Distributed Coordination Simulations Results: Distribution System Growth

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I. Study Case and Results

The defined study case is modified connecting a new DER as shown in Fig. 1. Defining the same four balanced three phase fault scenarios, the performance of the proposed protection algorithm is assessed.
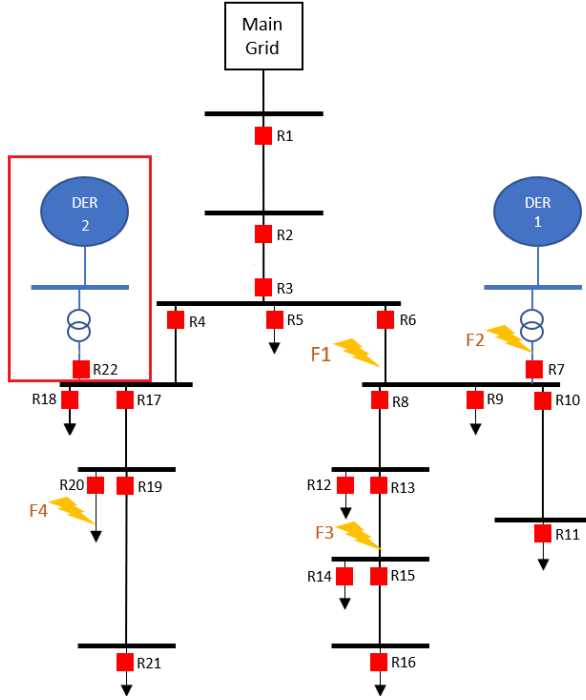

Fig. 1. Modified European MV CIGRE network with the defined fault locations under study.

With the newly connected protection equipment, the constants related to the voltage-restricted overcurrent curves of the existing equipment remain unchanged. For the new protection equipment, *R22*, the constants defined for *R7*, are used. In Table I, all the parameters related to the operating time curves are summarized.

The calculated operating times are presented in Table II.

With the connection of a new fault source in a distribution system, the complexity of the coordination problem increases due to the appearance of a new protection path in all fault scenarios. However, as shown in Table II, the proposed protection algorithm can accommodate system growth with changes only in the distributed optimization problem of the local new protection equipment neighborhood, without impacting the global selectivity of the protection system.

TABLE I
VOLTAGE-RESTRICTED OVERCURRENT SHAPE CONSTANTS.

Protection Equipment	R1, R2, R3 R4, R17	R6, R7, R22	R8, R13, R20
k1	2	2	2
k2	1	1	1
k3	5	1	10
k4	0.01	0.05	0.05

TABLE II
CALCULATED OPERATING TIMES FOR THE DEFINED STUDY CASE.

Fault Scenario	Primary operating time (ms)	Backup operating time (ms)				
F1	t_{R7} 40					
	t_{R6} 40		t_{R3} 104	t_{R2} 204	t_{R1} 307	
			t_{R4} 104	t_{R22} 263		
F2	t_{R7} 40	t_{R6} 112	t_{R3} 215	t_{R2} 316	t_{R1} 415	
			t_{R4} 204	t_{R22} 362		
F3	t_{R13} 40	t_{R8} 105	t_{R7} 306			
		t_{R6} 207	t_{R3} 311	t_{R2} 414	t_{R1} 510	
			t_{R4} 302	t_{R22} 400		
F4	t_{R20} 40	t_{R17} 108	t_{R4} 210	t_{R6} 309	t_{R7} 409	
				t_{R3} 310	t_{R2} 413	t_{R1} 508
		t_{R22} 210				