PROTECTION OF LV GENERATORS

With increase in requirement reliable and continuous power supply, Generators are often used to guarantee availability. Depending on the scenario either they are used as alternative to utility supply or in parallel with utility power.

The protection devices selection also based type of configuration with Generators is used. The following configurations are very commonly used.

1. Independent functioning (Island supply) where generators feed critical loads in case of power supply from utility fails.
2. Generators supply is paralleled with Utility network (very limited in India)

When it comes to short circuit protection in generator networks, special care is to be taken in protection settings of circuit breakers. Fault current continue to have a constant contribution from utility network, however in case of generators the short current is supplied by generator itself and will continue to decay with time. The contribution of generator current can attributed to 3 different phases.

1. Sub transient phase
2. Transitory phase
3. Synchronous phase

SUB TRANSIENT PHASE

During sub transient phase, sub transient reactance(X''_d) value is considered to determine short circuit current during the first few cycles after the fault occurs. This value is very useful during short circuit studies. The sub transient reactance value normally between 5-20% of total impedance is of brief duration of 10-50ms.

TRANSITORY PHASE

Transitory phase is further extension of sub transient phase where transient reactance (X'_d) value will be between 15-40% of rated impedance and will lost between .03 to 2.5seconds. This value is often used voltage regulation studies.

SYNCHROUNOUS PHASE

This phase may continue to persist until protection device trips. The synchronous reactance(X_d) value will be between 80 to 300% of the total impedance. This value is always used to determine setting of over current protection.

PROTECTION OF LV GENERATORS

The below curve provides typical characteristics of Generator (fig 1) which clearly shows 3 different phases. In fig 2, the cross indicates thermal withstand point of generator for period of 30 seconds.

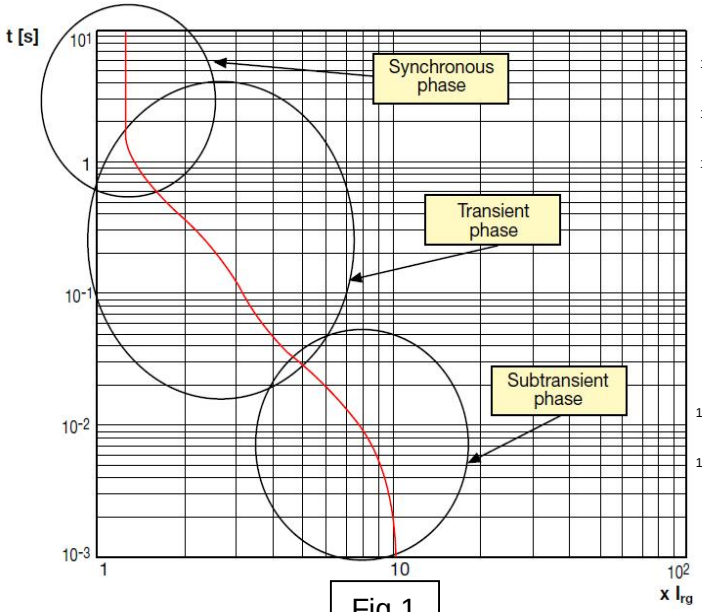


Fig 1

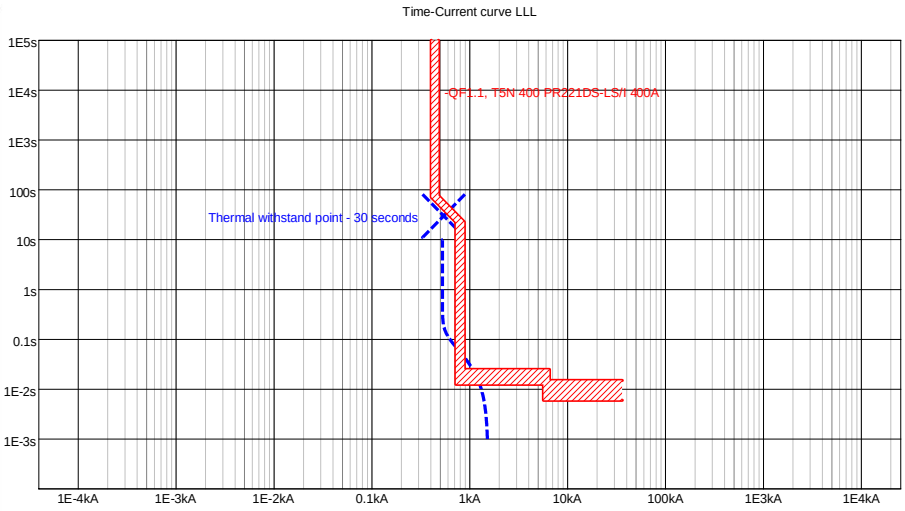


Fig 2

An estimated maximum value of short circuit current of the generator can be arrived with following formula. It is very important to ensure that all reactance values are furnished by Generator vendors.

$$I_{kg} = \frac{I_{rg} \cdot 100}{X''_d\,\%} \qquad I_{rg} = \frac{S_{rg}}{\sqrt{3} \cdot U_r}$$

Where

I_{kg} is Maximum short circuit current

I_{rg} is rated current of the generator

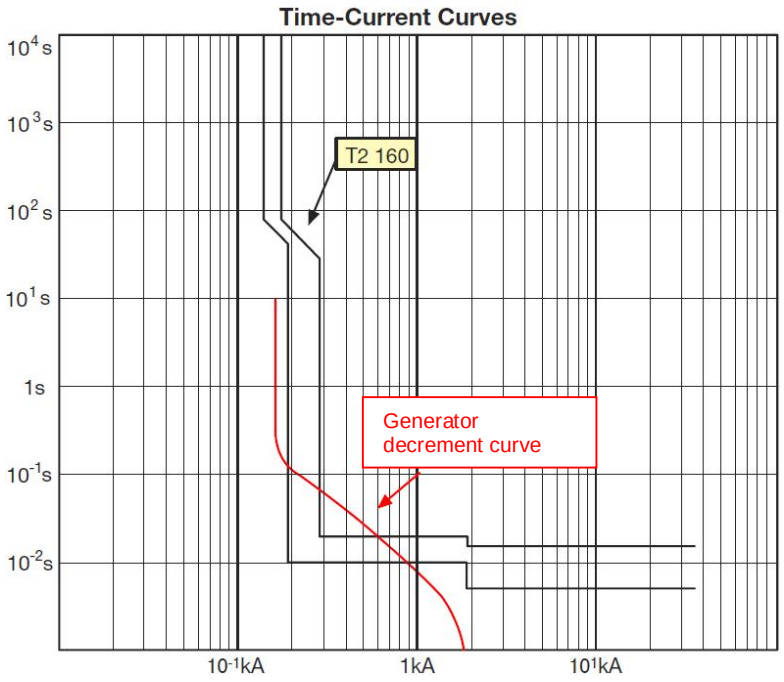
U_r is rated voltage of the installation

PROTECTION OF LV GENERATORS

The selection criteria of circuit breaker for protection of the generator are based following parameters.

- The breaking capacity of circuit breaker (I_{cu} or I_{cs}) shall be higher than fault level at the point of installation considering
    1. Icu or Ics shall be >/= Short circuit current rating(I_{kg}) of generator in case single generator.
    2. In case of multiple generators in parallel, I_{cu} or I_{cs} shall be >/= I_{kg}*(n-1) where "n" is number of generators.
    3. In case of operation parallel with network, I_{cu} or I_{cs} shall be >/= I_{net} where "I_{net}" is Fault current contribution from utility network.

- When circuit breaker with thermo magnetic releases is used, magnetic threshold I_3 is set 2.5 to 3times rated current of the circuit breaker.
- When circuit breaker with electronic releases is used "S" protection is set in such a way that it intercepts decrement curve of the Generator as indicated in the figure shown. If protection release selected has "S" protection, setting can be between 1.5 to 4 times rated current of circuit breaker. If "S" is not available, "I" can be set to same value.



For ease of selection of circuit breakers for Generator protection application, ABB has published a below chart through which circuit breakers can be selected based on KVA rating of the generators.

PROTECTION OF LV GENERATORS

400V Generators

S_{rg} [kVA]	MCB	MCCB	ACB
4	S20L/S260 B6	T2 160 In=10	
6	S20L/S260 B10		
7			
9	S20L/S260 B13	T2 160 In=25	
11	S20L/S260 B16		
14	S20L/S260 B25		
17			
19	S20L/S260 B32	T2 160 In=63	
21			
22			
28	S20L/S260 B50		
31			
35	S20L/S260 B63		
38			
42			
44	S280 B80	T2 160 In=100	
48			
55			
69	S280 B100		
80		T2 160 In=160	
87			
100		T2 160	
111		T4 250	
138			
159		T3 250	
173		T4 250	
180		T4 320	
190			
208			
218			
242		T5 400	
277			
308		T5 630	E1/E2
311			
346			
381			
415			
436		T6 800	E1/E2
484			
554		T7 1000	E1/E2
692			
727		T7 1250	E1/E2
865			
1107		T7 1600	E1/E2
1730			E3 2500
2180			E3 3200
2214			
2250			E4 4000
2500			
2800			E6 5000
3150			
3500			E6 6300

440V Generators

S_{rg} [kVA]	MCB	MCCB	ACB
4	S20L/S260 B6	T2 160 In=10	
6	S20L/S260 B8		
7	S20L/S260 B10		
9	S20L/S260 B13	T2 160 In=25	
11	S20L/S260 B16		
14	S20L/S260 B20		
17	S20L/S260 B25		
19	S20L/S260 B32	T2 160 In=63	
21			
22			
28	S20L/S260 B40		
31	S20L/S260 B50		
35			
38	S20L/S260 B63		
42			
44			
48	S280 B80		
55		T2 160 In=100	
69	S280 B100		
80		T2 160 In=160	
87			
100		T2 160 In=160	
111			
138		T4 250	
159		T3 250	
173		T4 250	
180		T4 320	
190			
208			
218			
242			
277		T5 400	
308		T5 630	E1/E2
311			
346			
381			
415			
436			
484		T6 800	E1/E2
554			
692		T7 1000	
727			
865		T7 1250	E1/E2
1107		T7 1600	
1730			E3 2500
2180			E3 3200
2214			
2250			
2500			E4 3600
2800			E4 4000
3150			E6 5000
3500			

PROTECTION OF LV GENERATORS

ABB offers Air circuit breakers, Moulded case circuit breakers and Miniature circuit breakers with versatile range of protection releases with which perfect protection function can be achieved for Generators in low voltage networks. The right selection and settings of protection releases is critical in ensuring correct protection for Generators.

Note – Product development is a continuous process in ABB and the chart provided is subjected to changes.

Contact us for further information

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