



1. REQUIRED TESTS FOR MODULAR CAPACITORS BANK & SWITCHING MODULE SYSTEM – Item 1

1.1. Type tests

According to IEC 62271-200:2021 Clause 7

No	Test denomination	Sub clause	Value
1.1.1.	Power frequency withstand voltage test (See Note #1). Value of test voltage-common value ([kV rms] / [sec]):	7.2.6	70
1.1.2.	Lightning impulse withstand voltage test (See Note #1). Value of test voltage-common value ([kV peak])	7.2.6	170
1.1.3.	Power frequency withstand voltage test on auxiliary and control circuits. Value of test voltage ([kV rms] / [sec]):	7.2.11	2 / 60
1.1.4.	Measurement of the resistance of the main circuit	7.4	
1.1.5.	Continuous current tests (contacts, terminals, auxiliary and control equipment etc.) (See Note #2).	7.5	
1.1.6.	Short-time withstand current and peak withstand current tests, Value of test current (kA rms./sec) :	7.6	
1.1.7.	Verification of the IP coding	7.7.1	At least IP-54
1.1.8.	Verification of making and breaking capacities	7.101	
1.1.9.	Mechanical operation tests	7.102	
1.1.10.	Tests to verify the protection of persons against dangerous electrical effects.	7.104	

Note #1: The tests can be done with "fictive" capacitor units (empty container + bushings).

Note #2: The tests can be done with "fictive" capacitor units (empty container + bushings +
resistance elements representing the equivalent capacitor heating losses).

1.2. Type tests – (Continue) According to IEC 60529

№	Test denomination	clause	Value
1.2.1.	Tests for protection against access to hazardous parts.	12	
1.2.2.	Tests for protection against solid foreign objects.	13	
1.2.3.	Tests for protection against water.	14	

1.3. Routine tests According to IEC 62271-200:2021 Clause 8

№	Test denomination	Sub clause	Value
1.3.1.	Dielectric test on the main circuit, Value of test voltage ([kV rms] / [sec]) :	8.2	70
1.3.2.	Test of auxiliary and control circuits Value of test voltage ([kV rms] / [sec]) :	8.3	2 / 60
1.3.3.	Measurement of the resistance of the main circuit	8.4	
1.3.4.	Design and visual checks	8.6	
1.3.5.	Mechanical operation test	8.102	

1.4. Seismic qualification - According to IEEE Std. 693-2018 Annexure O

№	Test denomination	Sub clause	Value
1.4.1	Prove that the anchorage of the capacitors bank & switching module satisfies the requirements	A.1.5	Moderate Level
1.4.2	prove that the capacitors bank & switching module including all accessories will operate fully satisfactory during and after earthquake	A.1.5	Moderate Level

2. REQUIRED TESTS FOR CONTROL AND PROTECTION UNIT – Item 2

2.1. Type tests for protection relays

№	Test denomination	According To	Value
1.	Contact performance test	IEC 60255 PT0-20	
2.	Dielectric test with 2.5 kV , 50 Hz, 1 min. of input circuits	IEC 60255 PT5	
3.	Impulse voltage test with 5 kV impulses waveform 1.2/50 μ s on all inputs and outputs	IEC 60255 PT5	
4.	Fast transient test on all inputs according to class IV (2 kV)	IEC 60255 PT44-4	
5.	High frequency disturbance test 1 MHz burst test class III (2.5 kV)	IEC 60255 PT22-1	
6.	Electrostatic discharge test severity level 8 kV	IEC 60255 PT22-2	
7.	Interruption and ripple in DC auxiliary voltage	IEC 60255 PT11	
8.	Vibration test class 1	IEC 60255 PT21-1	
9.	Seismic test class 2	IEC 60255 PT21-3	
10.	Humidity test	IEC 60068 PT2-30	
11.	Accuracy dependence test for measuring elements and timers for frequency, DC supply and ambient temperature dependence.		
12.	Power consumption and overload test.		
13.	Accuracy test for measuring elements and timers.		
14.	Operating and resetting time test with and without CT saturation for over current relays.		
15.	Tests to prove all basic and additional functions of the protection relays.		

2.2. Seismic qualification

According to IEEE Std. 693-2018

№	Test denomination	According to Annexure	Value
1	Prove that the protection and control cubicle including all accessories will operate fully satisfactory during and after earthquake.	M	Moderate Level
2	Seismic analysis report to prove the qualification level of the entire cubicle and of each component.	S	Moderate Level

2.3. Factory acceptance tests

№	Test denomination	Value
1.	Measure of tripping time of relays.	
2.	Measure of all important pick-up values.	
3.	Measure tolerances and errors for pick-up values and timers.	
4.	Stability of differential relays for external faults.	
5.	Functional tests including test of input and output circuits.	
6.	High voltage (2 kV/50 Hz, 1 min.) and insulation resistance tests (500 VDC)	
7.	Control all functions of internal test facilities (if available).	
8.	Verify the equipment in the rack of protection cubicles and card cage against documents.	
9.	Checking of wiring in protection cubicle and wire connection. The test shall include point-to-point continuity test and electrical insulation test. Checking of ground connection.	

3. REQUIRED TESTS FOR CAPACITOR UNIT

3.1. Type tests

According to IEC 60871-1:2014 Sub-Clause 6.3

№	Test denomination	clause	Value
3.1.1.	Thermal stability test	13	
3.1.2.	Measurement of the tangent of the loss angle ($\tan \delta$) of the capacitor at elevated temperature	14	
3.1.3.	AC voltage test between terminals and container	15.1	
3.1.4.	Lightning impulse voltage test between terminals and container	15.2	
3.1.5.	Overvoltage test	16	
3.1.6.	Short-circuit discharge test	17	

3.1.7. Disconnecting test on internal fuses (see 5.3 of IEC 60871-4:1996).

3.1.8. Test of an external fuse in combination with a capacitor (see Annex C).

3.2. Routine tests

According to IEC 60871-1:2014 Sub-Clause 6.2

№	Test denomination	clause	Value
3.2.1.	Capacitance measurement	7	
3.2.2.	Measurement of the tangent of the loss angle ($\tan \delta$) of the capacitor	8	
3.2.3.	Voltage test between terminals	9	
3.2.4.	AC voltage test between terminals and container	10	
3.2.5.	Test of internal discharge device	11	
3.2.6.	Sealing tes	12	

3.2.7. Discharge test on internal fuses (see 5.1.1 of IEC 60871-4:1996).

4. REQUIRED TESTS FOR CAPACITOR SWITCH

4.1. Type tests

According to IEC 62271-100:2021 Clause 7

№	Test denomination	Sub clause	Value
4.1.1.	<u>Dielectric tests as follows:</u>	7.2	
	a. Power frequency voltage test	7.2.6.1	
	b. Lightning impulse voltage test	7.2.6.2	
4.1.2.	Radio interference voltage tests	7.3	
4.1.3.	Measurement of the resistance of the main circuit.	7.4	
4.1.4.	Temperature rise tests	7.5	
4.1.5.	Short-time withstand current and peak withstand current test	7.6	
4.1.6.	Tightness tests	7.8	
4.1.7.	EMC tests	7.9	
4.1.8.	Additional tests on auxiliary and control circuits	7.10	
4.1.9.	Mechanical operation test at ambient air temperature	7.101.2 Class M2	
4.1.10.	Short circuit current making and breaking test	7.102 to 7.106	
4.1.11.	Capacitive current switching tests: cable-charging current breaking tests ($U_r \leq 52$ kV)	7.111.5.2	
	Mandatory type tests, where applicable		
4.1.12.	Verification of the degree of protection	7.7	
4.1.13.	Extended mechanical endurance tests on circuit-breakers for special service conditions *#	7.101.2.4	
4.1.14.	Low and high temperature tests	7.101.3	
4.1.15.	Humidity test	7.101.4	
4.1.16.	Static terminal load tests	7.101.6	
4.1.17.	Critical current tests	7.107	
4.1.18.	Short-line fault tests *	7.109	
4.1.19.	Out-of-phase making and breaking tests *#	7.110	
4.1.20.	Electrical endurance tests (only for rated voltages of 52 kV and below) *#	7.112	
4.1.21.	Test to prove operation under severe ice conditions *#	7.101.5	
4.1.22.	Single-phase and double earth fault tests *#	7.108	
4.1.23.	Capacitive current switching tests: • line-charging current breaking tests* ($U_r \leq 52$ kV) • single capacitors bank switching tests *# • back-to-back capacitors bank switching tests *#	7.111.5.1 7.111.5.3 7.111.5.3	

NOTE: All type tests shall be carried out using the number of test samples specified in 6.1.1 of IEC 60694 and in 6.102.2. Where, in the case of circuit-breakers with a rated voltage of up to and including 52 kV, the test is marked by *, an additional test sample is allowed for the marked test.

Also for Capacitor switch of capacitors bank & switching modules:

4.1.24. Back-to-back current switching tests that shall include 120 closings with the following parameters (see Clause 7.111.9.1.5 of Standard 62271-100:2021), with the following parameters:

- Peak phase-to-ground voltage in (kV peak)
- Back-to-back capacitors bank inrush making current in (kA peak)
- Frequency of the inrush current in (Hz)

4.1.25. In order to prove the ability of the proposed circuit breaker to disconnect capacitors banks without restrike, three –phase switching tests of a rated voltage capacitors bank with floating neutral shall be performed. The test shall include the following operations (see Clause 7.111.9.1.4 of Standard IEC 62271-100:2021):

- Test duty 2 BC2: 80 CO of 400 A, at circuit breaker Rated Voltage.
- Test duty 1 BC1: 24 O of 100 A, at circuit breaker Rated Voltage.

4.2 Seismic qualification

According to IEEE Std. 693-2018

№	Test denomination	According to Annexure	Value
4.2.1	Prove fulfillment of the requirements of A.1.5.	C	Moderate Level
4.2.2	Prove the adequateness of the anchorage according to A.1.5	C	Moderate Level

4.3. Routine tests**According to IEC 62271-100:2021 Clause 8**

№	Test denomination	Sub clause	Value
4.3.1.	Dielectric test on main circuit	8.2	
4.3.2.	Tests on auxiliary and control circuits	8.3	
4.3.3.	Measurement of the resistance of the main circuit	8.4	
4.3.4.	Tightness tests	8.5	
4.3.5.	Design and visual checks	8.6	
4.3.6.	Mechanical operating tests	8.101	

5. REQUIRED TESTS FOR REACTORS

5.1. Type tests

According to IEC 60076-6:2007 Sub-Clause 9.10.3

№	Test denomination	Sub clause	Value
5.1.1.	Measurement of inductance	9.10.5	
5.1.2.	Measurement of loss and quality factor	9.10.6	
5.1.3.	Temperature rise test	9.10.8	
5.1.4.	Lightning impulse test	9.10.9	

5.2. Routine tests

According to IEC 60076-6:2007 Sub-Clause 9.10.2

№	Test denomination	Sub clause	Value
5.2.1.	Measurement of winding resistance according to IEC 60076-1.	-----	
5.2.2.	Measurement of inductance	9.10.5	
5.2.3.	Measurement of loss and quality factor	9.10.6	
5.2.4.	Winding overvoltage test – if applicable.	9.10.7	

6. REQUIRED TESTS FOR EARTHING SWITCH

6.1. Type tests

According to IEC 62271-102:2018 Clause 7

№	Test denomination	Sub clause	Value
6.1.1.	Dielectric tests	7.2	
6.1.2.	Measurement of the resistance of the main circuit	7.4	
6.1.3.	Short-time withstand current and peak withstand current test	7.6	
6.1.4.	Verification of protection	7.7	
6.1.5.	Operating and mechanical endurance tests	7.102	

6.2. Routine tests

According to IEC 62271-102:2018 Clause 8

№	Test denomination	Sub clause	Value
6.2.1.	Dielectric test on the main circuit	8.2	
6.2.2.	Dielectric test on auxiliary and control circuits	8.3	
6.2.3.	Measurement of the resistance of the main circuit	8.4	
6.2.4.	Tightness test	8.5	
6.2.5.	Design and visual checks	8.6	
6.2.6.	Mechanical operating test	8.101	

7. REQUIRED TESTS FOR CURRENT TRANSFORMER

7.1. Type tests

According to IEC 61869-2:2012 Sub-Clause 7.2

№	Test denomination	Sub clause	Value
7.1.1.	Temperature-rise test	7.2.2	
7.1.2.	Impulse voltage withstand test on primary terminals	7.2.3	
7.1.3.	Tests for accuracy	7.2.6	
7.1.4.	Short-time current tests	7.2.201	

7.2. Routine tests

According to IEC 61869-2:2012 Sub-Clause 7.3

№	Test denomination	Sub clause	Value
7.2.1.	Power-frequency voltage withstand tests on primary terminals	7.3.1	
7.2.2.	Tests for accuracy	7.3.5	
7.2.3.	Verification of markings	7.3.6	
7.2.4.	Determination of the secondary winding resistance (R_{ct})	7.3.201	
7.2.5.	Determination of the secondary loop time constant (T_s)	7.3.202	
7.2.6.	Test for rated knee point e.m.f. (E_k) and exciting current at rated knee point e.m.f. E_k	7.3.203	
7.2.7.	Inter-turn overvoltage test	7.3.204	

8. REQUIRED TESTS FOR SUPPORT INSULATORS

8.1. Type tests

According to IEC 60660:1999 Sub-Clause 3 (*)

№	Test denomination	Sub clause	Value
8.1.1.	Partial discharge extinction voltage test	3.5	
8.1.2.	Mechanical failing load test	3.7	
8.1.3.	Test for deflection under load at normal ambient temperature conditions	3.8	

8.2. Routine tests

According to IEC 60660:1999 Sub-Clause 4 & 5 (*)

№	Test denomination	Sub clause	Value
8.2.1.	Verification of dimensions	4.2	
8.2.2.	Visual examination	5.2	
8.2.3.	Mechanical routine test	5.3	
8.2.4.	Electrical routine test and partial discharge measurement	5.4	

(*) In case of using post insulators of ceramic material or glass the tests can be done according to IEC 60168.

(*) In case of using composite line post insulators the tests can be done according to IEC 61952.