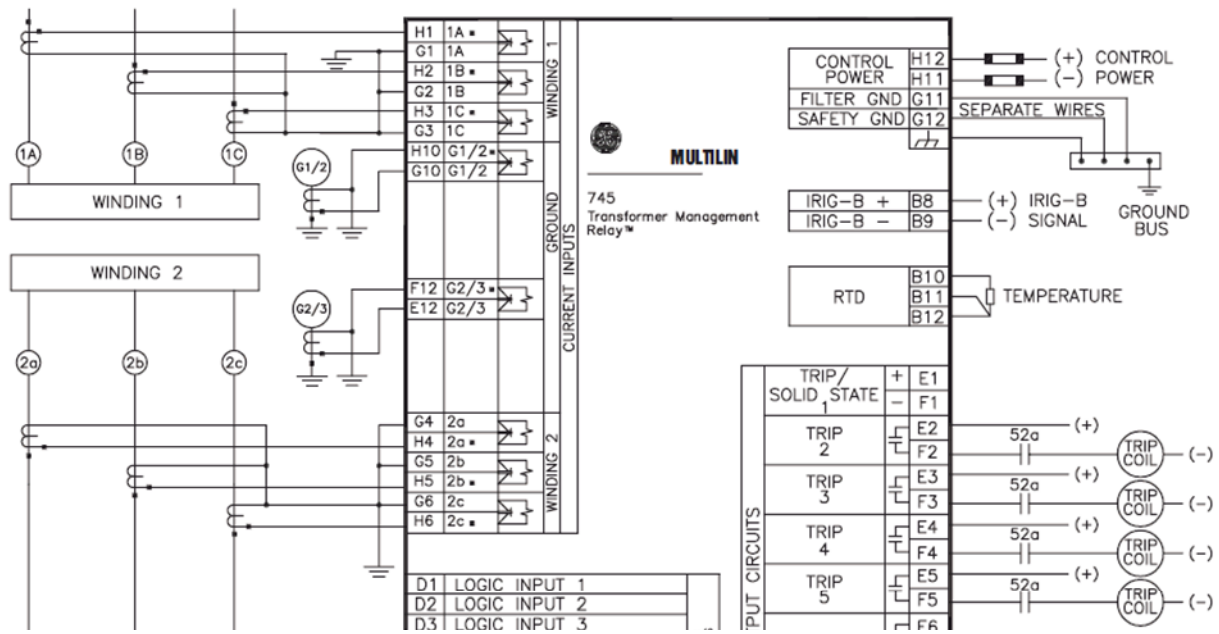
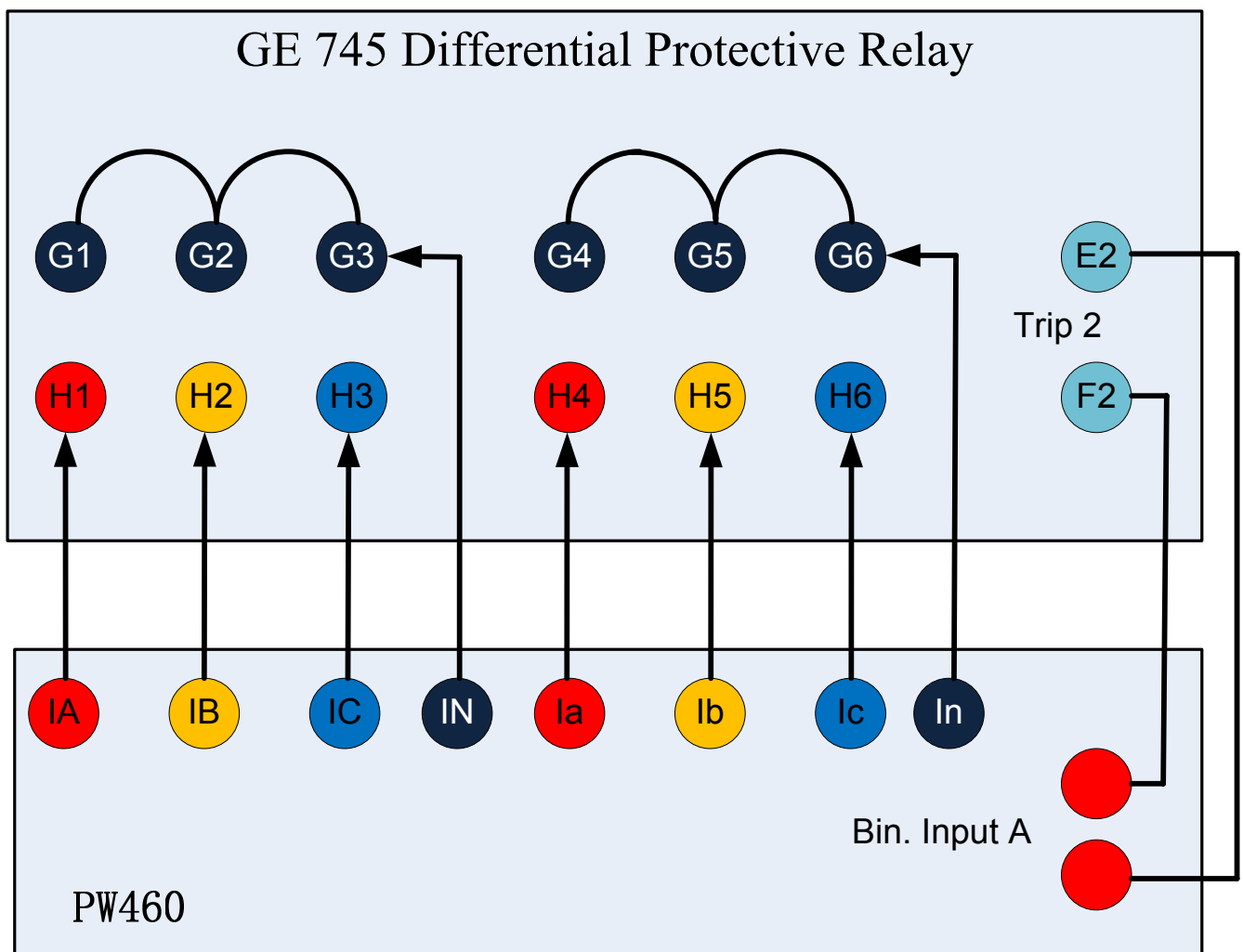


Wiring for the test



TYPICAL WIRING FOR TWO WINDING TRANSFORMER

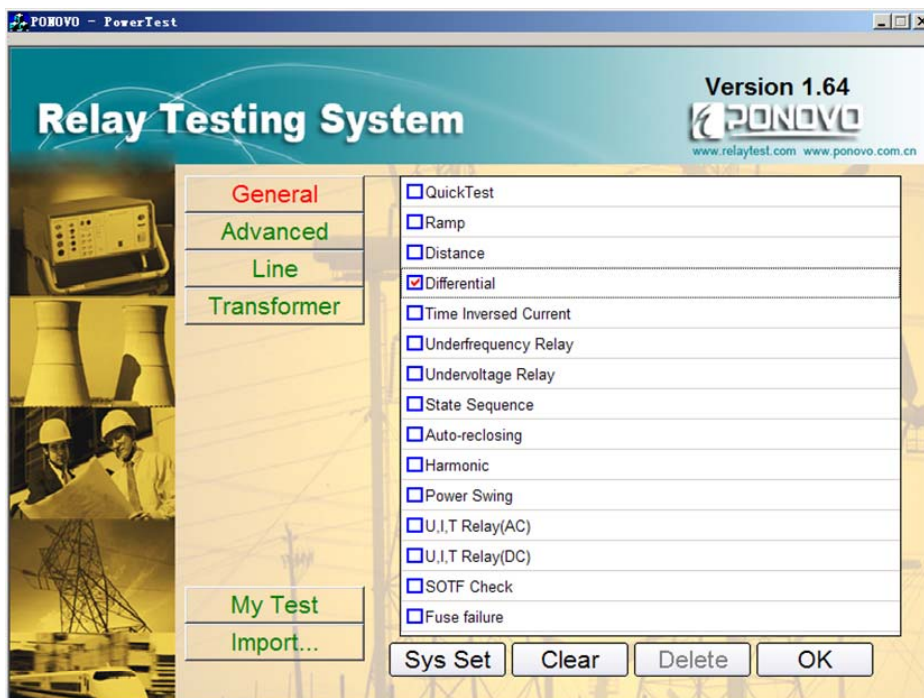


The steps for testing GE 745

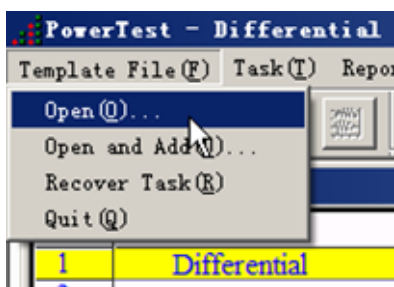
Purpose of the test:

1. **Check Ir/Id characteristic**
 - a. Pick-up current
 - b. Check the gradient of slop 1 (need to set two test points for the calculation)
 - c. Check the gradient of slop 2 (need to set two test points for the calculation)
2. **Check harmonic restraint**
 - a. 2nd harmonic restraint
 - b. 5th harmonic restraint
3. **Check Trip time**

1.Run PowerTest-> select 'Differential' -> click 'OK' .



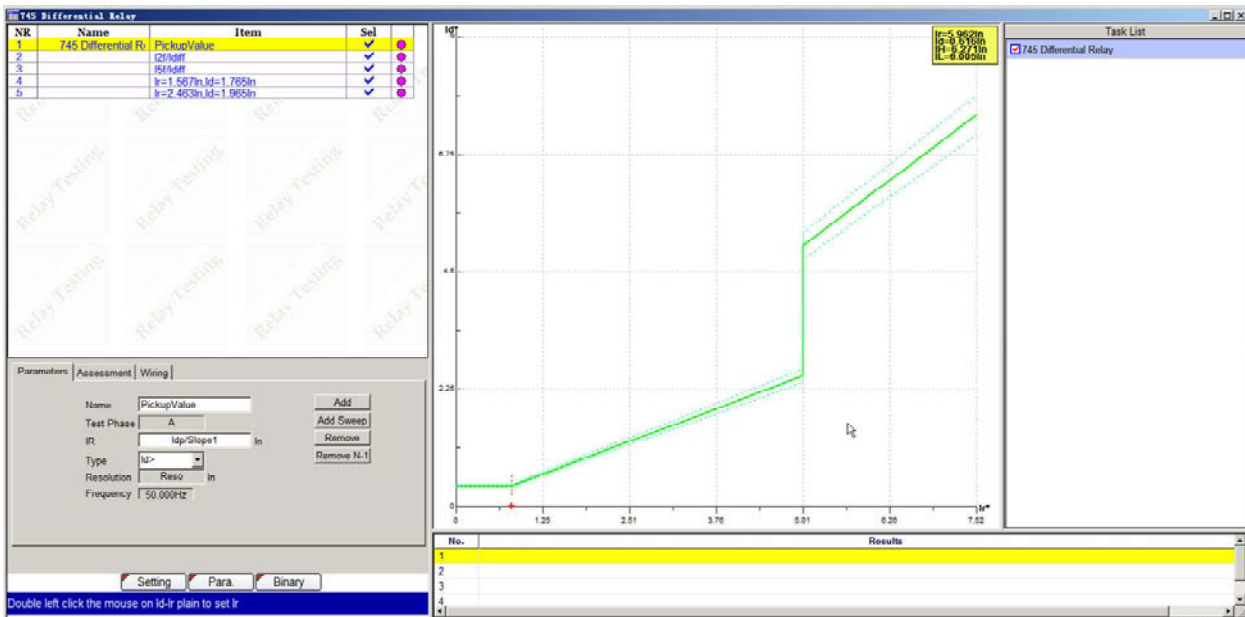
2. Open the template file of GE745.



If the template is sent by us to you separately you need to direct to the place where you have saved it.

In case the template is already included in the software you can find it under the directory of 'Test Template' -> General

3. The template of GE745 is then being opened.



3. Click 'Setting' to make settings for GE745

Sn	180.000MVA	Sn
Un(H)	225.500kV	U1n
Un(M)	117.000kV	U2n
Un(L)	36.400kV	U3n
INprim(H)	1200A	Ih1n
INprim(M)	1200A	Im1n
INprim(L)	7000A	Il1n
INsec	1A	I2n
I_DIFF>	0.400In	Idp
I_DIFF>>	6.000In	Idh
SLOP1	0.500	Slope1
SLOP2	1.000	Slope2
Slope Knee Point	5.000In	KneePoint
I2/Idiff	0.150	K2xb
I5/Idiff	0.150	K5xb

Settings in PowerTest

Sn
Un(H)
Un(M)
Un(L)
INprim(H)
INprim(M)
INprim(L)
INsec
I_DIFF>
I_DIFF>>
SLOP1
SLOP2
Slop Knee Point
I2/Idiff
I5/Idiff

Settings in GE745 relay

WINDING 1 RATED LOAD
WINDING 1 NOM Φ - Φ VOLTAGE
WINDING 2 NOM Φ - Φ VOLTAGE
WINDING 3 NOM Φ - Φ VOLTAGE
Rated current for primary of CT, winding1
Rated current for primary of CT, winding2
Rated current for primary of CT, winding3
Rated current for secondary of CT, set 1 or 5
PERCENT DIFFERENTIAL PICKUP
Here is no useful, you can set as 10.
PERCENT DIFFERENTIAL SLOPE 1
PERCENT DIFFERENTIAL SLOPE 2
PERCENT DIFFERENTIAL KNEEPOINT
2nd harmonic INHIBIT
5th harmonic INHIBIT

All settings in PowerTest can be found in GE745 relay setting (in relay or in relay setting paper)

See the FIGURE 1 to 6.

Setting page in GE745 - 1

PATH: SETPOINTS ▾ ▾ S2 SYSTEM SETUP ▾ ▾ WINDING 1(3)

[▷]		WINDING 1 NOM Φ - Φ VOLTAGE: 220.0 kV	Range: Dependent on LOW VOLTAGE WINDING RATING; see below.
MESSAGE		WINDING 1 RATED LOAD: 100.0 MVA	Range: Dependent on LOW VOLTAGE WINDING RATING; see below.
MESSAGE		WINDING 1 PHASE CT PRIMARY: 500:5 A	Range: 1 to 50000:5 A in steps of 1
MESSAGE		WINDING 1 GROUND CT INPUT: NONE	Range: None, G1/2, G2/3
MESSAGE		WINDING 1 GROUND CT PRIMARY: 2000:1 A	Range: 1 to 50000:1 A in steps of 1
MESSAGE		WINDING 1 SERIES 3 Φ RESISTANCE: 10.700 Ω	Range: 0.001 to 50.000 Ω in steps of 0.001

Figure 1. Yellow parts are the settings to be set in PowerTest

Setting page in GE745 - 2

PATH: SETPOINTS ▾ ▾ S4 ELEMENTS ▾ ▾ DIFFERENTIAL ▾ PERCENT DIFFERENTIAL

[▷]		PERCENT DIFFERENTIAL FUNCTION: Enabled	Range: Enabled, Disabled
MESSAGE		PERCENT DIFFERENTIAL RLYS (1-8): -----	Range: 1 to 8
MESSAGE		PERCENT DIFFERENTIAL TARGET: Latched	Range: Self-Reset, Latched, None
MESSAGE		PERCENT DIFFERENTIAL PICKUP: 0.30 x CT	Range: 0.05 to 1.00 x CT in steps of 0.01
MESSAGE		PERCENT DIFFERENTIAL SLOPE 1: 25%	Range: 15 to 100% in steps of 1
MESSAGE		PERCENT DIFFERENTIAL KNEEPOINT: 2.0 x CT	Range: 1.0 to 20.0 x CT in steps of 0.1
MESSAGE		PERCENT DIFFERENTIAL SLOPE 2: 100%	Range: 50 to 100% in steps of 1
MESSAGE		PERCENT DIFFERENTIAL BLOCK: Disabled	Range: Logic Inpt 1 to 16, Virt Inpt 1 to 16, Output Rly 2 to 8, SelfTest Rly, Vir Output 1 to 5, Disabled

Figure 2. Yellow parts are the settings to be set in PowerTest

Setting page in GE745 - 3

PATH: SETPOINTS ▾ ▾ S4 ELEMENTS ▾ ▾ DIFFERENTIAL ▾ ▾ HARMONIC INHIBIT

[>]		HARMONIC INHIBIT FUNCTION: Enabled	Range: Enabled, Disabled
MESSAGE		HARMONIC INHIBIT PARAMETERS: 2nd	Range: 2nd, 2nd + 5th
MESSAGE		HARMONIC AVERAGING: Disabled	Range: Enabled, Disabled
MESSAGE		HARMONIC INHIBIT LEVEL: 20.0% f ₀	Range: 0.1 to 65.0% f ₀ in steps of 0.1

Figure 3. Yellow parts are the settings to be set in PowerTest

Setting page in GE745 - 4

PATH: SETPOINTS ▾ ▾ S4 ELEMENTS ▾ ▾ DIFFERENTIAL ▾ ▾ 5th HARM INHIBIT

[>]		5th HARMONIC INHIBIT FUNCTION: Enabled	Range: Enabled, Disabled
MESSAGE		HARMONIC AVERAGING: Disabled	Range: 0.10 to 0.50 x CT in steps of 0.01
MESSAGE		5th HARMONIC INHIBIT LEVEL: 10.0% f ₀	Range: 0.1 to 65.0% f ₀ in steps of 0.1

Figure 4. Yellow parts are the settings to be set in PowerTest

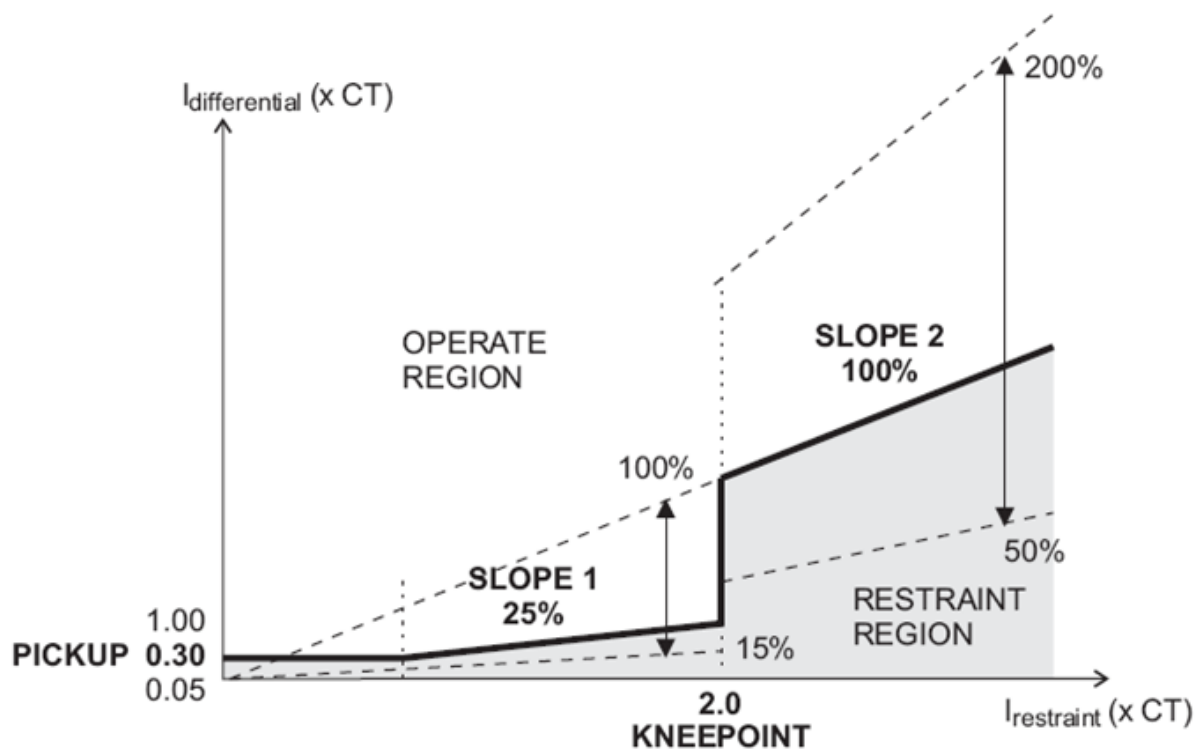


FIGURE 5-8: Percent differential dual-slope characteristic

Figure 5. Id/Ir curve from GE745 relay user manual

Setting page in GE745 - 6

PATH: SETPOINTS ▾ ▾ S2 SYSTEM SETUP ▾ TRANSFORMER

[▷]		NOMINAL FREQUENCY: 60 Hz	Range: 50 Hz, 60 Hz
MESSAGE		FREQUENCY TRACKING: Enabled	Range: Enabled, Disabled
MESSAGE		PHASE SEQUENCE: ABC	Range: ABC, ACB
MESSAGE		TRANSFORMER TYPE: Y/d30°	Range: Refer to Transformer types on page 5-101
MESSAGE		LOAD LOSS AT RATED LOAD: 1250 kW	Range: 0 to 20000 kW in steps of 1 (Auto-ranging; see table below)
MESSAGE		LOW VOLTAGE WINDING RATING: Above 5 kV	Range: Above 5 kV, 1 kV to 5 kV, Below 1 kV
MESSAGE		RATED WINDING TEMP RISE: 65°C (oil)	Range: 65°C (oil), 55°C (oil), 80°C (dry), 115°C (dry), 150°C (dry)
MESSAGE		NO-LOAD LOSS: 125.0 kW	Range: 0.1 to 2000.0 kW in steps of 0.1 (see description below)
MESSAGE		TYPE OF COOLING: OA	Range: FA, OA, Directed FOA/FOW, Non-Directed FOA/FOW
MESSAGE		RATED TOP OIL RISE OVER AMBIENT: 10°C	Range: 1 to 200°C in steps of 1
MESSAGE		XFMR THRML CAPACITY: 1.00 kWh/°C	Range: 0.00 to 200.00 kWh/°C in steps of 0.01
MESSAGE		WINDING TIME CONST: 2.00 min.	Range: 0.25 to 15.00 min. in steps of 0.01
MESSAGE		SET ACCUMULATED LOSS OF LIFE: 0 x 10h	Range: 0 to 20000 x 10h in steps of 1

Figure 6. Yellow parts are the settings to be set in PowerTest

$$I_r = I_{restraint} = \max(|\vec{I}_1|, |\vec{I}_2|); I_d = I_{differential} = |\vec{I}_1 + \vec{I}_2|$$

$$\%slope = \frac{I_d}{I_r} \times 100\%$$

Figure 7. Equation for calculating Ir and Id from GE745 user manual

3.2 Click' **Para.** ' button for set parameters.

Name	Value	Variable
Tprefault	2.000sec	PreFaultTime
Tfault	1.000sec	FaultTime
CB Sim.	No	BCSIMULATI...
Topen	100mS	TripTime
Tclose	100mS	CloseTime
Winding	Side1-Side3	WindSide
Test Phase	A	Phase
Side 1	wye-winding	WindH
Side 2	wye-winding	WindM
Side 3	wye-winding	WindL
Conversion	No	AngleMode
phase shifting(Clock Notationtested windings)	12	ConnMode
Search Mode	dichotomic	SearchMode
CT starpoint	tow.Prot.Obj	IdEqu
Bias. Equ.	IR=max(I1 , I2)	Equation
K1	1	K1
K2	1	K2
Uz	57.740V	Uz
Resolution	0.010	Reso

Setting in PowerTest

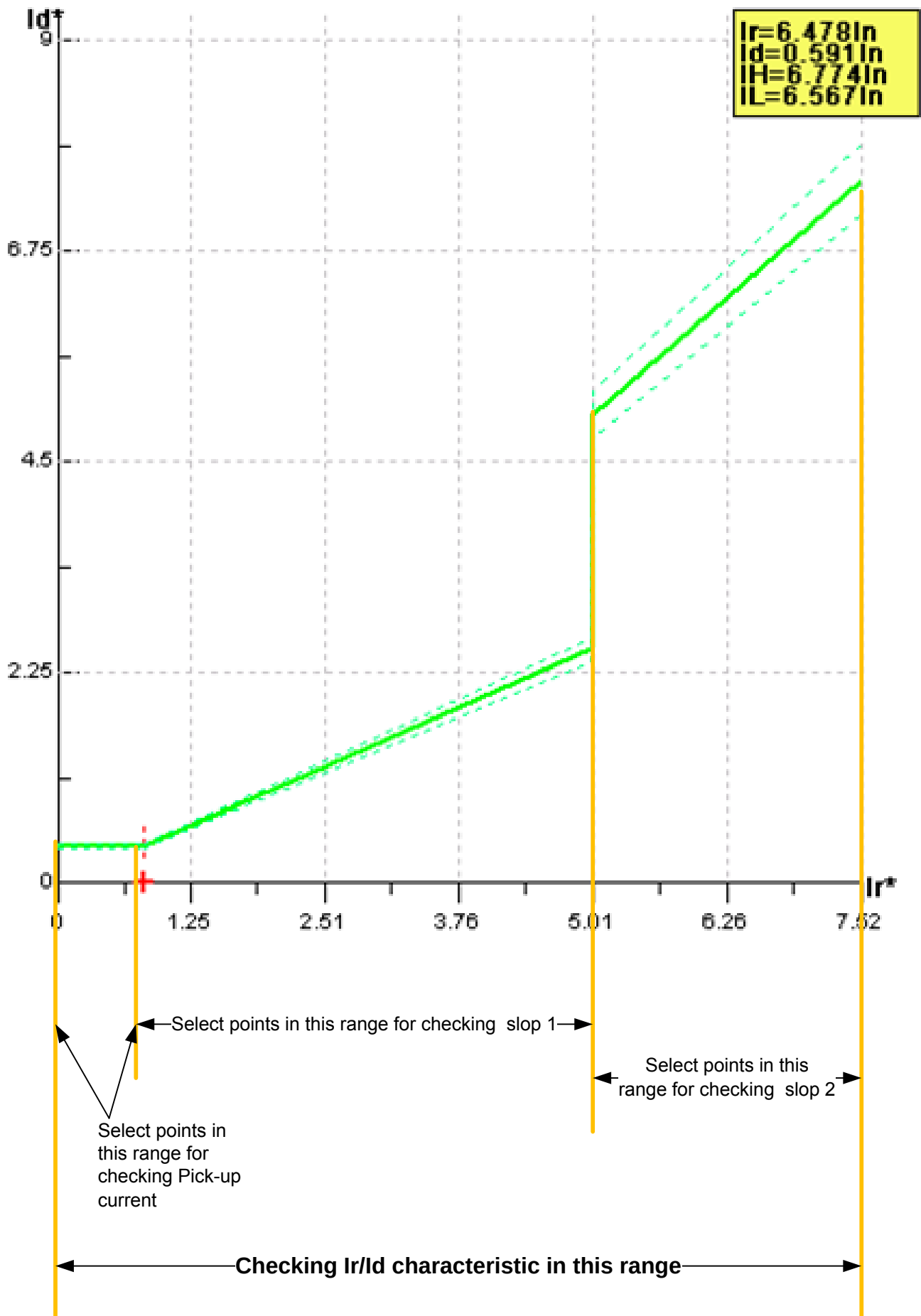
Tprefault
Tfault
Winding
Test Phase
Side1
Side2
Side3
Phase Shifting
CT Starpoint
Bias. Equ.
Resolution

Setting in GE745 relay

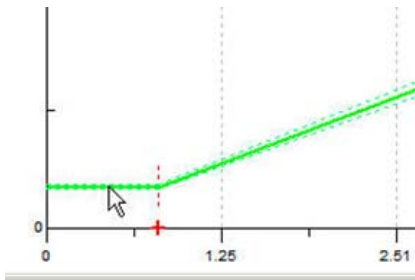
No fault output, (keep default)
Max fault time, (keep default)
Winding side for test
Select the phase for test
Transformer connection for winding1
Transformer connection for winding2
Transformer connection for winding3
TRANSFORMER TYPE
'Tow. Prot. Obj.' Is 'Id=|I1+I2|'
IR=Max{|I1|,|I2|}
Resolution of ID, (keep default)

All settings in PowerTest can be found in GE745 relay setting (in relay or in relay setting paper)

Where to select test points



4. Set 'pick up' check point



Move cursor to the point where you want to set 'pick up' check point

Double click the left mouse button to confirm the selection.

The screenshot shows the 'Parameters' tab of a software interface. It contains the following fields and buttons:

- Name: PickupValue
- Test Phase: A
- IR: 0.474 In
- Type: Id>
- Resolution: Reso In
- Frequency: 50.000Hz
- Buttons: Add, Add Sweep, Remove, Remove N-1

Red arrows point from the IR field and the Type dropdown to explanatory text below.

The actual test current for Ir will be displayed here

A red vertical line will be displayed here to indicate the test point

In case we already know the test current here we can also be set the value directly in this box

Select 'type' for the test point:

Click the 'drag down' button for 'Type' we can see the following available types of the test

The screenshot shows the 'Type' dropdown menu with the following options: Id>, Verify curve, Slope 1, Slope 2, Id>.

Verify curve

Slope 1

Slope 2

Id>

Id>>

verify one test point

check the point for slope 1

check the point for slope 2

check the 'pick up' value

check the trip time (not to be used in our test)

5. Set check points for slop 1

We need to add test items for testing slop 1 and slop 2 in the following test item list

NR	Name	Item	Sel	
1	745 Differential R	PickupValue	✓	●
2		I2f/I diff	✓	●
3		I5f/I diff	✓	●
4		Triptimetest(IR=1.567In.Id=1.765In)	✓	●
5		Trip time test(IR=2.463 In.Id=1.965 In)	✓	●



Click ‘Add’ button to add one new test item.

NR	Name	Item	Sel	
1	745 Differential R	PickupValue	✓	●
2		PickupValue	✓	●
3		I2f/I diff	✓	●
4		I5f/I diff	✓	●
5		Triptimetest(IR=1.567In.Id=1.765In)	✓	●
6		Trip time test(IR=2.463 In.Id=1.965 In)	✓	●

A new test item is added with the same name as the earlier test item

Parameters | Assessment | Wiring

Name: PickupValue Add
Test Phase: A Add Sweep
IR: 0.431 In Remove
Type: Id+ Remove N-1
Resolution: Reso In
Frequency: 50.000Hz

NR	Name	Item	Sel	
1	745 Differential R	PickupValue	✓	●
2		slop1.1	✓	●
3		I2f/I diff	✓	●
4		I5f/I diff	✓	●
5		Triptimetest(IR=1.567In.Id=1.765In)	✓	●
6		Trip time test(IR=2.463 In.Id=1.965 In)	✓	●

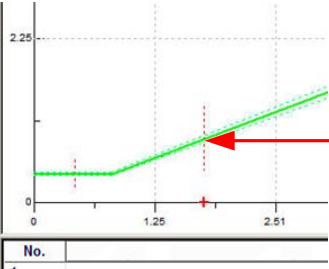
Change the name here

Parameters | Assessment | Wiring

Name: slop1.1 Add

Parameters | Assessment | Wiring

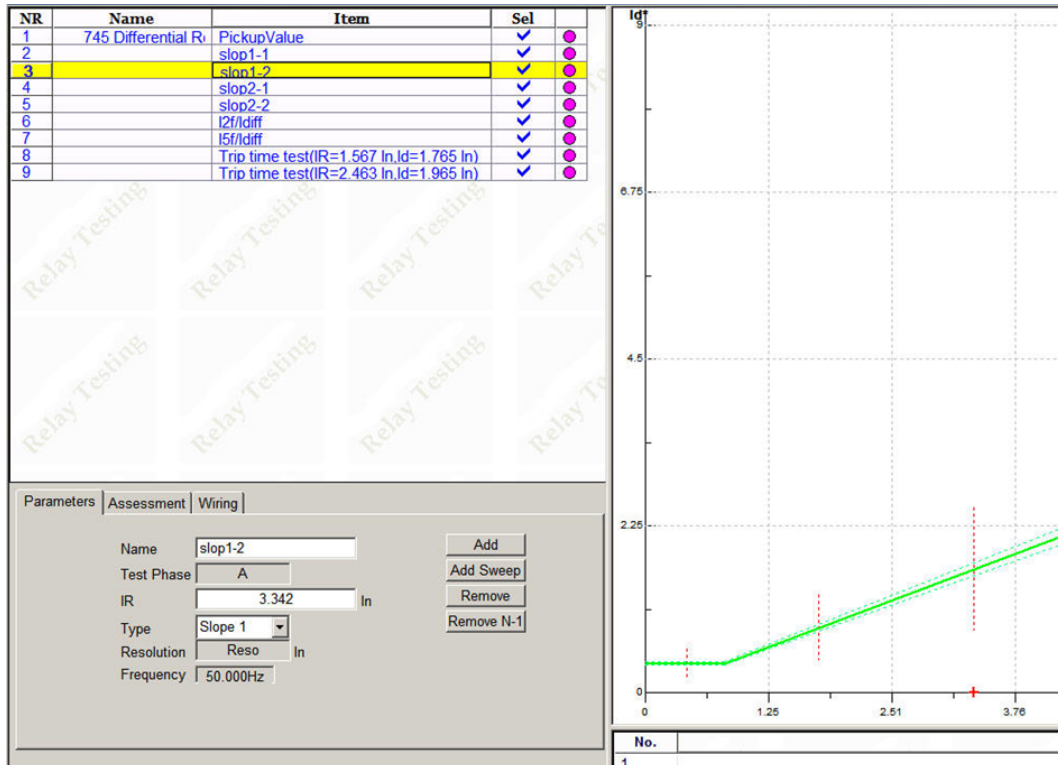
Name: slop1.1 Add
Test Phase: A Add Sweep
IR: 1.768 In Remove
Type: Slope 1 Remove N-1
Resolution: Reso In
Frequency: 50.000Hz



Set the test point here by using mouse button as described in point 4.

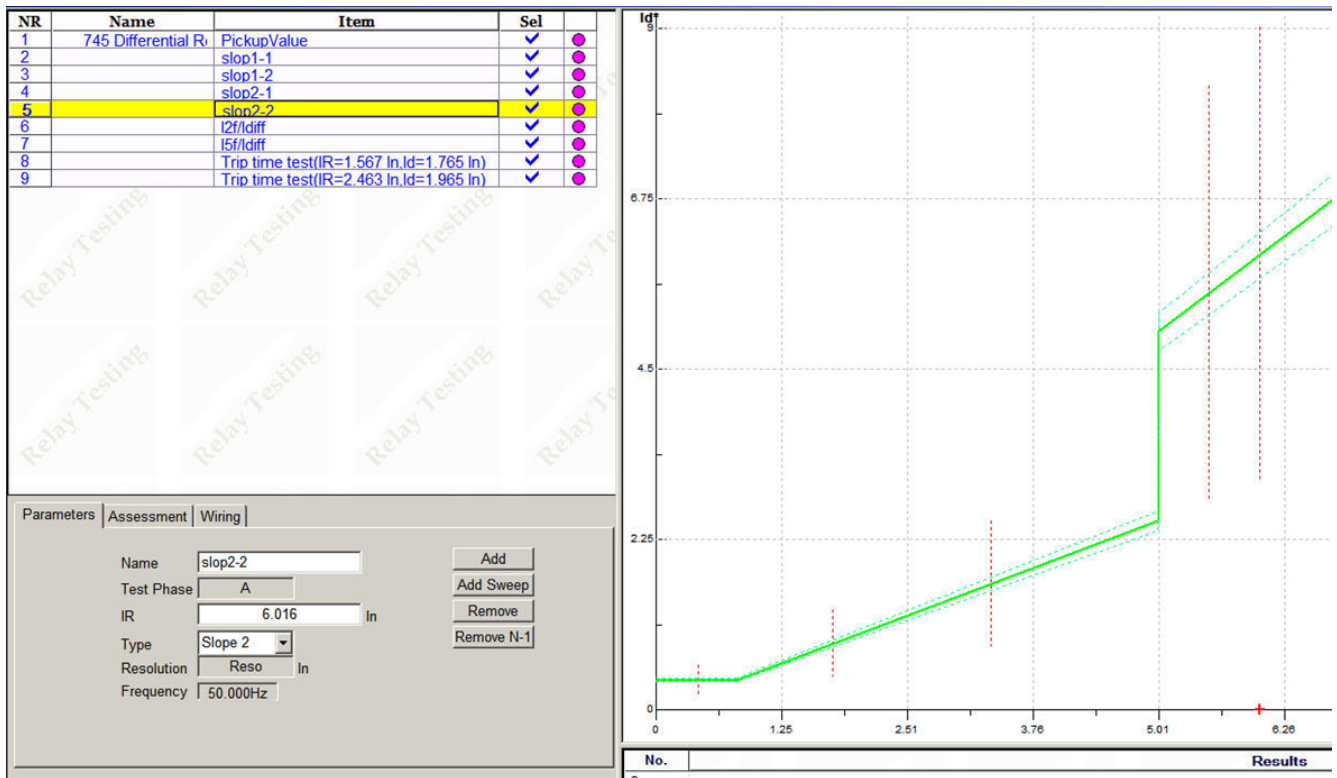
Select ‘slope 1’ here

Similarly we can add another test point for slop 1



6. Set check points for slop 2

With the same method we can easily add two test points for slop 2



So far we have set 5 test points

7 Add test points for 2nd harmonic restraint check

NR	Name	Item	Sel	
1	745 Differential R	PickupValue	✓	●
2		slop1-1	✓	●
3		slop1-2	✓	●
4		slop2-1	✓	●
5		slop2-2	✓	●
6		I2f/Idiff	✓	●
7		I5f/Idiff	✓	●
8		Trip time test(IR=1.567 In,Id=1.765 In)	✓	●
9		Trip time test(IR=2.463 In,Id=1.965 In)	✓	●

Select test item I2f/Idiff

Parameters
Assessment
Wiring

Name
2harmonic restraint
Add
Remove

Test Phase
A

Id
0.5 In

Harmonic
2nd

Frequency
50.000Hz

Resolution
Reso Ixf/Id

Select 2nd here

Set test current here. This value should be bigger than pick-up value. If pick-up value is 0.4 then we can set 0.5 here

8. Add test points for 5nd harmonic restraint check

NR	Name	Item	Sel	
1	745 Differential R	PickupValue	✓	●
2		slop1-1	✓	●
3		slop1-2	✓	●
4		slop2-1	✓	●
5		slop2-2	✓	●
6		2harmonic restraint	✓	●
7		5nd harmonic restraint	✓	●
8		Trip time test(IR=1.567 In,Id=1.765 In)	✓	●
9		Trip time test(IR=2.463 In,Id=1.965 In)	✓	●

Parameters
Assessment
Wiring

Name
5nd harmonic restraint
Add
Remove

Test Phase
A

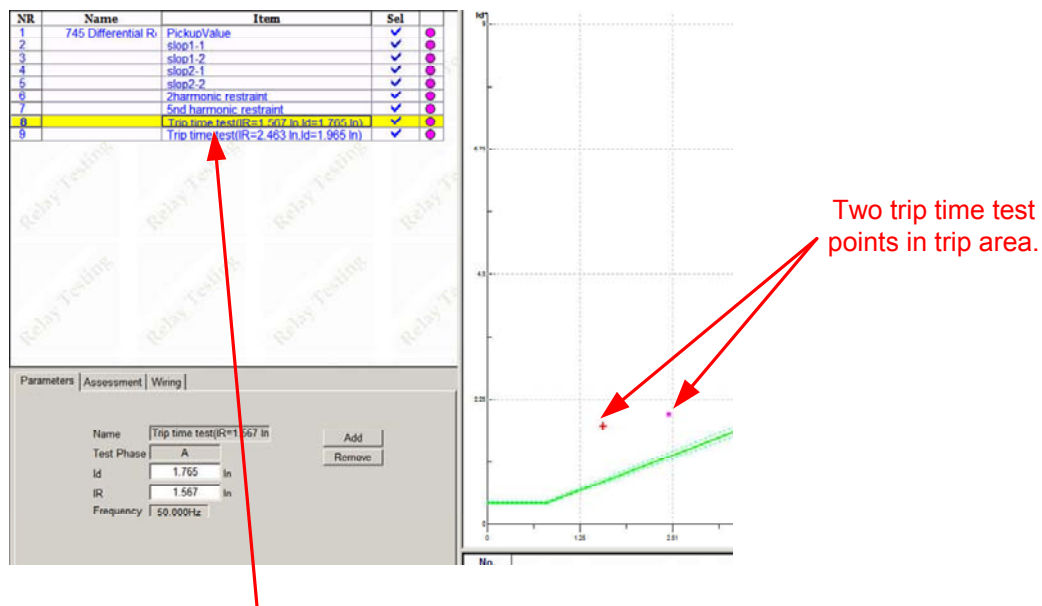
Id
0.5 In

Harmonic
5nd

Frequency
50.000Hz

Resolution
Reso Ixf/Id

9. Add test points for check trip time.



Step1. Select test item 'Trip time test'

Step2. Change IR/ID value. Be sure that the test points should be in tripping area (see above)

10. Enable or disable the test items

NR	Name	Item	Sel
1	745 Differential R	PickupValue	✓
2		slop1-1	✓
3		slop1-2	✓
4		slop2-1	✓
5		slop2-2	✓
6		2harmonic restraint	✓
7		5nd harmonic restraint	✓
8		Trip time test(IR=1.567 In.Id=1.765 In)	✓
9		Trip time test(IR=2.463 In.Id=1.965 In)	✓

This column gives us the possibility to enable or disable the test items

NR	Name	Item	Sel
1	745 Differential R	PickupValue	✓
2		slop1-1	✓
3		slop1-2	✓
4		slop2-1	✓
5		slop2-2	✓
6		2harmonic restraint	✓
7		5nd harmonic restraint	✓
8		Trip time test(IR=1.567 In.Id=1.765 In)	✓
9		Trip time test(IR=2.463 In.Id=1.965 In)	X

Move the mouse button to this place and make one click to disable the test item.

- Click the mouse button again to change the status again
- Only test items with 'enable' sign will be tested automatically

11. Click start button for testing.

