1. **GENERAL DATA AND INFORMATION**

|  |  |  |  |
| --- | --- | --- | --- |
| Designation No. |  | TR. Differential Relay Type |  |
| TRF Manufacture |  | TR.R.E.F Relay Type |  |
| Rating |  | HV CT Ratio | / Class: |
| Winding Vector Group |  | LV CT Ratio | / Class: |
| Impedance % |  | HV BCT Ratio | / Class: |
| No. of Taps |  | LV BCT Ratio | / Class: |
| Ratio |  | Main Tap: / KV | Last Tap: / KV |

1. Transformer Stability and Sensitivity Test Procedure
   1. Objective:

The objective of this test is confirm that the differential relay or REF relay doesn't operate at normal conditions even though load currents are high, where It should operate when a fault occurs in its zone.

* 1. Source:
  + Suitable 3 phase generator (Separate) – 380 volt – 60 Hz or Suitable Voltage.
  + SEC supply.

1. Precautions:
   1. Good earth of:
      1. The Generator.
      2. The Transformer.
      3. The shield of the cables.
   2. The correct size of connected testing cables.
   3. Determine working zones and places and preventing any person to be in these zones.
   4. Suitable MCB for 3-phase supply.
   5. CT terminal blocks must be checked and tightness well.
   6. All REF (Restricted Earth Fault) relays must be removed or its CT terminal shorted.
   7. Check the Phase Sequence of the 3-Phase Supply.
   8. Test equipments and tools:
   * Calibrated multi-meters.
   * Calibrated testers for measure current and phase angle.
2. Calculation:

The following calculation is as a general example.

Technical Data of Power Transformer:

* Two winding - three phase - Ynyn0d1 transformer.
* 132/13.8 KV.
* 60 MVA.
* Rated current 262.43 / 2510.22 A.
* HV CTR = 300/1.
* LV CTR = 3000/1.
* Percentage impedance:
  + At Tap 7L = 25.137 %
  + At Tap N = 23.594 %
  + At Tap 11R = 21.847 %

Calculation:

At normal tap.

* H.V side:





* LV Side:







* 
* At Tap 7L 

When we apply 380 V power supply at LV side





*After IPCT* 





*After IPCT*  

* At Tap N



When we apply 380 V power supply at LV side





*After IPCT* 





*After IPCT* 

* At Tap 11R



When we apply 380 V power supply at LV side





*After IPCT* 





*After IPCT* 

1. Final setting testing check:
   1. Check the final setting of the differential relay.
   2. Check the final setting of the REF relays.
2. Transformer differential stability and sensitivity test for tap no ------
   1. stability test
      1. Primary measurements

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Source | | | | | | | V&I |
| B-R | Y-B | R-Y | N | B | Y | R |
|  |  |  |  |  |  |  | V (V) |
|  |  |  |  |  |  |  | I (A) |

* + 1. Secondary measurements

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Diff. relay  (LV side) | | | Diff. relay  (HV side) | | | LV Side | | | | HV Side | | | | Phase |
|  | I (mA) | T.B. |  | I (mA) | T.B. |  | I sec. (mA) | T.B. | I pri. (A) |  | I sec. (mA) | T.B. | I pri. (A) |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | R |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | Y |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | B |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | N |

* + 1. Differential Relay Current Measurement (for Digital relays)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Phase | DIFF Relay Measurement  HV side current A | DIFF Relay Measurement  LV side current A | DIFF Current  Id mA | Restrain Current  IR mA |
| R |  |  |  |  |
| Y |  |  |  |  |
| B |  |  |  |  |

* 1. Sensitivity Test by swapping CT Terminals :
     1. Secondary measurements

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Diff. relay (LV side) | | | Diff. relay (HV side) | | | LV Side | | | | HV Side | | | | Phase |
|  | I (mA) | T.B. |  | I (mA) | T.B. |  | I sec. (mA) | T.B. | I pri. (A) |  | I sec. (mA) | T.B. | I pri. (A) |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | R |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | Y |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | B |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | N |

* + 1. Differential Relay Current Measurement (for Digital relays)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Phase | DIFF Relay Measurement  HV side current A | DIFF Relay Measurement  LV side current A | DIFF Current  Id mA | Restrain Current  IR mA |
| R |  |  |  |  |
| Y |  |  |  |  |
| B |  |  |  |  |

1. Transformer differential stability and sensitivity test for tap no ------
   1. stability test
      1. Primary measurements

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Source | | | | | | | V&I |
| B-R | Y-B | R-Y | N | B | Y | R |
|  |  |  |  |  |  |  | V (V) |
|  |  |  |  |  |  |  | I (A) |

* + 1. Secondary measurements

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Diff. relay (LV side) | | | Diff. relay (HV side) | | | LV Side | | | | HV Side | | | | Phase |
|  | I (mA) | T.B. |  | I (mA) | T.B. |  | I sec. (mA) | T.B. | I pri. (A) |  | I sec. (mA) | T.B. | I pri. (A) |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | R |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | Y |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | B |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | N |

* + 1. Differential Relay Current Measurement(for Digital relays)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Phase | DIFF Relay Measurement  HV side current A | DIFF Relay Measurement  LV side current A | DIFF Current  Id mA | Restrain Current  IR mA |
| R |  |  |  |  |
| Y |  |  |  |  |
| B |  |  |  |  |

* 1. Sensitivity Test by swapping CT Terminals :
     1. Secondary measurements

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Diff. relay (LV side) | | | Diff. relay (HV side) | | | LV Side | | | | HV Side | | | | Phase |
|  | I (mA) | T.B. |  | I (mA) | T.B. |  | I sec. (mA) | T.B. | I pri. (A) |  | I sec. (mA) | T.B. | I pri. (A) |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | R |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | Y |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | B |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | N |

* + 1. Differential Relay Current Measurement(for Digital relays)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Phase | DIFF Relay Measurement  HV side current A | DIFF Relay Measurement  LV side current A | DIFF Current  Id mA | Restrain Current  IR mA |
| R |  |  |  |  |
| Y |  |  |  |  |
| B |  |  |  |  |

1. Transformer differential stability and sensitivity test for tap no ------
   1. stability test
      1. Primary measurements :

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Source | | | | | | | V&I |
| B-R | Y-B | R-Y | N | B | Y | R |
|  |  |  |  |  |  |  | V (V) |
|  |  |  |  |  |  |  | I (A) |

* + 1. Secondary measurements:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Diff. relay (LV side) | | | Diff. relay (HV side) | | | LV Side | | | | HV Side | | | | Phase |
|  | I (mA) | T.B. |  | I (mA) | T.B. |  | I sec. (mA) | T.B. | I pri. (A) |  | I sec. (mA) | T.B. | I pri. (A) |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | R |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | Y |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | B |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | N |

* + 1. Differential Relay Current Measurement (for Digital relays)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Phase | DIFF Relay Measurement  HV side current A | DIFF Relay Measurement  LV side current A | DIFF Current  Id mA | Restrain Current  IR mA |
| R |  |  |  |  |
| Y |  |  |  |  |
| B |  |  |  |  |

* 1. Sensitivity Test by swapping CT Terminals :
     1. Secondary measurements

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Diff. relay (LV side) | | | Diff. relay (HV side) | | | LV Side | | | | HV Side | | | | Phase |
|  | I (mA) | T.B. |  | I (mA) | T.B. |  | I sec. (mA) | T.B. | I pri. (A) |  | I sec. (mA) | T.B. | I pri. (A) |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | R |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | Y |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | B |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | N |

* + 1. Differential Relay Current Measurement (for Digital relays)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Phase | DIFF Relay Measurement  HV side current A | DIFF Relay Measurement  LV side current A | DIFF Current  Id mA | Restrain Current  IR mA |
| R |  |  |  |  |
| Y |  |  |  |  |
| B |  |  |  |  |

1. Stability And Sensitivity Of REF HV Side At Tap No ----
   1. Stability test

VRN= \_\_\_\_\_\_\_ VYN= \_\_\_\_\_\_\_ VBN= \_\_\_\_\_\_\_

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Connected Supply to Phase | I primary (A) | Measured I secondary | | | | REF relay | |
| Wire From neutral CT | | Wire From CT's sum | | I (mA) | V (V) |
| I (mA) |  | I(mA) |  |  |  |
| T.B. No | |  | |  | |  |  |
| R-N |  |  |  |  |  |  |  |
| Y-N |  |  |  |  |  |  |  |
| B-N |  |  |  |  |  |  |  |

* 1. Sensitivity Test by Swapping CT Terminals :

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Connected Supply to Phase | I primary (A) | Measured I secondary | | | | REF relay | |
| Wire From neutral CT | | Wire From CT's sum | | I (mA) | V (V) |
| I (mA) |  | I (mA) |  |
| T.B. No | |  | |  | |  |  |
| R-N |  |  |  |  |  |  |  |
| Y-N |  |  |  |  |  |  |  |
| B-N |  |  |  |  |  |  |  |

1. Stability and sensitivity of REF HV Side at Tap No ----
   1. Stability and sensitivity of REF HV Side at Tap No ----

VRN= \_\_\_\_\_\_\_ VYN= \_\_\_\_\_\_\_ VBN= \_\_\_\_\_\_\_

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Connected Supply to Phase | I primary (A) | Measured I secondary | | | | REF relay | |
| Wire From neutral CT | | Wire From CT's sum | | I (mA) | V (V) |
| I(mA) |  | I(mA) |  |  |  |
| T.B. No | |  | |  | |  |  |
| R-N |  |  |  |  |  |  |  |
| Y-N |  |  |  |  |  |  |  |
| B-N |  |  |  |  |  |  |  |

* 1. Sensitivity Test by Swapping CT Terminals :

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Connected Supply to Phase | I primary (A) | Measured I secondary | | | | REF relay | |
| Wire From neutral CT | | Wire From CT's sum | | I (mA) | V (V) |
| I(mA) |  | I(mA) |  |  |  |
| T.B. No | |  | |  | |  |  |
| R-N |  |  |  |  |  |  |  |
| Y-N |  |  |  |  |  |  |  |
| B-N |  |  |  |  |  |  |  |

1. Stability and sensitivity of REF HV Side at Tap No ----
   1. Stability and sensitivity of REF HV Side at Tap No ----

VRN= \_\_\_\_\_\_\_ VYN= \_\_\_\_\_\_\_ VBN= \_\_\_\_\_\_\_

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Connected Supply to Phase | | I primary (A) | Measured I secondary | | | | REF relay | |
| Wire From neutral CT | | Wire From CT's sum | | I (mA) | V (V) |
| I(mA) |  | I(mA) |  |  |  |
| T.B. No | | |  | |  | |  |  |
| R-N |  | |  |  |  |  |  |  |
| Y-N |  | |  |  |  |  |  |  |
| B-N |  | |  |  |  |  |  |  |

* 1. Sensitivity Test by Swabing CT Terminals :

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Connected Supply to Phase | I primary (A) | Measured I secondary | | | | REF relay | |
| Wire From neutral CT | | Wire From CT's sum | | I (mA) | V (V) |
| I(mA) |  | I(mA) |  |  |  |
| T.B. No | |  | |  | |  |  |
| R-N |  |  |  |  |  |  |  |
| Y-N |  |  |  |  |  |  |  |
| B-N |  |  |  |  |  |  |  |

1. Stability and sensitivity of REF LV Side at Tap No ----
   1. Stability and sensitivity of REF HV Side at Tap No ----

VRN= \_\_\_\_\_\_\_ VYN= \_\_\_\_\_\_\_ VBN= \_\_\_\_\_\_\_

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Connected Supply to Phase | I primary (A) | Measured I secondary | | | | REF relay | |
| Wire From neutral CT | | Wire From CT's sum | | I (mA) | V (V) |
| I(mA) |  | I(mA) |  |  |  |
| T.B. No | |  | |  | |  |  |
| R-N |  |  |  |  |  |  |  |
| Y-N |  |  |  |  |  |  |  |
| B-N |  |  |  |  |  |  |  |

* 1. Sensitivity Test by Swapping CT Terminals :

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Connected Supply to Phase | I primary (A) | Measured I secondary | | | | REF relay | |
| Wire From neutral CT | | Wire From CT's sum | | I (mA) | V (V) |
| I(mA) |  | I(mA) |  |  |  |
| T.B. No | |  | |  | |  |  |
| R-N |  |  |  |  |  |  |  |
| Y-N |  |  |  |  |  |  |  |
| B-N |  |  |  |  |  |  |  |

1. Stability and sensitivity of REF LV Side at Tap No ----
   1. Stability and sensitivity of REF HV Side at Tap No ----

VRN= \_\_\_\_\_\_\_ VYN= \_\_\_\_\_\_\_ VBN= \_\_\_\_\_\_\_

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Connected Supply to Phase | I primary (A) | Measured I secondary | | | | REF relay | |
| Wire From neutral CT | | Wire From CT's sum | | I (mA) | V (V) |
| I(mA) |  | I(mA) |  |  |  |
| T.B. No | |  | |  | |  |  |
| R-N |  |  |  |  |  |  |  |
| Y-N |  |  |  |  |  |  |  |
| B-N |  |  |  |  |  |  |  |

* 1. Sensitivity Test by Swapping CT Terminals :

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Connected Supply to Phase | I primary (A) | Measured I secondary | | | | REF relay | |
| Wire From neutral CT | | Wire From CT's sum | | I (mA) | V (V) |
| I(mA) |  | I(mA) |  |  |  |
| T.B. No | |  | |  | |  |  |
| R-N |  |  |  |  |  |  |  |
| Y-N |  |  |  |  |  |  |  |
| B-N |  |  |  |  |  |  |  |

1. Stability and sensitivity of REF LV Side at Tap No ----
   1. Stability and sensitivity of REF HV Side at Tap No ----

VRN= \_\_\_\_\_\_\_ VYN= \_\_\_\_\_\_\_ VBN= \_\_\_\_\_\_\_

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Connected Supply to Phase | I primary (A) | Measured I secondary | | | | REF relay | |
| Wire From neutral CT | | Wire From CT's sum | | I (mA) | V (V) |
| I(mA) |  | I(mA) |  |  |  |
| T.B. No | |  | |  | |  |  |
| R-N |  |  |  |  |  |  |  |
| Y-N |  |  |  |  |  |  |  |
| B-N |  |  |  |  |  |  |  |

* 1. Sensitivity Test by Swapping CT Terminals :

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Connected Supply to Phase | I primary (A) | Measured I secondary | | | | REF relay | |
| Wire From neutral CT | | Wire From CT's sum | | I (mA) | V (V) |
| I(mA) |  | I(mA) |  |  |  |
| T.B. No | |  | |  | |  |  |
| R-N |  |  |  |  |  |  |  |
| Y-N |  |  |  |  |  |  |  |
| B-N |  |  |  |  |  |  |  |