Amplifier Output Power

Say we have an amplifier with gain G = 30 dB (i.e., G = 1000).

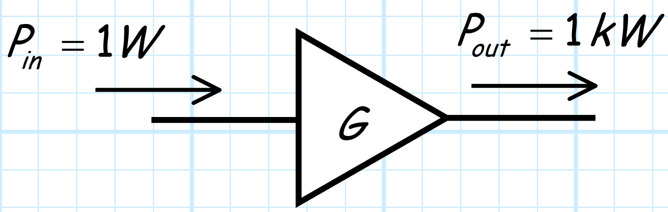
If the input power to this amplifier is 0 dBw (i.e., P_{in} = 1W), then the output power is:

$$P_{in}\, G = P_{out}$$

$$(1 \text{ W})\, 1000 = 1000 \text{ W}$$

Or, in dB:

$$0 \text{ dBw} + 30 \text{ dB} = 30 \text{ dBw}$$



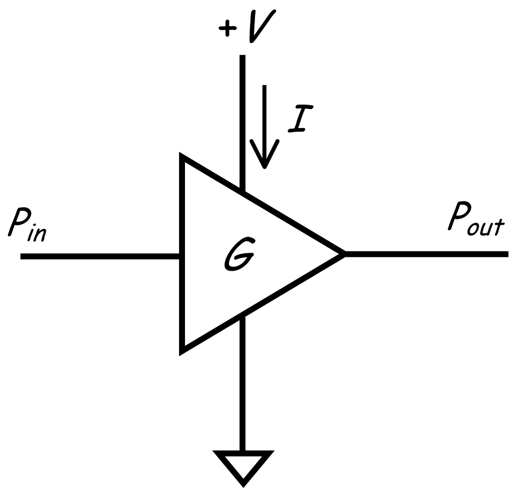
WOW! We created 999 Watts !

The energy crisis is solved !

Of course, the amplifier cannot **create** energy.

Q: *Then, where does the power come from ???*

A: The **D.C.** power supply ! (Every amplifier has one).



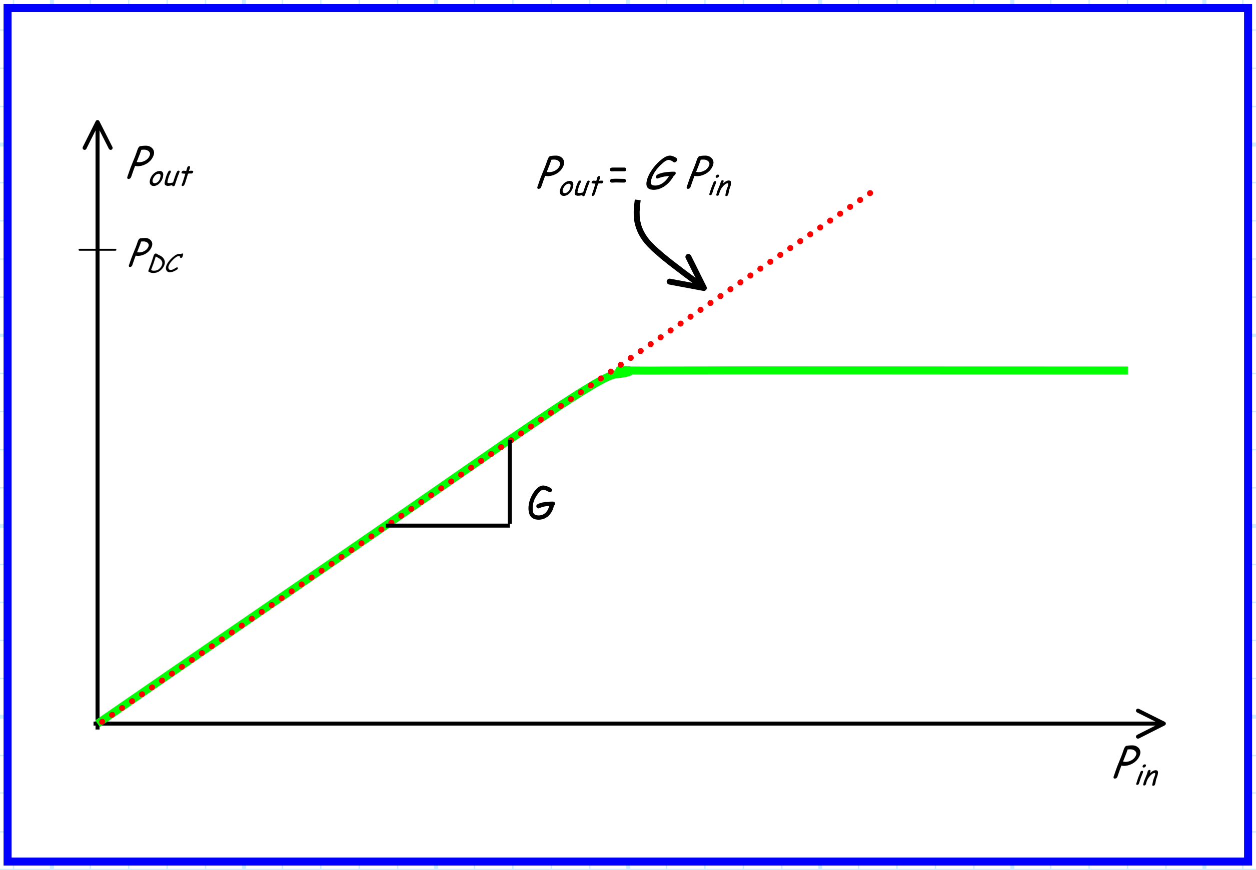
$$\text{D. C. Power} = P_{DC} = V\,I > P_{out}$$

The output power P_{out} cannot exceed the power delivered by the D.C. supply.

Q: *What happens to the D.C. power not converted to signal power P_{out} ??*

A:

So, if we were to plot P_{out} vs. P_{in} for a microwave amplifier, we would get something like this:



We notice that the output power **compresses**, or saturates.

Note there is **one** point on this curve where the amplifier output power P_{out} is 1 dB less than its ideal value of $G\,P_{in}$. In other words, there is one (and only one!) value of P_{in} and P_{out} that will satisfy the equation:

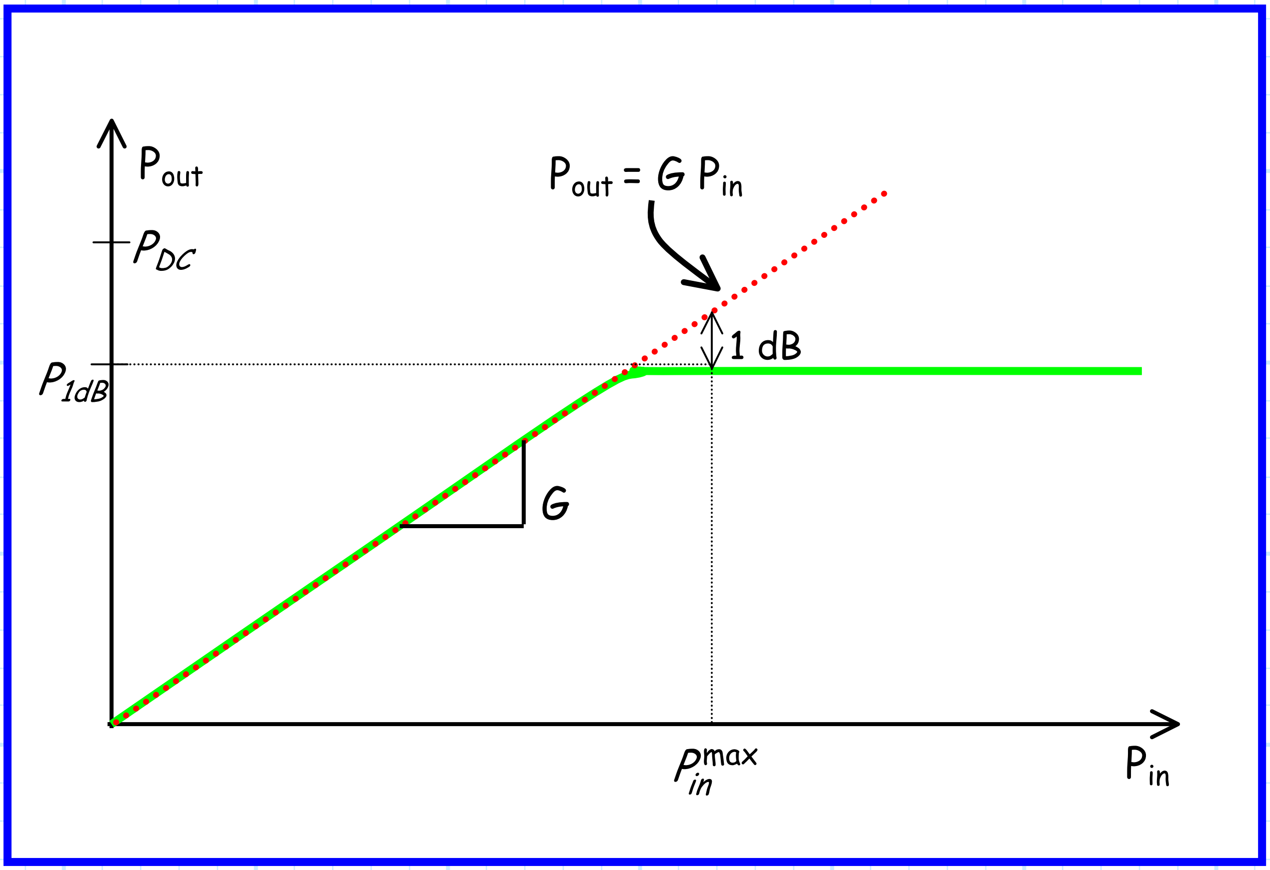
$$P_{out}(dB) = \left[P_{in}(dB) + G(dB)\right] - 1\ dB$$

At this point, the amplifier is said to be compressed 1 dB. Therefore, a 10 dB amplifier would appear to be a 9 dB amplifier!

The output power when the amplifier has compressed 1dB is called the **1 dB compression point** $\doteq$ $\mathbf{P_{1dB}}$ of the amplifier.

The 1 dB compression point is generally considered to be the **maximum power output** of the amplifier.

The input power at the 1 dB compression point is said to be the **maximum input power** (P_{in}^{max}) of the amplifier. We of course **can** put more than P_{in}^{max} into the amplifier—but we **won't** get much more power out!



Note the equation $P_{out}(dB) = \left[P_{in}(dB) + G(dB)\right] - 1\ dB$ alone is **not sufficient** to determine the 1 dB compression point, as we have two uknowns (P_{in} and P_{out}). We need **another** equation!

This second "equation" is the actual **curve** or **table** of data relating P_{in} to P_{out} for a **specific** amplifier.

Amplifier Efficiency

We can define **amplifier efficiency** e as the ratio of the maximum output power (P_{1dB}) to the D.C. power:

$$e = \frac{P_{1dB}}{P_{DC}}$$

(**don't** use decibels here!)

For example, if e=0.4, then up to 40% of the D.C. power **can** be converted to **output power**, while the remaining 60% is converted to **heat**.

→ We require **high power** amps to be **very** efficient!