

Re: linear model Hioki – Telecommunications

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Brian wrote:

>
> *Greetings,*
>
> *I am requesting clarification and assistance from the scientific*
> *community, if anyone can offer it, on Hioki's, "Telecommunications"*
> *Fourth Edition.*
>
> *If you have a copy of the text, you will have noticed many of the errors,*
> *most notably the editors did not catch an error with Ohms law and Joules*
> *law on page 12. After that, my confidence in this text was shot, but I*
> *am stuck with it for class.*
>
> *My question is regarding the use of the linear model for Signal out and*
> *Noise out Chapter 2.2.3, example 2.11 page 17.*
>
> *Hioki (and my instructor) have stated that Signal is the combination of*
> *the intelligence and noise such that.*
>
> *So = Signal Out*
> *Si = Signal In*
> *No = Noise Out*
> *Ni = Noise In*
> *Ap = Amplification*
> *Nr = Noise added by the equipment such as an amplifier*
>
> *No = Ni * Ap + Nr*
> *So = Si * Ap*
>
> *However, it seems odd that the formula for No is not applied to So. Hioki*
> *left off the Nr. Now if Signal includes the Noise, this does not make*
> *sense.*
>
> *Please provide explanation if Hioki is correct. Either way, please*
> *provide references to a text I can use to further clarify the situation*
> *as this text has absolutely no credibility at this point.*
>
> *Thank–you,*

> *Brian*

I have no references that i can cite.

However, signal and noise are never separate.

That said, there is a concept that two or more signals can be analyzed as if they were separate; sort of a $1+2 = 2+1$ and $(1)+(2) = (1+2)$ etc.

Well, sort-of true – *IF* and only if the system is perfectly linear, and a good approximation if the system (for all cases of the signals in question) is "reasonably" linear (say 1% or better for similar accuracy in results).

So, the amplifier "sees" ($S_i+N_i+N_r$) as a *composite* signal, as amplifier noise is almost always referred to its input.

That one convention "destroys" the usability of the relationships you gave.

Now, the amplifier has a gain of A_p , so AS LONG AS THE AMPLIFIER IS LINEAR FOR THE SIGNALS GIVEN (emphasis is on purpose), then at the output one has: $(S_o+N_o) = A_p * (S_i+N_i+N_r)$.

That is to say, the complete signal at the input, which one may be able to estimate the actual signal level S_i and the actual noise that is in that signal N_i , and measure the amplifier noise N_r , will total to the composite ($S_i+N_i+N_r$).

That is what the amplifier works with or "sees".

Now the signal S_i or the noise N_i or the amplifier noise N_r OR THE TOTAL AT ANY GIVEN INSTANT IN TIME may drive the amplifier into non-linearity that is sufficient to *create* harmonics of a magnitude as to "noticeably" add to the output signal.

Such added information can be considered as "noise", even tho it is not random (noise is usually considered to be a random signal).

So here we get into semantics.

One can have a S_i of 100KHz pure sine wave, which is the signal of interest and wanted.

One can "pipe" it thru a coax cable that is rather long, and have a truck drive over the cable at an extremely regular interval – creating bursts of noise, said bursts being very regular.

In fact, short the input (no generator) and measure the noise and put it thru a spectrum analyzer.

Oooh! Look at that low frequency "spike". Nice N_i .

Now replace that long cable and truck with a *second* generator that puts out pulses at that same rate; twiddle the rise, width and fall times to get a similar spectrum. Almost identically looking N_i .

But one used a *signal generator* (!).

Too bad; it is !!NOISE!! because, like a weed, it is UNWANTED.

((As an aside, to measure amplifier noise, one uses a NOISE GENERATOR (that is to say, a special signal generator that creates a known level and *spectrum* of noise) to drive the amplifier input.

In this case a "real" signal is UNWANTED and the *noise* is desired.))

Now i have never heard anyone calling distortion at the *output* of an amplifier as being named "noise".

It certainly is not S_i or N_i or N_r amplified, but it is (normally)

UNWANTED.

So that is a semantics problem that conventional terminology created.

The extra output is called distortion, and not noise.

Never mind that the $A_p * (S_i + N_i + N_r)$ is *not* equal to the output, never mind that it may be almost impossible to recognize even one component of the input; the convention is that one has $A_p * (S_i + N_i + N_r)$ plus distortion.

Hopefully, i have not confused you, and instead partly clarified the situation.

In any event, do not argue in class; *ask* polite questions about the discrepancies in the book and couch them as errors caused by the publisher.

The writer of the book is "never" wrong – most especially if (s)he has one or more degrees!

If the instructor brushes off your careful and plitew queries, or sas or implies that you are wrong, then shut up about it and cease the queries.

Else you may get a very bad grade that you did not earn (at minimum).

Just find other texts (older ones are probably better; look up what Shannon had to say about communications over a noisy channel; one can say that he "defined" information theory) for more enlightenment.

And filter out the "noise" of those errors; your brain becomes a different kind of a non-linear "amplifier" that gives $(S_i + N_i + N_r) \text{ ---> } S_o = A_p * S_i$.