1. **GENERAL DATA AND INFORMATION:**

|  |  |  |  |
| --- | --- | --- | --- |
| Designation no. |  | Rated Current |  |
| Manufacturer |  | Rated Voltage |  |
| Type No. |  | Rated Freq. |  |
| Serial No. |  | Aux. Voltage |  |
| Model No. |  |  |  |
| Panel name |  | |  |

1. **MECHANICAL CHECK AND VISUAL INSPECTION:**

|  |  |  |
| --- | --- | --- |
| ITEM | DESCRIPTION | CHECKED |
| 1 | Inspect for any physical damage or defects. |  |
| 2 | Verify connections as per approved drawings. |  |
| 3 | Check tightness of all connections. |  |

1. **ELECTRICAL TEST:** 
   1. **FUNCTION TEST:**

|  |  |  |
| --- | --- | --- |
| ITEM | DESCRIPTION | CHECKED |
| 1 | Test switch checked for correct function. |  |
| 2 | Date & time |  |
| 3 | Alarm contacts checked. |  |
| 4 | Trip contacts checked. |  |
| 5 | Indication checked. |  |
| 6 | Disturbance report check |  |
| 7 | Make test mode enable under commissioning menu to check alarm (yellow). |  |
| 8 | Check case earth. |  |
| 9 | Watchdog contacts (M11-M12 closed, M13-M14 open) |  |

* 1. **INPUT OPTO-ISOLATORS CHECKS:**

Test Procedure:

Go to Commissioning Test,

Test mode (test mode),

then go to system data (Opto I/P Status)

to check the status of the binary inputs.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| OPTO Input No. | V DC Applied Terminal No. | | Function | Results |
| +Ve Terminal No. | -Ve Terminal No. |
| OPTO-1 | E2 | E1 |  |  |
| OPTO-2 | E4 | E3 |  |  |
| OPTO-3 | E6 | E5 |  |  |
| OPTO-4 | E8 | E7 |  |  |
| OPTO-5 | E10 | E9 |  |  |
| OPTO-6 | E12 | E11 |  |  |
| OPTO-7 | E14 | E13 |  |  |
| OPTO-8 | E16 | E15 |  |  |
| OPTO-9 | C2 | C1 |  |  |
| OPTO-10 | C4 | C3 |  |  |
| OPTO-11 | C6 | C5 |  |  |
| OPTO-12 | C8 | C7 |  |  |
| OPTO-13 | C10 | C9 |  |  |
| OPTO-14 | C12 | C11 |  |  |
| OPTO-15 | C14 | C13 |  |  |
| OPTO-16 | C16 | C15 |  |  |
| OPTO-17 | G2 | G1 |  |  |
| OPTO-18 | G4 | G3 |  |  |
| OPTO-19 | G6 | F5 |  |  |
| OPTO-20 | G8 | G7 |  |  |
| OPTO-21 | G10 | G9 |  |  |
| OPTO-22 | G12 | G11 |  |  |
| OPTO-23 | G14 | G13 |  |  |
| OPTO-24 | G16 | G15 |  |  |

* 1. **OUTPUT RELAYS CHECKS (With Relay Energized):**

Test Procedure:

Go to Commissioning Test,

Test mode (Contacts blocked),

Test Pattern mode

and select each relay to be tested

and Apply Contact Test,

after test; apply remove test to de-energize the relay

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Output Relay No. | Output Contact No. | Function | Contact resistance | Relay status |
| RL1 | L1 – L2 |  |  |  |
| RL2 | L3 – L4 |  |  |  |
| RL3 | L5 – L6 |  |  |  |
| RL4 | L7 – L8 |  |  |  |
| RL5 | L9 – L10 |  |  |  |
| RL6 | L11 – L12 |  |  |  |
| RL7 | L13 – L14 – L15 |  |  |  |
| RL8 | L16 – L17 – L18 |  |  |  |
| RL9 | K1 – K2 |  |  |  |
| RL10 | K3 – K4 |  |  |  |
| RL11 | K5 –K6 |  |  |  |
| RL12 | K7 – K8 |  |  |  |
| RL13 | K9 – K10 |  |  |  |
| RL14 | K11 – K12 |  |  |  |
| RL15 | K13 – K14 – K15 |  |  |  |
| RL16 | K16 – K17 – K18 |  |  |  |
| RL17 | J1 – J2 |  |  |  |
| RL18 | J3 – J4 |  |  |  |
| RL19 | J5 – J6 |  |  |  |
| RL20 | J7 – J8 |  |  |  |
| RL21 | J9 – J10 |  |  |  |
| RL22 | J11 – J12 |  |  |  |
| RL23 | J13 – J14 – J15 |  |  |  |
| RL24 | J16 – J17 – J18 |  |  |  |
| RL25 | H1 – H2 |  |  |  |
| RL26 | H3 – H4 |  |  |  |
| RL27 | H5 – H6 |  |  |  |
| RL28 | H7 – H8 |  |  |  |
| RL29 | H9 – H10 |  |  |  |
| RL30 | H11 – H12 |  |  |  |
| RL31 | H13 – H14 – H15 |  |  |  |
| RL32 | H16 – H17 – H18 |  |  |  |

* 1. **LEDs FUNCTION CHECK:**

Go to hardware test to view the physical position of the LED

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| LED no. | Function | Check | LED COLOR | Remarks |
| 1 | R PHASE TRIP |  |  |  |
| 2 | Y PHASE TRIP |  |  |  |
| 3 | B PHASE TRIP |  |  |  |
| 4 | CURRENT DIFF TRIP |  |  |  |
| 5 | Z1/ AIDED TRIP |  |  |  |
| 6 | Z2,Z3,Z4DELAY TRIP |  |  |  |
| 7 | AIDED 2 TRIP |  |  |  |
| 8 | CBF OPRT |  |  |  |
| F1 | OC/EF OPRT |  |  |  |
| F2 | DIFF BLOCK |  |  |  |
| F3 | SOFT OP |  |  |  |
| F4 | TCS2 FAIL |  |  |  |
| F5 | VT FUSE FAIL |  |  |  |
| F6 | PSD |  |  |  |
| F7 | AIDED 1,2 CS |  |  |  |
| F8 | AIDED 1& 2 CR |  |  |  |
| F9 | COMMION CH1, CH2 FAIL |  |  |  |
| F10 | REST LED |  |  |  |

1. **MEASURMENTS CHECK:**
   1. **CURRENT INPUTS CHECK:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| INPUT CURRENT | APPLIED VALUE | CT RATIO  APPLIED | DISPLAYED SECONDARY VALUE  (A) | DISPLAYED  PRIMARY VALUE  (A) |
| IA | 1.0 A |  |  |  |
| IB | 1.0 A |  |  |
| IC | 1.0 A |  |  |
| IN | 1.0 A |  |  |

* 1. **VOLTAGE INPUTS CHECK:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| INPUT VOLTAGE | APPLIED VALUE  (V) | VT RATIO  APPLIED | DISPLAYED SECONDARY VALUE (V) | DISPLAYED PRIMARY VALUE (KV) |
| VA |  |  |  |  |
| VB |  |  |  |
| VC |  |  |  |
| VAB |  |  |  |
| VBC |  |  |  |
| VAC |  |  |  |
| VB-C/S |  |  |  |

* 1. **POWER MEASUREMENTS:**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Inj. Values | | | Exp. Values | | | | Meas. Values | | | |
| Cur (A) | Vol. (V) | Angle | MVA | MW | MVAR | P.F | MVA | MW | MVAR | P.F |
| 1.0 | 66.4 | 0.0 | 274.4 | 274.4 | 0 | 1.0 |  |  |  |  |
| 45 | 194 | -194 | 0.707 |  |  |  |
| 90 | 0 | -274.4 | 0 |  |  |  |
| 135 | -194 | -194 | -0.707 |  |  |  |
| 180 | -274.4 | 0 | -1.0 |  |  |  |
| 225 | -194 | 194 | -0.707 |  |  |  |
| 270 | 0 | 274.4 | 0 |  |  |  |
| 315 | 194 | 194 | 0.707 |  |  |  |

1. **SETTING CHECK:**

Ensure all the settings are applied for used Functions………………………………………..…… [ ].

* 1. **PICKUP TEST.**

Settings:

|  |  |  |
| --- | --- | --- |
| IS1 |  | A |
| K1 |  | % |
| Is2 |  | A |
| K2 |  | % |
| T |  | Sec |



Test Procedure: there is two ways to test it

**First one:** Make a bridge by FO (Fibre Optic)cable to do external test loopback, so the local current is equal to the remote current in magnitude and same angle, you get the differential current equal to a double of injection value. (If FO cable not available you use Internal Loop back and get same result.)

(From Commission > Test Mode > choose Test Mode, then From Commission > Test Loopback > choose Internal or External)

**Second one**: not using loop back and connect 2 relay together so what you injected is the actual value for differential current

Idiff = K1\*I bias + IS1

I bias = ( I1+ I2) /2 and inject from single side …. I2 = 0

And what we inject is the actual differential current so I inject = I1 = Idiff

I bias = Idiff/2

Finally : I diff =0.5 x { IS1 / ( 1 – [ K1/2 ] ) } …….. for single side injection

\*\*\* test done using FO cable

* 1. **PICK UP TEST**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Fault Type | Expected Pickup  In Amp | Actual In Amp | | Expected Trip Time in m-sec  <50 ms | Actual Trip Time  in m-sec at 2 x I Pickup |
| Pickup | Drop off |
| R-E |  |  |  | 50 ms |  |
| Y-E |  |  |  | 50 ms |  |
| B-E |  |  |  | 50 ms |  |
| R-Y |  |  |  | 50 ms |  |
| Y-B |  |  |  | 50 ms |  |
| B-R |  |  |  | 50 ms |  |
| R-Y-B |  |  |  | 50 ms |  |

\* Limits: Pick up ± 10 %.

* 1. **BIAS CHARACTERISTIC CHECK:**

Activate loopback test as mentioned before , but note that :

Injected current is doubled inside relay cause loopback.

I bias = ( I1 + I2 )/2 …. And I2 = zero and cause loopback I1 is doubled so , I bias is what you inject exactly but differential is doubled value of injected .

Note : use one phase as bias current and other phase to test differential slope.

**A- Lower Slope Test:**

- IS1: Basic Diff Current Setting.

- K1: Lower Percentage Bias Setting.

- Id Calculated = 0.5 (Is1 +I bias K1) A

Differential Setting (Is1=0.2 , Is2=2 , K1= 30%, K2=150%).

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| K1 | IS1 | Injected Current A | I bias A | Id calculated | Id Measured | | |
| R | Y | B |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

Limits: ± 10 % According to ‘‘Catalogue: Commissioning and Maintenance – P54x/EN CM/G53 – Pages No. 30 & 31''

**B- Upper Slope Test:**

- IS2: Basic Diff Current Threshold Setting.

- K2: High Percentage Bias Setting.

- Id Calculated =0.5 {(I bias x K2) – [(k2-k1)x IS2]+ IS1 } A

Differential Setting (Is1=0.20 , Is2=2 , K1= 30%, K2=150%).

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| K2 | IS2 | Injected Current A | I bias A | Id calculated | Id Measured | | |
| R | Y | B |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

1. **DISTANCE FUNCTION CHECK:**
   1. **IMPEDANCE REACH CHECK:**

|  |  |  |
| --- | --- | --- |
| Item | Description | Checked |
| 1 | Print out from FREJA attached |  |

Impedance tolerance: +/- 10 % for all zones.

* 1. **OPERATING TIME TESTING:**

|  |  |  |
| --- | --- | --- |
| Item | Description | Checked |
| 1 | Print out from FREJA attached |  |

1. **VTS FUNCTION TEST:**

Setting:

VTS time delay = 2 SEC

VTS I2> inhibit = .1 In

* 1. Loss of one or two phases test:

Fixed setting: V2 = 10 volt, I2> inhibit less than setting.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Phase | Pick up | Drop Off | Meas. Blocking  Cur. I2> (A) | Set Time  (sec) | Measured Time  (Sec) |
| One phase |  |  |  |  |  |
| Two phases |  |  |  |  |

* 1. Loss of all 3 phase voltages under load condition test(detect 3ph):

Fixed Setting: a- For fuse fail pick up; V = 10 VOLT

b- For fuse fail reset; V = 30 VOLT

.

|  |  |  |  |
| --- | --- | --- | --- |
| Pick up voltage(v) | Reset voltage(v) | Set time (Sec) | Meas. Time (Sec) |
|  |  |  |  |

* 1. **VT FAIL FUNCTION CHECK:**
* Check the relay blocking from the external fuse fail………………………………………. [ ].
* Check DIST protection blocking by the fuse fail function…………...……………………. [ ].
* Check the directional earth fault blocking by the fuse fail function………...……...…….. [ ].

1. **SOTF TEST & TOR TEST**

**SOTF TEST**

SETTING:

-SOTF active with = External pulse enabled.

-

-SOTF Pulse = 1 Sec.

|  |  |  |
| --- | --- | --- |
| SOTF IN | Measured Time (ms) | |
| With MC signal | Without MC signal |
| Zone 2 |  |  |

* Measured SOTF pulse time =
* TOR Reset Delay =
* TOC Delay =

1. **POWER SWING BLOCKING TEST:**

Setting

PSB status = BLOCKING

Check the power swing blocking for Zones 1, 2, 3 & 4…………………….. [ ].

1. **SCHEME COMMUNICATION LOGIC:**

Setting:

* Aided 1Dist. delay =
* T rev =
* Aided 2Dist. delay =

1. **POR1 SCHEME:**

Send logic: Inj. Fault in ZM1…………………………DIS Signal send after [ ]

Trip logic:

* ZM2 (w/o CR) and (with comm. OK)…....Indication ZM2 TRIP *,*

Meas. Trip time =

* ZM2 with (CR) or with (comm. OK)……..Indication AIDED DIST TRIP

Meas. Trip time =

1. **CURRENT REVERSAL LOGIC CHECK:**
   * + Apply a reverse / forward fault to check: t rev guard:

|  |  |  |
| --- | --- | --- |
| Fault type | t rev guard setting (ms) | t rev guard measured (ms) |
| Reverse/ forward | 20 + TRIP TIME ( 38 msec ) |  |

1. **DIRECTIONAL EF TEST**

* 1. **AIDED DEF SETTINGS:**

Vn> (3Vo) =

Scheme logic =

IN >FW (3Io) =

Polarization =

IN >RV (3Io) =

RCA =

Note:

* Apply 3phase volts healthy voltage ( 2 sec ) , inject only one phase current to the phase under test and reduce voltage of phase under test.
* Vo=Vn/3 = (Va + Vb + Vc)/3
  1. **AIDED DEF ELEMENT TEST:**
     1. **PICK-UP CURRENTS & POLARIZING QUANTITIES TEST:**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Phase | Set zero sequence  3V0 (V) | Voltage applied (V) | | | Meas. Zero sequence 3V0 (V) | Fwd. pick up current (A) | | Rev. pick up  current (A) | |
| R | Y | B |
| Set | Meas. | Set | Meas. |
| R | 1 |  |  |  |  | 0.1 |  | 0.080 |  |
| Y |  |  |  |  |  |  |
| B |  |  |  |  |  |  |

- Current accuracy ±5 %, voltage accuracy ±10 % at 90 degree.

* + 1. **CHECK THE OPERATING CHARACTERISTIC ANGLE:**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Phase | RCA setting | Voltage applied (V) | | | Current  setting | Exp. Phase  angle (Deg.) | | Meas. Phase  angle (Deg.) | |
| R | Y | B | From | To | From | To |
| R | -60 Deg. |  |  |  | 0.1 A |  |  |  |  |
| Y |  |  |  |  |  |  |  |
| B |  |  |  |  |  |  |  |

* 1. **SCHEME COMMUNICATION LOGIC:**

Setting:

* Aided 1 DEF. delay =
* T rev =

1. **POR SCHEME:**

* Send logic:

DEF FWD (wo CR) and (with comm. OK)..............

Indication carrier send*,* EF TRIP

Meas. Send =

Trip logic:

* DEF FWD (with CR) and (with comm. OK)...............

Indication AIDED DEF TRIP *,* carrier send

Meas. Trip time =

* DEF RVS (wo CR) and (with comm. OK).........................

EF TRIP

1. **CURRENT REVERSAL LOGIC CHECK:**

* Apply a reverse / forward fault to check: t rev guard:

|  |  |  |
| --- | --- | --- |
| Fault type | t rev guard setting (ms) | t rev guard measured (ms) |
| Reverse/ forward | 20 + TRIP TIME |  |

1. **BACK-UP OVER CURRENT TEST I>1:**
   1. **PICK-UP AND DROP-OFF TEST:**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Current settings Is | R-PHASE | | Y-PHASE | | B-PHASE | |
| Pick-up | Drop-off | Pick-up | Drop-off | Pick-up | Drop-off |
|  |  |  |  |  |  |  |

DT: Is ± 2% , IDMT: 1.1 Is ± 2%

* 1. **TIMING TEST**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Current  Setting Is | Curve  Setting | TMS | Current  Setting Is Times | Op. Time  Calculated Sec. | Actual Op. Time Sec. | | |
| R-Phase | Y-Phase | B-Phase |
|  |  |  |  |  |  |  |  |

1. **BACK-UP EARTH FAULT TEST:**
   1. **PICK-UP AND DROP-OFF TEST:**

|  |  |  |
| --- | --- | --- |
| Current setting | N-Phase | |
| Pick-up | Drop-off |
|  |  |  |

DT: Is ± 2% , IDMT: 1.1 Is ± 2%

* 1. **TIMING TEST**

|  |  |  |  |
| --- | --- | --- | --- |
| TMS | Current  Setting Is Times | Op. Time  Calculated Sec. | Actual Op. Time Sec. |
| N-Phase |
| 0.2 | 2XIos | 2.05 |  |
| 0.2 | 5 | 1 | 876.6 |

1. **FAULT LOCATOR FUNCTION**

Line Length: KM line Impedance: ohm

|  |  |  |  |
| --- | --- | --- | --- |
| Fault Type | Fault Impedance | Expected display | Actual display |
| A-N 25% |  |  |  |
| B-N 50% |  |  |  |
| C-N 75% |  |  |  |
| A-B 25% |  |  |  |
| B-C 50% |  |  |  |
| C-A 75% |  |  |  |
| A-B-C 100% |  |  |  |

1. **BREAKER FAILURE TEST**
   1. **CBF CURRENT PICK UP AND DROP OFF**

Simulate CB closed by activation BI and protection trip for CBF initiation

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| PHASE | I> BF (A) setting | PICKUP(A) | DROP OFF(A) | REMARKS |
| R |  |  |  |  |
|  |  |  |  |
| Y |  |  |  |  |
|  |  |  |  |
| B |  |  |  |  |
|  |  |  |  |

* 1. **TIME TEST**

|  |  |  |
| --- | --- | --- |
| Phase | Setting | TIME |
| R |  |  |
| Y |  |
| B |  |