Selection criteria for Circuit Protection in LV networks

Designing protection philosophy is becoming day by day important as focus on limiting electrical hazards is increasing in low voltage network. This brings lot of importance on selection of circuit breakers with right protection features and characteristics depending on application as well as location where it is used.

There are two international standards which are in place for circuit breakers based on application. The following are two standards

1. IEC 60947-2 (Low voltage Switchgear and control gear – Circuit Breakers).
2. IEC 60898 (Circuit Breakers for over current protection for house hold and similar installation).

These standards also adopted by Indian standards (IS 60898/IS 60947).

For better understanding of application of these standards, we will analyze the basic difference between two standards in this technical paper.

IEC 60898	IEC 60947-2
This standard prescribes circuit breakers intended for protection against over currents of electrical wiring systems installed in residential buildings and similar applications.	This standard prescribes circuit breakers which are to be used industrial environment with rated voltage not exceeding 1150V ac or 1500V dc
These circuit breakers are designed for use by unskilled/uninstructed people.	These circuit breakers are designed to be used by skilled /instructed people
Short circuit protection – Electromagnetic plunger provides instantaneous tripping in case of a short circuit in the network. IEC 60898 distinguishes three different types characteristics based on instantaneous release current setting namely B,C,D	Short circuit protection – Electromagnetic plunger provides instantaneous tripping in case of a short circuit in the network. IEC 60947 allows the calibration of magnetic release to manufacturer's decision
Thermal release – Bimetallic strip initiates the tripping of circuit breakers. Reference ambient considered is 30˚C.	Thermal release – Bimetallic strip initiates the tripping of circuit breakers. Reference ambient considered is 40˚C.
Circuit breaker rated current defined in the regulations is maximum of 125A	No rated current limit is specified
Short circuit breaking capacity is defined as Icn and Ics(Service) in IEC 60898	Short circuit breaking capacity is defined as Icu(Ultimate) and Ics(Service) in IEC 60947-2

The selection of characteristics is based on application where circuit breakers are used. The following chart will give an insight into tripping requirements based on type of circuit breakers selected in accordance with IEC 60898.

Type	Test current	Time to trip	Typical applications
B	3 In 5 In	t>/= 100ms t<100ms	B type circuit breakers are suitable for resistive loads like water heaters, Electric stoves etc
C	5 In 10 In	t>/= 100ms t<100ms	C type circuit breakers are suitable for socket outlets, lighting loads and motors of smaller capacity
D	10In 20In	t>/= 100ms t<100ms	D type is used to protect the circuit where there higher transient inrush currents typically larger motors

Another major difference between the two standards is testing (Type tests) procedures which are to be followed to comply with the respective standards. The tests according to IEC 60898 are more stringent in nature since unskilled persons will be using the devices. The following table provides overview of tests that required to be conducted to comply with respective standards.

Serial No	IEC 60898	IEC 60947-2
1	Indelibility of marking	Temperature rise
2	Reliability of screws, current carrying parts and connections	Tripping limits and characteristics
3	Reliability of terminals for external conductors	Dielectric properties
4	Protection against electric shock	Operational performance capability
5	Dielectric properties and isolating capability	Over load performance(Where applicable)
6	Temperature-rise	Short circuit breaking capacities
7	28 day test	Short time withstand current(where applicable)
8	Tripping characteristic	Performance of integrally fused circuit breakers
9	Mechanical and electrical endurance	
10	Short circuit	
11	Resistance to mechanical shock and impact	
12	Resistance to heat	
13	Resistance to abnormal heat and to fire	
14	Resistance to rusting	

We will specifically discuss about two tests in this technical paper. In 28 day test, Circuit breaker is subjected to 28cycles of tests. Each cycle is – 21hours rated current and 3hours no load. Temperature at the terminal is measured. Temperature rise shall not exceed 15K. Current is increased steadily within 5 seconds to tripping value. Circuit breaker should trip within conventional time.

The circuit breakers are also required to undergo glow wire test for the insulating body according to IEC 60695-2-10(For IEC 60898 compliance). External insulating part of the circuit breakers is necessary to retain position of current carrying parts and parts of protective circuit when the test is conducted at a temperature of 960˚C+/-15%.

According IEC 60947-2, Service short circuit breaking capacity(Ics) with respect to Ultimate short circuit breaking capacity(Icu) can be defined by manufacturer(there is no mandate by IEC to have specific Ics value). In case of IEC 60898, Standards clearly defines the required level of service short circuit breaking capacity (Ics) with introduction of “k” factor. k factor is ratio between Ics and Icn (Short circuit breaking capacity).

Icn	k
Rating less than or equal to 6kA	1
Between 6kA and 10kA	0.75 (minimum value to be 6kA)
More than 10kA	0.5 (minimum value to be 7.5kA)

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In many cases circuit breakers are tested for both standards by manufacturers. A circuit breaker which can withstand 10kA according IEC 60947-2 may have breaking capacity (Icn) of only 6kA according to IEC 60898 due to stringent test conditions. When selecting care must also be taken to ensure circuit breaker with correct breaking capacity is selected. It is advisable to verify a copy of type test report which guarantees breaking capacity according to the required standards.

When typical high rise building is considered, the short circuit level at lower floor levels are much higher due to lesser cable impedance compared to short circuit level at higher floor level (longer cable lengths).Presently with the use of bus bar trunking system (lower impedance compared to cable) in high rise building, fault levels will be on higher side even at higher floor level.

When you have 2 different fault currents at different levels, circuit breakers is also required to be chosen in line with fault current. Instead of using multiple ranges of products (6kA & 10kA) in same building, it is recommended to standardize on 10kA so that any possible error by maintenance personnel during replacement is avoided.

Another important aspect which has to be kept in mind while selecting circuit breakers is selectivity with upstream devices.

Normally DB's in final circuits are fed either from sub distribution boards or from metering boards which are located outside the apartment in service area. Upstream circuit breaker can either be MCCB or MCB. If selectivity is not achieved, for fault inside apartment, circuit breaker in metering panels trips where user has to wait till it is reset by maintenance personnel. If selectivity is achieved, circuit breaker within the apartment trips which can be reset by the user and power is restored. ABB offers comprehensive selectivity option between MCB and MCB as well as MCCB and MCB. Please find below typical example.

			E.	S800N							
	Char.			C							
L.		I_{cu} [kA]		36							
			I_n [A]	25	32	40	50	63	80	100	125
S200	C	10	0.5	T	T	T	T	T	T	T	T
			1	T	T	T	T	T	T	T	T
			1.6	0.6	T	T	T	T	T	T	T
			2	0.5	1	T	T	T	T	T	T
			3	0.3	0.5	0.7	1.2	2.1	T	T	T
			4	0.3	0.4	0.7	1	1.5	2.6	T	T
			6		0.4	0.5	0.7	0.9	1.4	2.4	4.8
			8		0.3	0.4	0.5	0.7	0.9	1.3	2
			10		0.3	0.4	0.5	0.7	0.9	1.3	2
			13		0.3	0.4	0.5	0.7	0.9	1.3	1.9
			16		0.3	0.4	0.5	0.7	0.9	1.3	1.9
			20			0.4	0.5	0.7	0.9	1.2	1.8
			25			0.4	0.5	0.7	0.9	1.2	1.8
			32				0.5	0.6	0.8	1	1.4
			40					0.6	0.8	1	1.4
			50						0.7	0.9	1.3
			63							0.9	1.2

					Supply S.	T2	T1 - T2							T1 - T2 - T3					
					Version	B, C, N, S, H, L													
	Char.	I_{cu} [kA]			Release	TM													
		10	15	25	I_n [A]	12.5	16	20	25	32	40	50	63	80	100	125	160		
Load S.	C	S200	S200M	S200P	≤2	T	T	T	T	T	T	T	T	T	T	T	T		
		S200	S200M	S200P	3	T	T	T	T	T	T	T	T	T	T	T	T		
		S200	S200M	S200P	4	T	T	T	T	T	T	T	T	T	T	T	T		
		S200	S200M	S200P	6	5.5[1]	5.5	5.5	5.5	5.5	5.5	5.5	10.5	T	T	T	T		
		S200	S200M	S200P	8			5.5	5.5	5.5	5.5	5.5	10.5	T	T	T	T		
		S200	S200M	S200P	10			3[1]	3	3	3	4.5	7.5	8.5	17	T	T		
		S200	S200M	S200P	13			3[1]		3	3	4.5	7.5	7.5	12	20	T		
		S200	S200M	S200P	16					3[1]	3	4.5	5	7.5	12	20	T		
		S200	S200M	S200P	20					3[1]		3	5	6	10	15	T		
		S200	S200M	S200P	25							3[1]	5	6	10	15	T		

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ABB as an inventor of miniature circuit breakers have pioneered in manufacturing circuit breakers for various applications. For example some of the range is with characteristics K & Z in accordance to IEC 60947-2.

The circuit breakers with “K” characteristics are having instantaneous tripping of 8 and 12 times In (rated current). These can be used for Starting of motors/switching transformers which will have much higher inrush currents.

The “Z” curve circuit breakers are having lower instantaneous tripping (2 and 3 times of rated current). Many sensitive types of equipment like semiconductors can be protected by using these circuit breakers.





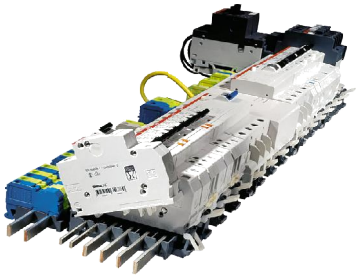

ABB offers comprehensive protection solutions for various application be it AC or DC network complying to both IEC 60898 and IEC 60947-2. Some of the solution is

- Residential/Commercial Buildings
- Industrial application
- Photo voltaic power plants(Solar)
- Wind mill application
- Railway application(Rolling stock)
- Motor application

Data Centers

ABB offers complete solutions with auto reclosures for MCB’s and RCCB’s. Modular bus bar system complying to IEC 60439 ensures safe and reliable power distribution in data centers with pluggable MCB’s for easy and quick replacements

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