Study Committee A3

Transmission and Distribution Equipment

Paper 10441_2022

Automated Rack In & Rack out of 22kV/33kV AIS Breakers

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Motivation

In Transmission utilities 22kV & 33kV SF6 & VCB are used to cater the load to various consumer. Maintenance of this switchgear is very important to have reliable power supply and increased life of equipment, breaker outages are carried out for various maintenance activities. All existing 22kV & 33kV Air insulated switchgear (AIS) breakers are racked in & racked out manually as per the standard operating procedure. This task is carried out by the operational engineer using Arc suit.

- Aim of study

To enhance the safety of the operating activities, a pilot project done by team transmission & developed prototypes, Automated fixed type & Robotic Mechanism for rack in & rack out of 33kV AIS Breakers.

Method/Approach

- Develop a safe device with technology adoption and cost effective solution for safe isolation of air insulated switchgear(AIS) breakers.
- Following two methods adopted
- Automated fised type rack in & rack out for 22kV /33kV AIS breaker
- Robotic isolation of 22kV / 33kV AIS breaker

Objects of investigation

- Use of PPE such as Safety shoes, helmet, Hand gloves and Arc suit are having its own limitations.
- To enhance the safety of the operating person and improve operational efficiency
- Reduced outage time.
- Shall improve customer satisfaction.
- Remote isolation of breaker

Experimental setup & test results

- One breaker which is in load service is mounted with fixed type rack in rack out mechanism and after its successful results two more breakers are mounted with fixed type rack in rack out mechanism on 33kV AIS breaker.
- Robot is developed and above fixed type mechanism is incorporated in it.

Discussion

- Fixed type rack in & rack out mechanism is mounted on three breakers at one of our receiving station at Mumbai and is now used for isolation of breaker. Even operation engineer can now isolate the breaker from SCADA.
- Robot is now enabled to isolate 10 breakers on the 33kV Bus section -4 at our receiving station.

Conclusion

This project “Automated rack in & rack out of 22kV / 33kV Breakers “with engineering controls has created the safe working environment for operating persons of this breakers. Thus, preventing fatality, permanent disability, or harm to operating persons due to any untoward incident during breaker isolation.

Following are the few notable advantages of the project.

- Automated rack in & rack out device shall rack out or rack in the AIS breaker with a single command using a user-friendly mobile app.
- Interlocks are incorporated to handle exigencies arising during the breaker rack in & rack out process.
- Three Zone torque setting for smooth breaker movement.
- Human intervention is not required as this device is mounted on the breaker cubicle.
- Single mobile application can handle up to 100 breakers
- Breaker isolation can be done from safe distance of 100mtr.Thus avoiding injury or fatality to the operating person in case of breaker damage during isolation process.
- Interlock is provided to prevent this device from operating when breaker is in closed condition.
- This device can be customized to isolate the breakers as per the requirements of the Utilities.

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AIS/ GIS breaker

All existing 22kV & 33kV AIS breakers are racked in & racked out manually as per the standard operating procedure.

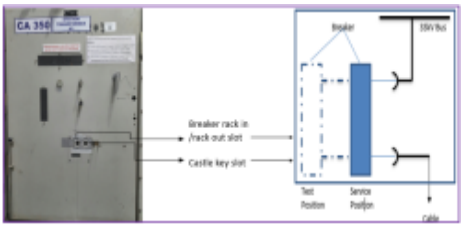


Figure-1 : Front view of Breaker & Side view of breaker with busbar (from left to right)

Current Practice for Breaker rack in / rack out:

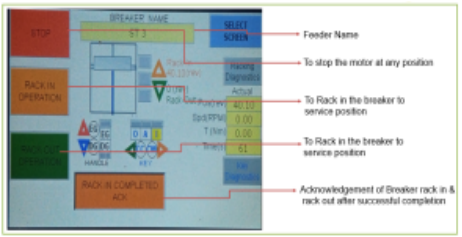
Use of PPE such as Safety shoes, helmet, Hand gloves and Arc suit are having its own limitations, as massive energy released in the event of fault can cause destruction of equipment involved, fire, and injury not only to an electrical worker but also to bystanders.

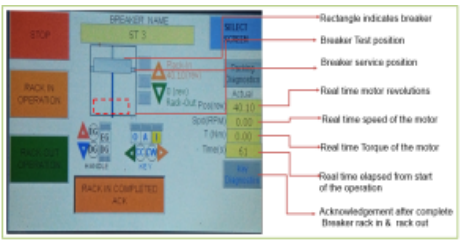
- Figure-2: Operating person wearing Arc suit for carrying out rack in & rack out of breaker

Project-1: Automated fixed type Rack in & Rack out device

- This project is executed in three stages
- Stage-1 : Breaker rack in & rack out through motor
- Stage-2 : Test / service position key operation through motor.
- Stage-3 : Interlock checking & integrated operation trials of both motors and development of android app.
- Logic built to enable user to handle breaker emergency condition by suitable prompts such as “Recall the breaker either to Rack out position or Rack in position”.

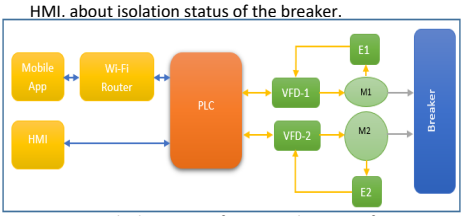
HeadlineAndroid app main display options: Figure-3 & 4





Working principle of Motor control circuit used for breaker movement

- User can use mobile app/ Human-Machine Interface (HMI) display for performing task which will communicate to PLC.
- Programmable logic Controller (PLC) issues command to Variable frequency drive of Castle key (VFD-1). Motor (M1) turn the castle key from 0 deg to 90 as per command from VFD-1 and encoder E1 sends feedback to VFD-1.
- After receiving feedback from VFD-1, PLC will give command to Variable frequency drive of breaker (VFD-2), Motor (M2) will move the breaker to test / service position as per command from VFD-2 & Encoder E2 will give feedback to PLC through VFD-2.
- PLC will again issue command to VFD-1 to turn the castle key from 90 deg to 180 deg in anti-clockwise direction. Encoder-1 will again give feedback to PLC through VFD-1, thus completing the breaker isolation. PLC will also communicate to Mobile app/ HMI, about isolation status of the breaker.



- Figure-5 : Block Diagram for Control Circuit of motor used for Breaker movement.

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Deployment:

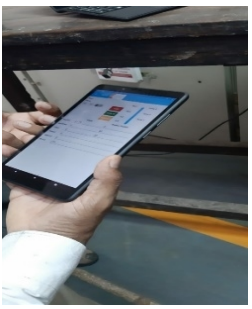

Figure-6: Motors mounted on the breaker panel & Mobile app

Project-2:

Robotic rack in & rack out of breaker

Single Robotic device is used to isolate any breaker on the bus as per the requirement of the user

- RFID tags & reader are user to identify the breaker location.
- Line sensors are used to guide robot to reach breaker and align.
- Proximity sensors are mounted on the robot to stop its sideward movement.
- With the help of actuator and slider, robot will align the motor with racking slot of breaker.
- Ultrasonic proximity sensor are used to detect any obstacle on its path.
- HD camera to have live visual on the dashboard.
- 2.4Ghz Wi-Fi module is used for communication over the internet.

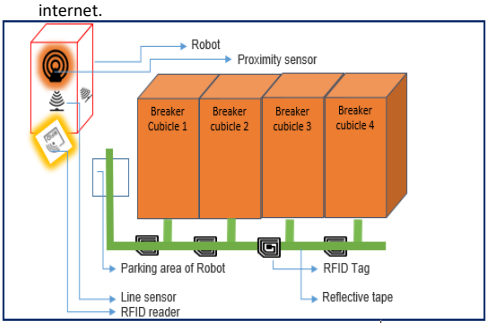

Figure-7: Block diagram of Main control circuit

Main control circuit of Robot

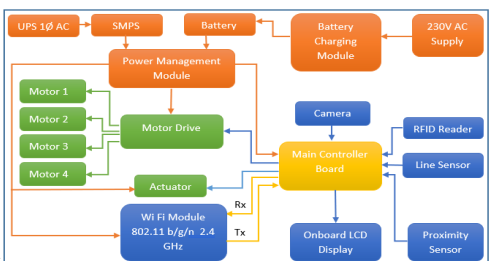

Figure-8: Block diagram of Main control circuit of Robot

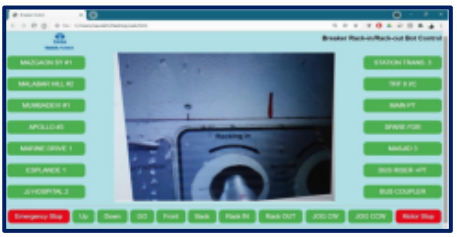

Figure-9: Remote monitoring and Control dashboard

Figure-10: Robot images in switchgear room

Conclusion

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