Basics of Noise and Its Measurements

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Lecture - 37
Considerations for Selecting Instruments for Noise Measurements

Hello, welcome to Basics of Noise and its Measurement. Last week we had been discussing this Discrete Fourier Transform and we developed the expression for it, and we also did some examples. We also covered the topic of Reverse or Inverse Fourier Transform and then, at the concluding part of last week we had started discussing about what kind of considerations we should have, should we factor into when we go around selecting different pieces of equipment for noise measure measurement.

Specifically we had discussed about analog to digital converters and specific to that we had discussed something related to whether it is a 10 bit device, 12 bit device and how the resolution of this device depends on the bit. I mean what kind of bit device that converts a (Refer Time: 01:19). So, that is what we had covered then, there are some. So, what we will do today in this particular lecture is, we will continue that discussion for another 5, 7 minutes and then we will discuss some other considerations in context of selecting instruments as pertaining to noise measurements.

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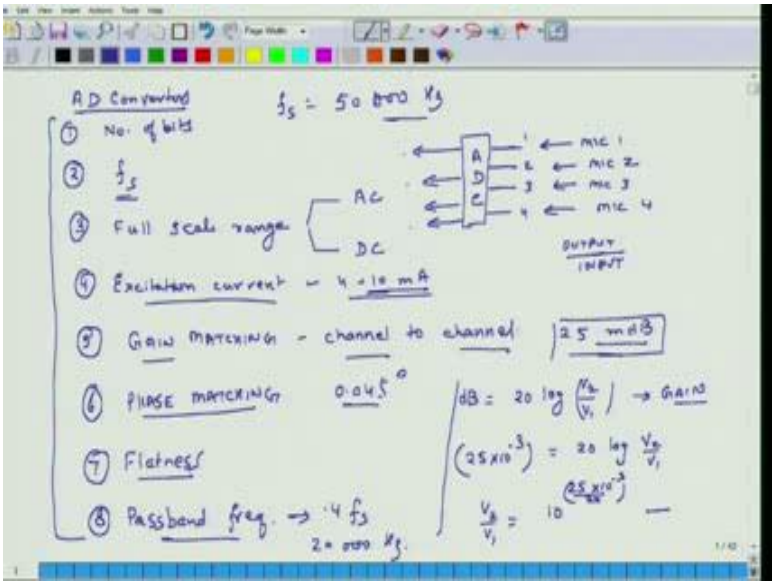

So, 1 consideration which we had was for A to D converters. So, 1 consideration was number of bits but, then our way to analog to digital converters something like this, it has several other parameters, and which we should certainly look at. So, the second parameter is what kind of sampling frequency it can support. So, if you are looking at a noise, where we here maximum frequency may be something like 20000 hertz, then your sampling frequency should certainly the other 40 hertz based on nyquist criteria and to make things more accurate and you have several cycles of that noise.

A sampling frequency should be may be even higher may be 80 kilo hertz or something like that. So, sampling frequency is important from that is point, stand point. Then the other thing is that if you are expecting, your signal to be less or plus minus 10 volts then there is a parameter associated with device that is known as full scale range. So, this will tell you what the maximum value of voltage is. It will be able to measure. So, if you are expecting plus minus 10 volts in your actual signal and if, the device suppose only plus minus 5 volts then, it will be no good may be it may even get damaged and several times the full scale range will vary it may be something for AC currents or AC signals and another thing for DC signals.

So, you have to look at that, a lot of times some of these A to D converters; they also the supply current. That is known as excitation current. Typically this 1 I know that it supply somewhere between 4 to 10 milliamps of current. What is the use of this current? So, earlier I had said that your microphone, several times it is connected to an external power supply it may be something like this is an external power supply. So, you connect your microphone to this device.

Now, if your microphone can be excited by this kind of supply current, then you do not need this particular device usually, so all you need is this. So, what this will do? It will supply that current to the microphone and also help it develop that full raising voltage and stuff like that and simultaneously through the same cable it will also get the signal back to measure the noise. So, it is supplies current and it measure measures the voltage and, so this excitation. So, some of these AD converters do that some of them do not. If you do that then it in certain cases it may be helpful for you.

Then another parameter is gain matching channel to channel. So, what is gain matching, suppose you have an analog to digital converter, and some of these converters can accept inputs from more than 1 microphone. So, this 1 can accept input from 3 microphones, but some of them can take inputs from 4 microphones or some of them can take even more than that.

So, now these are the 4 inputs 1, 2, 3, 4. So, you are connecting a microphone to mic 1 mic 2. So, this does this is mic 3. So, we are connecting 3 different or 4 different cables suppose you have 4 microphones. So, in 1 physical box, there may be 4 different AD converters right and each of these AD converters is a. So, is called a channel. So, there are 4 channels through which this conversion is happening. As this conversion is happening whatever is going in some signal also goes out, and there may be some ratio between output to input. Ideally if the conversion is perfect this ratio should be unity.

So, there should be no gain they should not it should neither get amplified or neither should it get reduced, but in reality nothing is higher you know perfect in reality. So, this gain of each channel they vary from 1 channel to other. So, you may want to look at this gain and what this device is says is that the gain is going to be at the most 25 difference

between channel to channel is the difference of this gain will be something like 25 milli-decibels.

So, what is zero decibels? Zero decibels correspond to a gain of 1. dB is equal to 20 log and in this case, let say v 2 over v 1 if v 2 over v 1 is 1 then this decibel this is suppose; this is we have gain then this gain will be 0. So, if it is 25 milli dB, this means is 25 into 10 to the power of minus 3. This is equal to 20 log v 2 over v one. So, v 2 over v 1 equals 10 to the power of 25 into 10 to the power of minus 3 over 20 and this is pretty close to 0. So, it is fairly close to one, but. So, this number the lesser this number is the better it is then another parameter is phase matching.

What is phase matching? Again, you have signal 1 coming in it will have some amplitude and some phase your signal 2 it will have another signal you know, and we have to measure that as A to D conversion is happening, the phase of the signal does not change significantly, and that change of in phase should not vary from channel to channel also. If I look at this specifications of this they are not printed here, but in some separate literature they are pretty low, it something lies 0.045 degrees or something like that. So, that is pretty good it is not a significant difference of phase, and another thing is flatness.

So, this is another thing which is flatness and the last 1 is 8 pass band frequencies. Pass band frequency. So, what does pass band frequency? So, what does this means? This means that I should be able to sense something which is in below this frequency and for this it is specified as 0.4 fs, and for this particular device fs was, what was it I think, I do not remember this, but I think it was something like 50,000 hertz. So, pass band frequency was 20,000 hertz and when there was no parameters, but also we have some of the important parameters and once we do this couple of times you will become comfortable, but at least in the beginning it is important.

That, when you go start doing this kind of measurements you should look at every single parameter of that device and understand it for yourself as to what that particular parameter means. Now, what we will do is we will discuss some other important considerations as we are selecting the equipment for measuring noise.

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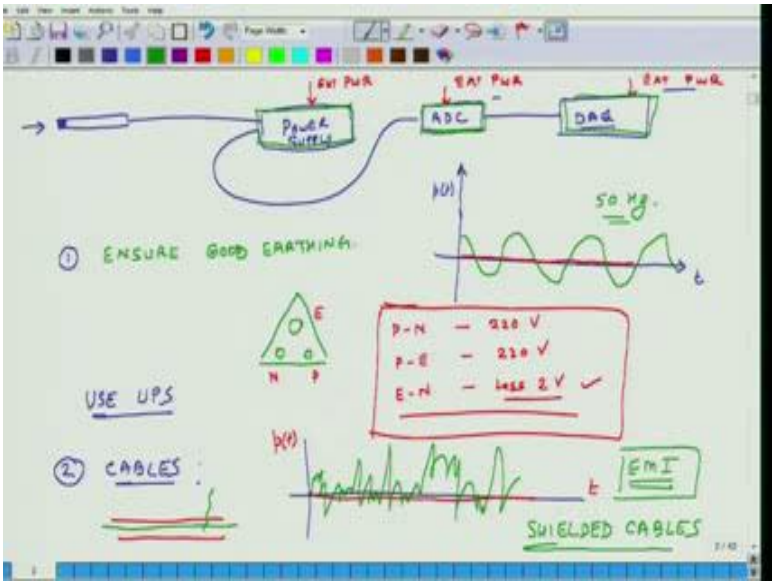

So, what I will do is I will again take the schematic layout. So, that is my microphone and this microphone is connected to a power supply, and this is my analog to digital converter and the signal. So, this is not good. So, it is ADC and the signal from ADC goes to my data acquisition system, which could be typically a laptop or a computer or a dedicated system. It will have some hardware as well as some software. If the ADC also supplies some excitation current, and if that excitation current is sufficient for exciting my microphone; and if I have the right type of the connectors then, I do not necessarily need this power supply. So, so this is the other thing I wanted to mention is, this is getting some external power. This is also getting external power because for all of these guys to run they need some power and this also getting some external power.

So, couple of important considerations the first consideration is in a lot of cases what will be happening is, Let say this DAQ, Data Acquisition System; could be a computer or a laptop and this external power may be coming from 200 and 20 volt supply. You may have a 220 volt supply, and then inside the computer it converts it into DC, but means to the whole box you are actually getting 220 volt supply same thing may or may not be happening to a DC and also to power supply. So, you get either and then purely based on a battery supply or you may use AC, and then convert it to DC and then run these equipments.

If you are using AC to run these equipments then, sometimes if you are not careful you know. So, suppose my true signal. Suppose; there is no sound, which is coming from here. So, let say the microphone is not seeing any sound. When I measure this in reality if I have this is time, and this is pressure of t as measured by the microphone, in reality the actual signal should be flat. But what will happen, in reality is that you may see some sort of a sign signal, or some sort of a harmonic signal or it may be a signal and it may have a frequency of 50 hertz. This value could be large in certain cases, if you are not careful and where this thing is coming from is if all these devices are not properly ground if.

So, one thing is ensure good earthing every device should be properly grounded; it should be properly grounded a lot of times. So, what does that mean? So, first thing is that your electric supply for 220 volt supply. So, this is your plug this is the earth point this is one over them was phase. So, this is let say earth this is phase and this is neutral, right? Typically, if your electric supply line is good then the voltage difference between phases on neutral will be 220 volts or in some cases meant 2 times 240 in that range, and between phase and earth will also be 200 and 20 volts.

If the grounding is good if the grounding is good then between earth and neutral if it is a really good supply it should not be it should be less than add the most 2 volts, add the most 2 volts if this voltage is large then you have a grounding issue if you have a grounding issue. If you have grounding issue and you have to solve this problem you have to solve this problem.

So, if to figure out how to solve this problem, you have to go back and check everything is grounded correctly and physically this pin is actually connected to the physical ground and if it is not then, you have to then it is a very expensive solution. Because you are you have to get the actual grounding done correctly, but unfortunately at least in our country a lot of times this earthing is not done properly. So, we get this noise and this noise is because of this bad grounding. So, one way to avoid this problem you convert our spend a lot of money in trying to make a very deep hole and putting a conductor in it and filling it with salt and water I mean that is how they do all the grounding the one way to avoid this problem is that we use UPS.

So, what if you have a good UPS it charge it up and if it can run for may be it few hours during the course of your experiment it charge it up connect all your equipment to UPS and then disconnect physically the UPS from 200 and 20 volt supply not just switch off the plug, but you actually removed the plug and disconnected. So, it is not physically connected. So, that is imp. One important way to ensure that your grounding is correct second cables a lot of types you will see that signal again, I mean if you have a signal if your microphone is not and in noise.

If there is no noise been generated no signal is coming. So, then once again I was mentioned earlier your actual signal should be like this is my time and this is my pressure, but you may see some noisy signal and again this could be very large it could be small if the some amount of if the magnitude of this signal is, sufficiently large that it start bothering you. Then you should seriously think whether you have an EMI electromagnetic interference issue or not what is EMI. So, I will just give you 1 example. So, suppose in the neighborhood if you are equipment you may have an electric motor running and there may be sparking going on inside the motor because, that is how electric motor there is contact between conductors and it is not you know when did contact or a sold at contact it is like things are moving like this.

So, there may be some gaps and sparking may go on or you may have a tube light which is running and there is also spark happening in tube light also or things like that or you may have general noise coming from a mobile phone or the universe is full of all sorts of electromagnetic interference noise. You know here electromagnetic noise and what may be happening is that your cable. So, what it is? A cable, it is basically a piece of wire and then it is surrounded by some insulator.

Now, this electro insulator is good for low frequencies, but high frequency noise which is in megahertz or gigahertz those electromagnetic radiations they just can directly come on to the conductor from the air those electromagnetic radiations. They can and they become them travel on the cable on the conductor and here microphone not microphone with the system will pick it up, and this is what you will see. So, this is called EMI noise. So, 1 way is to make sure that not the you know these types of machines which create

arts and things like, that they are not around the second thing is that if you have a seriously in my issue then you should think of using shielded cables.

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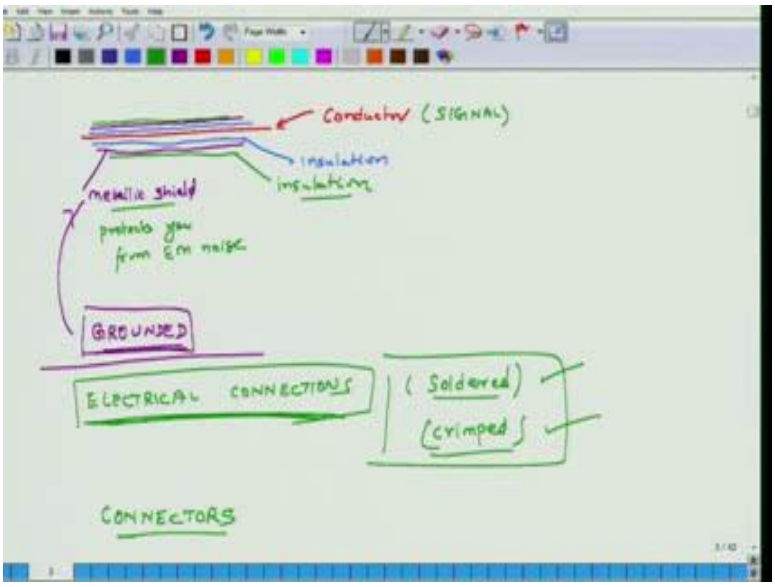

So, what is shielded cable shielded cable is basically your core. So, this is a conductor then outside the core you have a layer of insulation then, outside the insulation you have a thin sheet of foil or mesh of wire or something. So, this is some metallic shield and in some cases or most of the cases they are take them finally, covered by a layer of insulation. So, the conductor actually carries your signal which you are trying to measure this insulation, insulates the metallic shield and the conductor. So, that they do not touch each other and the metallic shield is basically like shield. It is a shield which does not permit electromagnetic radiation to come in. If you go back to 12th standard physics, you will see that electromagnetic radiation cannot trans penetrate easily into metallic structures.

So, this is your protects you from protect you from electromagnetic noise and then the final outside layer of insulation actually covers that. So, that is also insulated. So, that it does not exceed at touches some voltage source, and develops a voltage of it is own and important point note about is this thing is, but this metallic shield it should be grounded

otherwise, it will have some floating voltage based on whatever EMI and that will again generate noise.

So, this should be grounded and all the grounds in your system they should be connected to 1 single physical ground 1 single physical ground. So, you have a ground for a cable you may have a ground for a box. You may have a ground for computer, but all of them ultimately they should be physically connected to 1 single ground. If that does not happen then, some part is on some ground another part is at some other reference level and that will create problems. So, this is important to understand. So, that is there last thing your electrical connections ok.

So, whenever we join 2 pieces of metal, if I have to run an electric bulb lot of times we strip out wire there is some conductor and we just twisted it by hand and join 2 pieces of wire and then, put it a tape put tape around it and that connection works for an electric bulb, but never do that never, never do that type of a connection for taking measurements, which we are trying to do here.

Every single connection should be rarely soldered either it should be really soldered and you should follow this practice blindly or it should be crimped because, what we are talking about is measuring data at extremely high frequencies 10,000 hertz 20,000 hertz. Several 1000 hertz and these connections if they are not perfectly bonded together they may be, doing this at very small time scales, but at those time scales and when this happens there is also arcing go on. It is generating it is own noise and when this happens it generates it is own noise, and also the connections are physically becoming value may become zero and non zero.

So, you know that totally upset results. So, never use that the regular thing which you try for connecting 2 pieces of wire to light a bulb that kind of an approach should never be used. Every single electrical connection it should be good it should be either soldered or it should be crimped. So, I cannot understate this, I cannot say that this is not important or it is slightly less important a lot of times, at least in my experience lot of times people when they make these connections. They just casually connect 2 pieces of wire, and most

of the times when they take measurements their results are upset because they were not careful enough to take care of this consideration.

So, these are some of important considerations, and when we last thing is about connectors. So, you have a cable it has to get connected to a power supply or something like this and again whenever we use some connectors to join cable of one equipment to another equipment. These connectors should be of high quality and the electrical connections in these connectors should be also either crimped or they should be soldered. There should not be any third option. So, these are some of the important considerations which will help you make good measurements in area of noise and vibrations, and with this I will close this discussion today. Starting tomorrow; we will start a new series of topics and probably we will be discussing about weighting and also about octave band analysis.

Thank you and have a great day.