COMPACT TESTING KIT FOR LOW VOLTAGE SWITCHGEAR PANEL

Gayatri A. Wagh, Akanksha S. Ruikar, Bhushan L. Sonawane, Joydeep Sarkar
Department of Electrical Engineering, Sandip Institute of Engineering and Management, Nashik

Abstract- The objective behind working on this concept is to work with switching devices like breakers, panels and test their reliability for a continual operation**.** Relays are essential part of switchgear operation. Site mounting of the switchgear includes different structural panels and different types of breaker arrangements. The testing kit developed necessitates quick and short hand tests to check operative condition of low voltage level switchgears. The testing kit includes breaker operation tester, over current detector, earth fault detector, all type of meter testing i.e. (ammeter, voltmeter energy meter), wiring checking with continuity tester, relay timing tests, indication checking and thermostat and heater circuit check on switchgear. The relay operation tests are for the purpose of checking the relay function and time as per customer requirement. The purpose of breaker operation testing is to ensure that is the breaker capable of switching on/off during fault condition within required time. These tests are conducted to ensure that the product is in accordance with the equipment on which the routine tests have been passed**.** The routine tests are for the purpose of proving the function of switchgear, their operating devices and their auxiliary equipment.

I. INTRODUCTION

In power supply system, switchgear is the amalgamation of electrically disengaged switches, fuse arrangements, and circuit-breakers is used to control, protect and isolation of electrical equipment. Switchgears are used both to de-energize equipment to countenance work to be done and to clear faults downstream. This type of paraphernalia is directly linked to the steadfastness of the electricity supply. Oil-filled equipment allowed arc energy to be contained and safely controlled. A switchgear line-up would be a metal-enclosed structure with electrically functioned switching elements. Substitutes are accessible in the arrangement of air-blast, vacuum, or SF_6 equipment, allowing large currents and power levels to be safely controlled by automatic equipment. The technology has been improved over time and can now be used with voltages up to 1,100 kV. Switchgears in sub-stations are positioned on individually on the high- and low-voltage sides of big power transformers. The switchgear on the low-voltage side may be situated in a building, with medium-voltage circuit breakers for supply side circuits, accompanied by metering, control, and protection equipment.

II. LITERATURE REVIEW

The reputation of electric supply in everyday life has reached such a stage that it is desirable to protect the power system from harm during fault conditions & to ensure maximum continuity of supply. For this purpose, it needs some device(for control) to make on and off operations on generators, transformers, bus-bars, transmission lines, distributors and other equipment under both normal and abnormal conditions. This is achieved by an apparatus called Switchgear. Therefore various types of switching equipment are incorporated in the power system. Generally, switchgear is used for protection of equipments of customer side. Basically, there are five compartments in a switchgear panel which carries out the entire operation of the switchgear cubicle:

a) **Metering Compartment:** The door of metering box compartment has following devices mounted on it:

1. Breaker auxiliary control multiplier
2. Breaker service control multiplier
3. Breaker test control multiplier
4. Ammeter
5. Space heater ammeter
6. Indication lamps

2) Breaker compartment- A circuit breaker is a mechanical switching device, capable of making, carrying and interrupting currents under normal circuit conditions, and also make and carrying for specified time and interrupting current under abnormal conditions such as those occurring during short circuits. Many different methods of achieving this functionality have developed over the years. A protection relay is installed in each vacuum circuit breaker module. It consists of two or three core, As, per the ratings of the CT they are classified as class A, class B, class C etc.

- 1st core used for metering.
- 2nd core used for protection
- 3rd core is auxiliary core

3) Bus-bar compartment: Bus-bar compartment consist of:

1. Jumpers (bus conductor)
2. Insulators and Spacers
3. Hardware for bus-bar fitment

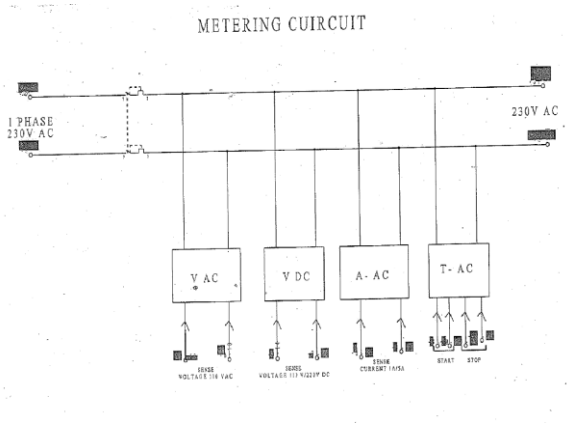
4) Potential Transformer compartment:

Potential transformers are used for measurement and protection. A transformer specially designed to accurately represent the primary voltage in a secondary circuit. Potential transformer can be used to power metering devices, or provide control power. Potential transformers are necessary for voltage, directional, distance protection. Primary of

potential transformer is connected to power circuit between phase and ground. There are two types of constructions:
1) Electromagnetic potential transformer.
2) Capacitor potential transform

5) Cable and Current transformer compartment:
The instrument transformers, which are used in conjunction with ammeter, over current relay, etc. Current transformers are step-down transformers. A transformer specially designed to accurately represent the primary current in a secondary circuit. CT's provide isolation from the high voltage primary, permit grounding of the secondary for safety, and step-down the magnitude of the measured current to a value that can be safely handled by the instruments. The secondary terminals of the CT are always grounded or keep loaded, they never keep opened, if they opened then it may cause high voltage at secondary which results in damage of CT.

III. CONSTRUCTION



- It consists of compact of 2.0 mm thick sheet metal box with two compartments.
- Sheet metal of suitable size was cut and bended to form a folded cubicle box. After which it was welded by mig welding. Then all the rough surface finished properly by sandering & thus proper finishing was obtained. Then it was given for powder painting of 80 michrons.
- Top compartment fixed with top plate for mounting all meters, indicating lamps.
- In Top compartment there is digital DC voltmeter, AC voltmeter, Ammeter, timer & led indicating lamps are mounted on top plate.
- Bottom compartment also fixed with top plate for mounting push buttons & dimmerstat knob.
- In bottom compartment there are various materials i.e. transformers, rectifier unit, contactors, relays, dimmerstat, push buttons, ammeter & voltmeter selector switches, input & output socket terminals, ELCB, MCB, PVC wires.
- Top plate & bottom plate fixed to top & bottom compartment with screw.
- Fibre sheet is fixed at the bottom side of bottom compartment.
- All the apparatus inside the bottom compartment are mounted on galvanised sheet plate.
- For Input 230v ac supply three core cable is required for the test kit.
- For DC voltage, AC voltage and current output 16 pin plug & socket is required.
- For connection between Switchgear under test & Test kit 16 pin plug with 16 core cable is required.

IV. WORKING PRINCIPLE

When single phase 230v ac supply is applied to the rectifier unit it converts ac input to dc output. The voltmeter is connected across the rectifier output to measure the voltage given to the breaker closing coil and tripping coil. The voltage is adjusted as per rating of the closing coil and tripping coil of the breaker i.e 110v dc or 220v dc with the help of selector switch. By pressing the close push button breaker closing coil will energized and breaker will close and breaker close lamp will indicate on the front panel of the test kit. By pressing the trip push button breaker tripping coil will energized and breaker will trip and breaker trip lamp will indicate on the front panel of the test kit.

Dimmerstat is used for adjusting the variable current required and an ammeter is connected across the dimmerstat which shows the current of dimmerstat output. Suppose the over current relay rated current is 1 amp and over current setting is 1.2 amp and then by increasing the current from the dimmerstat to the over current relay the relay coil will get actuated when the current exceeds above 1.2 amp then breaker will trip and it will show fault trip indication on the front panel.

The Test kit is connected to the switchgear panel with the help of output cables to the metering circuit. When we increase the current from the dimmerstat the deflection of the ammeter on the panel can be check as per rated current.Apply110 volt ac through selector switch to the voltmeter connected in switchgear panel. It will show the full scale reading.

1. Single phase 230 volt ac supply applied to test kit through ELCB. Then power on indication will glow. Press Test on push button Test on indication & 230 volt ac contactor will get on .For contactor on circuit variac should be on zero position

2. Single phase 230 volt ac supply goes to input of auto transformer (T1). Auto transformer is having three output taps 110 volt ac,120 volt ac,245 volt ac. Auto transformer output 120 volt ac & 245 volt ac connected to the bridge rectifier circuit to covert ac to dc voltage.

3. There is 4 pole 3 way selector switch is connected for selection of voltages 110 v dc,220 v dc,110 v ac. Auto transformer output tap 110 volt ac tap is directly connected to

selector switch. After selection we will get 110 volt ac supply to the output terminal nos.5 & 6 of test kit through 1 pole 6A MCB. Single phase 230 volt ac supply is directly connected to output terminal nos.3 & 4 of test kit through 1 pole 6A MCB.

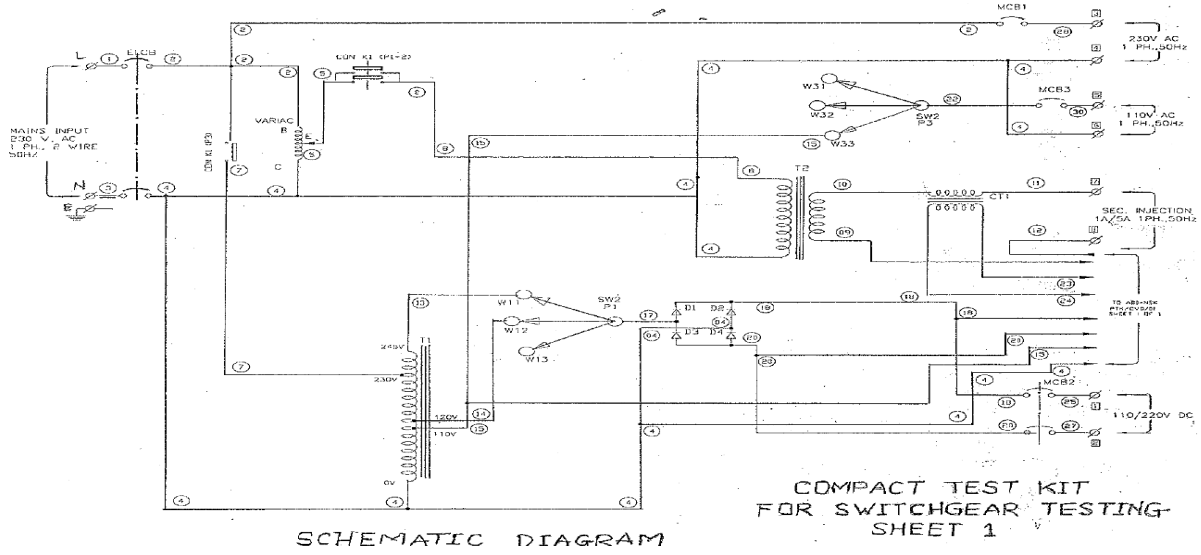


Figure -

4. Bridge rectifier output 110 volt dc/220 v dc is connected to selector switch & selector switch connection goes to the output terminal no.1& 2 through 4A DC MC

5. For secondary current injection 230 volt ac supply input given to the variac & its output 1A/5A is connected to the output terminal nos.7& 8

Testing & Troubleshooting Operations

1. Over current and earth fault relay tripping by secondary current injection:-

First three pin plug of test kit input to be connect to the single phase 230 volt ac supply. Press test on green push button. Select the required DC voltage 110 volt/220 volt for relay auxiliary coil through selector switch. Check the voltage indication display on DC voltmeter. Then make on DC voltage 4A MCB .We will get required output DC voltage at terminal nos.1 & 2. Secondly set the overcurrent setting on protection relay more than rated current. Suppose secondary rated current of relay is 1A then set overcurrent setting at 1.2 A. Then gradually increase the current through variac . If current exceeds more than 1.2A, Relay will operate & trip command goes to Circuit BKR through relay NC contact .At the same time fault trip indication will glow on Test kit as well as on switchgear panel. Same way we can set the earth fault setting on protection relay 10 to 40 % of rated current. Suppose secondary rated current of relay is 1A then set overcurrent setting at 0.2 A. Then gradually increase the current through variac .If current exceeds more than 0.2A, Relay will operate & trip command goes to Circuit BKR through relay NC contact .At the same time fault trip indication will glow on Test kit as well as on switchgear panel.

2. Breaker on/off operation:-

Press test on green push button. Select the required DC voltage 110 volt/220 volt for Breaker closing & tripping coil through selector switch. Check the voltage indication display on DC voltmeter. Then make on DC voltage 4A MCB .We will get required output DC voltage at terminal nos.1 & 2.Then connect the output cable wire no.1 & 2 to the switchgear panel DC supply terminals. Select the local/remote selection on panel & Close the bkr by TNC switch. After closing operation give the trip command through TNC switch. Take 5 closing & 5 opening operation. Move CB from test to service position –5 times & check the smooth operation. Move CB from service to test position –5 times & check the smooth operation. Verify interlock operation like closed CB can't move in and out.

3. Ammeter and voltmeter testing by current and voltage injection:-

Press test on green push button. Select the ampere setting as per requirement 1A/5A on the selector switch. Gradually increase the current by variac .Check required current on digital ammeter mounted on test kit. Connect the output cable wire no.7 & 8 to the panel metering circuit. Give secondary rated current to Ammeter ckt. & check meter shows reading/deflection. Meter shows deflection as per requirement. Select the 110 volt ac selection on selector switch check the required voltage on Digital meter. If it is ok then make 6 A MCB on. We will get the voltage at output terminal no.5 & 6. Connect the output cable wire no.5 & 6 to

the panel voltmeter circuit. Check meter shows reading/deflection. Meter shows deflection as per requirement.

4. Energy meter testing by current and voltage injection:-

Press test on green push button. Select the ampere setting as per requirement 1A/5A on the selector switch. Gradually increase the current by variac. Check required current on digital ammeter mounted on test kit. Connect the output cable wire no.7 & 8 to the panel metering circuit. Give secondary rated current to energy meter ckt. & check meter shows reading/deflection. Meter shows deflection as per requirement. Select the 110 volt ac selection on selector switch check the required voltage on Digital meter. If it is ok then make 6 A MCB on. We will get the voltage at output terminal no.5 & 6. Connect the output cable wire no.5 & 6 to the panel energymeter circuit. Check meter shows reading/deflection. Meter shows deflection as per requirement.

5. Wiring continuity check with continuity tester:-Check the continuity of wiring as per schematic wiring. There are two terminals on tests kit. Connect one end of wire to the one terminal other end of the circuit is connected to the second terminal. If continuity is there we will get LED indication as well as audio sound. Likewise we can check the total scheme prior to inject the voltages & current.

6. Breaker closing & tripping timing check with timer:- Press test on green push button. Auxiliary supply 230 volt ac directly connected to the Digital timer. Connect two wires of BKR auxiliary switch NO contact to timer start connection & another two wires of BKR auxiliary switch NC contact get connected to timer stop connection. Timer start & stop terminal wires are connected to the output terminals nos.13-14 & 15-16 of test kit. These wires are connected to panel circuit with test kit output cable. Thus we can measure the BKR closing & opening time on Timer.

7. Indication checks:- During switchgear testing by injecting the required voltage, we can check indicating lamps as per requirement. Also we can check the lamp indications on front panel of Test kit like BKR ON, BKR OFF, FAULT TRIP.

8. Thermostat, heater and illumination circuit check:- Press test on green push button. We will get 230 volt ac supply directly at output terminal nos.3& 4. Connect the output cable wire no. 3 & 4 to the thermostat & heater circuit. Check the thermostat setting & heater on /cut off operation. Also we can check proper working of illumination lamp mounted in switchgear panel.

V. CONCLUSION

The Testing panel module is very compact and requires small space and it's mobile. Only 230V AC supply is required to power the test kit. It can be used for testing overcurrent and earth fault relay function, meter testing, circuit breaker opening and closing operation testing. It can be used for checking ammeters, voltmeters functions, deflection and working. It can also be used for checking of wiring as per schematic diagram with the help of continuity tester provided in this test kit. It can be used for testing all types of protection relays. During the testing, if somebody mis-operates any switch, then electronic circuits trip the total testing kit.

VI. REFERENCES

[1] "Inspection, Testing and Commissioning of Electrical Switchboards, Circuit Breakers, Protective Relays, Cables and PLCs", IDC Technologies, ISBN: 978-1-921716-86-7

[2] Baass, W., Brand, K.P., Gerspach, S.: 'Exploiting the IEC 61850 potential for new testing and maintenance strategies'. CIGRE, Paris, 2008

[3] D. König, P. Rösch, B. Müller, "Contribution on the specification of an aging test for the insulation of enclosed air-insulated switchgear", *IEEE Transactions on Electrical Insulation*, vol. EI-22, no. 6, pp. 769-774, December 1987.

[4] "Additional requirements for enclösed switchgear and controlgear from 1 kV to 72.5 kV to be used in severe climatic conditions", *IEC Report 932*, 1988.

[5] ANSI C37.20.7 - IEEE Guide for Testing Medium-Voltage Metal-Enclosed Switchgear for Internal Arcing Faults

[6] G. Reeves, "Specific contact resistance using a circular transmission line model", *Solid-State Electronics*, vol. 23, pp. 487-490, 1980

[7] David L. Swindler, Carl J. Fredericks, "Modified Differential Ground Fault Protection", *Square D Power Systems Engineering Data*, vol. 1, no. 8, July 1994.