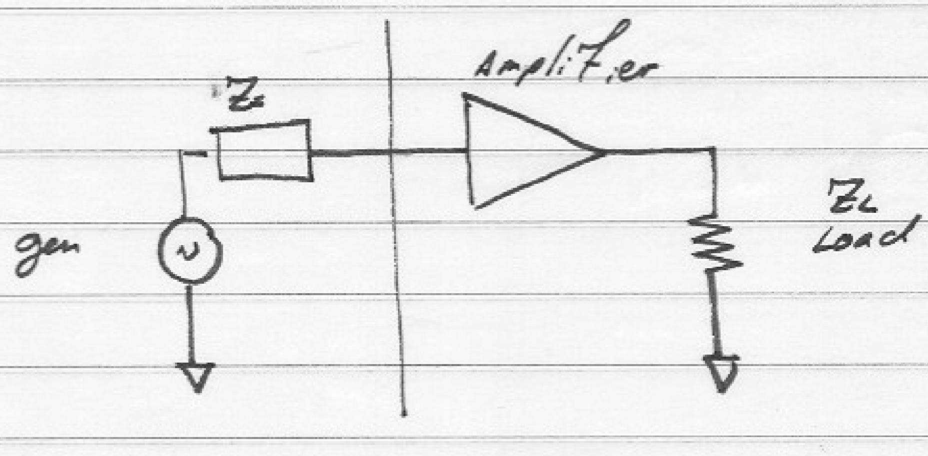
Available source power



$$P_{available} = \frac{\| V_{oc}\ (RMS) \|^2}{4\, Re(Z_s)}$$

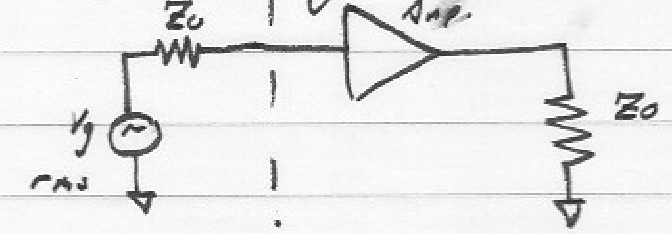
$$= \frac{\| V_{oc}\ (peak) \|^2}{8\, Re(Z_s)}$$

Available Power delivered to a load $Z_L = Z_s^*$



what do we call the power gain of the amplifier? Many definitions, so many types of power gain.

First power gain:



In this case: $a_1 = \frac{V_g/2}{\sqrt{Z_0}}$, $a_2 = 0$

so $b_2 = S_{21} a_1 = S_{21} (V_g/2) / \sqrt{Z_0}$

load power $= \|b_2^2\| = \|S_{21}\|^2 V_g^2 / 4Z_0$

$= \|S_{21}\|^2 P_{available\ gen} = \|S_{21}\|^2 P_{AVS}$

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<u>Transducer</u> power gain is defined as

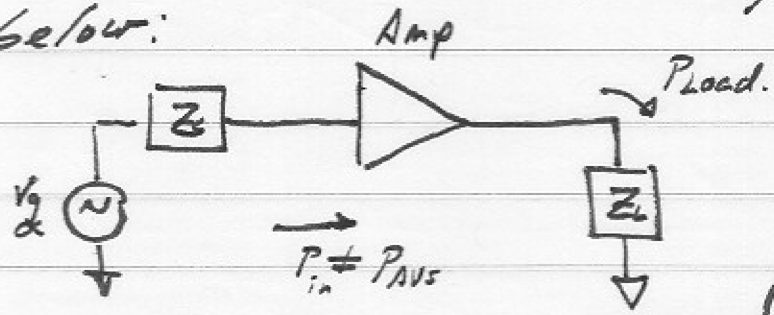
$$G_T = \frac{\text{Power delivered to the load}}{\text{Power available from the source}}$$

even if

1) load is <u>not</u> matched to amplifier so that available power from amp is not delivered to load.

2) amplifier is <u>not</u> matched to generator so that available power from source is not delivered to amplifier.

In general, the transducer power gain is defined as below:



$$G_T \equiv \frac{P_{Load}}{P_{AVS}}$$ { depends on both Γ_s, Γ_ℓ

Note that source available power is not necessarily all absorbed (input) by amplifier

operating power gain

$$\triangleq \frac{\text{Power delivered to load}}{\text{Input Power actually absorbed by amplifier}}$$

$$G_p = \frac{P_{Load}}{P_{in}}$$

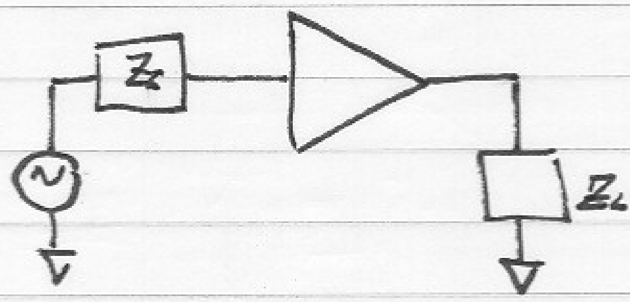
Because power delivered to load will differ from power available from amplifier, G_p depends on Γ_L.

Available output power depends upon input power absorbed (not available input power) so G_p is independent of Γ_s

Note that $G_P = \frac{P_{Load}}{P_{in}} = \frac{P_{Load}}{P_{AVS}} = G_T$

<u>iff</u> $P_{in} = P_{AVS}$, in other words <u>iff</u> the input is conjugate-matched. So G_P can be defined as "Power gain with input conjugate matched" as is stated in some texts. More precisely "<u>Transducer</u> power gain with <u>input</u> conjugate matched"

Available Power Gain



Available power gain is the power available from the ~~gen~~ amplifier divided by the power available from the generator:

$$G_A = \frac{P_{AVA}}{P_{AVS}}$$

Because power delivered from generator to amplifier will differ from available source power, G_A depends upon Γ_S.

As available output power (as opposed to power actually delivered to load) is independent of Load (Z_L) impedance (and therefore Γ_ℓ), G_A is independent of Γ_L.

Note that $G_A = \frac{P_{AVA}}{P_{AVS}} = \frac{P_{Load}}{P_{AVS}}$

iff $P_{AVA} = P_{Load}$, in other words iff the output is conjugate-matched. So G_A is often defined as the "power gain with the output conjugate matched" (text: Vendelin) or more exactly "Transducer power gain with output conjugate matched."

Maximum available Gain

$$G_{max} = \frac{P_{AVA}}{P_{in}} = MAG$$

Maximum available power gain is the power available from the amplifier divideded by the power actually absorbed at its input.

Available output power doesn't depend upon Z_L and hence Γ_L.

Available output power depends upon input power absorbed (not available input power), so G_{MAX} is independent of Γ_s.

Note that $G_{MAX} = \frac{P_{AVA}}{P_{in}} = \frac{P_{Load}}{P_{AVG}}$

<u>iff</u> <u>both</u> $P_{AVA} = P_{Load}$ and $P_{in} = P_{AVG}$, in other words if both the input & output are conjugate-matched.

- G_{max} is the "transducer power gain with both input and output conjugate matched"

- $G_{max} = \frac{P_{AVA}}{P_{in}} = \frac{P_{AVA}}{P_{AVS}}$ iff $P_{in} = P_{AVS}$, i.e. input is conjugate matched. Hence G_{MAX} is the "available power gain with input conjugate matched", which is the maximum value G_A can take on (hence the name)

- $G_{MAX} = \frac{P_{AVA}}{P_{in}} = \frac{P_{out}}{P_{in}}$ iff $P_{out} = P_{AVA}$, ie output is conjugate matched. Hence, G_{max} is also the "operating power gain* with output conjugate matched" which is the maximum value G_p can take on.

G_{MAX} = maximum possible value of G_p.

- Finally, G_{MAX} is clearly the maximum value G_T can ~~that~~ take on.

G_{MAX} = maximum possible value of G_T

so G_{MAX} is often written as $G_{A,max}$ or $G_{T,max}$ ← this book

Important point: S_{12} and S_{21} constitute interaction terms between input & output.
If $S_{12} \cdot S_{21} \neq 0$ then input & output matching become interactive. With sufficiently large values of $S_{21} \cdot S_{12}$, matching at both input & output simulteneously is <u>not</u> <u>possible</u> and GMAX no longer exists. These conditions correspond to potential instability in the amplifier (we will return to these issues later).
