DFIG FAULT DETECTION AND CONTROL STRATEGIES FOR OPTIMAL OPERATION OF LARGE RENEWABLE POWER PLANTS

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ABSTRACT

Renewable energy sources (RESs) are connected one way or the other to the grid through power electronic devices. The SC current of these RES plants exhibits characteristics such as limited amplitude, controlled phase angle which may lead to the malfunction of the RES side distance protection on the transmission line.

A distance protection method based on high frequency fault component is proposed in order to overcome this problem. The voltage drop caused by the fault has a full frequency component and this can be extracted by wavelet transform. After that, the high frequency impedance models of the inverter-interfaced renewable energy generator (IIREG) and the doubly-fed induction generator (DFIG) are established and the frequency selection principle that makes them have the stable phase angle is determined. Based on this the internal and external faults can be determined by comparing the high frequency voltage at the fault point and the magnitude of high frequency operating voltage. This method eliminates the influence of frequency offset and week feed of RESS using high frequency signals and it can also tolerate some noise. At the same time, due to the larger radius of Impedance circle at the high-frequency range, this method has a strong ability to withstand the fault resistance.

A distance protection method based on power electronic method using pwm controller is used in this project along with an algorithm & photovoltaic array protection as an extension to the previous method.

Index Terms: - Distance protection, high-frequency fault component, renewable energy sources and transmission line.

1.INTRODUCTION

Huge scope sustainable power sources Renewable Energy Sources are associated with the lattice to alleviate contamination and lessen utilization of fossil energy. Profiting from strategy support and mechanical progression, photovoltaic and wind power have turned into a significant piece of the force framework. Renewable Energy Sources are ordinarily gathered through the assortment framework and afterward associated with neighbourhood substation through the high-voltage transmission lines. Renewable Energy Sources are associated straightforwardly or by implication through the force gadgets. Its shortcoming qualities show unsteady interior impedance, restricted current abundancy, current recurrence offset and controlled current stage point, which is very unique in relation to those of simultaneous generators (SGs). Hence,

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conventional distance assurance faces huge difficulties.

The exhibition of customary force recurrence distance assurance is influenced by the frail without a doubt of RESs. Literary works pointed that the powerless issue current of inverter-interfaced environmentally friendly power generators Induction Interfaced Renewable Energy Sources (IIREGs) will incredibly enhance the impact of the issue obstruction, so the RES-side distance insurance has a high danger of refusal while the network side distance assurance is essentially unaffected by RESs. The creators in examined the shortcoming current attributes of doubly-took care of enlistment generators (DFIGs) and discovered that it additionally had a frail in feed impact on the distance insurance when the crowbar was not placed into activity.

There have been a few answers for the above issues. The equation of the new estimated impedance was built utilizing the huge zero-succession current for halter kilter establishing shortcomings, which could accurately mirror the separation from the issue highlight the transfer point, yet this technique was not reasonable for stage to-stage flaws. Reference disposed of the feeble infeed capacity of RESs by permitting the electrical switch on the lattice side to trip right off the bat, yet this strategy expanded the shortcoming disconnection time.

The European Union (EU), toward the start of 2017, surveyed the Renewable Energy Directive 2009/28/EC for expanding the objective of the portion of environmentally friendly power sources in the general energy blend to basically 27% in 2030 and to turn into the world forerunner in sustainable power. In this manner, the interconnection of the great portion of sustainable power sources in the current force frameworks is a convenient point, with specific arrangements relevant for every country. The examination of interconnection of a huge portion of sustainable power sources into Greek force frameworks was examined, featuring the effect of wind generators on power framework sufficiency and secure activity.

The examination of wind ranches, primarily seaward, reconciliation into the force frameworks in Europe what's more, especially in Germany is conveyed. Reference 4 examinations the effect of wind ranches on the power framework activity in Bosnia and Herzegovina, and the restricted limit that the force framework adaptability can oblige. The environmentally friendly power sources have a discontinuous person and their activity in the force framework requires extra adjusting activities, capacity of the accessible measures in the nation of beginning and net exchange limit with the adjoining nations.

The joining of the breeze ranches with significant effects on solidness conditions under framework blames and adjusting hold in the Spanish force framework is examined. The effect of wind ranches on voltage profile in a force framework space of Turkey is researched. The examination of wind ranch coordination into the California power framework on the power market, adjusting market and inclining necessities is explored.

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The expansion of the portion of environmentally friendly power sources in the general energy blend can have significant impacts on power frameworks activity, its level being dictated by:
- the working attributes of sources and their produced power;
- the attributes of the electrical network where these sources are associated;
- the working attributes of the traditional fuelled plants.

In concurrence with public and European guidelines, the organization administrators should permit the entrance of all clients, including sustainable power makers, to the electrical organization. The monetary benefits that EU and Romania presented to financial backers in not set in stone their monstrous advancement somewhat recently. The Romanian force framework activity is profoundly affected by the interconnection of new sustainable power sources, mostly wind and photovoltaic. The area of these sources isn't reliable with the public force framework necessities, however with the climatic conditions for sustainable sources, deciding the grouping of these new sources for the most part in the south-east part.

In light of this significant centralization of environmentally friendly power sources, their effect on the transmission framework is exceptionally significant, considerably more as the transmission organization was not measured and intended for these new working conditions. In this project, the impact of activity com-in of a breeze homestead of 600 MW (2 _ 300 MW), the biggest inland ranch in the south-east of Europe, was continued.

The interconnection of sustainable power sources to the public organization requires an investigation zeroed in on three ways:
_ examining the conceivable outcomes, variations, conditions for framework combination, in the area region.
_ a neighbourhood examination including a delimitation of the area region and confirming the working conditions in consistent state system, level of short out flows and so on.
_ dissecting the working states of the organization in the wake of associating the new inexhaustible sources.
_ neighbourhood including the investigation of organization region where the new sources are associated.
_ guaranteeing the ampleness in the event of high data transfer capacity variety in enormous constraints of the sources' created power, from zero to greatest force, for assessing the working conditions during one year, by breaking down the fleeting created powers as for determined qualities on short time stretches. The inter-connection of sustainable power sources (RES) into the force framework of Rome, from the transmission and circulation, not really settled:
_ the necessity for foundation fortifications;
_ challenges in adjusting the creation/utilization, needing to close down some need sources (like hydro power plants) and the cross-line trade that isn't basically conceivable.
_ the need to separate the RESs on the event of blackouts in the Romanian force framework, until the execution of fortifications.
_ the need to set up a force save that can instantly adjust the creation/utilization, following the arbitrary activity of wind

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power plants and photovoltaic establishments.
_ advising the makers on the current need to acquire the quick tertiary hold, utilized for adjusting the unexpected variety of forces produced by wind power plants and photovoltaic establishments.

Likewise, the versatile distance insurance is additionally proposed to take care of this issue. the outing limit could be changed with voltages and current progressions of the entire framework.

Writing developed the limit by the mistake impedance determined with the transport voltage, current and the limit of the force plant. Nonetheless, these insurance standards have higher necessities for the correspondence framework.

The breeze power plants are the significant supporter of the Europe electrical energy balance, and are portrayed by high creation changeability, an arbitrary cooperation inside the entire creation profile, and difficulties in the recurrence dynamic force control. The breeze power plants, associated with the public force framework, can prompt an over-burdening of the transmission or potentially conveyance organizations, what's more, the necessity that some WPPs diminish their creation until the level where the blockage is wiped out.

Additionally, the decrease of limit hold inside the force framework can happen. The significance of the current exploration is identified with the likelihood to defeat the organization clogs and the working exhibition of the entire force framework; the necessary safe activity will rely upon the transmission extension arranging, the project offering an explanation to this need and dissecting the uprightness of the framework for possibilities with high/low likelihood of event.

The oddity of this project is that it gives the rules for a dynamic cycle prompting fast execution of sustainable sources with regards to Romania's energy organization. The extent of the current examination is to investigate the difficulties of Romanian force framework not really settled the increase of the share of renewable energy sources in the overall energy mix can have important impacts over the power systems operation, its level of impact being determined by:
- the operating characteristics of sources in the system and their generated power.
- the characteristics of the grid where these sources are being connected.
- the operating characteristics of the fuelled plants.

In an agreement made with the national and European regulations, all the network operators must allow the access to customers, including renewable energy producers, of the electrical network. The economic advantages that are offered by EU and Romania to investors in renewable sources determined their massive development in the last 10 years. The power system operation in Rome is being highly affected by the inter-connection of new renewable energy sources, mainly photovoltaic and wind. The location of these non-renewablesources is not consistent with the necessities of national power system, but with the atmospheric conditions for renewable sources,

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determining the availability of these new sources mostly in the south-east part.

Because of this important concentration of renewable energy sources, their effect on the transmission system is highly important. In this project, the influence of operation com-in of a wind farm of 600 MW (2 _ 300 MW), the largest onshore farm in the south-east of Europe, was carried on.

The interconnection of renewable energy sources with the public network system requires an analysis mainly focused on 3 directions:

_ analysis of the conditions for system integration, possibilities, variants in the location area.

_ a normal analysis involving a de-limitation of the location and checking the operating conditions in steady-state regime, range of short-circuit currents etc.

_ analysis of the operating conditions of the network after connecting the new renewable
sources.

_ local area analysis which includes the study of network area where the new sources
are being connected.

_ assuring the adequate power in case of high band-width variation in huge limits of the sources' generated power, from zero to maximum possible power, for assessing the operating conditions for a period of1 year, by analysing the generated powers with respect to forecasted values on periodicshort time intervals.

The interconnection of renewable energy sourceswith the Romanian power system, from the transmission and distribution operator's point of view, determined by:

_ the requirement for infrastructure enlargement.

_ challenges faced in balancing the production&consumption, requiring to shut down some primary sources like hydro power plants and the trans-border export that is almost practically not possible.

_ the necessity to disconnect the Renewable Energy Sources on the incident of outages in the Romanian power system till the implementation of reinforcements.

_ the need to establish a power reserve that can quickly balance the production & consumption, following the random operation of wind power plants and photovoltaic array units.

_ informing the producers on the current necessity to procure the fast tertiary reserve, used for stabilizing the undesired variation of powers being generated by the wind power plants and photovoltaic equipment.

In addition, the adaptive distance protection is also proposed to solve this problem. the trip boundary could be adjusted with voltages and current flows of the whole system. Literature constructed the boundary by the error impedance calculated with the bus voltage, current and the capacity of the power plant. However, these protection principles have higher requirements for the communication system. In concurrence with public and European guidelines, the organization administrators should permit the entrance of all clients, including environmentally friendly power makers, to the electrical organization. The financial benefits that EU and Romania presented to financial backers in not set in stone their gigantic advancement somewhat recently. The Romanian force framework activity is

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profoundly impacted by the interconnection of new sustainable power sources, fundamentally wind and photovoltaic. The area of these sources isn't steady with the public force framework necessities, yet with the climatic conditions for inexhaustible sources, deciding the centralization of these new sources for the most part in the south-east part. Due to this significant grouping of sustainable power sources, their effect on the transmission framework is exceptionally significant, considerably more as the transmission organization was not estimated and intended for these new working conditions. In this project, the impact of activity com-in of a breeze ranch of 600 MW (2 _ 300 MW), the biggest coastal homestead in the south-east of Europe, was continued.

The interconnection of environmentally friendly power sources to the public organization requires an investigation zeroed in on three ways:

_ dissecting the conceivable outcomes, variations, conditions for framework coordination, in the area region—a nearby investigation including a delimitation of the area region and checking the working conditions in consistent state system, level of short out flows and so forth.

_ dissecting the working states of the organization in the wake of interfacing the new sustainable sources.

_ neighbour-hood including the investigation of organization region where the new sources are associated.

_ guaranteeing the sufficiency in the event of high data transmission variety in enormous restrictions of the sources' produced power, from zero to most extreme force, for assessing the working conditions during one year, by dissecting the fleeting produced powers regarding determined qualities on short time spans. The interconnection of environmentally friendly power sources (RES) into the Romanian force framework, from the transmission and conveyance, not really settled.

_ the prerequisite for foundation fortifications.

_ troubles in adjusting the creation/utilization, needing to close down some need sources (like hydro power plants) and the cross-line trade that isn't basically conceivable.

_ the need to detach the RESs on the event of blackouts in the Romanian force framework, until the execution of fortifications.

_ the need to build up a force save that can instantly adjust the creation/utilization, following the arbitrary activity of wind power plants and photovoltaic establishments.

_ advising the makers on the current need to obtain the quick tertiary save, utilized for adjusting the unexpected variety of forces created by wind power plants and photovoltaic establishments.

Then again, the recurrence offset of the DFIG issue current additionally critically affects the exhibition of the force recurrence distance insurance when the crowbar is placed into activity. The temperamental estimation direction made the distance security reject to work. In 21, the creators further broke down that the distance insurance neglected to be the reinforcement security of the subordinate line because of the changing estimation direction, and a comparing arrangement utilizing adjusted lenient overextend move trip (POTT) conspire was proposed. Writing proposed a distance insurance

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strategy dependent on the boundary distinguishing proof, mostly utilizing the R-L model of the synchronization framework. Taking into account that the consistent state stator voltage and current parts of the DFIG don't adjust to the R-L model, the distance assurance dependent on the R-L model is improved by sifting through the force recurrence parts.

Nonetheless, for the above strategy dependent on the time space, the principal request fractional subordinate is defenceless to higher sounds and the insurance execution is somewhat poor. Likewise, power recurrence variety distance security might decline to work due to the variable impedance point of RESs. Not at all like SGs stable at about 90°, the inside impedance point of RESs differs generally and might be capacitive, so power recurrence variety distance security loses its actual importance.

Hence, it is important to explore another distance insurance to defeat these issues. The high-recurrence shortcoming part-based distance security is proposed to take care of the issue that power recurrence distance assurance and force recurrence variety part distance insurance on the RES side have a high danger of refusal. The fundamental commitments of this project:

1) the proposed technique simply utilizes 10 ms of information including 5ms during the issue initiation and can work with a fast.

2) due to the utilized moderately high recurrence shortcoming transient data, it is resistant of control procedures of IIREGs and recurrence offset of the DFIG issue.

3) It can likewise endure a huge issue opposition and some clamour. These elements have been checked by the reproduction test performed on the ongoing advanced test system (RTDS) stage and field-testing data.

II.LITERATURE SURVEY

This whole research topic revolves around the distance protection of large renewable power plants i.e., large scale wind and solar power plants with huge generating capacity of the order of few kilowatts to megawatts.

So, based on the practical possible case, a practical wind farm (rather than an ideal case whose parameters and working efficiency are one hundred percent) is considered for the evaluation of the problem keeping in mind the losses and efficiency of the wind and solar plants face during the connection with the grid.

Most importantly the maximum efficiency at which a wind and solar power plants operates around are 50% and 25% respectively, so a convenient and economical way of protection is required keeping in mind the operating and running cost of the respective power plants, which is proposed in this project.

All the operating values are found to be satisfactory and within limits of the proposed protection system on this project.

MATLAB/Simulink is used effectively and extensively to solve the protection issue of the DFIG based wind farm and solar plants with the proposed protection system circuits being displayed in the next chapters of this file.

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A transmission line of 40km is considered in the circuit for the evaluation of the system parameters.

III. HIGH-FREQUENCY IMPEDANCE MODEL OF RES

3.1. Generation of the high-frequency signals

At the point when an issue happens on the active transmission line, the voltage drop at the shortcoming point resembles a stage signal, as displayed in Fig. 1(a). The progression signal has full recurrence area data after Laplace change, as displayed in Fig. 1(b). The ghostly energy steadily diminishes as the recurrence increments. At the point when the voltage turned out to associate with zero when a shortcoming happens, there will be no high-recurrence parts, yet most blames happen close to the pinnacle esteem. The wavelet change is utilized to understand the change from the time area to the recurrence space and concentrate the high-recurrence voltage and high-recurrence current in the transient cycle. The sign extraction just necessities an information window of 10 ms including 5 ms of information during a shortcoming, so it can work with a high velocity.

3.2. High-frequency impedance model of IIREGs

IIREGs principally incorporates photovoltaic sources (PVs) and super durable magnet simultaneous generators (PMSGs), which are straightforwardly associated with the framework through inverters, and an LCL channel is introduced at the power source of the inverter. The fundamental geography is displayed in Fig. 2. The IIREG has four high recurrence impedance structures under various exchanging states for a solitary stage establishing issue, which are definite in reference. One of impedance structures is displayed in Fig. 3. For the other three impedance structures, just the part inside the red specked edge is unique.

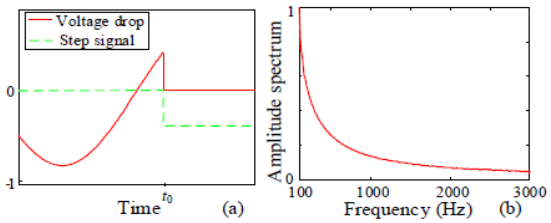

Figure 3.1a) unit step signal b) its amplitude spectrum.

At the point when the capacitive reactance of channel capacitor C is short of what one 10th of the inductive reactance of L1, the part in the blue strong wire edge can be disregarded, and the four impedance designs can be bound together as a RLC series circuit. For this situation, the chose recurrence ought to be fulfilled

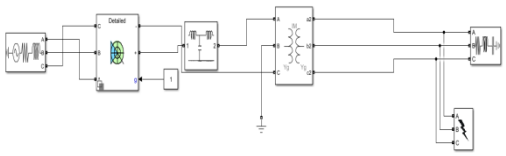

Figure 3.2 Principle Geography of DFIG

The principal geography of the DFIG is displayed in Fig. 4. It basically comprises of a non-concurrent generator and the rotor side equal branch. The high-recurrence impedance model for a solitary stage establishing issue has been accounted for in, which is made out of the same circuit of the non-concurrent generator and the channel capacitor branch, as displayed in fig are the stator-side opposition and inductance of

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the non-concurrent generator, Rr and Lr are the rotor-side obstruction and inductance of the offbeat generator, L_{mis} the excitation reactance of the offbeat generator, C is the capacitance worth of the channel capacitor, and R_{Crowar}represents the crowbar opposition. At the point when the crowbar gadget isn't placed into activity, the crowbar opposition in the specked edge is short circuited. When the crowbar gadget is placed into activity, the crowbar obstruction is embedded in the high frequency impedance model.

At the point when the capacitive reactance of the channel capacitor C is short of what one 10th of the inductive reactance of the same circuit of the non-concurrent generator associated in equal, the same part of the offbeat generator can be disregarded and the impedance model in Fig. 5 can be improved as the channel capacitor C. In this way, the chose recurrence ought to fulfil 3.

3.3. High-frequency impedance model of DFIGs

Nonetheless, because of the impact of the fundamental transformer, the assortment framework and the move forward transformer, the high recurrence impedance point estimated at the yield port of the transmission line actually shows an inductive state. To make this impedance point more noteworthy than 60°, the chose recurrence ought to likewise fulfil (2). Presently, R and L2 are individually the amount of the opposition and inductance of the primary transformer, the move forward transformer and the assortment framework.

The high-recurrence shortcoming network for an issue situated at the transmission line is displayed in Fig. 7. Zk is the high-recurrence line impedance from the shortcoming point to the transport W, ZL is the absolute high-recurrence impedance of the transmission line, Zw and Zs are the same high-recurrence impedance of RESs and the lattice, individually. Vw and Iw are the high-recurrence voltage and current estimated at the transport W, Vk is the high frequency voltage source created by the shortcoming, and Rg is the issue obstruction. As per the reference course in the Fig. 7, the high-recurrence current Iw and high-recurrence voltage Vw estimated at the hand-off point (The transport W) can be communicated as:

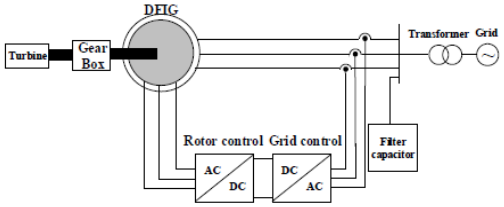

Figure 3.3 Main Topology of DFIG

IV. DISTANCE PROTECTION WHICH IS BASED ON THE HIGH FREQUENCY IMPEDANCE MODEL

4.1. Basic working principle

In case Zset is the setting worth of the zone I distance security, which is typically taken as 80%~85% of the great recurrence impedance of the transmission line, and the high-recurrence working voltage Vop can be developed as:

Thusly, the inside and outside shortcoming can be recognized by looking

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at the greatness between the high-recurrence working voltage Vop and the high-recurrence voltage Vk at the issue point. In any case, the high-recurrence voltage at the shortcoming point can't be straightforwardly estimated. Accordingly, it is important to utilize the voltage recognized at the hand-off highlight build a comparable high-recurrence voltage at the issue point. Since the voltage at the hand-off point before the shortcoming is essentially equivalent to the voltage at the issue point before the issue, so it tends to be utilized to build the high-recurrence voltage at the issue point.

At the point when an inward shortcoming happens at the transmission line, the greatness of the great recurrence working voltage and the high-recurrence voltage at the issue point can be communicated as follows:

As indicated by (11), the impedance circle trademark displayed in Fig. 9(a) can be drawn.

Since the high-recurrence impedances on the two sides of the shortcoming point are near 90°, the two-side flows Iw and Is are essentially in stage, and the extra impedance αRg is around unadulterated resistive. The extent connection between the different sides of the flows just relies upon the greatness of the great recurrence impedance on the two sides and it isn't influenced by as far as possible circle. Moreover, the sweep of the impedance circle in the chose recurrence range is a lot bigger than that at the force recurrence, while αRg is free of the recurrence. In this manner, the strategy has solid capacities to oppose issue obstruction. Furthermore, as they chose recurrence builds, the capacity to oppose issue opposition is likewise upgraded. Essentially, the impedance circle normal for the strategy for a shortcoming situated at the converse heading can be likewise gotten, as displayed in Fig. 9(b). It very well may be seen from Fig. 9(b) that the proposed technique won't breakdown for a shortcoming inthe turn around heading. In Fig. 9(b), =ZL+Zs.

If *Z*set is the setting value of the zone I distance protection, which is usually taken as 80%~85% of the high-frequency impedance of the transmission line, and the high-frequency
working voltage *V*op can be constructed as:

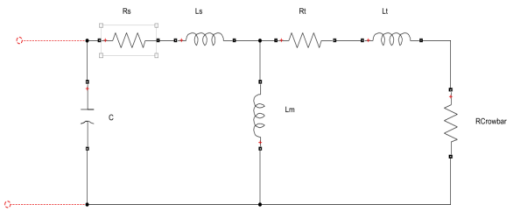

Figure 4.1 The high-frequency impedance structure of DFIGs.

V. EXPERIMENTAL VERIFICATION AND ANALYSIS

To confirm the proposed distance assurance, test tests have been performed on the test stage portrayed in Fig. 11. The RTDS recreation framework comprises of five fundamental parts: principle regulator, screen, PWM generator, simple yield card and RTDS processor. The RTDS testing stage is intended to perform electromagnetic transient recreations and yield voltage and current information on the RES side progressively by simple yield card and force speaker, and this information are input into widespread

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assurance control stage (UPCP) by fibre links and the intelligent card of UPCP. The assurance calculation is acted in the advanced sign processor (DSP) on the UPCP to confirm the Proposed technique.

$$I_{\mathrm{w}}=\frac{-V_{\mathrm{k}}}{Z_{\mathrm{w}}+Z_{\mathrm{k}}}$$

$$V_{\mathrm{w}}=-I_{\mathrm{w}}Z_{\mathrm{w}}$$

The model on RES plants outlined in Fig. 6 is based on this test stage. Force sources can be exchanged among IIREGs and DFIGs, and the two boundaries are represented in Table A. ⅰ and Table A. ⅱ, separately. The appraised limit of the force plant is 100MW, the length of the transmission line is 40km, and different boundaries are definite in Table A.

$$V_{\mathrm{op}}=V_{\mathrm{w}}-I_{\mathrm{w}}Z_{\mathrm{set}}=-I_{\mathrm{w}}\left(Z_{\mathrm{w}}+Z_{\mathrm{set}}\right)$$

Faults are set on the half, 100% the length of the transmission line from the primary transformer of the force plant, which are individually set apart as K1 and K2. The issue circle just contains the stage to ground circle and the stage-to-stage circle, so the shortcoming types are set to stage an establishing (AG) blames and stage B-to-stage C (BC) blames separately. The exchanging recurrence of the inverter is 5 kHz. As a guideline, the transmission capacity of the current circle is normally 1/10 of the exchanging recurrence of the converter, so they chose recurrence should be higher than 500 Hz. Since the upper recurrence limit concentrated in this project is 3 kHz, the examining rate is set to 20 kHz to adequately mirror the high frequency signals.

VI. FIELD TESTING DATA ANALYSIS

Field-testing information is gotten from a breeze ranch in Jilin, and a PV power plant in Jiangxi. The fundamental geography of the Jilin wind ranch is displayed in Fig. 6, and it is made out of 66 PMSGs of a similar kind. A stage C establishing shortcoming happens at the 220kV transmission line, and the length of the transmission line is 25.461 km. For the information in Jiangxi, the PV power plant is associated with the circulation network by a 35kV exceptional line. A stage B-to-stage C issue happens at the PV side of the extraordinary line, and the length of the unique line is 3.924 km. Fig. 21 and Table ⅱ show the exhibition of conventional force recurrence distance insurance and force recurrence variety part distance security, individually.

It tends to be seen from Fig. 21(a) that the estimation direction is situated external the impedance circle of the zone ⅰ and zone ⅱ distance insurance, so the distance security won't work. Be that as it may, it is near the limit of the impedance circle in light of the fact that the short out current on the RES side isn't a lot more modest than the one on the lattice side because of the enormous zero-arrangement current when a single-phase establishing issue happens at the 220 kV transmission line. In expansion, as can be seen from 21(b) for the stage to-stage issue, the estimation direction is amazingly a long way from the impedance circle of the zone ⅰ and zone ⅱ and the distance security will won't work in light of the fact that the shortcoming current on the RES side is a

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lot more modest than the one on the matrix side. The boundaries of LCL channel for Jilin and Jiangxi and both lower recurrence limits are represented in Table iii. It very well may be seen from Fig. 22 that the high-recurrence impedance point of RESs is nearest to - 90° from as far as possible to 1.6 kHz for the information in Jilin, so this recurrence range is utilized as the one for concentrating on the high-recurrence issue part-based distance assurance.

For the information in Jiangxi, the deliberate high-recurrence impedance point is nearest to - 90° in the scope of lower cut-off to 1 kHz. Accordingly, the presentation of the proposed distance security in this recurrence range is primarily examined. In the higher recurrence range, the two-information stray by - 90° in light of the fact that their testing recurrence is just 5 kHz and 3.2 kHz. Also, only one or a few frequencies are utilized in genuine designing rather than a recurrence range. It tends to be known from Fig. 23 that the proposed distance insurance has great execution in the chose recurrence range and the zone i distance security can work accurately when power recurrence distance assurance and force recurrence variety part distance assurance won't work.

6.1 Circuit Diagram

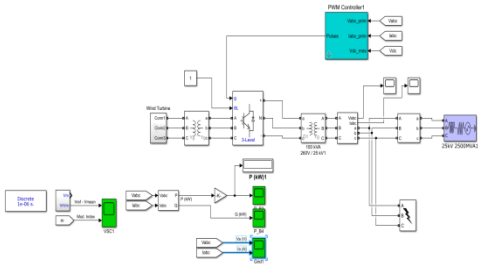

Figure 6.1 Wind turbine to Grid Connection with L-G Fault

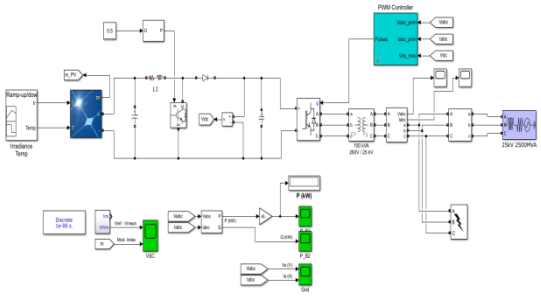

Figure 6.2 Photovoltaic Array to the Grid with L-G fault

Field-testing information is gotten from a breeze ranch in Jilin, and a PV power plant in Jiangxi. The fundamental geography of the Jilin wind ranch is displayed in Fig. 6, and it is made out of 66 PMSGs of a similar kind. A stage C establishing issue happens at the 220kV transmission line, and the length of the transmission line is 25.461 km. For the information in Jiangxi, the PV power plant is associated with the dispersion network by a 35kV extraordinary line. A stage B-to-stage C shortcoming happens at the PV side of the extraordinary line, and the length of the unique line is 3.924 km. Fig. 21 and Table ii show the presentation of customary force recurrence distance security and force recurrence variety part distance assurance, separately.

Site	Zone -1	Zone – 2	Fault Point
Jilim	51.574	53.9524	105.524
Jiangxi	30.125	30.125	32

Figure 6.3 Zone wise protection of Areas

It tends to be seen from Fig. 21(a) that the estimation direction is situated

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external the impedance circle of the zone i and zone ii distance security, so the distance assurance will won't work. Nonetheless, it is near the limit of the impedance circle in light of the fact that the short out current on the RES side isn't a lot more modest than the one on the matrix side because of the enormous zero-succession current when a solitary stage establishing shortcoming happens at the 220 kV transmission line. Furthermore, as can be seen from 21(b) for the stage to-stage issue, the estimation direction is incredibly a long way from the impedance circle of the zone i and zone ii and the distance security will won't work in light of the fact that the shortcoming current on the RES side is a lot more modest than the one on the lattice side.

6.3 Output waveforms

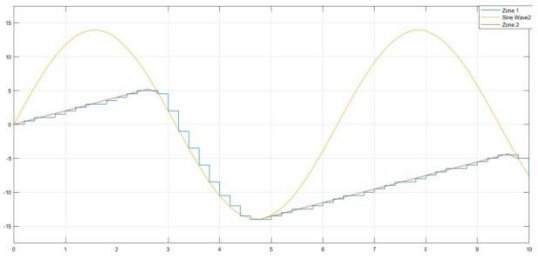

Figure 6.7 Input sine wave, Zone 1 & Zone 2 operating waveforms

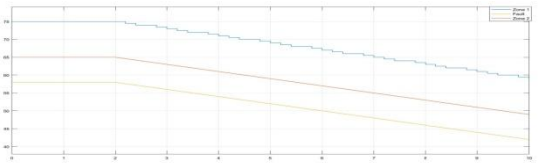

Figure 6.8 Zone 1 & Zone 2 operating waveforms depending on the fault occurred

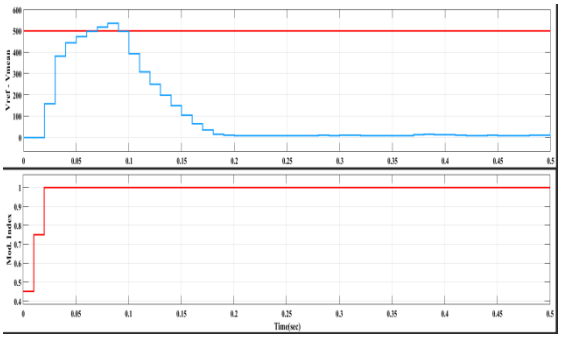

Figure 6.9 Reference voltage vs Existing voltage at the fault point

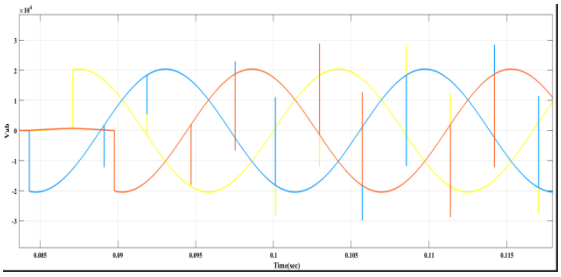

Figure 6.10 Voltage in the line “ab”

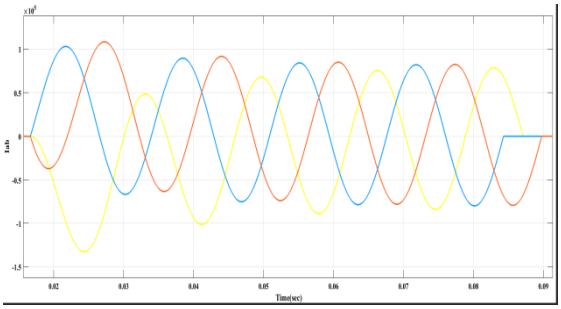

Figure 6.11 Current in the line “ab”

VII.CONCLUSION

RESs show issue qualities like the frail to be sure, current recurrence offset and unsound inside impedance, so the distance security on the RES side has a high danger of refusal. To tackle this issue, the high-recurrence shortcoming part-based distance security is proposed. The high-recurrence impedance model of RESs is set up to tackle the issue of

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unsound inner impedance of RESs under power recurrence. On this premise, inside and outside flaws can be dependably dictated by contrasting the high-recurrence working voltage and the high-recurrence voltage at the shortcoming point.

The proposed technique can work with a high velocity and is basically unaffected by control procedures and recurrence offset on the grounds that the chosen recurrence is higher than the data transmission of the current circle and the rotor-speed recurrence. It additionally has a solid capacity to oppose the issue obstruction because of the enormous impedance circle in the chose recurrence range.

The proposed method also operates in an automatic loop control system with the presence of PWM controller in the circuit.

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