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NPTEL ONLINE CERTIFICATON COURSE

Course
On
Analog Communication

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Lecture 23: Effect of Carrier Synchronization

Okay we are talked about this coherent and non coherent demodulation it is the part of the receiver circuitry okay. We have already talked about that if we have to do coherent demodulation we need to extract the area and what will be trying to prove today if that carrier requirements how important that carrier recovery is. If there is some error in the carrier recovery what kind of detrimental we will have in the recovery of the signal. So that is something will try to explode today. So let us have see for DSB signal.

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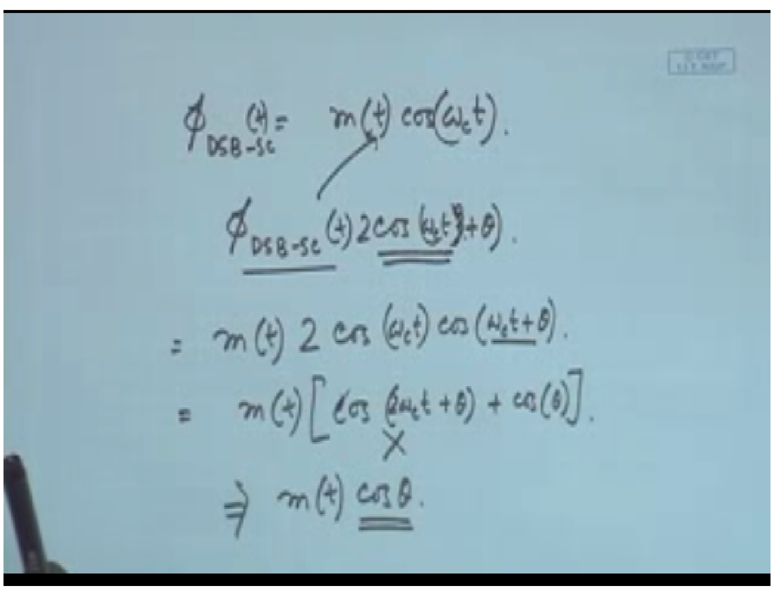

So let say my DSB –SC which is nothing but m(t) cos ω_ct right. So that is a typical DSB signal where mt is the modulating signal than limited of course it occupies in this band up to band width D and then we have chosen carrier which is ω_c much bigger than D okay. So that is the DSB signal. Now let say what I will be doing I will be locally generating at area okay. To demodulate it first I will take it from the channel through antenna and then locally generate a carrier whichever way I get that carrier.

Let say I get that carrier I will multiply with this carrier right so generally my demodulation process is something like this. DSB – SC (t) multiplied by through cos $\omega_c t$ okay so multiply by this and pass it through a low pass filter. Is what p2 low pass filter which as a bandwidth roughly or correct frequency at D. so this is what we do but let ay this carrier that I will be multiply with it is not completely in synchronize. Let say that as a phase off set of θ with a incoming carrier okay.

So let say that that is happening that I have probably detect the frequency very nicely the frequency is completely in synchronize but the phase that is off set of θ okay. But that is the carrier I am generating so I will multiply with that carrier so do I get okay so I can replace this by this so I will get m(t) 2 comes over here cos ω_c t x cos (ω_c t+θ) so that is 2 cos a cos b it should be cos a+b x cos a-b okay. So I can immediately write m(t) this is cos A+B means cos ω_c t sorry 2 ω_c t,+ ω_c t, 2 ω_c t+θ and + cos is ω_c t+θ- ω_c t so that should be θ right.

Now I will be putting a low pass filter so this term will be canceled because that frequency is 2 ω_c t that ω_c so I will be cancelling out this term that will just of the term after demodulation I will be getting m(t) cos θ I will the when it was fully synchronized there is no phase off set in the local area has getting all the empty that was good. Now I am getting m(t) x cos θ okay. So whatever off set we have this is not a time varying term as you can see.

So basically is there is a phase off set I get almost empty multiplied by constant term. So the message signal will have similar and duration and time okay. So the pattern of the message signal remains the same. It is just get modulated sorry it is just get multiplied by a constant term which is called cos θ the θ is the offset. The problem with this is what the maximum value is of cos θ that is 1 but I have a chance getting 0 over here.

Suppose that θ off set is π/2 then I get 0 so what do I get, I get nothing so there is a then the other of huge a situation if I have a phase off set I do not no that phase off set will be random right if somehow I choose a phase a I get a phase offset of π/2 or around π/2 I will have a huge off set means huge of innovation of the message signal. The message signal pattern will not getting change because it I getting multiplied by a constant term.

So there is no problem in that message signal pattern is still remaining the same all the things that unnecessarily due to my demodulation there is a innovation term which is coming up if my phase off set is near to 0 I know that not much at innovation will be happening. But if it is near to $\pi/2$ I have a big problem okay. Finally the signal with the strength will go down heavily so this one problem if there is a phase off set, now let see if there is a frequency drift okay.

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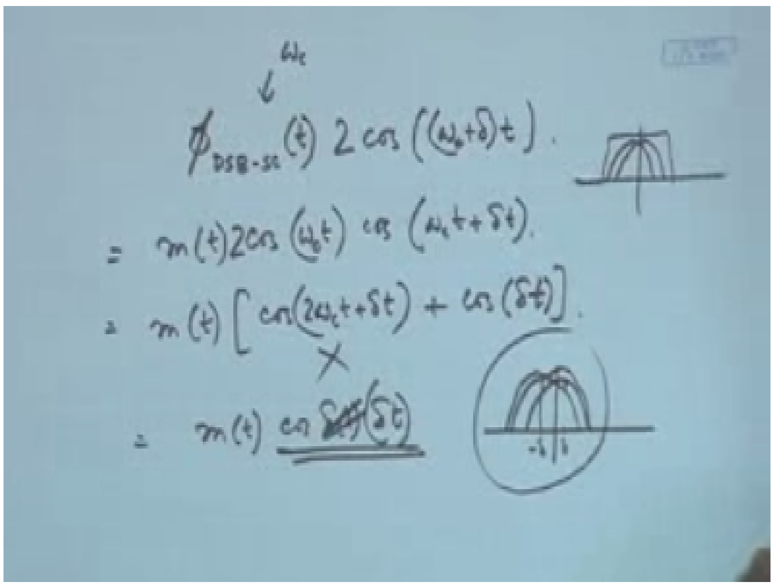

So I will again have ΦDSB -SC (T) okay which is now will be modulated sorry this is already modulated signals I get that okay. Now what should be means what will be doing will be now demodulating it okay, so while demodulating I will be again multiplying by the local carrier, let us now say this is modulated with ω_c but this local carrier has a frequency drift, so it is means I could not crack that frequency so I get a δ drift to the frequency.

So let us say ω_c is the targeted frequency but I get $\omega_c+\delta$ or $-\delta$ which where you way you take and there is no phase shift let us say if one term of that there is phase shift there will be additional effect we know already what will happen if there is a phase shift, and let us say phase there is no drift but frequency I could not track completely so there is a drift in frequency. So now I can write this as $m(t)\cos(\omega_c t)\cos(\omega_c t+\delta t)$ right, and the two term is there again I will put cos A.B so it should be $m(t)\cos A+B$ so that should be $(2\omega_c t+\delta t)+\cos(\delta t)$ right.

Let us say now what will happen there is a frequency term at m(t) modulated by some very small frequency because whenever I am tracking the carrier I will not have huge drift I will have a small drift, so there will be a small shift little bit of shift in the frequency so there will be a small drift of that in frequency domain if I wish to track that so what will happen there will be a I means it will not come as m(t) there will be a small drift of that right, so it should have something like this okay, so there will be a δ drift and the other part will actually go into $2\omega c+\delta$ and $-2\omega c$ it means $-2\omega c-\delta$, okay.

So that is why it will go if I put low pass filtering now it will just take this thing rest of the things will be gone so I will be not getting this I will still get this which is nothing but m(t) $\cos\delta t$ I should not say δt it is δ into t right. Now this term is no longer a constant term okay, what it is actually the m(t) is now getting a modulated term with cos some small frequency δ into t, so this will distort the signal.

So frequency drift is even more detrimental than the phase drift, phase drift my message signal was almost similar okay, and I was getting something over there as long as the phase was not going near to $\pi/2$ because then the attenuation it was just attenuated signal and the attenuation was not very big okay, so that I was safe but here what is happening my message signal is now getting modulated means whenever I demodulate I expect that I should be getting message signal but it is no longer the message signal it has some modulation on top of this which is modulated by that δ okay, the problem with this is as you can see in the spectrum because this δ is small so there will be a small drift only so you will never be so this is centered at δ and this will be centered at $-\delta$.

So the positive shift and negative shift will super imposed and they will actually generate a different kind of signal or different kind of spectrum which will completely change the overall signal quality and it will never be able to separate that out because a higher modulation will always keep the signal shape intact or spectrum shape intact but this is a lower modulation so they get overlap the negative half and positive half gets overlapped and I get something which is completely different okay.

So I will never be able to recover by signal back from this if this happens, because I know that the δ will be smaller and however small it is it will start distorting the signal okay. So that has a huge detrimental effect in demodulation so the I am just telling this because now we can appreciate why carrier recover is so important and why carrier phase and frequency synchronization is so important without that any coherent detection is off no meaning okay. Now let us try to see what happens if I have this quardrature amplitude modulation QA.

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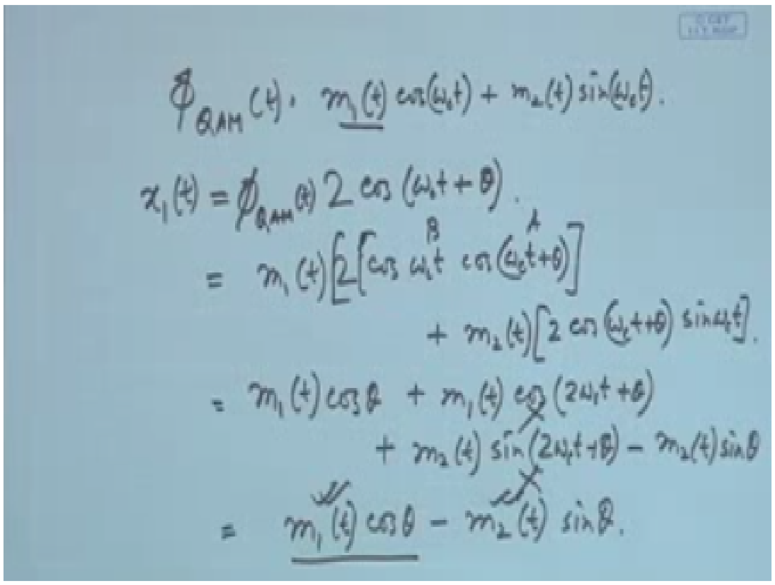

So let us say I have φ QAM t which is m1 t cos ω CT + M2T sin ω Ct that is what we have said write will be this now I will demodulating I have to demodulated let say I want to just demodulate this M1 T so what is have to do? I have to multiply with a local co sinusoidal let us say that has a phase drift. So I will be multiplying this φ QAM t with 2 cos ω CT + a drift of θ okay. Let us say this is my X1 T what do I get? So it will be M1t 2 cos ω CT x cos ω Ct + θ right I get this + M2t 2 cos ω CT + θ x sin ω CT.

So all we have to do is cos A cos B and cos sin B so we put the formula of that so we will be getting M1T cos θ A- B is this is A this is B + M1T cos 2ω CT + θ and will have M2T sin 2ω CT + θ – M2T sin θ fine. I will be putting passing it through up though pass filter these two term will be gone what do I left with m1t cos θ – m2t sin θ, earlier for DHBSE I was getting this right, which was okay because cos θ is constant term now what I am getting?

I am getting this signal better Fourier signal coming from here also so now because I have modulated it in such a way that they are actually co occupying the same band so I will demodulating if I have a phase drift I will interference coming from the other signal. This is mode at trimesters, earlier I will just getting a attenuated signal we have told that there are no free log gels you got of very nice frequency or band width response by QAM but if you have a drift in carrier for DHBSE it just add some attenuation.

Whereas for this one you will have a interference tone coming from other signal that you cannot do anything right now because they will all mixed in the base band and you have no way to actually demodulate them any further okay. So it will just interfere your signal and it will got up to your signal so this is the problem that QAM will have which again you will see that our SSD will not have that SSB will not have probably similar problem.

But QAM will have a bigger problem coming some amount of interference from other signal okay. so after knowing this that the importance of carrier recovery and importance of not having any phase or frequency drift and which particular modulations scheme suffers from a phase or frequency drift in what extant. So after seeing that let us try to see if for VSB or SSB signal if we wish to actually demodulate it sorry not demodulate we wish to get carrier back what will be the associated problem okay. So before demonstrating that let us try to see how do I actually get a carrier back from a DSB signal double side band modulated.

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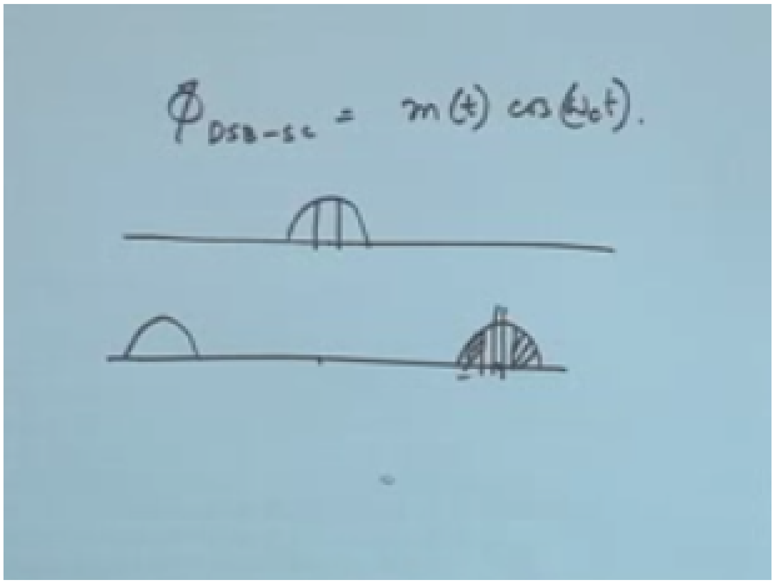

So let us say φ DSB SC signal which is nothing but MT cos ω CT right this is by DSB signal. So what I can do this MT cos ω Ct I wish to task ether carrier so this will be suppose this is my MF I do a modulation it close over there okay so it has all the frequency term if I can put a very narrow band pass filter centered around that fc whatever I will be getting that will give me means the frequency term almost okay.

The problem is with this particular method if you just say that anyway this has been modulated with carrier I could have very narrow band I will be getting my carrier back that something I should be getting but that has some danger first of all to put a narrow band, band pass filter you need to know the frequency okay roughly probably you will be knowing the frequency but you might not know it exactly so you will have to put at least some amount of bigger band over there. But that not has detrimental as the next one I will talking about suppose this is a voice signal what will happen? Will it have any DC value?

No the spectrum will look like this once I modulate there will be nothing over there. So around the carrier I have nothing so I put a band pass filter I get 0, I would not be able to detect any signal. So even though I know there is a carrier involves in it but somehow the carrier is evicting me I am not able to get that carrier right.   So what I can employ over here is something like this.

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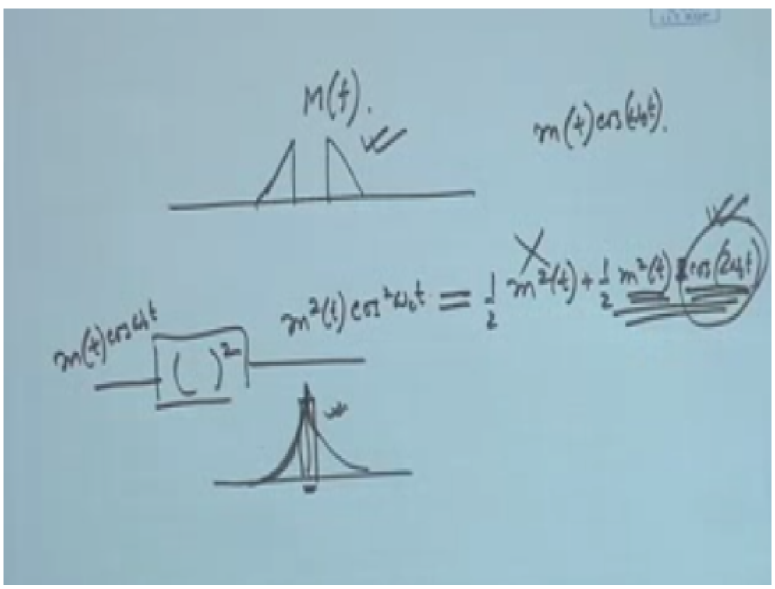

I have this signal right this MT cos ω CT even if this has no value around WC can I somehow generates something around WC or ω C what is the chance of doing that let us putt eh circuit which is the squaring of it okay, so let us have MT cos ω CT I square it so what do I get? Here I will be getting M^2T cos ^{2} ω CT right which I can write as ½ m^2 T + ½ m^2 T cos 2 ω CT okay if it has some phase that also will be tract over there, so I will get this now if I put a band pass filter this will be gone.

But for this one I have now a better guaranty of getting something because what is happening and now actually suppose it was not having any DC term it was having some spectra which was divide of any DC term or around that DC term. Now this is by MF what I am getting over here is m^2 T in frequency domain what will happen I will get convoluted right, so if I convolute this signal with itself what will happen?

So now I can represent that in a similar fashion has we have done for envelope decision with carrier so I can do represent m(t) and mh(t) has some cos θ e x some sin θ t right I can write that so immediately I will be writing E(t) this as cos ψt depending on = or – I can write that as θ(t) so I get this VSSB can be represent this now if I just square it all about squaring and all we have seen which square we are getting things.

So now you square it $[VssB\ (t)]^2$ what do we get ,we get E^2 (t) [ψct +θ(+)] take half E^2 [1+ψ[2ψct+θ(t) I do get this is around ψ c so if I just put an arrow fitter I will be getting this thing so what we getting again there arrow pass filter the carrier that we are getting that is lot to ψct has some modulated part which is not the pure career okay, already I was getting the carrier back For VssB.

I was getting the carrier back fortunately I was getting ψ if it has a driffed ψ+θ but now I am getting some θ t which is actually determine by this m(t) and mh(t) which is coming from the message and that will actually change this not pure this is something else so that I cannot take thus a carrier ∞because it is a corrupted carrier signal which Is not pure so whatever I do even after squaring I do not get my carrier back okay.

I can put up employ band pass filleted out but whatever I will be getting that is not actually a carrier so with that I will able to employ any demodulation so that is why you can see for VSSB also same thing you will be happening because this will be instead if hit is will be mv after passing through that right. So again there will be some θ in the carrier it is try to square it so you will never be able to through arrow pass filter get extract that carrier from there so that is why if SSB and VSB modulated without carrier that is not possible if first of all we will not carrier back so all you will have to do is ,you will have to send some carrier along with it.

So that is where it becomes infinite because we have already seen that if we just try to put some power for VSB if we wish to do envelop dedication and we will have to actually put huge amount of power employ the envelop dedication of course can be improved for VSB the power will not be that high has compared to but you will have to put all which is very high compared to amplitude.

So that is pretty much the discussion from engineering point of you modulation you that what happens different kind of modulation they have some advantage some disadvantage we have explode that and now we are in a position to actually explore more on carrier we have already seen anywhere we wish to employ coherent demodulation we have some nice carrier coherent we have already VSSB we have already told that might keeping it but try to means make that even more act to it so that circuit will come into the picture this called phase law that has a big important communication system so will try to now explore the PNL circuitry from next class thank you.