Star-Auto Evaluation

Aim: Is to perform auto evaluation of the protective device settings and co-ordination carried out in the previous section exercise.
This requires entering of required inputs into Rulebook for protection setting adequacy and time-current co-ordination.

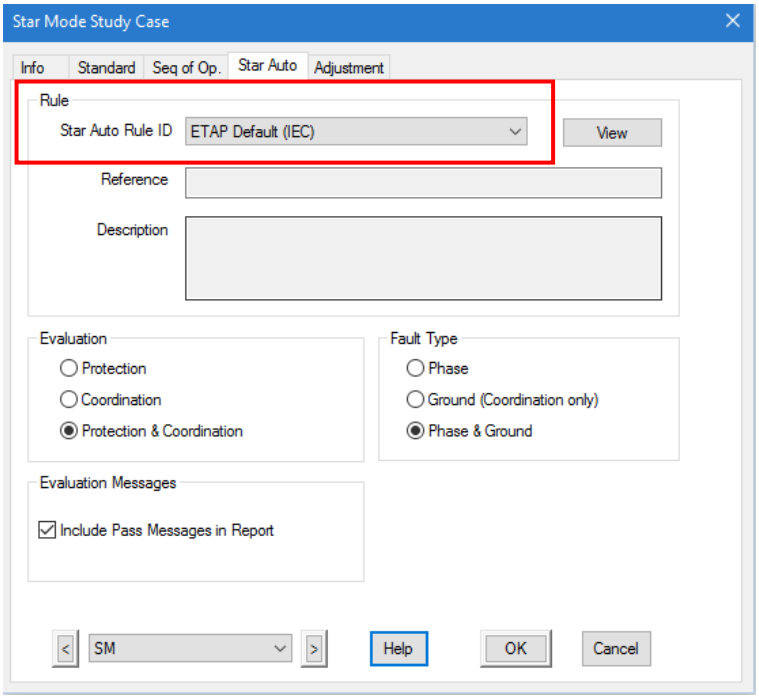
The rulebook requires the following inputs to be entered:

A. Threshold of protective device current pick up settings for various devices providing protection to each of different power system components such as cables, transformers, induction motors etc.
B. Co-ordination interval for various protective devices such as relays, releases etc. with or without inclusion of downstream CB opening time.
(If CTI is selected with CB opening time; then CB opening time has to be entered as zero. Otherwise enter the actual CB opening time.)

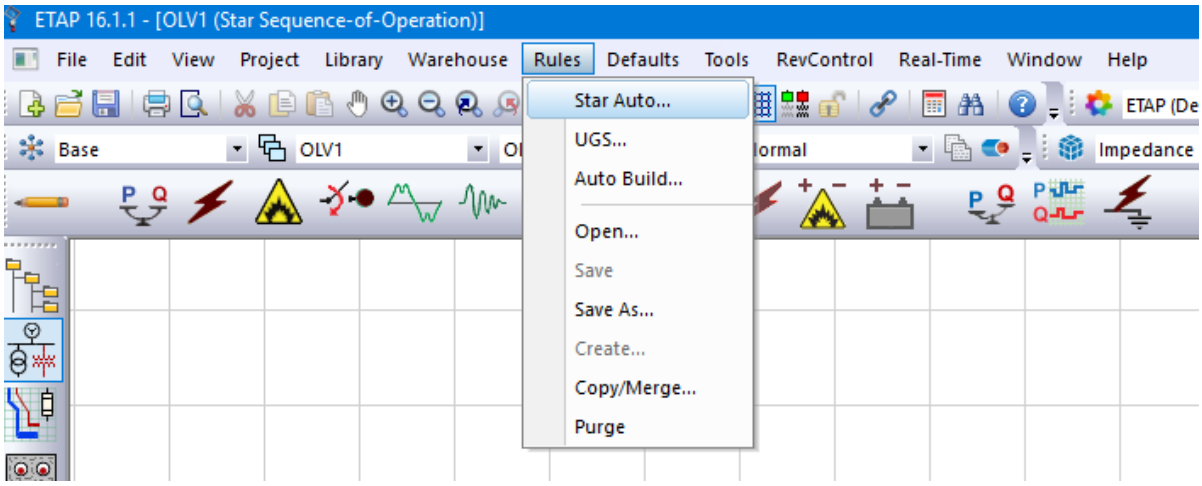
Auto-Evaluation run of selected circuits with protective device settings, results in table of evaluation of adequacy of protection and co-ordination of every element with respect to rulebook.

Star-Auto Evaluation

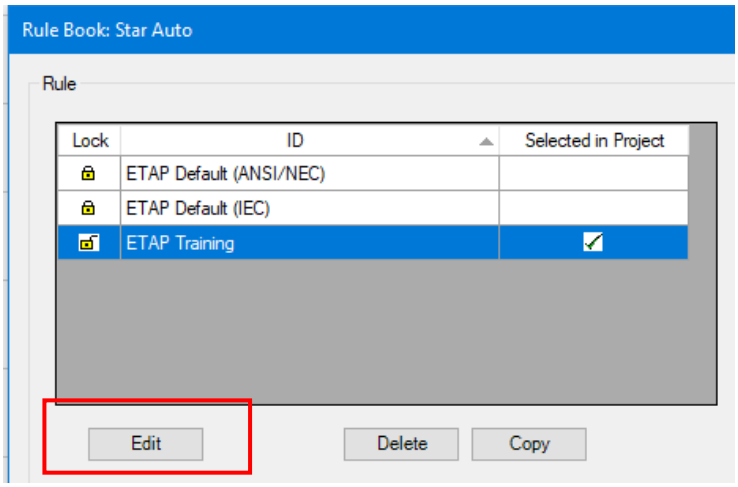
1. For doing Star-auto evaluation, go to relay co-ordination study case,check the rulebook selected is '**ETAP Default (IEC)'.**



2. Go to Rules>>Star Auto.
   Copy the '**ETAP Default (IEC)'** rulebook to **'ETAP Training'**



Star-Auto Evaluation



3. For this exercise, make the following changes in the new rulebook **'ETAP Training'** by clicking on **Edit** option:

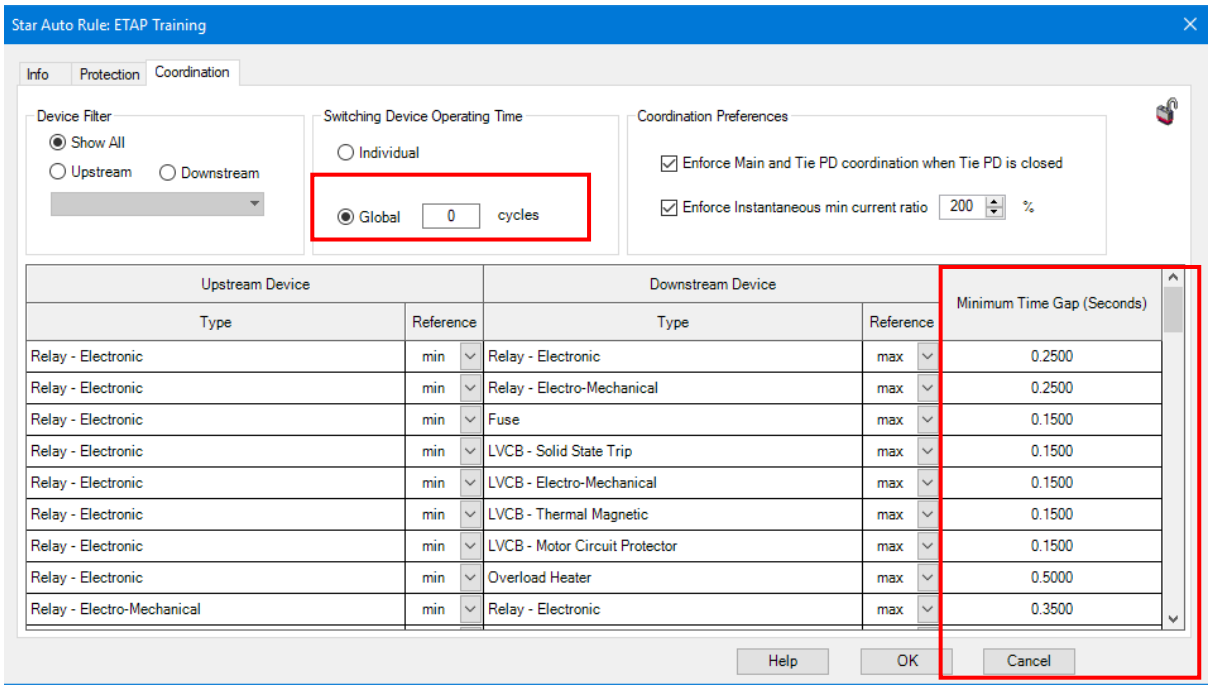
   - Go to the Co-ordination page of Rulebook, Set switching device operating time to Global= 0 cycles
     Because the table given below includes the circuit breaker opening time
     OR
     The below table need to be updated and Circuit Breaker opening time is need to add in Global box

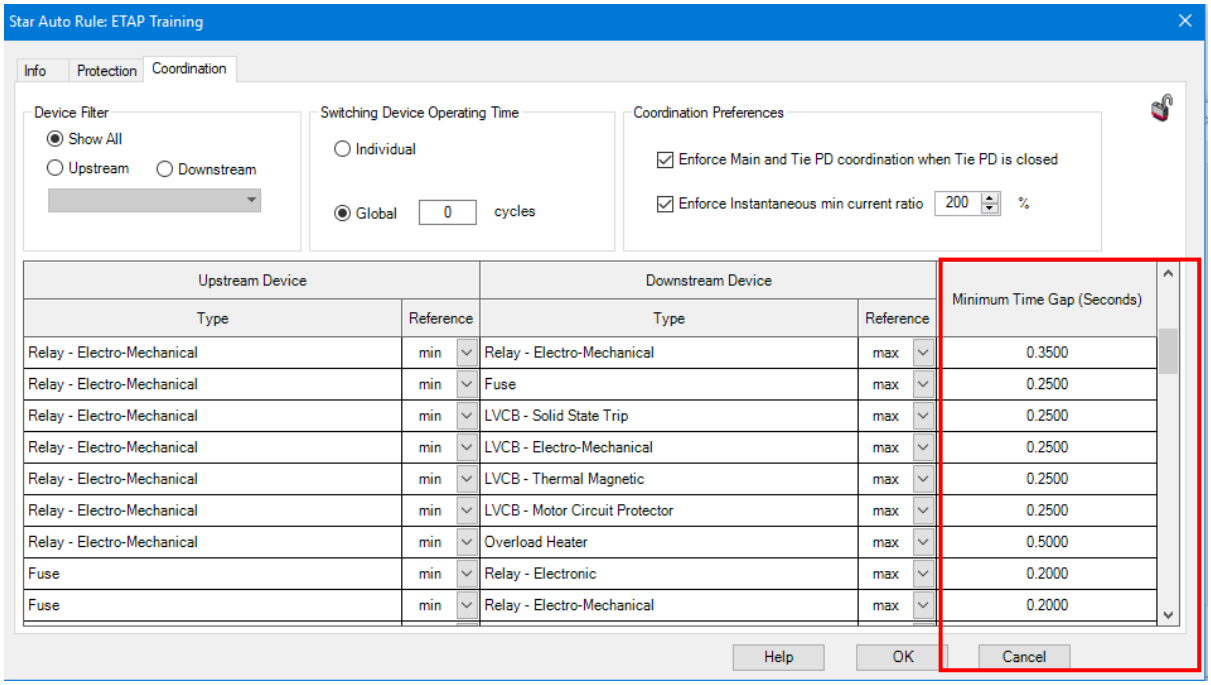
   - Give the Minimum time gap between upstream and downstream protective devices as shown below:

Downstream	**Upstream**			
	Fuse	Low Voltage Circuit Breaker	Electromechanical Relay	Static relay
Fuse	CS	CS	0.25 s	0.15s
Low Voltage Circuit Breaker	CS	CS	0.25s	0.15s
Electromechanical Relay (5cycles)	0.20 s	0.20 s	0.35s	0.25s
Static relay (5 cycles)	0.20 s	0.2 s	0.35s	0.25s

CS= Clear space between curves with upstream minimum melting curve adjusted for pre-load.

Star-Auto Evaluation





4. Observe the Protection page.
   It ask for the type of protective devices need to consider in protection evaluation and in maximum (threshold) evaluation.

Star-Auto Evaluation

a. Cable Protection options:

Use maximum limit based on NEC Section 240 for HV cable

When checked, the maximum limit value for overload protection devices in the High Voltage maximum column become display only and set based on NEC 240.101 (A). The maximum limit for the remaining devices are editable.

Allow next higher setting / rating above the LV cable Ampacity based on NEC

Check to allow the protective device threshold setting or rating to next available setting / rating above the cable ampacity/capacity. This option applies to protective device protecting a low voltage cable with threshold setting / rating less than 800A (Per NEC article 240.4 Section B)

Report minimum protection tolerance of % from damage curve

Check to report if the combined tripping curve is not to the left and below of the damage curve by at least the minimum tolerance specified.

Report under-utilized cable if less than % of the Ampacity

Check to report if the cable is under-utilized by setting the threshold reference below the specified percentage of cable Ampacity / Capacity.

b. Induction Motor Protection options:

Base

This is a display only field to define the base reference for the Minimum and Maximum threshold limit. The FLA is the Full Load Amps of the Motor read from the Nameplate page of the editor. The LRA is the Locked Rotor Amps read from the Imp page of the editor.

Use maximum overload limit based on

When checked, the maximum limit value for overload protection devices become non-editable and set based on the values defined in assigned tables to selected list box. The list box has following selections:

- NEC 430.32(A)(1)
- User-Defined

Clicking on the Limits button for NEC 430.32(A)(1) opens a display only table where Maximum % (FLA) fields are fixed and defined based on motor Service Factor (SF) per NEC article.

Star-Auto Evaluation

Clicking on the Limits button for User-Defined opens editable table where Maximum % (FLA) fields are defined by user.

The maximum overload limit table defines the maximum allowable setting as a percentage of the Motor FLA depending on the Motor Service Factor for the Overload Protective Devices.

Allow next higher setting / rating above the maximum limit

Check to allow the protective device threshold setting or rating to next available setting / rating above the maximum threshold limit.

Report minimum protection tolerance of % from damage curve

Check to report if the combined tripping curve is not to the left and below of the motor damage curve(s) by at least the minimum tolerance specified.

Report minimum protection tolerance of % from locked rotor current

Check to report if the combined tripping curve is not to the right and above of the locked rotor current curve by at least the minimum tolerance specified.

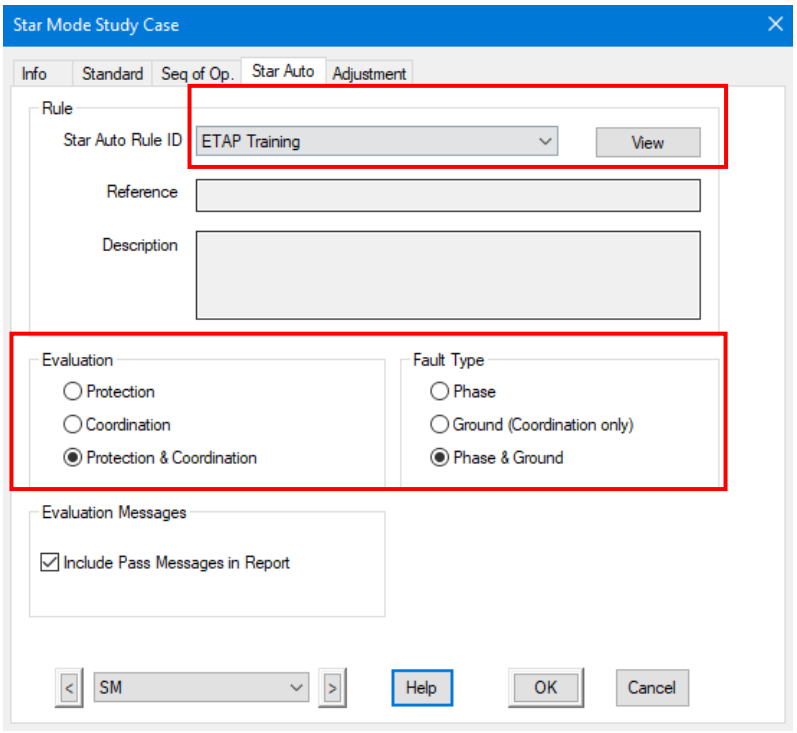
Report minimum protection tolerance of % from acceleration time

Check to report if the combined tripping curve is not to the right and above of the acceleration time curve by at least the minimum tolerance specified.

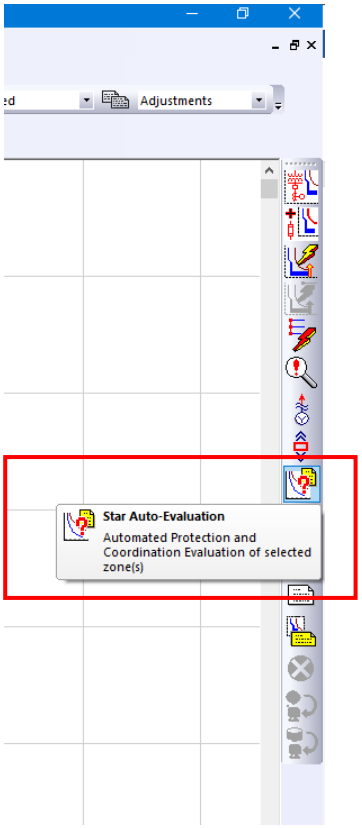
5. Now, go to the Relay co-ordination module study case >> Star Auto Page and select the new rulebook **'ETAP Training'** from drop down menu.

   Also select Evaluation as '**Protection & Co-ordination**' and Fault type as '**Phase & ground**'.

Star-Auto Evaluation

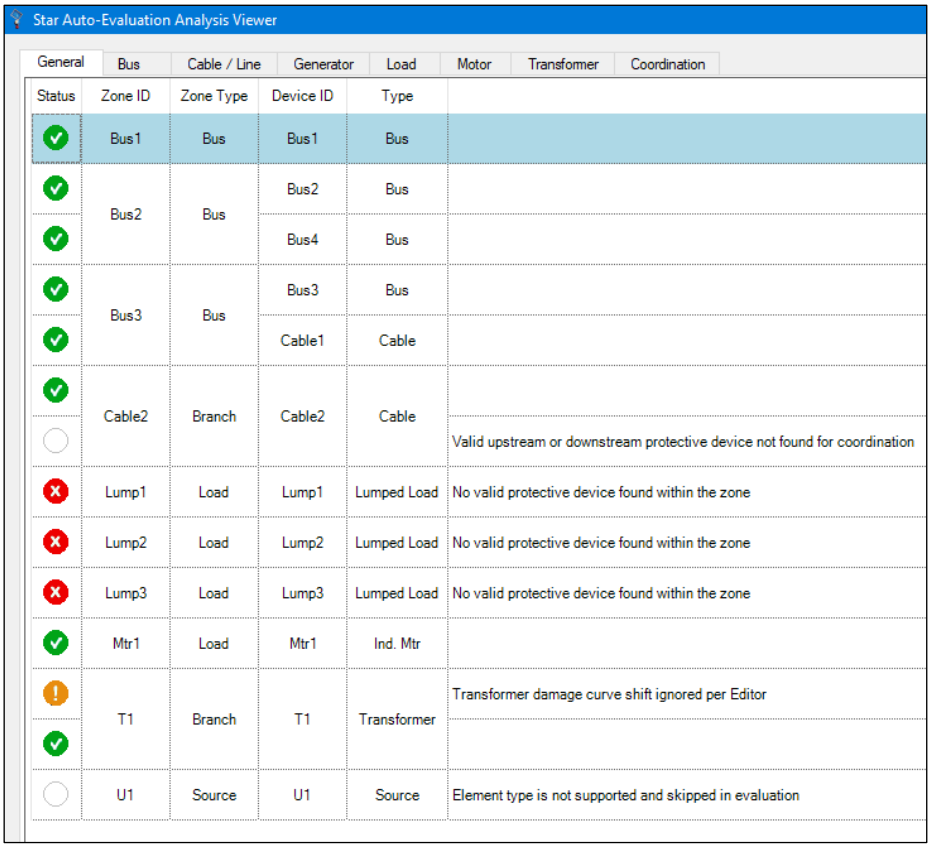


6. Select complete SLD, and run the star-auto evaluation. It will show you the following result. If required co-ordination can be checked by running auto evaluation for each small portion of SLD.



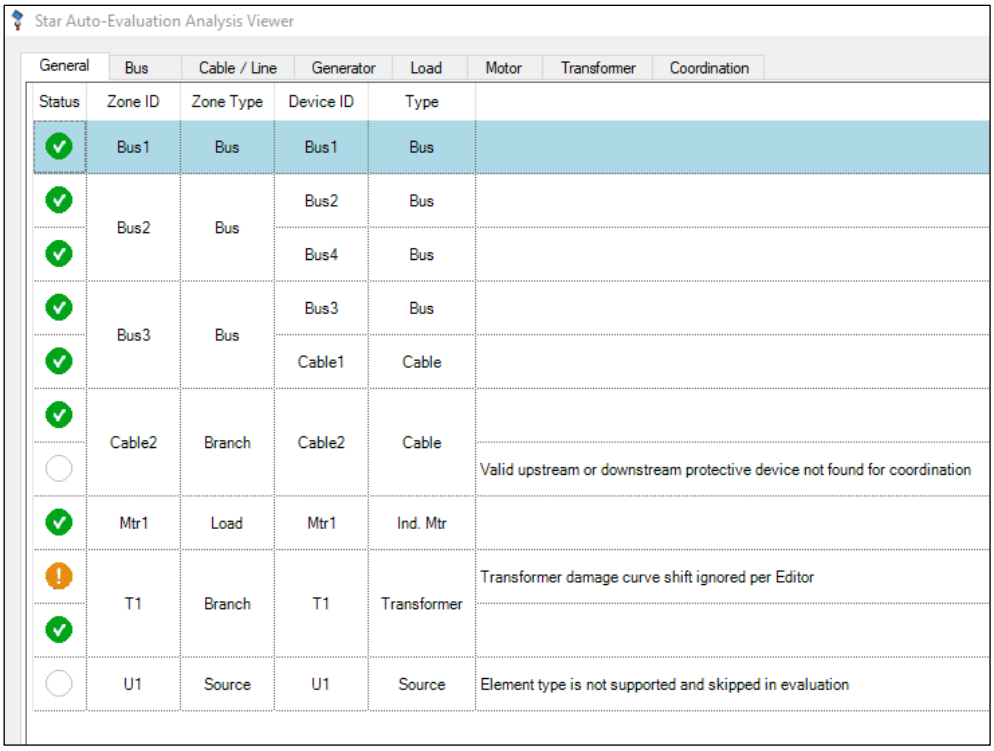
Star-Auto Evaluation

Results of star auto evaluation from ETAP are attached below:



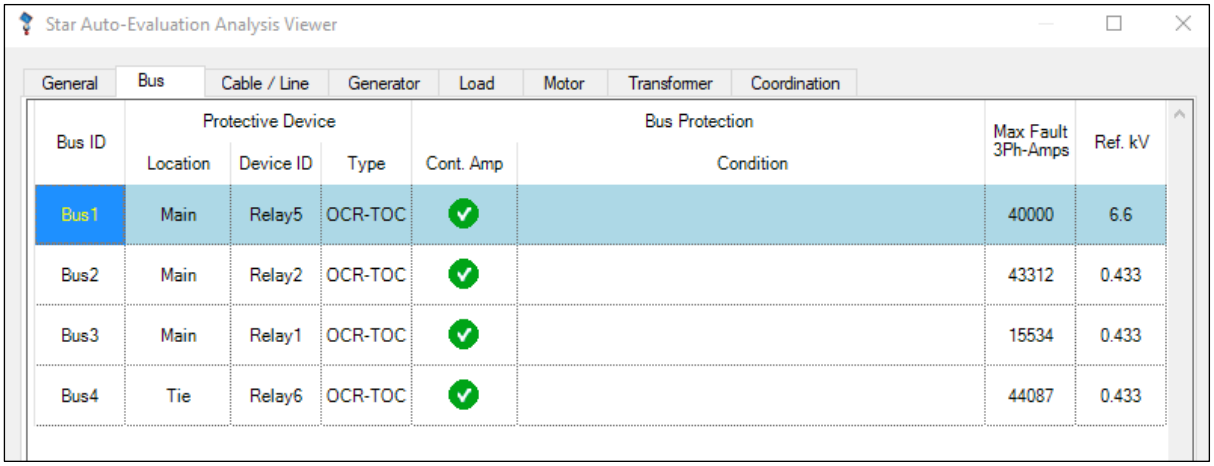
Status	Zone ID	Zone Type	Device ID	Type	
✓	Bus1	Bus	Bus1	Bus	
✓	Bus2	Bus	Bus2	Bus	
✓			Bus4	Bus	
✓	Bus3	Bus	Bus3	Bus	
✓			Cable1	Cable	
✓	Cable2	Branch	Cable2	Cable	
○					Valid upstream or downstream protective device not found for coordination
✗	Lump1	Load	Lump1	Lumped Load	No valid protective device found within the zone
✗	Lump2	Load	Lump2	Lumped Load	No valid protective device found within the zone
✗	Lump3	Load	Lump3	Lumped Load	No valid protective device found within the zone
✓	Mtr1	Load	Mtr1	Ind. Mtr	
!	T1	Branch	T1	Transformer	Transformer damage curve shift ignored per Editor
✓					
○	U1	Source	U1	Source	Element type is not supported and skipped in evaluation

7. Make lump loads 1, 2 & 3 as service out and re-run the star auto evaluation.

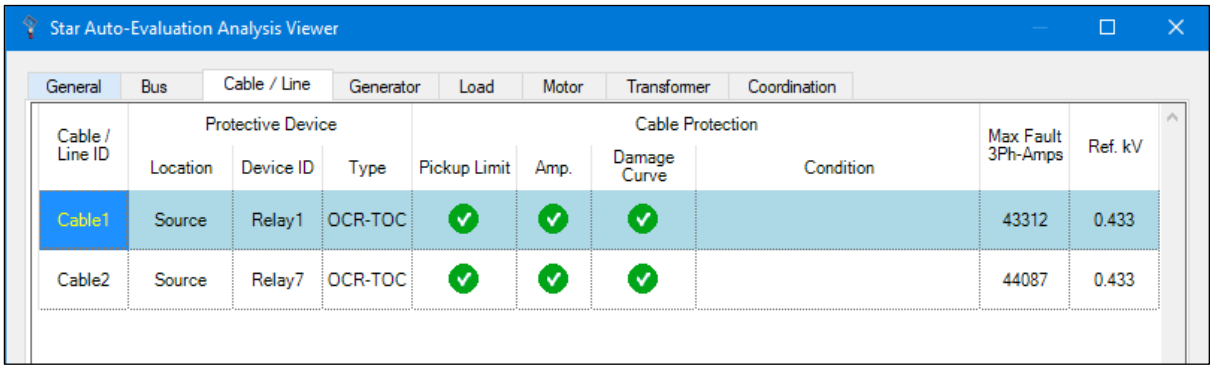


Status	Zone ID	Zone Type	Device ID	Type	
✓	Bus1	Bus	Bus1	Bus	
✓	Bus2	Bus	Bus2	Bus	
✓			Bus4	Bus	
✓	Bus3	Bus	Bus3	Bus	
✓			Cable1	Cable	
✓	Cable2	Branch	Cable2	Cable	
○					Valid upstream or downstream protective device not found for coordination
✓	Mtr1	Load	Mtr1	Ind. Mtr	
!	T1	Branch	T1	Transformer	Transformer damage curve shift ignored per Editor
✓					
○	U1	Source	U1	Source	Element type is not supported and skipped in evaluation

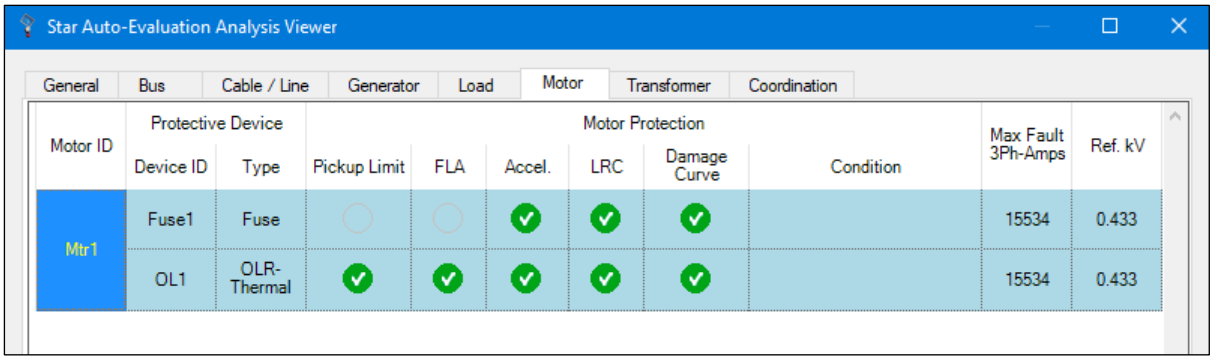
Star-Auto Evaluation



Bus ID	Protective Device			Bus Protection		Max Fault 3Ph-Amps	Ref. kV
	Location	Device ID	Type	Cont. Amp	Condition		
Bus1	Main	Relay5	OCR-TOC	✓		40000	6.6
Bus2	Main	Relay2	OCR-TOC	✓		43312	0.433
Bus3	Main	Relay1	OCR-TOC	✓		15534	0.433
Bus4	Tie	Relay6	OCR-TOC	✓		44087	0.433

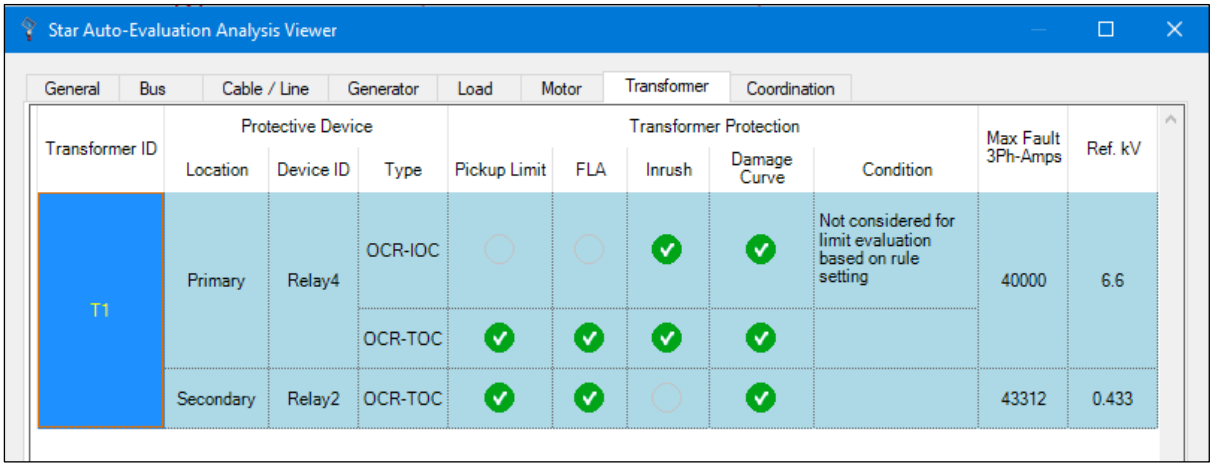


Cable / Line ID	Protective Device			Cable Protection				Max Fault 3Ph-Amps	Ref. kV
	Location	Device ID	Type	Pickup Limit	Amp.	Damage Curve	Condition		
Cable1	Source	Relay1	OCR-TOC	✓	✓	✓		43312	0.433
Cable2	Source	Relay7	OCR-TOC	✓	✓	✓		44087	0.433

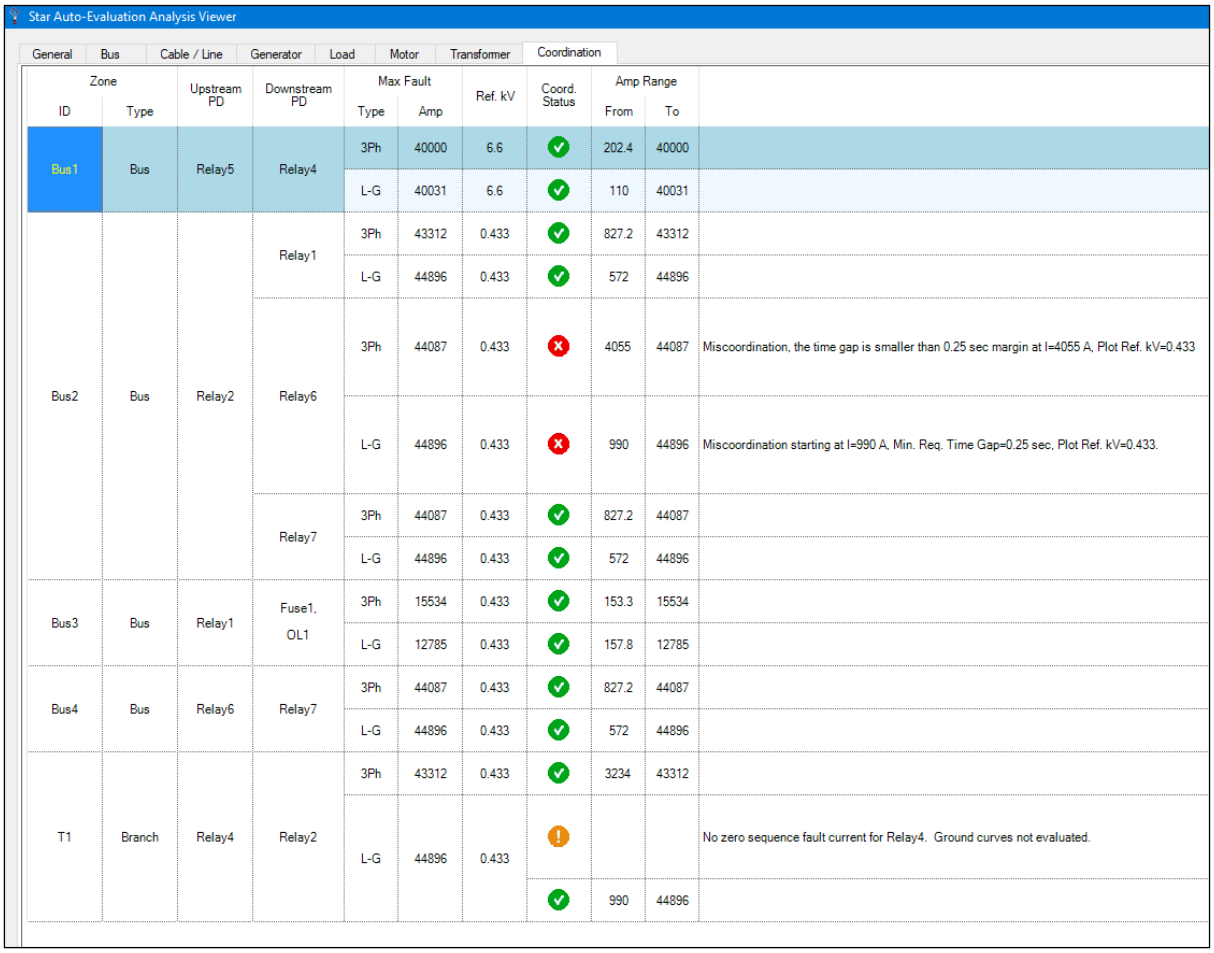


Motor ID	Protective Device		Motor Protection						Max Fault 3Ph-Amps	Ref. kV
	Device ID	Type	Pickup Limit	FLA	Accel.	LRC	Damage Curve	Condition		
Mtr1	Fuse1	Fuse			✓	✓	✓		15534	0.433
	OL1	OLR-Thermal	✓	✓	✓	✓	✓		15534	0.433

Star-Auto Evaluation



Transformer ID	Protective Device			Transformer Protection					Max Fault 3Ph-Amps	Ref. kV
	Location	Device ID	Type	Pickup Limit	FLA	Inrush	Damage Curve	Condition		
T1	Primary	Relay4	OCR-IOC			✓	✓	Not considered for limit evaluation based on rule setting	40000	6.6
			OCR-TOC	✓	✓	✓	✓			
	Secondary	Relay2	OCR-TOC	✓	✓		✓		43312	0.433

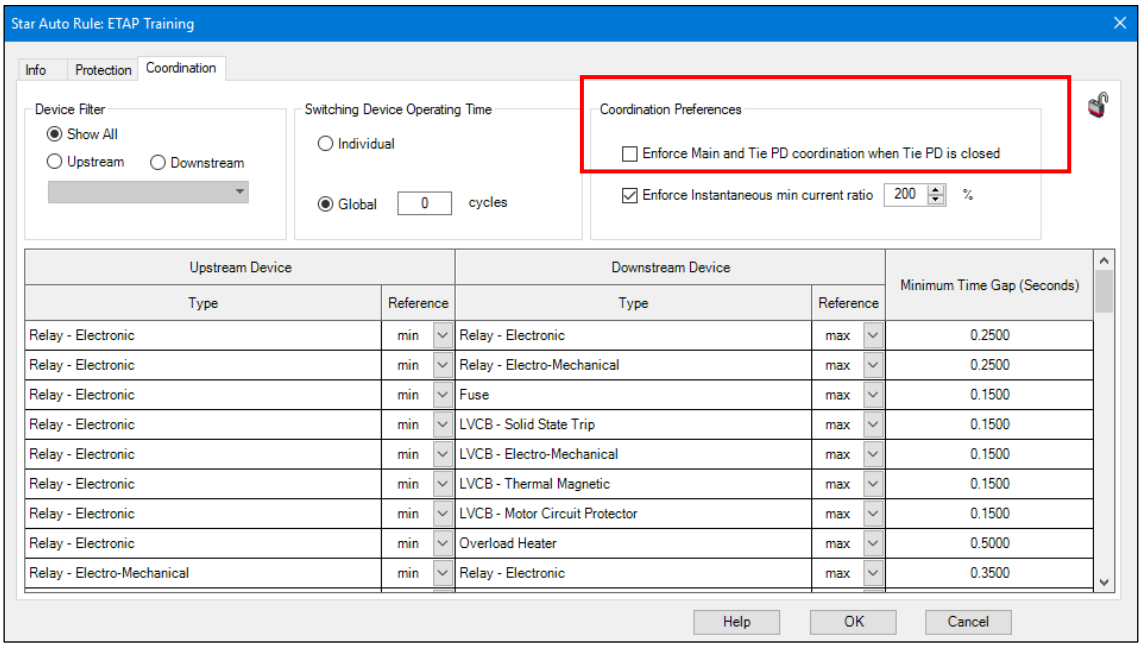


Zone ID	Zone Type	Upstream PD	Downstream PD	Max Fault Type	Max Fault Amp	Ref. kV	Coord. Status	Amp Range From	Amp Range To	
Bus1	Bus	Relay5	Relay4	3Ph	40000	6.6	✓	202.4	40000	
				L-G	40031	6.6	✓	110	40031	
Bus2	Bus	Relay2	Relay1	3Ph	43312	0.433	✓	827.2	43312	
				L-G	44896	0.433	✓	572	44896	
			Relay6	3Ph	44087	0.433	✗	4055	44087	Miscoordination, the time gap is smaller than 0.25 sec margin at I=4055 A, Plot Ref. kV=0.433
				L-G	44896	0.433	✗	990	44896	Miscoordination starting at I=990 A, Min. Req. Time Gap=0.25 sec, Plot Ref. kV=0.433.
			Relay7	3Ph	44087	0.433	✓	827.2	44087	
				L-G	44896	0.433	✓	572	44896	
Bus3	Bus	Relay1	Fuse1, OL1	3Ph	15534	0.433	✓	153.3	15534	
				L-G	12785	0.433	✓	157.8	12785	
Bus4	Bus	Relay6	Relay7	3Ph	44087	0.433	✓	827.2	44087	
				L-G	44896	0.433	✓	572	44896	
T1	Branch	Relay4	Relay2	3Ph	43312	0.433	✓	3234	43312	
				L-G	44896	0.433	!			No zero sequence fault current for Relay4. Ground curves not evaluated.
							✓	990	44896	

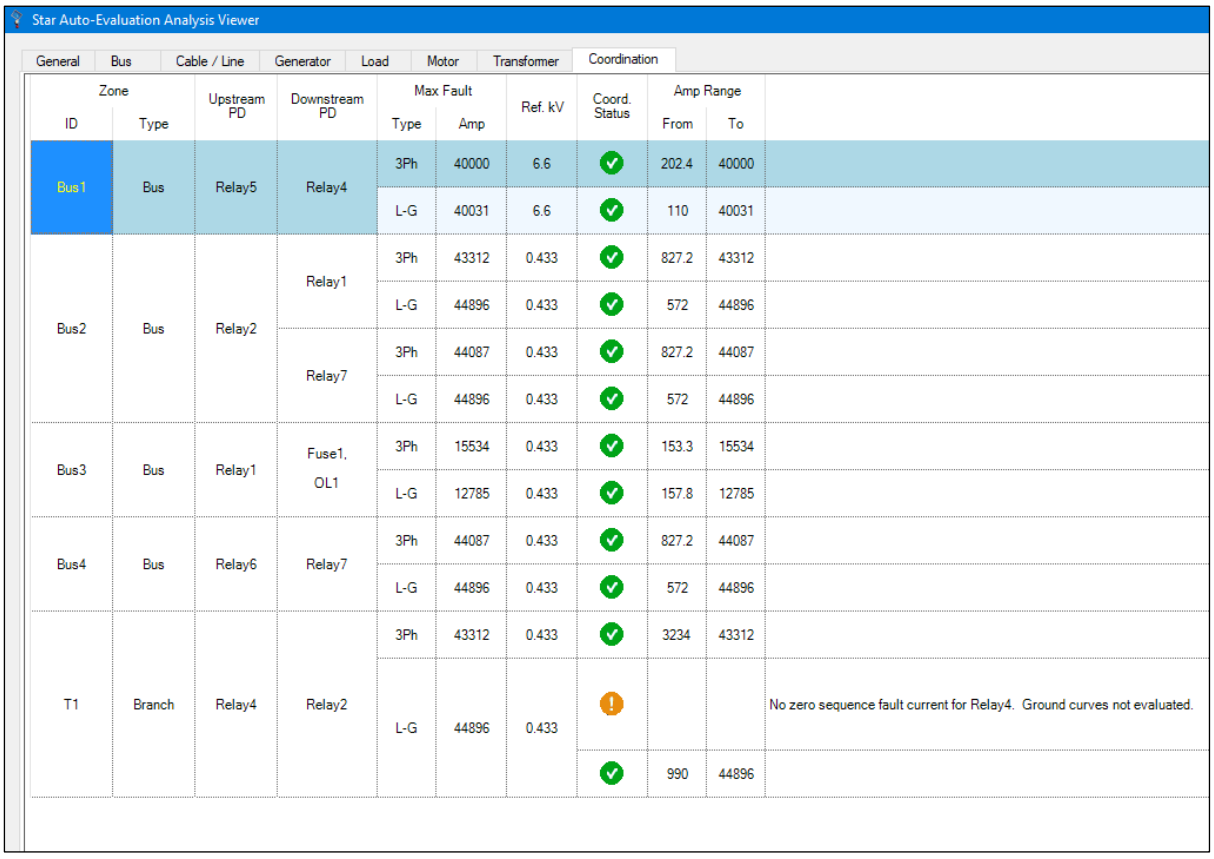
<u>Red Cross Alert Symbol:</u> It shows that, there is miscoordination between Relay 2(incomer relay) & Relay 6 (bus coupler relay), the time gap between these two relay is smaller than 0.25sec.

Star-Auto Evaluation

8. Now, Go to rules>>star auto>> **ETAP Training rulebook**>>Edit option>>Co-ordination page & **uncheck** the box '**Enforce Main & Tie PD co-ordination when Tie PD is closed.'**



9. Now, select complete SLD and re-run the star auto evaluation. The following results will get displayed on co-ordination page:



Zone ID	Zone Type	Upstream PD	Downstream PD	Max Fault Type	Max Fault Amp	Ref. kV	Coord. Status	Amp Range From	Amp Range To	
Bus1	Bus	Relay5	Relay4	3Ph	40000	6.6	✓	202.4	40000	
				L-G	40031	6.6	✓	110	40031	
Bus2	Bus	Relay2	Relay1	3Ph	43312	0.433	✓	827.2	43312	
				L-G	44896	0.433	✓	572	44896	
			Relay7	3Ph	44087	0.433	✓	827.2	44087	
				L-G	44896	0.433	✓	572	44896	
Bus3	Bus	Relay1	Fuse1, OL1	3Ph	15534	0.433	✓	153.3	15534	
				L-G	12785	0.433	✓	157.8	12785	
Bus4	Bus	Relay6	Relay7	3Ph	44087	0.433	✓	827.2	44087	
				L-G	44896	0.433	✓	572	44896	
T1	Branch	Relay4	Relay2	3Ph	43312	0.433	✓	3234	43312	
				L-G	44896	0.433	!			No zero sequence fault current for Relay4. Ground curves not evaluated.
							✓	990	44896	

Star-Auto Evaluation

10. Hence, if this checkbox for '**Enforce Main & Tie PD Co-ordination when Tie PD is closed'** in rulebook is unselected then ETAP ignores the co-ordination between incoming and bus coupler protective devices.