

## Multiple Parallel Sources Coordination

### Purpose and Description:

The purpose of this exercise is to coordinate incomer relays with the outgoing relay when there are multiple parallel incoming sources. In such a scenario for an outgoing fault, the incomer relays will see lower fault current when compared to the total fault current seen by the outgoing relay.

Coordination of Inverse time OC/EF relays using 0.25 - 0.35 coordination intervals are required to be observed and evaluated by working out operation of incomer and outgoing relays at different fault currents. The exercise shows an easier method that can check coordination on a common fault in per unit terms.

### Procedure:

- 1) Open the ETAP File – Normalized TCC Example.OTI  
Library Location – C: -> ETAP 1610 -> lib -> etaplib1610.lib

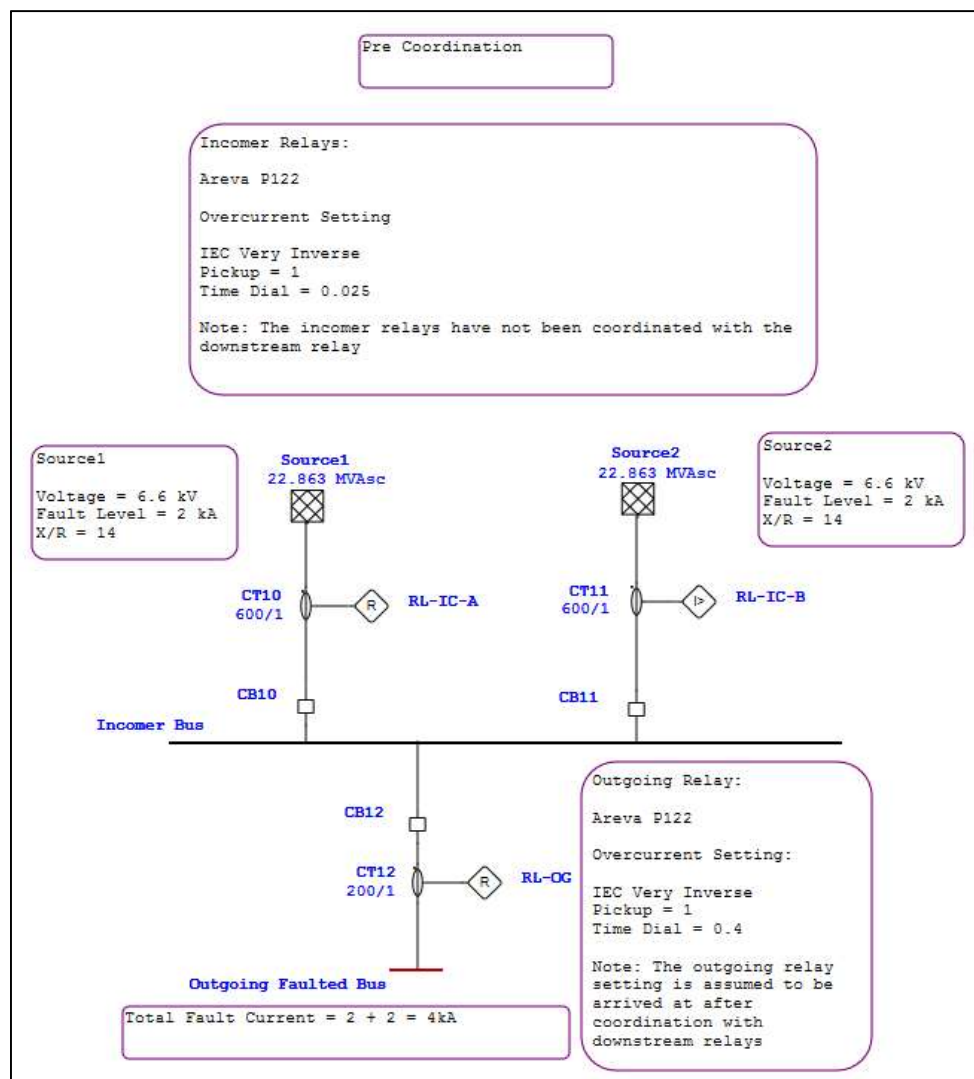




Figure: Before Coordination

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2) The above figure is the system under consideration for the relay coordination exercise. Three methods can be adopted to coordinate the incomer relays (RL-IC-A & RL-IC-B) with the outgoing relay (RL-OG).

#### **Method 1: Manual Method – Maintaining coordination at two separate fault current levels by finding the difference between the operating times at the two fault levels**

- i) Select the entire system for relay coordination study and click on “Create Star View” .
- ii) Zoom in on the selected system by clicking on the “Zoom in – Star One-Line” icon  in the Star View and place the network to the right hand side of the TCC.
- iii) Display the settings of the relays in the TCC by right clicking on the relay curves.
- iv) Display the fault level of the outgoing relay by right clicking the fault arrow named “RL-OG-3P”.
- v) Rename the TCC as “Method 1 TCC”
- vi) Prior to the coordination, the TCC will look as shown below,

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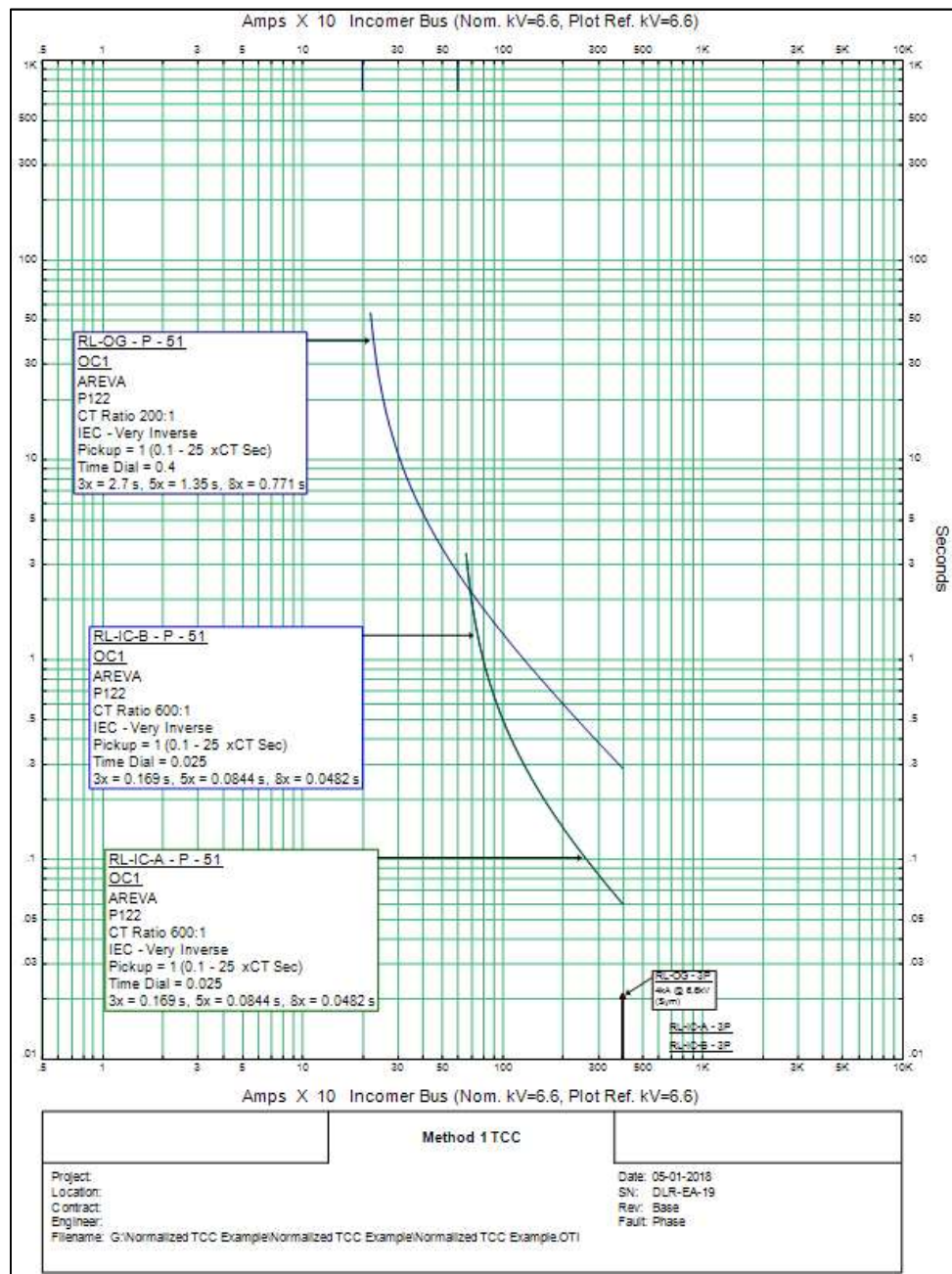

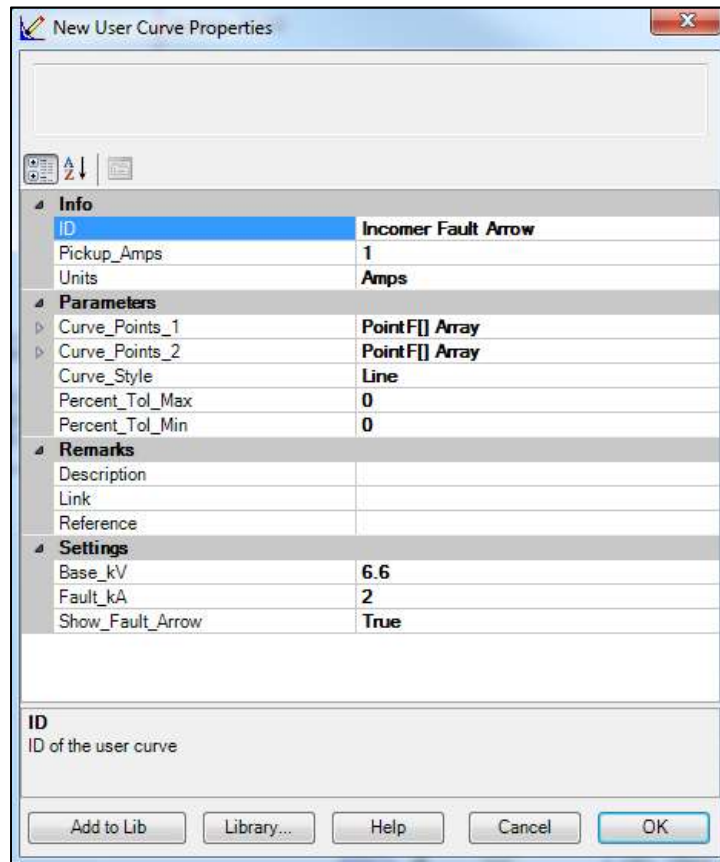


Figure: Method 1 TCC – Before Coordination

vii) It should be noted that the incomer relays have been updated with the total bus fault current (i.e. 4kA). However, for an outgoing fault when the outgoing relay sees 4kA the incomer relays will only see 2kA.

viii) In order to monitor the incomer relays at 2kA, create a new “User Curve”  as shown below,

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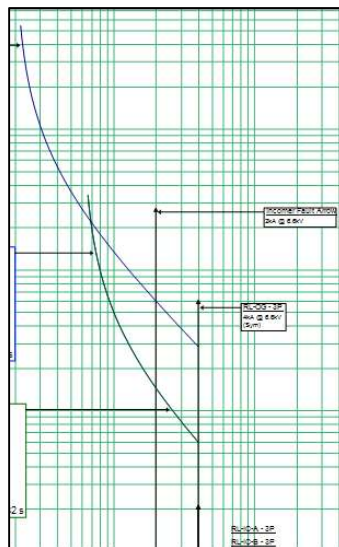
Info	
ID	Incomer Fault Arrow
Pickup_Amps	1
Units	Amps
Parameters	
Curve_Points_1	PointF[] Array
Curve_Points_2	PointF[] Array
Curve_Style	Line
Percent_Tol_Max	0
Percent_Tol_Min	0
Remarks	
Description	
Link	
Reference	
Settings	
Base_kV	6.6
Fault_kA	2
Show_Fault_Arrow	True

**ID**  
ID of the user curve


Add to Lib   Library...   Help   Cancel   OK


Figure: User defined fault arrow (2kA at 6.6kV)

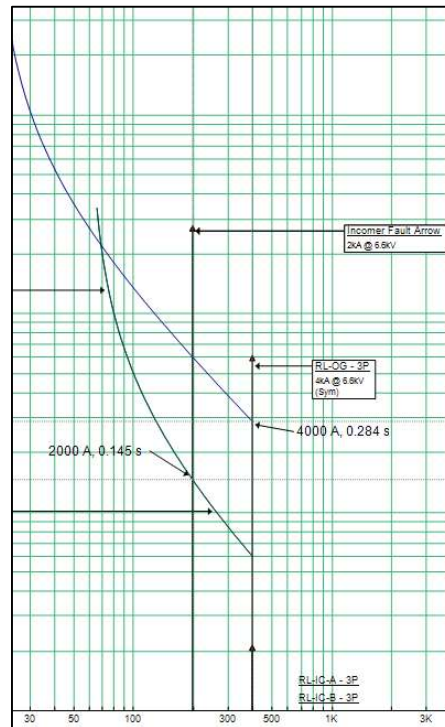
ix) Extend the newly created “Incomer Fault Arrow” and the outgoing relay fault arrow “RL-OG-3P” such that they intersect their corresponding relay curves respectively.



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x) Click on the outgoing relay curve and click on the “Crosshair” icon  and place it at 4000 A. Note the operating time at 4000A of the relay to be 0.284 seconds.

xi) Click on the incomer relay curve “RL-IC-A-P-51” and click on the “Crosshair” icon  and place it at 2000A. Note the operating time at 2000A of the relay to be 0.145s initially.



xii) Now if the incomers have to be coordinated properly then at the least the coordination time interval of 250ms have to be maintained between the outgoing relay at fault of 4kA and incomer relay at a fault of 2kA.

The time dial setting of the incomer relays are increased to keep the difference between the operating times of outgoing relay at 4kA and the operating time of incomer relay at 2kA is equal to or greater than 250 ms.

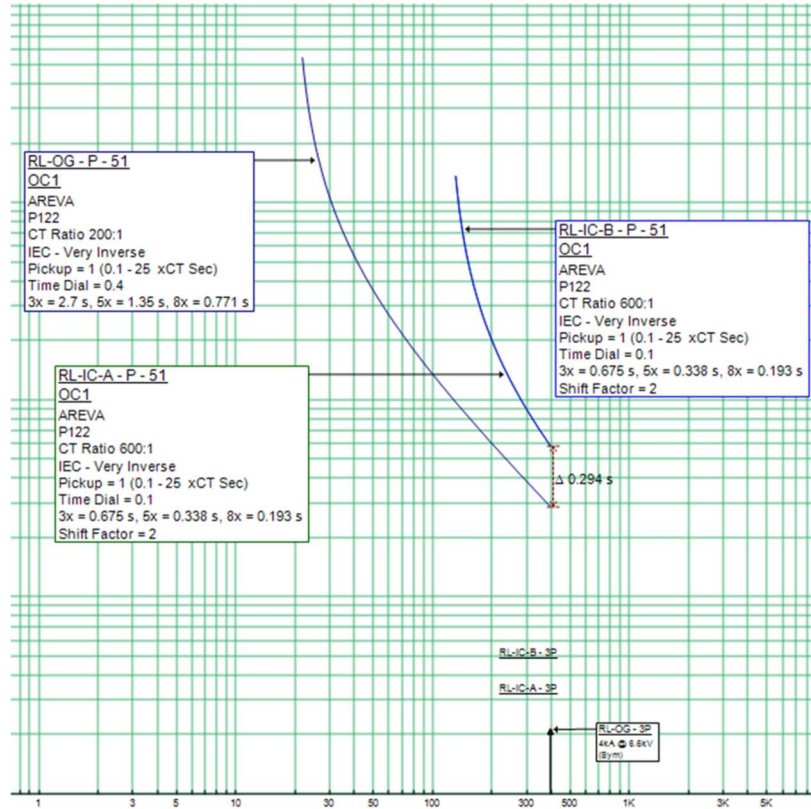
Operating time of outgoing relay at 4kA = 0.284 sec

Coordination Time interval to be maintained = 0.25 sec

Required operating time of incomer relay at 2kA =  $0.284 + 0.25$   
= 0.534 sec

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Due to the step size available in the relay, the time dial setting is made to 0.1 so that the operating time at 2kA for the incomer relay is 0.579 sec




To check operating time for incomers on common outgoing fault level for ease of coordination, there is a need to bodily shift incomers to right by a factor determined by ratio of “Total fault seen by outgoing relay / Fault seen by incomer relay”. See Method 2 on next page for further description.




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#### Method 2: Coordination after curve shifting using shift factor entered manually

Ensuring coordination time interval at two different fault current levels (Method 1) manually is a cumbersome. Hence, ETAP allows the user to shift the curves by some factors after which the coordination can be done in the traditional way.

i) Select the entire system for relay coordination study and click on “Create Star View” .

ii) Zoom in on the selected system by clicking on the “Zoom in – Star One-Line” icon  in the Star View and place the network to the right hand side of the TCC.

iii) Display the settings of the relays in the TCC by right clicking on the relay curves.

iv) Display the fault level of the outgoing relay by right clicking the fault arrow named “RL-OG-3P”.

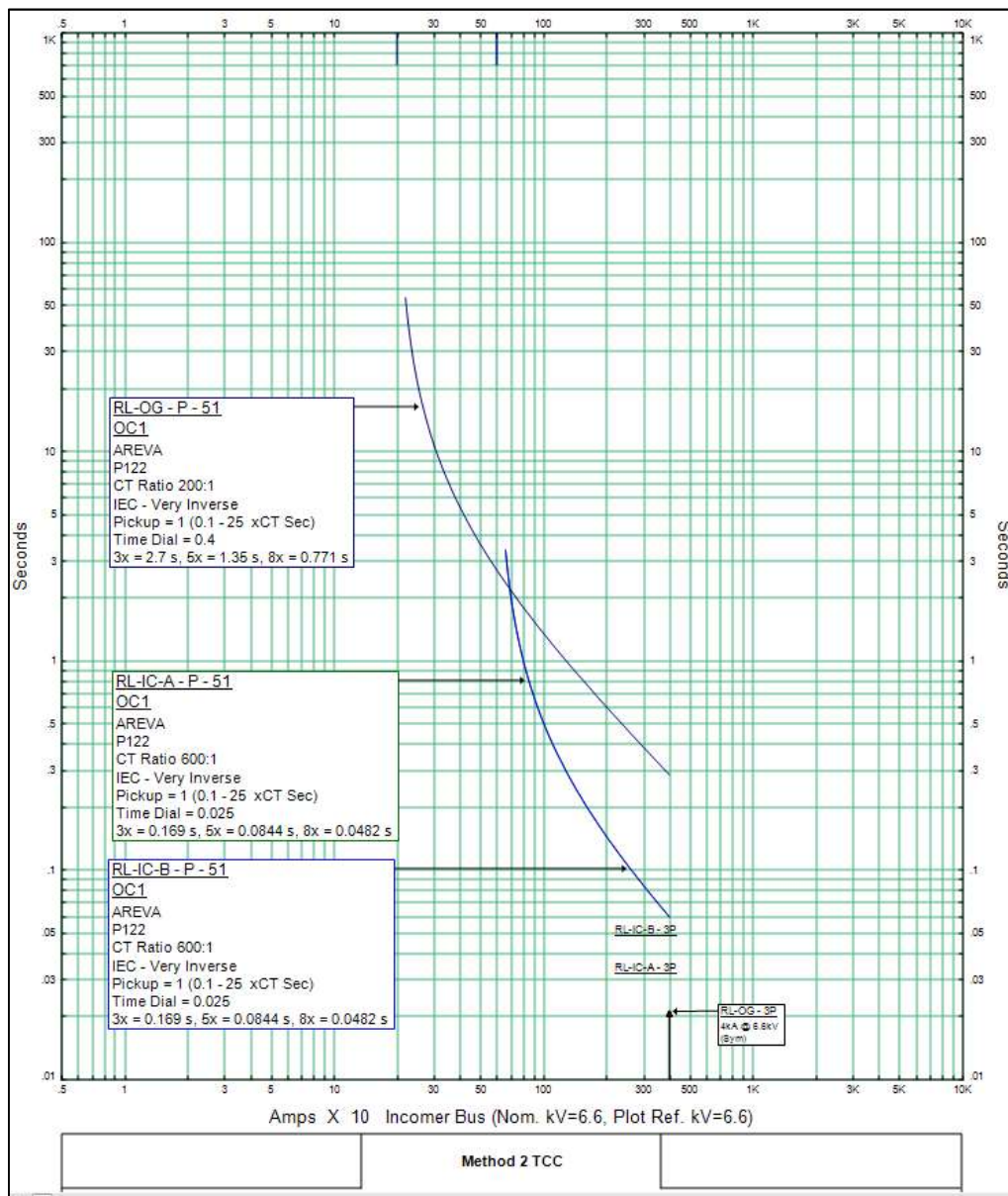
v) Rename the TCC as “Method 2 TCC”

vi) Revert the incomer relay settings back to the initial values as given in the table below,

Curve Type	IEC Inverse
Pickup	1
Time Dial	0.025

vi) The TCC will look as shown below,

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vii) The factor to be used on the incomer relays for shifting is derived as follows,

Shift Factor = Total Outgoing Fault Current / Fault Current Seen by the Incomer Relay

Shift Factor = 4 kA / 2 kA

= 2

*Note: It is not compulsory that the curve shifting has to be done on the incomer relay. The curve shifting can be done for outgoing relay as well. If outgoing relay curve is to be shifted,*



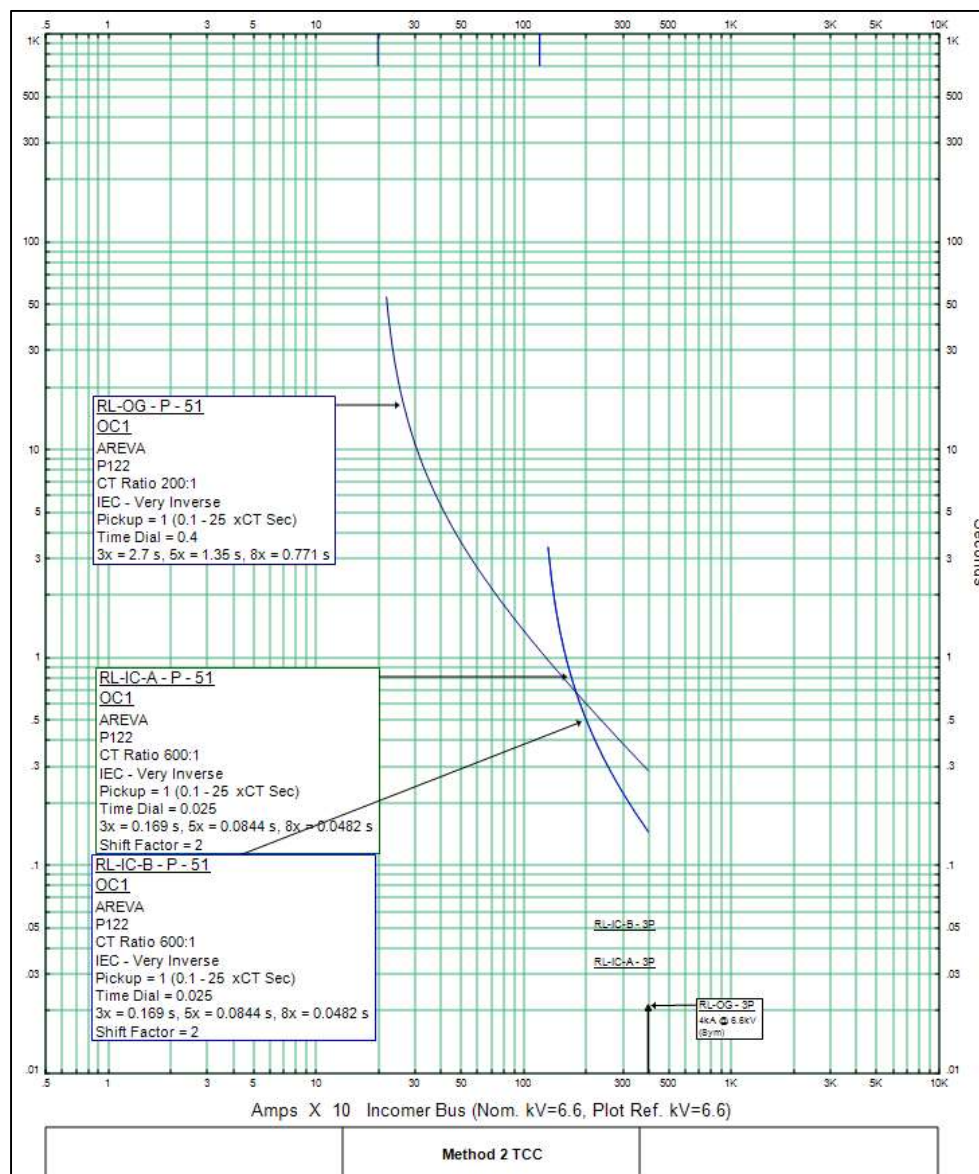
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
then the shift factor will be the inverse of the above factor ( $1/2 = 0.5$ ). In this exercise, we shall be shifting the incomer relay curve only.

viii) Right click on the incomer relay curve (RL-IC-A-P-51 and RL-IC-B-P-51) and select “Plot Options”

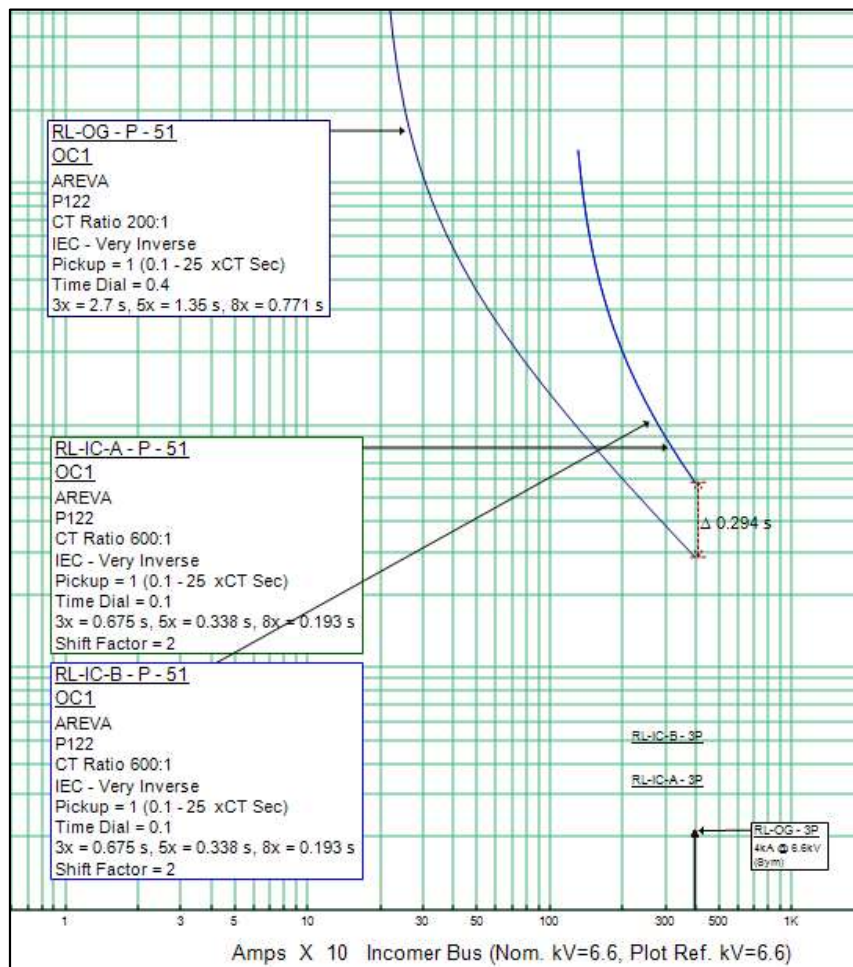
ix) In the “Preferences” tab enter the shift factor as 2 and click Ok

x) Now the curves will shift to the right as shown below,



xi) Now, coordinate the incomer relay using the “Time Difference” tool  at the outgoing fault of 4kA.

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Note: The arrived Time Dial setting (0.1) using Method 2 is the same as the time dial arrived using Method 1

### Method 3: Coordination using Normalized TCC where Etap automatically applies the shift factor

Unlike the above 2 methods, Etap can automatically shift the curves based on the fault current seen by each relays. Following are the procedure to do the same,


i) Revert the incomer relay settings back to the initial values as given in the table below,


Curve Type	IEC Inverse
Pickup	1
Time Dial	0.025

ii) In the OLV view, insert a 3-Phase Fault  at the bus named “Outgoing Faulted Bus” after ensuring that the report name in place is “Prompt”

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iii) Name the report as “Outgoing Fault – SOP”

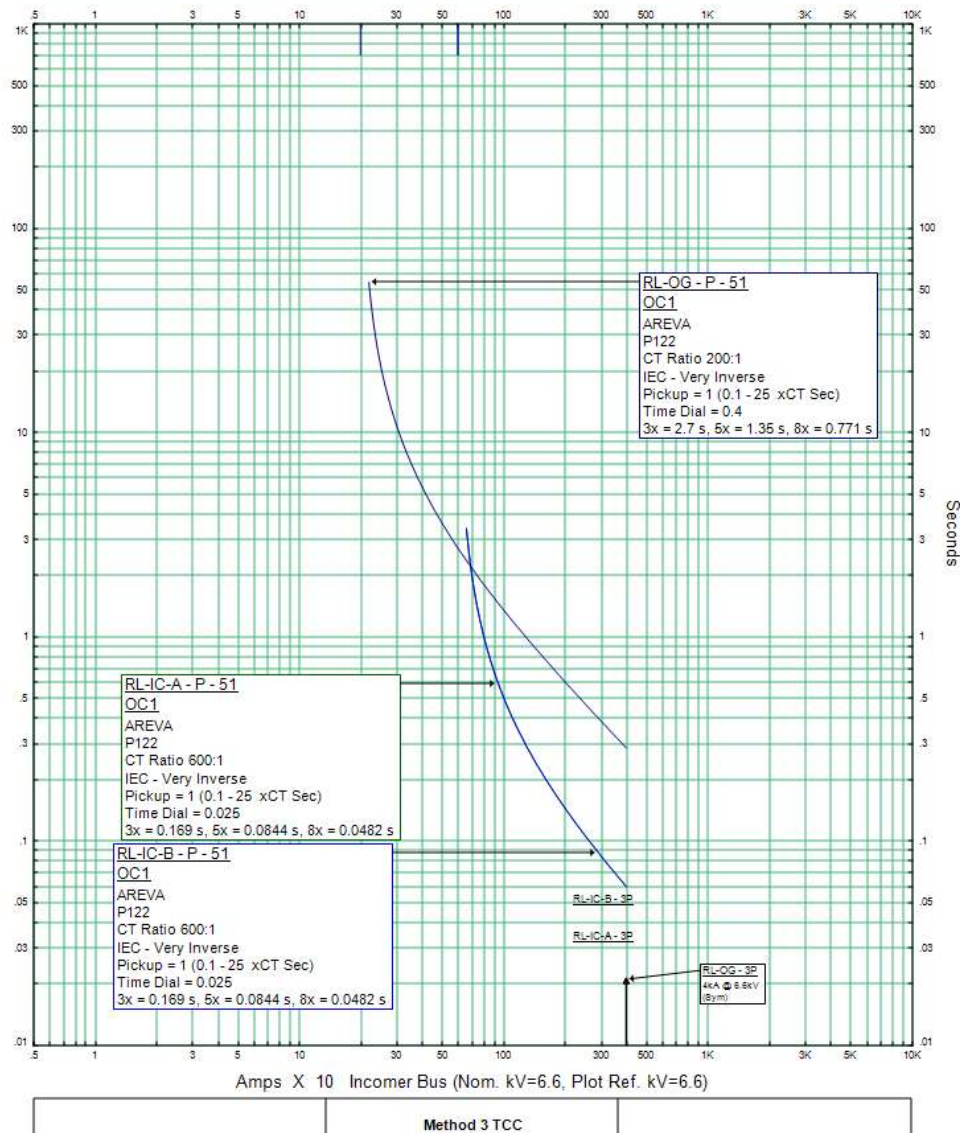
iv) Select the entire system for relay coordination study and click on “Create Star View” .

v) Zoom in on the selected system by clicking on the “Zoom in – Star One-Line” icon  in the Star View and place the network to the right hand side of the TCC.

vi) Display the settings of the relays in the TCC by right clicking on the relay curves.

v) Rename the TCC as “Method 3 TCC”

vi) The TCC will be as shown below,



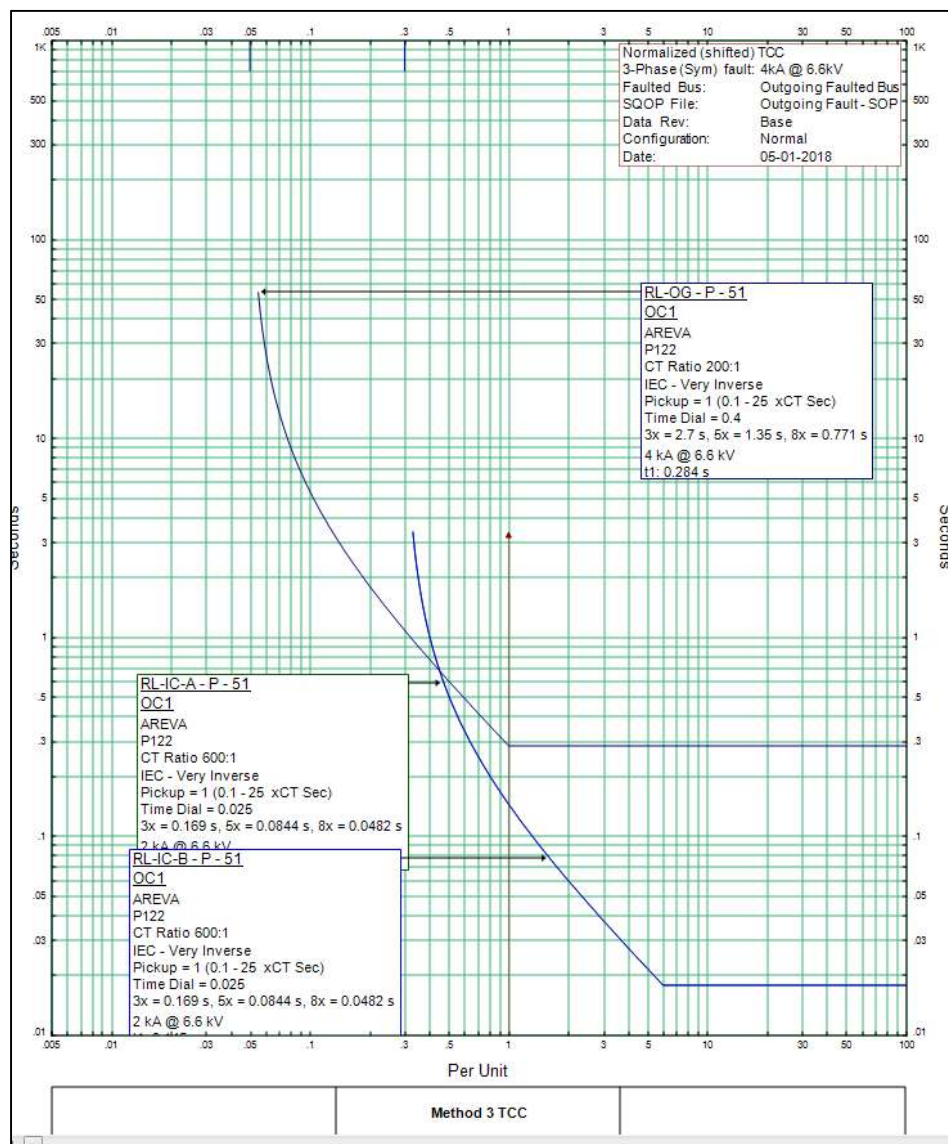
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vii) In the star view, select the report “Outgoing Fault – SOP” from the drop down menu



viii) Click on the “Normalized TCC” button  present in the right hand side of the window.

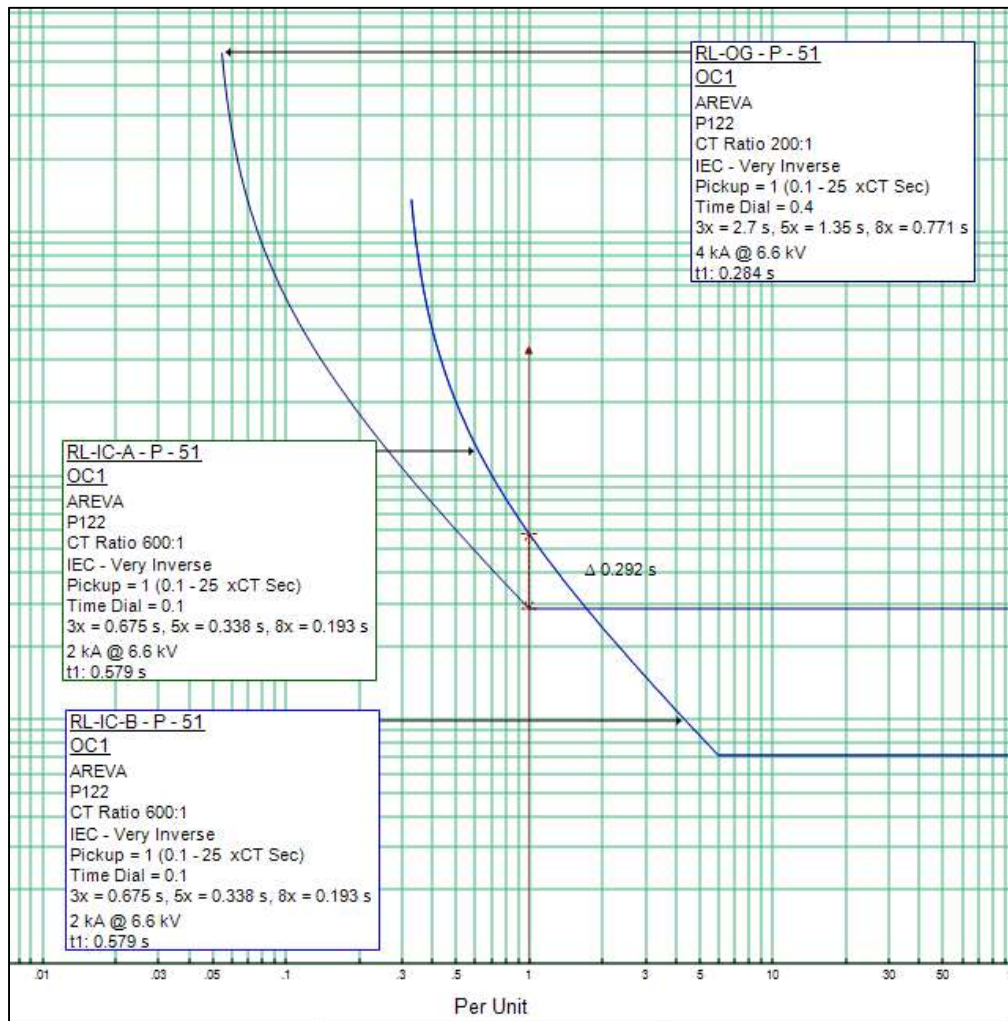
ix) Now the normalized TCC will look as shown below,





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xii) Coordinate using the Time difference tool to maintain the necessary CTI



*Note: The arrived Time Dial setting (0.1) using Method 3 is the same as the time dial arrived using Method 1 and Method 2.*

xii) Normalized TCC can also be created by,

Step 1: In the OLV view, insert a 3-Phase Fault  at the bus named “Outgoing Faulted Bus”

Step 2: Select the OLV which needs to be displayed in the TCC

Step 3: Click on “Create Star View” 

This will generate the TCC curve in an normalized star view.