Introduction to Smart Grid
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Lecture - 18
Islanding Detection Techniques - III

Good morning to all of you. In this lecture, we will discuss about three different types of islanding detection techniques; one is active islanding detection technique and the second one is hybrid islanding detection technique; and third one is the communication based technique.

Now, in the previous lecture, we have discussed regarding the island detection technique. Then the major drawback of this particular technique is the NDZ problem. The non detection zone is very high I mean it is very difficult to overcome suppose if power mismatch is zero percent that is very difficult to detect the islanding of the micro grid system, so that is why the alternative another technique which is active island detection technique. And there are number of techniques are available as for as the active islanding detection technique is concerned.

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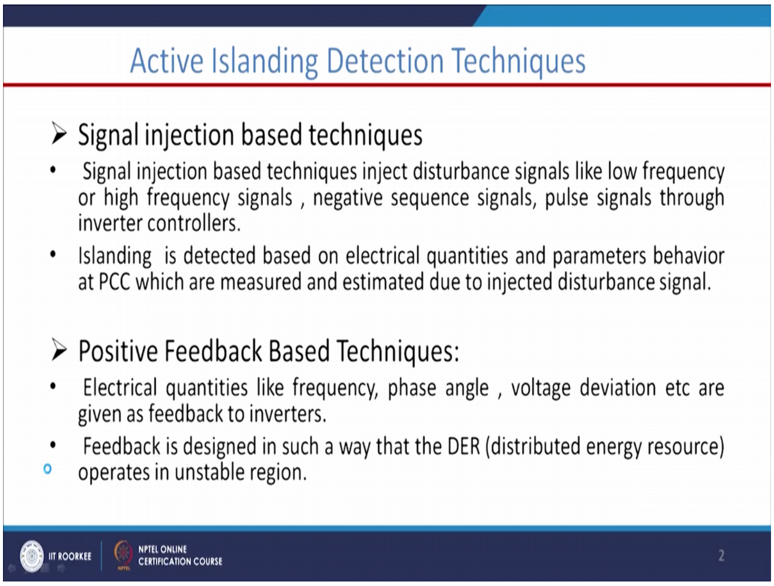

And also we have many number of hybrid islanding detection techniques are now developed. And the communication based technique those are in basically many pril premature states you know this wide monitoring system, PMU or micro PMU, they are going to play great role as well as the communication based islanding detection technique is concerned.

Coming to this active islanding detection technique, here if you see that the first type of active islanding detection technique that is the signal injection based technique. And in this in this technique, the signal injection based technique what we do basically we inject the signals like disturbance signals with low frequency or high frequency also sometimes or sometimes also we inject negative sequence signals or pulse signals through the inverter controllers.

In case of solar and wind system, we have inverters; and the controls have also present for the inverter system. And what we do in active islanded detection technique, we inject intentionally some disturbance signal with low frequency or high frequency to the controller of the inverter system. Now, after injecting this disturbance signal, we measure the electrical quantities are parameters at the terminal of the PCC that is the common coupling point, point of common coupling after measuring those quantities and parameters, then we will decide whether this micro grid is islanded or it is not islanded.

Now, coming to this positive feedback based techniques, there basically what we do we basically provide some parameters or quantities like voltage phase angle as a feedback as a feedback to the controller of the inverter circuit. And from there again we measure the voltage and current parameters, voltage and current quantities like at the PCC bus. And then we decide whether this micro grid is islanded or not.

Coming to the first active islanded detection based technique that is signal injection based technique.

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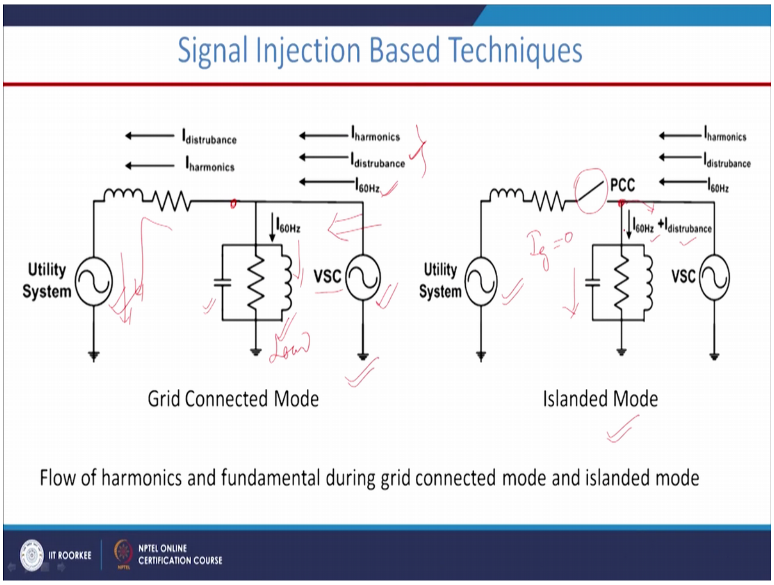

If you could see here this figure, here we have taken the grid connected mode of operation of the micro grid. This is our grid; and this is our renewal energy source. This VSC stands for voltage source converter system. Those are basically the solar systems or wind system. And here this one is our load. Then in the grid connected mode we just inject this I disturbance with certain low frequency let us consider that is 30 hertz.

If our fundamental frequency is 60 hertz or 50 hertz and we are injecting a disturbance signal of 30 hertz. And these are the currents harmonic currents and those currents appear due to the presence of non-linear loads or may be electronic components or a electronic devices in the circuit you know this renewable sources are basically having the electronic gadgets electronic components. So, due to that this harmonics are basically present in the system. And this is our fundamental signal I 60 hertz or I 50 hertz.

Next there is current if we will see the impedance of this load path basically is high and the impedance of this source path is slow. And if you could see from this side from right side, and we can make it the source as short circuit path and their this as a result the 60 hertz component is going to flow through the load and the I disturbance, I harmonics are going to flow through the grid side terminal. And during this islanded mode of operation, islanded operation means our circuit breaker at the grid side is open. As a result this grid current this 0, I is e equal to 0 in this case during the islanded mode of operation.

What happens during this condition this I 60 or 50 hertz signal and I disturbance including the harmonic components also flow through this load. That is what the difference between this grid connected mode and islanded mode of operation. So, as a result what will happen in this case in the first case this PCC voltage is govern by this grid, but however during this islanded mode of operation this PCC voltage is basically due to this some disturbance and 60 hertz signal. So, the voltage which is due to this disturbance signal or harmonic signal, so we can measure always the harmonic voltage at the PCC and then corresponding detection process can be developed.

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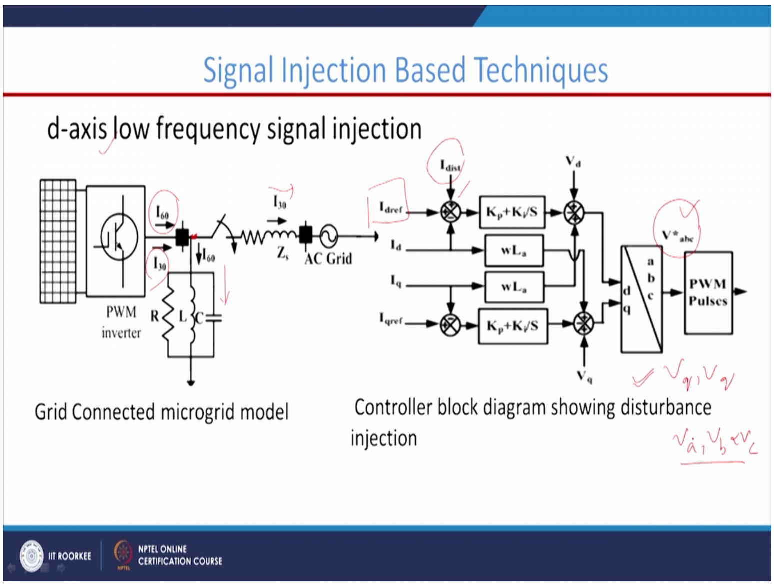

Now, the first one as I discussed that we inject like low frequency signal or high frequency signal here I have taken like I 30. I 30 is the basically current signal with 30 hertz. And this is our fundamental current signal I 60. And during this grid connected mode, this I 60 is going to flow through the load; and I 30 is going to flow through the grid side.

But when it is islanded then together this I 60 and I 30 are driven through the load path. And at this PCC common coupling point, we will see that what is the value of this particular harmonic voltage or harmonic current signals this is how this block diagram shows some part portion of the controller for the solar system. And you can see here how this basically disturbance signal is injected to the controller of the inverter circuit of the solar system. This is our I d reference this is basically the dx is low frequency signal injection.

What we do that with a low frequency this I d this direct access current is injected to the controller of this inverter of the solar system. And after that the corresponding this V abc star that is after converting this dq component of the voltage to abc component like abc frame, there we can always measure this V star abc. So, in our hand everything is there we can see like V q, V d, V a, V v and V c. So, due to this injection of the disturbance what is the impact on particular this PCC voltage that is your V abc or V q or V d. And from there we can always determined or we can decide whether this is there is islanding situation or there is non-islanding situation.

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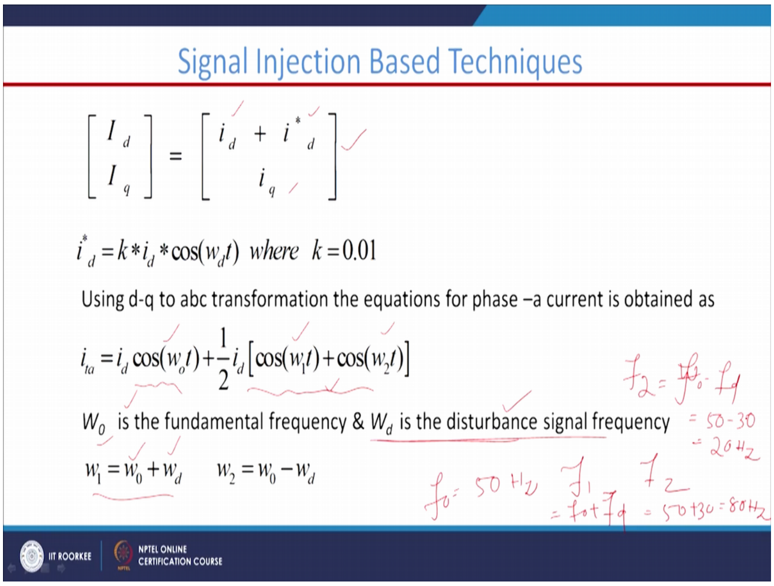

And this is our looks this particular I d. And this is i d is actual current and this i d star is the disturbance current. And i q we are not going to disturb after this disturbance and converting this from the d-q frame to abc frame then this i ta basically the this i ta stands for the instantaneous current of phase a that is what this i ta small i ta. It looks like this. It is it has two parts the first I have saw first part is the fundamental component path that is I d cos omega at naught t, and the second part consisting of 2 that is cos omega 1 t and cos omega 2 t.

Now, if you could see that what is this w 1, the w 1 is nothing that is w naught plus w d. The w d is our fundamental disturbance signal frequency and w naught is the fundamental frequency. This w d is the disturbance signal frequency; and this w naught is the fundamental frequency the signal which is present fundamental signal. If I know this w naught let us say it is 50 hertz, if I will take f naught is equal to 50 hertz, then the corresponding this w 1 I can always calculate that is based on this f 1 and this f 2. How to calculate it, that is f naught plus this f d. If I will take f d is equal to 30 hertz, then it will be 50 plus 30 is equal to 80 hertz that is my upper limit of this particular disturbed I mean phase a signal, because I have already infected one disturbance signal to my controller for the as for as the dx is concerned right.

And next this particular f 2 is equal to omega naught this is f naught I am taking f naught minus f d that is equal to 50 minus 30 is equal to 20 hertz that means, the range is basically within 80 hertz to 20 hertz that particular signal phase a current instantaneous phase a current lies this frequency of the second component is between these two. So, lot many exercise can be done and I mean many parameters or quantities we can take. And we can analyze whether this there is islanding or not.

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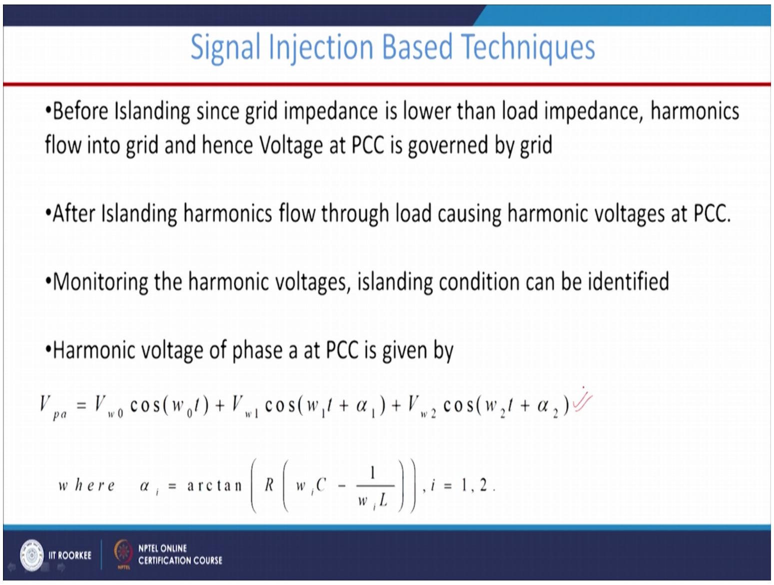

Now, after that we are going to measure the PCC voltage of phase a. So, this phase a voltage has two parts; the first part is v omega naught cos omega naught t plus v omega 1 cos omega 1 t plus alpha 1. And this omega naught to omega 2 t and alpha 2, where this alpha i is the basically the angle and this is expressed here r into this omega i c minus 1 upon omega i l and this i is equal to basically 1 and 2. This is how this particular signal injection based technique provides the information about the current as well as the voltage of phase a.

After this we will measure the voltage that is V d because as I said from the beginning while we will inject this particular signal that is i d.

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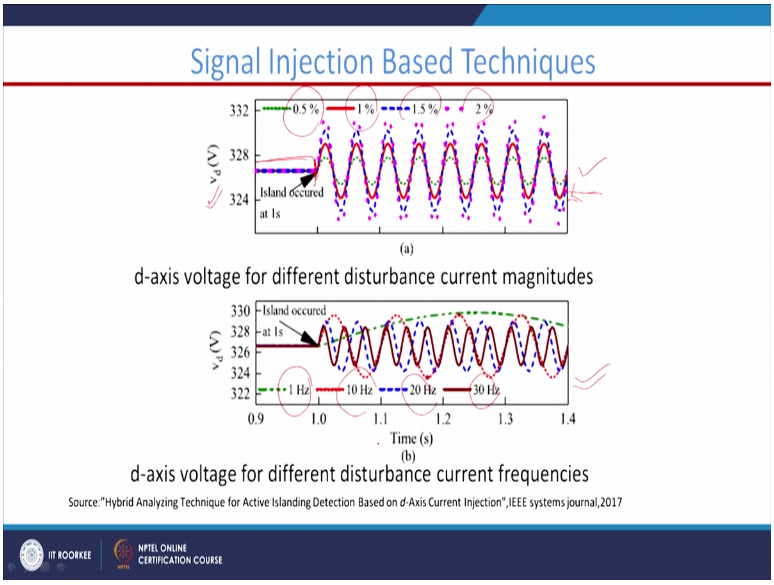

And again this i d is some percentage of the reference signal. I just if you will see this figure here we have taken first 0.5 percent or we can take 1 percent, 1.5 percent and 2 percent. We can vary the percentage of this i d with respect to our reference signal. After that we will see the impact at the PCC bus that what is this value of this v d, this v d is looks like this. After this islanding you can see here up to islanding the signal is almost constant it is td there is no variation. But after islanding the signal is going to oscillate with the frequency of what at what rate we have injected 30 hertz, 20 hertz or we are just going beyond our fundamental frequency it is basically 70 hertz or 80 hertz.

So, this oscillation if we can test, if you can track, then always we can say there is an islanding situation. Similarly, if you will see by varying the frequency of the injected signal, if you see the second figure that is we have taken 1 hertz then we can take 10 hertz, 20 hertz, 30 hertz the here we are just varying the frequency of the injected disturbance signal. If we will vary that a in the pattern of this v d which is measured basically estimated that will also vary. So, based on this concept we can always detect whether the system is islanded this micro grid islanded or not islanded.

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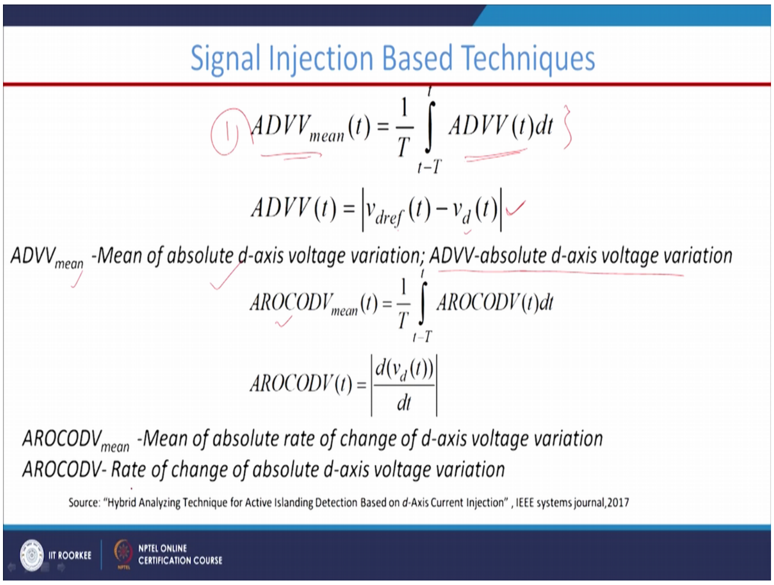

From there again this is another parameter or you can say indices other indices are calculated. The first one is ADVV mean. This ADVV stands for mean of absolute dx is voltage variation. And this ADVV means absolute d-axis voltage variation. This is if we will just keep it here mean that is absolute d-axis voltage variation mean. And here you could see that by taking within a single period 1 upon t t minus t to t we have calculated the mean of this particular voltage. What is that voltage, the difference of these two voltages v d reference and the v d actual value.

If we will take the difference between these two and then we will take the mean of this particular voltage, then we will get this ADVV mean. This is one index that is one index which will used to detect the islanding situation. And another index another parameter we can say we are just calculating directly from the v d voltage the dx is voltage that is AROCODV that stands for this AROCODV stands for rate of change of absolute d-axis voltage variation. We will take the d vd by dt. If we will see this equation what is that d or derivative of small v dt divided by dt. The rate of change of this particular voltage dx is voltage instantaneous voltage that is also another index to detect whether the micro release islanded or it is not islanded.

After that we will take mean of this particular voltage the rate of change of v d. If it will take this mean it will also another index. See, why where doing all this exercise because sometimes what happens if we will take more of number of features, I can say this is these are basically features, you can take voltage, you can take the mean of the voltage or rate of change of the voltage or energy present in rate of change of voltage. Those are basically different features why you are taking many number of features because a single feature may not be sufficient to detect whether it is islanding or not or it is non islanding situation or not it may happen sometimes that is few non islanding situations we will behave like a basically islanding an islanding situation. So, in that case, if you have more number of features that will be the final decision will more reliable and more accurate. For that reason basically we are just interested to have more number of features.

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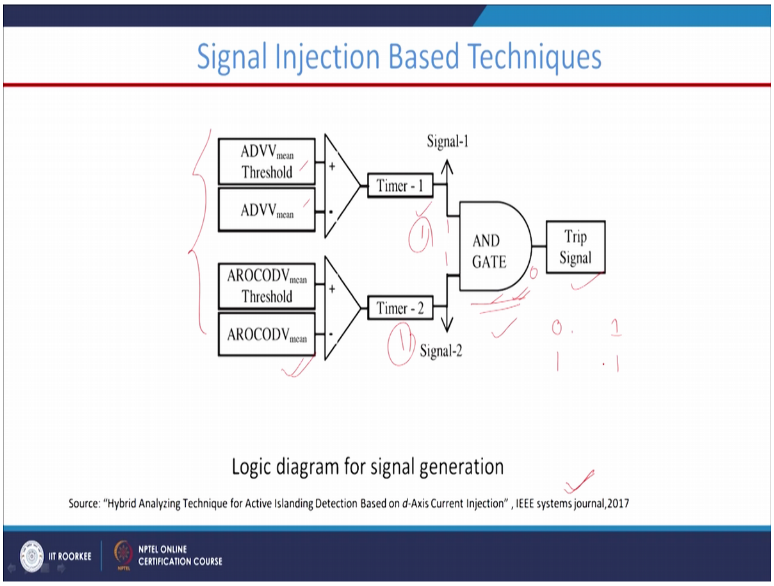

Based on this in this particular paper, they have formulated one logic diagram the logic they have developed. These two features they have taken and through this summer plus minus this is threshold and actual value the difference I have taken. If suppose the value of this particular feature exceeds to threshold value. Then this timer will be on; and this output will be given to this the signal which is going to given to this AND gate. And similarly this feature if the threshold value I mean the threshold now the value of this particular feature is exceeding the threshold, then these particular signal will be given to this AND gate right.

So, this AND gate means if this particular status timer output which is 1, and this timer output is 1, then only I mean this two inputs these two inputs are 1, then only this AND gate will operate and then the trip signal is going to be generated that is what the meaning of this AND gate. If any one of this particular feature output is 0 that means, if in another one is 1, still there will be no trip signal right. So, if the output is going to be 0 that means, together the two signals should be 1.

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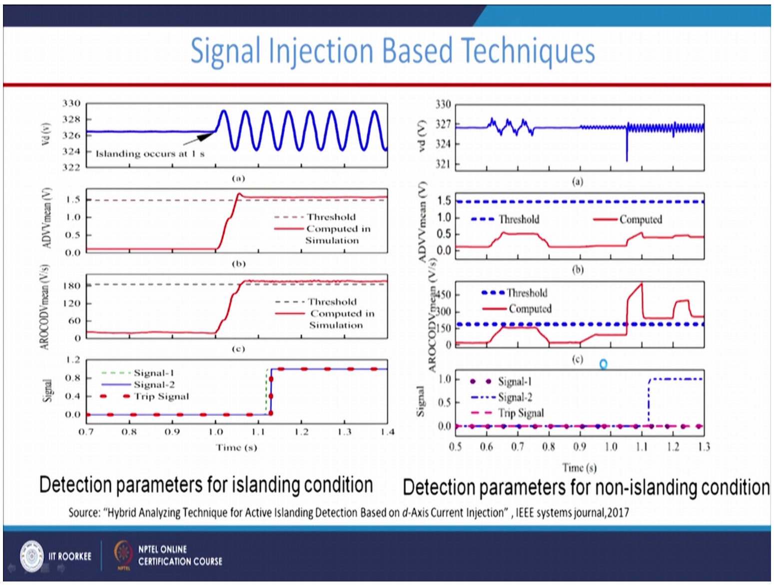

This is how the they have just simulated the system and they have just kept few signals in front of us. So, we will just discuss it and we have taken from this particular paper or article you can say this you can just download it and you can see and you can read more about it. In fact, to be honest there lot many papers are there, a lot many research papers are there based on this active validation technique. This is in this particular class we are just discussing one technique, you can follow many techniques. The idea may be different, but the concept everywhere same like we are injecting some disturbance signal to the controller and then just we are measuring the parameters or quantities at the PCC bus.

Now, if you will see the first figure that is v d that is in volt, you can see here this particular left side figure is for the islanding situation and the right side figure is for the non islanding situation. This is a valuation of this v d. And you can see here it oscillates with certain frequency and the corresponding first feature that is ADVV mean and this is the threshold the dotted line is the threshold. And you can see here very clearly the computed value of this ADVV mean is crossing the threshold value.

And similarly here you can see for the second feature, the value is crossing this threshold and that is why this trip signal the rate dotted line is present here the tripper this trip signal is now generated at this point, so that is how. And you can see here the this particular event is initiated hero, but however, after point one second this trip signal is generated; it takes some time to generate the trip signal.

Now, coming to this non islanding situation, you see here the variation of this particular islanding situation and this corresponding here the non islanding events everywhere you can see this particular variation of this ADVV almost below this threshold value. Here also below threshold value so that is why the trip signal is almost zero throughout. And you can see here though this particular computed value of this ARCOD crossing this threshold. But however, at that time another feature is not crossing the threshold that is why this trip signal is absent.

As I said the output of the two signals should be 1, 1, then only this and gate output will be one and the trip signal will be generated. So, though even one feature is and another feature is not satisfying that is where this trip signal is silent at this point. And similarly many authors they have also injected current and the Q-axis, they have injected the d-axis current through the Q-axis of the controller. And also they have seen this variation of the voltage and current.

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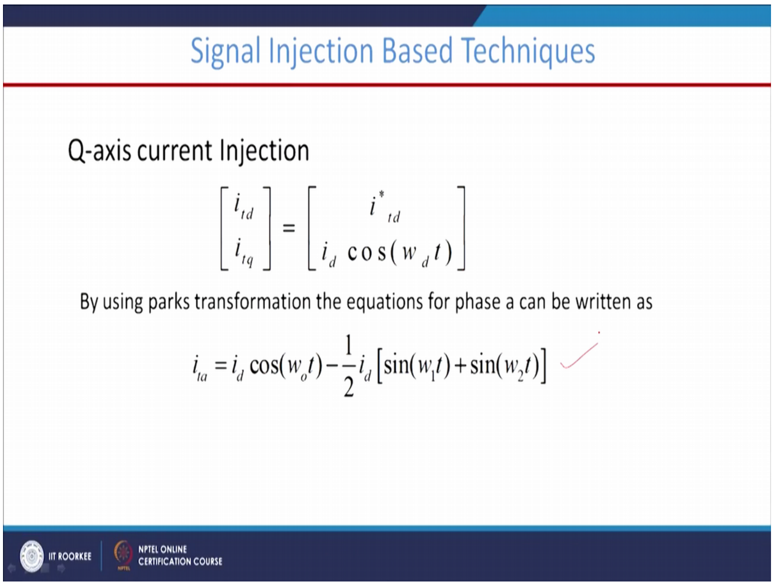

And if you will see for this Q-axis variation this is the in the Q-axis current they have just injected this i d then the i d current and the corresponding phase d current just we have discussed in the previously for this i d injection current. Similarly, here the difference is that minus in place of plus and we will get here sin component. And this comes due to the transformation matrix between this dq frame to the abc frame that is all. So, you can always calculate using this transformation matrix.

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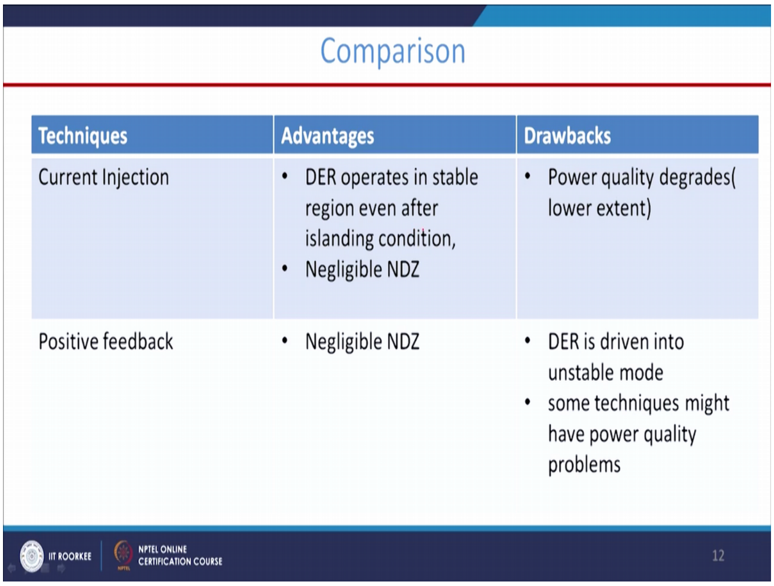

Now, we will have a good comparison. And here you can see that in case of this current injection based method, this DER operates in stable region and negligible NDZ. But in this case as we are injecting some disturbance signal, this power quality of the system may be degraded may be affected.

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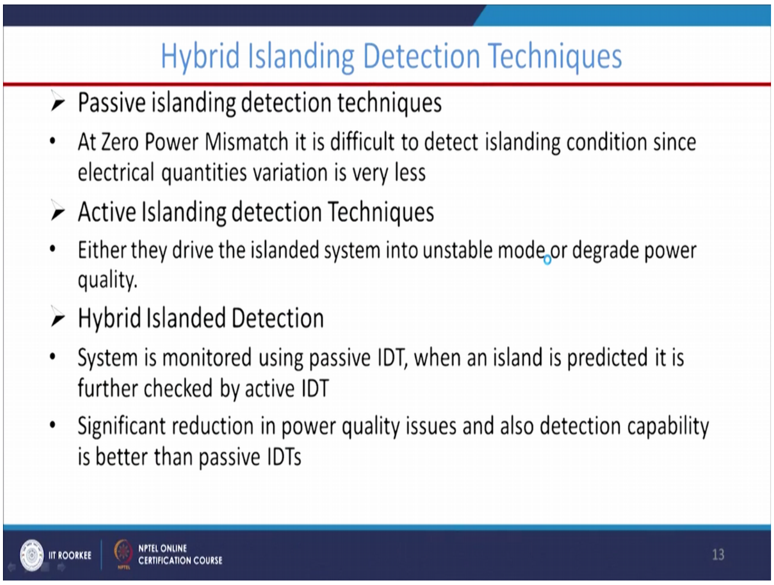

Now, we will come this hybrid based detection technique that is our passive islanding detection based technique if you see in case of passive islanding detection technique basically the NDZ problem is there like certain label is maintained like for 15 percent power mismatch above that this particular technique will work fine. Otherwise this below 15 percent the technique is not going to respect that is what the major drawback of this particular passive islanding detection technique.

To overcome this NDZ problem, we have this active islanding detection technique. We have just discussed one that is our basically the injecting the disturbance signal to the controller of this inverters of the solar or wind system, we can measure the parameters or we can estimate the parameters or we can measure the quantities at the PCC to decide whether the micro grid is islanded or not. And also we have positive feedback type active islanded detection technique. There actually we pass this voltage angle or frequency from the PCC to the controller to see the corresponding PCC voltage variation or frequency variation or power variation whether there is islanding the system or not.

In case of positive feedback based active islanding detection technique that is basically this NDZ problem is not there, but the DG the DERs or the renewable sources are driven to a basically two one unstable mode of operation that is a major drawback of positive feedback based active islanding detection technique. Now, similarly this for this hybrid system what happens we will just combined together. We will just have both passive and active techniques together, so that we can remove the NDZ problem as well as also we can just try to minimize the power quality thread or we will just minimize the percentage of this DG is going to be non stable mode of operation that is where the main aim of this hybrid islanding detection technique.

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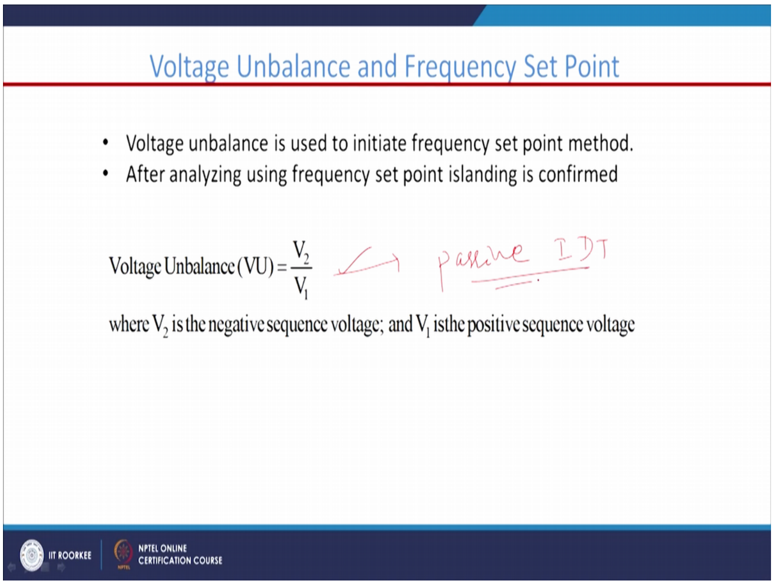

Here I have taken one technique that is basically voltage on the lengths that is V 2 upon V 1. This first feature this one is basically the passive technique. This is passive islanding detection technique. This passive islanding detection technique what we do basically we took some parameters or we took some ratios of the voltage or current or frequency may be sometimes rate of change of frequency or some impedance measured at the terminal of this V cc.

So, those parameters or quantities, we can always take first initial indication whether there is islanding or not. If it is not islanding, so it is not necessary it is not required to inject any disturbance signal to the controller of the inverter that is what the main intention of this hybrid islanding detection technique. What we do basically if you just see in case of active islanding detection technique like first one that is the signal disturbance injection method, they are continuously we keep on injecting this disturbance signal to the controller which is not desirable.

So, every time our power quality has some problem, but in case of hybrid what you do initially first we will detect whether there is islanding situation or not, then only we can inject the disturbance signal to minimize their non detection zone problem, so that this particular NDZ problem which is not covered or tackled by the passive islanded detection technique. Then we can always do by this active I mean islanding detection technique. The passive basically fails for this NDZ there is why the first step is to calculate here the ratio of this negative sequence voltage to positive sequence voltage. And if this particular ratio exceeding particular percentage or threshold then s there is some islanding present in the smart grid system or micro grid system. And this V 2 is the negative sequence component of the voltage at the PCC and this V 1 is the positive sequence component of the voltage at the PCC.

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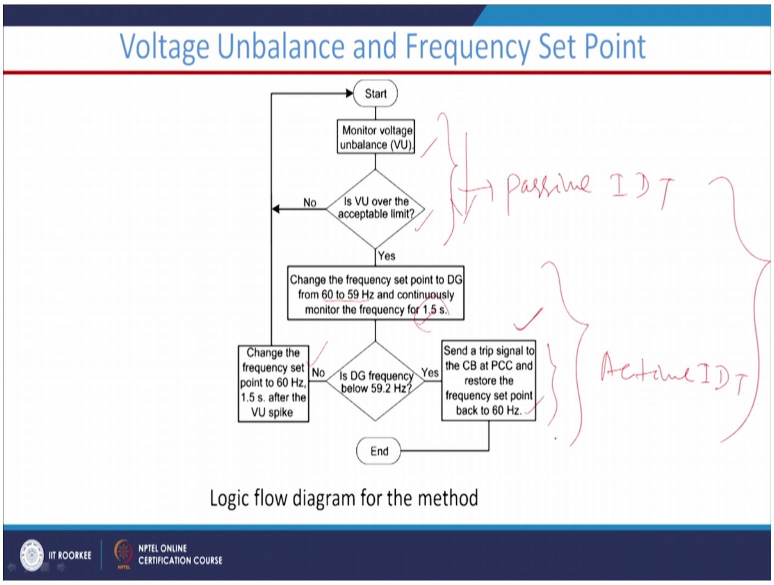

Now, after this if we can see this flow chart flow diagram logic diagram that we are monitoring this voltage unbalance what percentage of voltage unbalance is there or present in the system. If it is within the acceptable limit, yes or no, if it is this VU, VU stands for voltage unbalance VU over the acceptable limit, no, so again you have to go back; yes then change the frequency set point to DG from 62, 59 hertz this is important. If this is not I mean this is this UV over the acceptable limit yes then we have to change 62, 59 hertz continuously to one that the frequency for 1.5 second. The duration of this frequency monitoring is 1.5 second.

And after that e is the then we will just measure the frequency at the DG terminal. DG means there is distributed generation or we are calling it DER distributed energy resource. Now, again another check we will do that is this DG frequency below 59.2 hertz, yes or no. If it is yes then there is islanding. So, we have to generate the trip signal and that trip signal we will just open this circuit breaker at PCC. And again after that it will restore the frequency set point to 60 hertz. So, there are the steps ; or if it is no then the change the frequency set point to 60 hertz and after the UV spike. So, these are the steps basic element and in this particular technique that to just demonstrate in front of you that what is this hybrid technique.

In case of hybrid technique, this is how this passive part; this is our passive islanding detection technique. And this part is basically we are just varying the frequency point of this particular DG system where this is our active islanding detection technique; together it forms we can basically the hybrid based idt.

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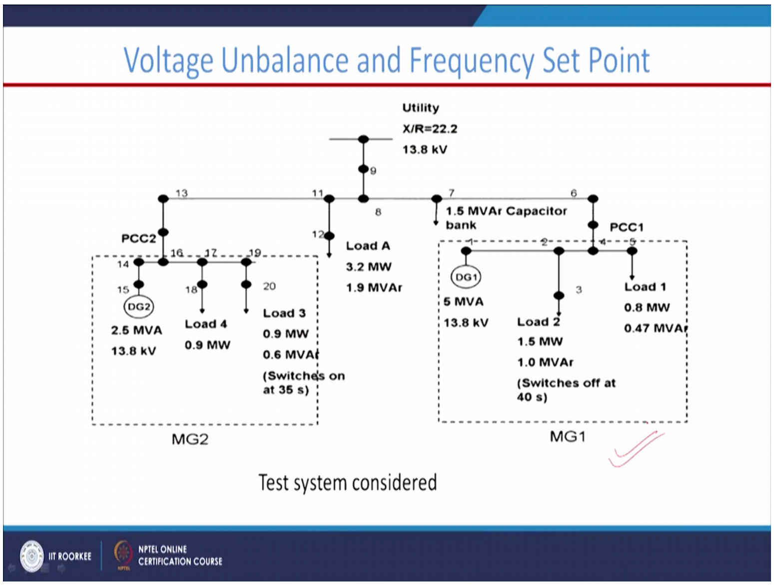

Now they are taken this particular system.

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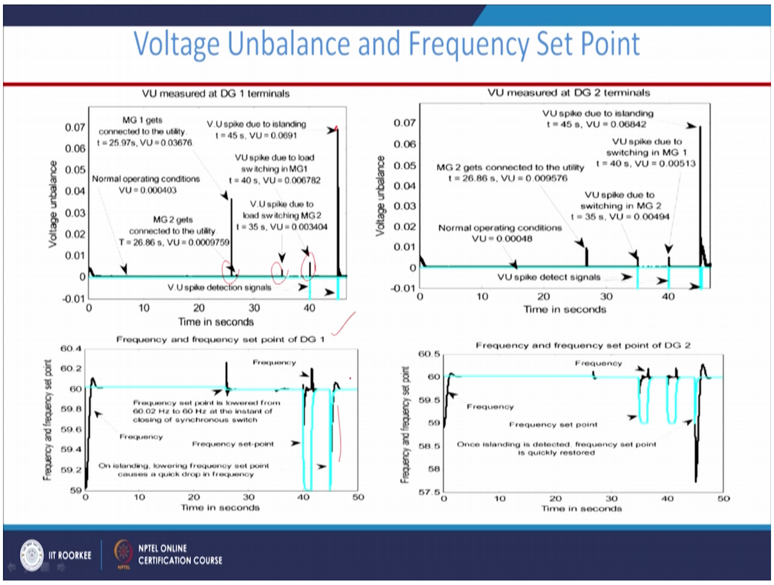

And this is the result you can see here that you can I will just explain this part. See the frequency and frequency set point for DG 1, they have taken two DGs and these are there corresponding results. For DG 1, you can see here at this point the voltage the ratio that is voltage unbalance is crossing the threshold. And at this point here this UV is not crossing the threshold very small values you can see here and in these two cases basically you can see, here it is crossing the threshold value.

And due to this spike they have also said the frequency point from 60 to 59 hertz. You can see here this is 59 hertz. And after this when this islanding has occurred now you can see so very quickly this frequency is dropping to below 59.2 see here it is 59.4, 50 basically it is dropping quickly. This frequency is dropping. And immediately this 59 hertz is resume to your 60 hertz that is what this particular technique says. If it any islanding is there, the frequency will drop very quickly below 59.2, then it is islanding situation. So, we have to they said this frequency to 59 to 60 hertz and also we have to restore and also we have to open this breaker and after that we have to restore.

And similarly this is for DG 2 terminal here we can see here they have generated them they had just set the frequency value from this 62, 59 for 1.5 second again here also same thing they have done. At this point you can see very quickly this frequency is dropping to below this 59.2 hertz. And at this point this value of this UV spike you can see here quite large and that is why this is it indicates that is some islanding situation.

So, the summary of this particular a hybrid based technique is it is not necessary continuously we will just keep on changing or just giving some disturbance signal to the controller of the inverter rather it is better if this islanding is detected ones let us start injecting this disturbance signal that is what this hybrid islanding detection technique. Somehow we can reduce the power quality thread in this particular technique.

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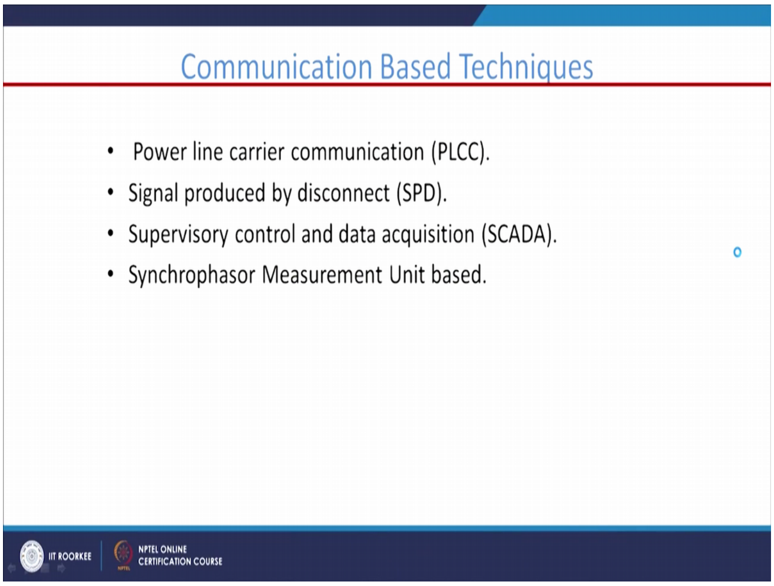

Now, if we will come to this communication based techniques, there are many techniques are there like first one is power line carrier communication, second one is signal produced by disconnect, and third one is SCADA that is supervisory control and data acquisition based technique, and the fourth one is synchrophasor measurement unit based technique. Now, researchers are trying to have more access to this particular technique, because now we are moving towards smart through it I mean this smart system. And there we need some smart technology and where this time gap and the delay will be very less.

And we also this is will very accurate and fast and for that this warm space technology or synchrophasor based technology is basically one very good research field you can say. And there many papers are also coming up for this communication based islanding detection technique based on this PMU measurements or micro PMU measurements. In many papers also you can see the grid eyes or effinet based techniques. And those are also communication based islanding detection techniques from the phasors of the voltage and current always we can measure whether we can decide whether there is islanding or not that is what the main aim of this particular technique.

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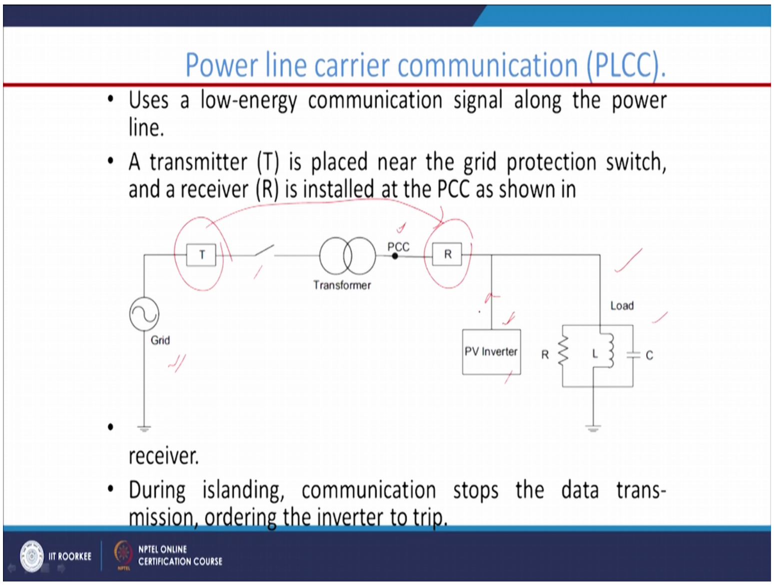

Now, if we will come to this power line carrier communication that is PLCC, what happens here the arrangement is shown in this particular figure. Here is our grid. And this T strands for transmitter; this R stands for receiver right. So, this is our common coupling point, this point of common coupling. And this is the transformer the PV inverter and the load.

Now, the point is when let us say this grid is disconnected, this transmitter will send the message to the receiver that now this grid is disconnected, then this inverter technology the controller will just shut down this particular PV system. So, that no current is going to be driven from this I mean no current is going to be supplied from this PV system to this particular load that is what the meaning of this power line carrier communication based technique.

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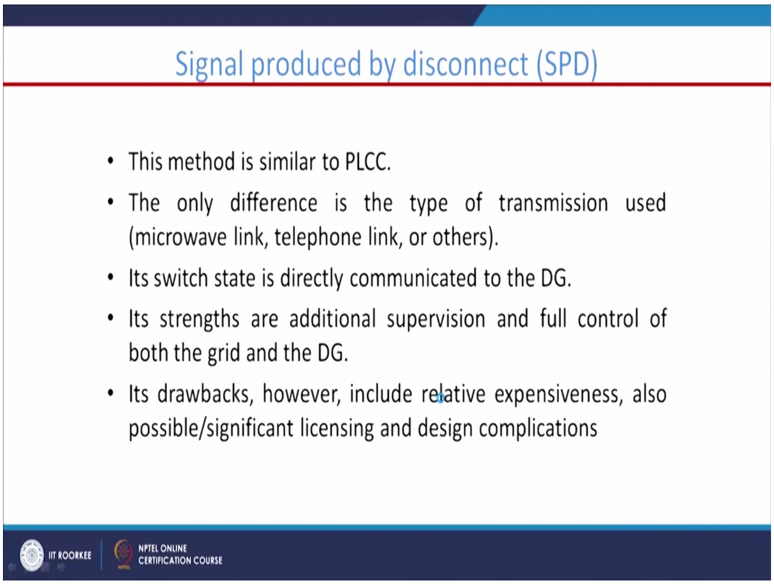

And similarly we have the signal produced by disconnect, it is almost similar to this the only difference is the type of transmission used like microwave link or telephone link or others right. So, these are the few power line carrier or signal produced by disconnect based communication techniques. In case of SCADA you were just already we have discussed in the previous classes that SCADA supervises the status of circuit breakers which are present inside the micro grid or smart grid system. By knowing the status of the circuit breaker, we can always decide what to do and which component should be shut down and what is the status of the whole network right, so that is what this SCADA does.

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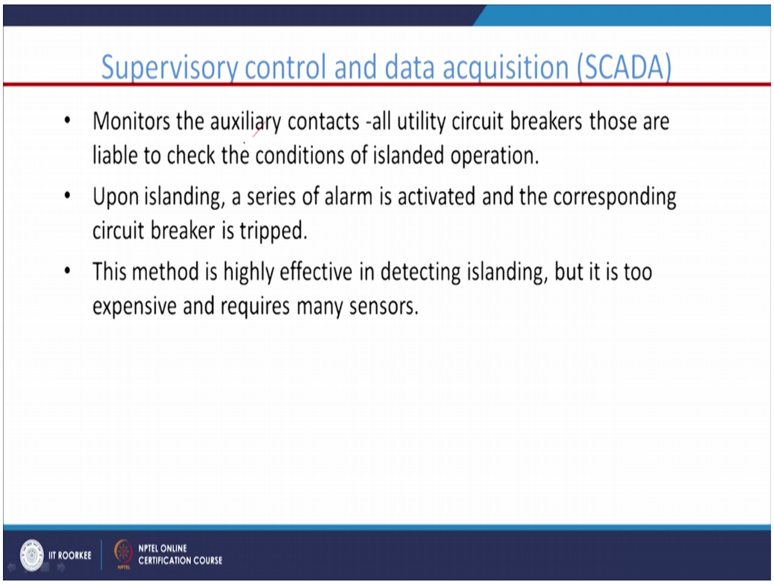

It monitors the auxiliary contacts-all utility circuit breakers those are able to check the condition of the islanded operation right. So, if it is islanded, if the main grid is islanded this, so that particular breaker is open at the grid side main grid side that particular status we will inform us that yes now the micro grid is disconnected from the main grid, so that is basically upon the islanding is series of alarm is activated and the corresponding circuit breaker is tripped and then we can decide we can take corresponding remedies that is what the SCADA system.

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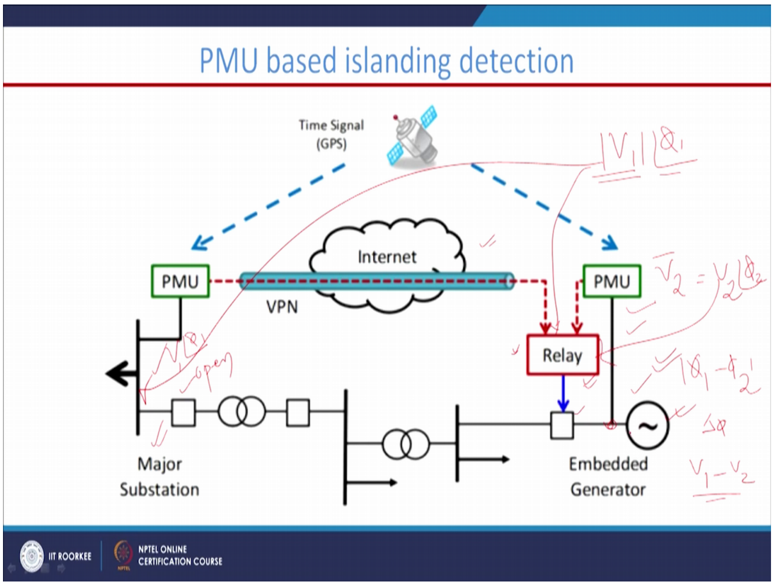

Now, the PMU based islanded detection technique if you could see this particular figure here, we have considered this particular bus where 1 PMU is installed and here the another PMU is installed. And this 2 PMU data are sent to this relay let us this relays are islanding relay or islanding detection relay. And this is our circuit breaker which is going to be basically triggered with help of this particular islanding relay. And this is our embedded generator or DG or you can say it is basically the DER. And this is our major station means main grid system. And here it is our basically the communication infrastructure that communication infrastructure is very essential as far as the worms is concerned where the two PMUs same there I mean this two PMUs send data to this relay through the communication platform and then this relay will take the decision.

Let us say for example, this particular major substation is disconnected and this breaker is open. Now, the voltage angle at this bus pursue sequence voltage and the corresponding angle information this V 1 magnitude and the corresponding angle right. This v 1 is the magnitude. And this is the angle we will reach to this relay. And similarly this PMU also will major this voltage at this bus some phasor that is some magnitude V 2 with angle of phi 2. Now, when this two quantities like voltage of this particular DG terminal voltage and the voltage of this particular this grid, when grid voltage will reach to this particular relay.

So, what will happen then this relay will decide whether there is some islanding situation or not. You can see you can simulate also this type of system that when this is this embedded generator is disconnected from this major substation or grid, now where he I mean distinct angle difference will be there. The angle difference between this phi and minus phi 2 this wave is visible I mean lets kind of you can say del phi is very I mean significant right. And also we can also then we take the difference V 1 minus V 2 this voltage difference is also I mean it is kind this V 2 is not negative sequence rather this voltage is the magnitude of this particular DG terminal bus voltage.

Now, you can say either take the voltage difference or you can take the angle difference; and from there and we can take many number of features. Now, why only the voltage you can also take the positive sequence current magnitude and phase angle. And from those features, we can always take the final decision at this relay terminal that whether we have this islanding is there or not. Now, let us have a general comparison of all the techniques. We have discussed active islanding detection based technique; and also we have discussed this hybrid based technique; and also we have little bit about this active in case of positive feedback based active IDT. And also this communication based IDT.

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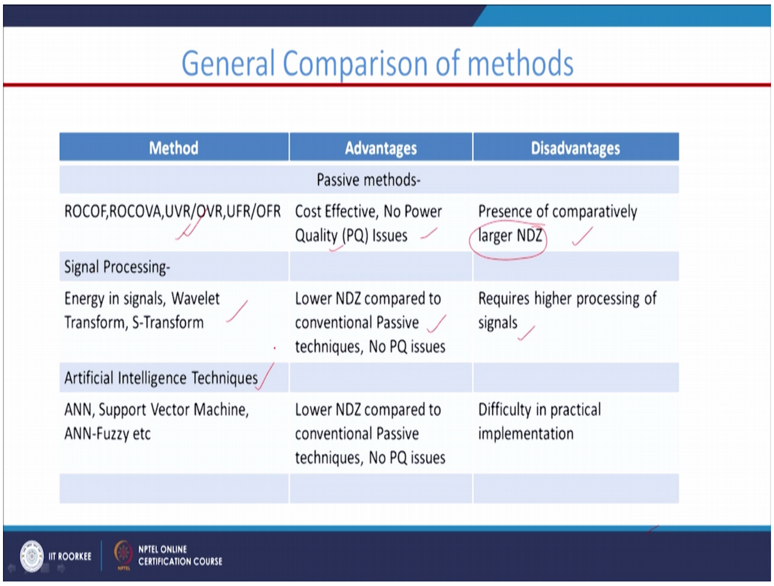

Now, if you will see these are the passive islanding detection technique in the previous class we have discussed the major I mean the advantages like cost effective and no power quality issue. So, these two are the major advantages of this particular passive IDT. Now, if you will see the disadvantages, the major disadvantage is the larger NDZ. This is important. So, we want to reduce this NDZ problem. And this particular NDZ problem can be reduced using this subsequent I mean the active and hybrid or communication based techniques.

Now, if we have also you can see in the review I mean literatures that we have signal processing techniques like energy in signals wavelet transform, S-transform and though this particular rate the lower NDZ compared to conventional passive techniques here and no power quality issues. But at the same time it requires higher processing of the signals very robust and very compact I mean which will be physically I mean it is implementable. And we can implement in real field that kind of signal processing techniques are desirable right. And there we need higher processing of the signals. And for faster operation we need the process should be quite I mean compatible with the current trend.

And coming to this artificial intelligence techniques like support vector machines, neural network, fuzzy systems both neural network and fuzzy. There we need huge training data set. So, in that case also it is very difficult in practical implementation part.

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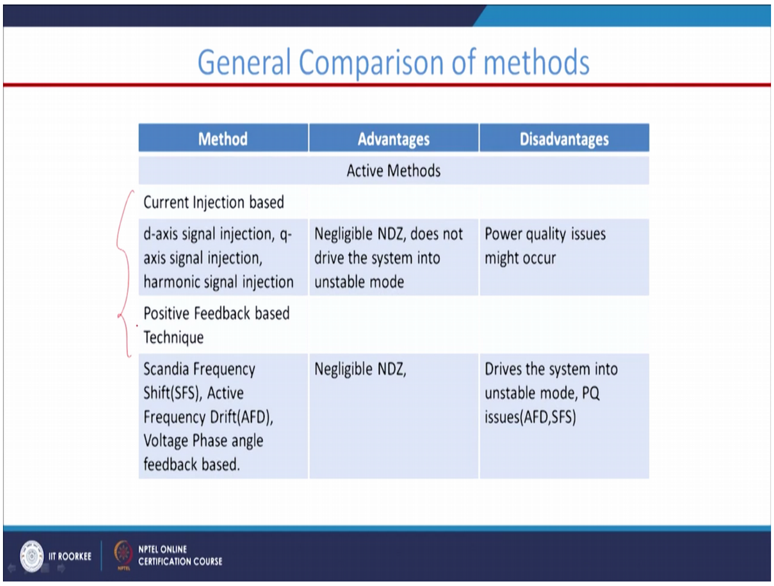

And those are some demerits and demerits. And if you come to this, this is basically our active islanding detection technique here in case of active IDT we have this negligible NDZ right. And also this active IDT does not drive the system into unstable mode this is important, but however, at the same time the power quality issues there that is why we are worried, so that we are going to have some hybrid based technique right. And here also we have some hybrid based techniques and negligible NDZ. But at the same time what happen the system is driven to on stable mode and the power quality issue some to some extent present when the disturbance signal is injected right.

So, this is all about our course today in this lecture we have discussed, first the active islanding detection technique. As we know that in case of passive islanding detection technique the major problem is the NDZ the non detection zone problem and that is where to overcome this we just to went for active IDT. And in case of active IDT, we have this power quality issues though the system is not driven to unstable mode, but we have this power quality issues and that is why again what we did which is combined together this a passive and active together to get this hybrid IDT. In case of hybrid IDT, we have like what happens when the signal is injected. Then the system may be made on unstable mode. In case of communication based technique, we can overcome again this NDZ problem. But however, this in this case the communication infrastructure is very costly and if some communication infrastructure failure is there, so we lose the data; so today this much.

Thank you so much.