Electronics

Edition: 1

Qi Meng

November 24, 2022

Contents

1 Amplifiers 2

2 Measure chain 2

3 Components of semiconductor 2

4 Background noise 2

5 Combinoric and sequential logic 3

6 Treatment of signal 3

1 Amplifiers

What is the lien between p and $j\omega$? Why for a operational amplifier we have

$$\frac{V_s(j\omega)}{\varepsilon(j\omega)} = \frac{A_0}{1+j\frac{\omega}{\omega_0}}$$

What is the significance of the product of passed band gain? Why is there a limitation in frequency for the operational amplifier? How to analyze a real operational amplifier with the source of current?

Why is a operational amplifier not always be a comparator? Since the caracteristiques for a operational amplifier should be almost the same according to me?

2 Measure chain

How to evaluate the performance of a measure chain?

What is the meaning of an arrow across some electrical elements, say, a capacitor?

What is the lien between the capteur and operational amplifier? What is the common mode? What is its significance?

3 Components of semiconductor

I don't quite understand why one gives me the current caused by the minority carriers, i.e.

$$I_S = I_0 e^{-\frac{qV_0}{\kappa T}}$$

and

$$I_D = I_S(e^{\frac{qV}{KT}} - 1)$$

When we want to analyze the diode, we need to follow the convention for receptors, and we need to simplify the diode to a wire or a source of tension or a switch. But I don't quite understand where does the source of tension comes from?

Notice what is the difference between the Zener diode and ordinary diode.

There are four parameters which are important to depict the working mode of a bipolar transistor: V_{BE}, I_C, I_B, V_{CE}. Why diodes and transistors share a common value of tension 0.6V?

What does a source of tension with an arrow mean in the diagram?

One does not tell me how I_E behaves.

4 Background noise

In order to understand why we say that the noise obeys the Gaussian distribution, you have to turn your head to the left side and focus on the amplitude, rather than the frequency.

I don't understand why we use $\gamma(f)$ to quantifiy the noise? What is its physical meaning? And I notice that a diode is said to be equivalent to two intersect circles where we label i_g^2 while for the resistance we put a circle in series with it and labels e_R^2. These labels are said to represent the power of the noise. And we also use the γ in a later section to represent the spectral density of power.

There is also a model for the operational amplifier, which I have no idea why it looks like that? And I don't know how to analyze the noise, for example, what physical quantities should I look at first? Besides all this, it seems that I need to develop a skill in how to look at the instruction book of the operational amplifier, especially how to pick up the information to calculte some quantities relevant to noise from a graph and a table?

5 Combinoric and sequential logic

When I see the logic functions for a while, I don't understand why there needs to list so many functions, I can go dirctly to the Boolean algebra without even have the physical representation as follows: a variable is equivalent to a switch, which is originally connected, it is when you press it that it becomes cut-off, but when you put a bar on it, the scheme is reversed, the switch is originally cut-off, while you have to pull it up to make it connected.

Now what are the new rules for Boolean algebra, which have two operations with symbol like . and +. This can be a big abuse of symbols if the rules for them are only partially inherited from the multiplication and addition. I list some abnormal properties as follows:

1. $a + (b.c) = (a + b).(a + c)$
2. $a + 1 = 1$
3. $a.\bar{a} = 0$
4. $a + \bar{a} = 1$
5. $a.a = a$
6. $a + a = a$
7. $\overline{a.b} = \bar{a} + \bar{b}$
8. $\overline{a + b} = \bar{a}.\bar{b}$

It comes to me that I don't understand how to see the table of Karnaugh. It seems to me that 0 in this table means the variable must take a bar on it and the column is put in front of the line.

And there is another notion: teeterboard. What can make use of it?

6 Treatment of signal

The first strange thing that I met is the Heaviside function, it's a function defind in a complex way though its graph is rather simple:

$$U(t) = \int_{-\infty}^{t} \delta(u) du$$

It is said that when we take the convolution of a signal with the dirac distribution, the signal will be retarded. Can we justify this from the definition of the convolution product?

$$x(t) * \delta(t - t_0) = \int dux(u)\delta(t - t_0 - u) \overset{\delta(-x)=\delta(x)}{=} \int dux(u)\delta(u - (t - t_0)) = x(t - t_0)$$

I have seen that $TF\left[\pi_T(t)\right] = \frac{\sin(\pi f T)}{\pi f}$ and $TF\left[\frac{\sin(\pi F t)}{\pi t}\right] = \Pi_F(f)$, there are two symbols for which I don't know their exact expressions. I try to figure it out by make the Fourier

Transform in explicit, say

$$\sqcap_F(f) = TF\left[\frac{\sin(\pi F t)}{\pi t}\right]$$
$$= \int dt e^{-i2\pi f t}\frac{\sin(\pi F t)}{\pi t}$$

But it does not look like any function I have ever met, for which I will simply treat it as a special function.

I always think of the Fourier decomposition as a consequence of the Fourier transform on the periodics functions, but today I realized that this is a somewhat silly thinking! Since When we perform a Fourier transform on a function in time domain, it is no longer a function in time domain, but a function in frequency domain. However, when we do the Fourier decomposition, we stay in the time domain. Nonetheless, the Fourier tranform of the periodic functions still have the special form which is directly due to the Fourier decomposition:

$$X(f) = TF\left[x(t)\right]$$
$$= \sum_{n=-\infty}^{+\infty} C_n TF[e^{j2\pi nFt}], F = \frac{1}{T}$$
$$= \sum_{n=-\infty}^{+\infty} C_n \delta(f - nF)$$

It is said that if we want to make a signal periodic, we need to take the convolution product of it with a so-called comb of Dirac, which is defined by $\sum_{k=-\infty}^{+\infty} \delta(t - kT)$. In this way, as we have said, we can retard the signal with different distance. But a natural problem is: Will this cause some overlap, if the signal is long compared to the short translation distance? What effects will this overlap have?

As well, there will be overlap of spectrum. But this appears in the sampling. We know that sampling can be achieved by multiplying the signal with a comb of Dirac while the question is: Do we need to be careful about pitch of teeth of the comb? The problem of arbitrarily choosing the pitch will be revealed when we pass to the frequency domain. The question here is that I don't understand what does the symbol F_M means? Where does it comes from? How can a signal becomes a triangle symmetric with respect to the origin after the Fourier transform?

The reconstruction process is confusing and the special functions π_T and $\sqcap_F$ recur, which makes the situation worse.

When the signal only lasts finite time, we say that the signal is of finite energy. But we have another type of signal, which is the signal of finite mean power. Does these two types of signal exclusives? The definition of the average power of signal is:

$$P_x = \lim_{\theta \longrightarrow \infty} \frac{1}{\theta} \int_{-\frac{\theta}{2}}^{\frac{\theta}{2}} |x(t)|^2 dt$$

and the θ is said to be observation time. Why do we need to distinguish these two type when we consider correlation? What is the physical meaning of correlation? From my point of view they are the convolution product of two signals in the time domain and consequently a simple product of their spectrum in the frequency domain.

Also there is an important notion, namely, the spectral density of power: $DSE = TF[C_x(\tau)]$, say, the Fourier transform of its self convolution. And for reasons to be find, we use different symbols for this same physical quantity:

$$c_x(f) = |X(f)|^2, \gamma_x(f) = TF[\Gamma_x(\tau)] = \lim_{\theta \to \infty} \frac{|X_\theta(f)|^2}{\theta}$$

How can we get these expressions? Also the spectral density of power will appears in the study of filtration, where we are interested in find the relation of the spectral density of power between the original signal and the signal after filtering: $\gamma_y(f) = |H(f)|^2 \gamma_x(f)$. How can we derive this?

References