

Exercise 6.4 – Short-Circuit Current and Dimensioning in Medium-Low-Voltage Networks

For the electrical network represented in Figure 1, you must:

1. Define and verify the characteristics of the medium-voltage (MV) line cable (EPR insulation), taking into account a maximum intervention time of 350 ms for circuit breaker I1 after a three-phase short circuit.
2. Determine the direct and inverse impedances of the medium-voltage network.
3. Define and verify the characteristics of the low-voltage (LV) line cable (EPR insulation), considering a maximum intervention time of 150 ms for circuit breaker I3 after a three-phase short circuit.
4. Calculate the three-phase short-circuit current for circuit breakers I5 and define its characteristics in terms of breaking and re-closing capacities.

Medium-Voltage Network Data (MV):

- Nominal voltage: 20 kV
- Neutral state of the network: isolated
- Short-circuit power: 350 MVA
- Ratio $R_{cc}^{MV}/X_{cc}^{MV} = 0$

Transformer MV/LV Data (attached data):

- Nominal power: 500 kVA
- Nominal transformation ratio: 20/0.4 kV
- Winding connection: Delta (20 kV winding) – Star grounded (0.4 kV winding)
- Oil-cooled.

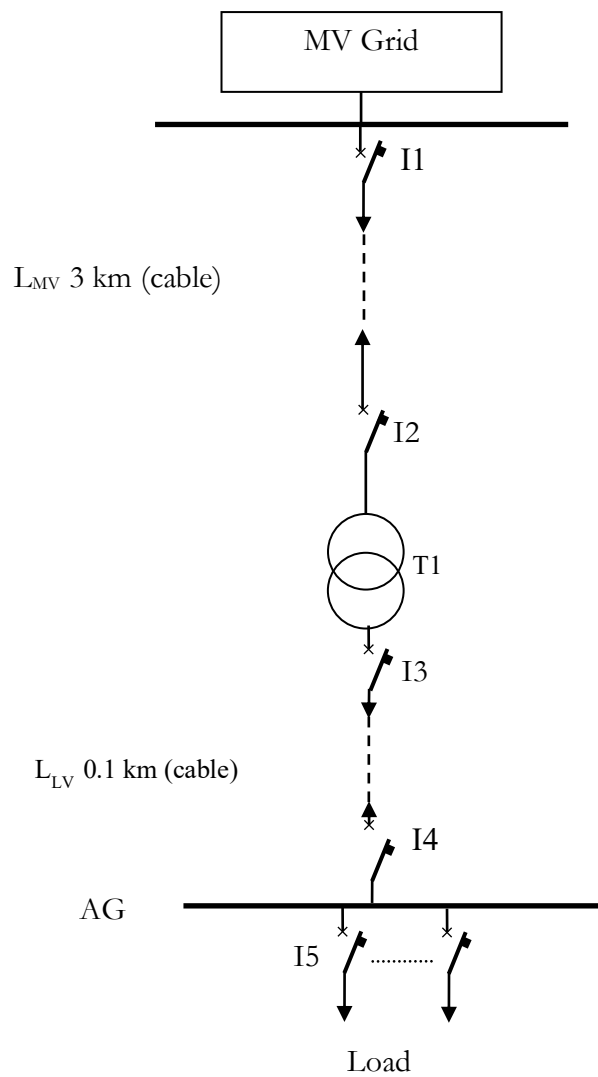


Figure 2 – Grid Schematics

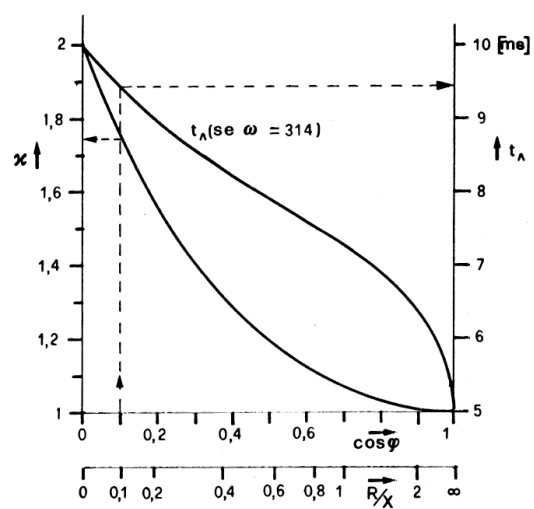


Figure 1 – χ Factor as a function of the ratio R_{cc}/X_{cc} of the short-circuit impedance $\bar{Z}_{cc}$.

Characteristics of low voltage cables (0.4kV) with EPR insulation ($K = 143$)

Conductor cross-section [mm ²]	Maximum Amperage [A]					
	30 °C in air	at 30°C in air tube	at 20 °C buried tube		at 20°C buried	
			p=1	p=1.5	p=1	p=1.5
1.5	24	20	22	21	35	32
2.5	33	28	29	27	45	39
4	45	37	37	35	58	51
6	58	48	47	44	73	64
10	80	66	63	59	97	85
16	107	88	82	77	125	110
25	135	117	108	100	160	141
35	169	144	132	121	191	169
50	207	175	166	150	226	199
70	268	222	204	184	277	244
95	328	269	242	217	331	292
120	383	312	274	251	377	332
150	444	355	324	287	420	370
185	510	417	364	323	476	419
240	607	490	427	379	550	484
300	703	-	484	429	620	546
400	823	-	564	500	700	616

Conductor cross-section [mm ²]	Resistance [ohm/km] at 70°C		Reactance [ohm/km] at 50°C	
	Dc	c.a	unipolar	multipolar
1.5	15.9	15.9	0.147	0.106
2.5	9.55	9.55	0.186	0.098
4	5.92	5.92	0.129	0.097
6	3.95	3.95	0.121	0.092
10	2.29	2.29	0.111	0.086
16	1.45	1.45	0.103	0.081
25	0.93	0.93	0.097	0.080
35	0.66	0.66	0.093	0.077
50	0.46	0.46	0.090	0.076
70	0.33	0.33	0.086	0.074
95	0.25	0.25	0.085	0.074
120	0.193	0.194	0.081	-
150	0.154	0.156	0.081	-
185	0.127	0.129	0.081	-
240	0.096	0.099	0.080	-
300	0.090	0.092	0.080	-
400	0.086	0.087	0.080	-

Characteristics of medium voltage cables (20kV) with EPR insulation ($K = 143$)

Section [mm ²]	Specific Resistance [Ohm/km]	Reactance [Ohm/km]	Specific Capacity [$\mu F / km$]	Maximum Current Value [A]
25	0.929	0.15	0.18	157
35	0.670	0.14	0.17	190
50	0.495	0.13	0.19	228
70	0.344	0.13	0.21	284
95	0.248	0.12	0.23	346
120	0.198	0.12	0.25	399

MV/LV transformer data

TPRE - V

SERIE

<= 24 KV

Perdite ridotte

Reduced losses SEA

Pertes reduites SEA

SEA abgesenkte verluste

CEI-UNEL 21010

Tensione II° a vuoto

Secondary voltage

Tension secondaire

Sekundär

400 V.

Regolazione MT

Tappings

Regulation

Klemmsache

+/- 5%

Gruppo vettor.

Vector group

Groupe vectoriel

Schaltgruppe

Dyn11

DATI ELETTRICI

ELECTRICAL DATA

DONNEES ELECTRIQUES

ELEKTRISCHE DATEN

CEI 14-13 - DIN 42500 - CENELEC HD 428.1 S1 TAB.8*

Pot.	KVA	(50)	100	160	250 (315)	400 (500)	630	630 (800)	1000	1250	1600	2000	2500	3150			
Wfe	Watt	150	250	360	520	510	740	740	1040	900	1090	1300	1600	2000	2400	3000	3600
Wcc (75 °C)	Watt	850	1400	1850	2600	3500	3650	4900	5200	5600	7000	9000	10600	13000	16000	21000	25500
Vcc (75 °C)	%	4	4	4	4	4	4	4	4	6	6	6	6	6	6	6	6
Ioo	%	1,9	1,5	1,3	1,1	1	0,9	0,9	0,8	0,8	0,8	0,7	0,6	0,5	0,5	0,5	0,5
Lwa	dB(A)	46	48	50	52	54	54	55	56	56	58	58	59	60	62	64	66
Lpa 1 ml.	dB(A)	41	42	44	46	48	48	49	49	49	50	50	51	51	52	54	55
μ cosfi 1 (75 °C)	4/4 %	98,04	98,38	98,64	98,77	98,74	98,91	98,88	99,02	98,98	99	98,98	99,03	99,07	99,09	99,05	99,08
	3/4 %	98,35	98,64	98,85	98,95	98,96	99,08	99,08	99,17	99,15	99,17	99,16	99,2	99,23	99,25	99,22	99,25
	2/4 %	98,57	98,81	98,98	99,07	99,13	99,18	99,22	99,26	99,28	99,3	99,3	99,32	99,35	99,36	99,34	99,37
μ cosfi 0,9 (75 °C)	4/4 %	97,83	98,2	98,49	98,63	98,61	98,8	98,76	98,91	98,87	98,89	98,87	98,93	98,97	98,99	98,94	98,98
	3/4 %	98,17	98,49	98,72	98,84	98,85	98,98	98,97	99,08	99,06	99,08	99,07	99,11	99,15	99,16	99,13	99,16
	2/4 %	98,41	98,68	98,87	98,97	99,03	99,09	99,13	99,18	99,2	99,22	99,22	99,25	99,28	99,29	99,27	99,3
μ cosfi 0,8 (75 °C)	4/4 %	97,56	97,98	98,3	98,46	98,43	98,65	98,61	98,78	98,73	98,75	98,73	98,79	98,84	98,86	98,81	98,86
	3/4 %	97,95	98,3	98,56	98,7	98,71	98,85	98,85	98,96	98,94	98,96	98,95	99	99,04	99,06	99,02	99,06
	2/4 %	98,22	98,52	98,73	98,84	98,91	98,98	99,03	99,08	99,1	99,12	99,12	99,16	99,19	99,21	99,18	99,21
Ie/In		12	11,5	11	10,5	10	9,5	9	8	8	8	7,5	7,5	7,4	7,2	7,2	7
T	sec.	0,06	0,07	0,08	0,08	0,1	0,12	0,14	0,15	0,16	0,16	0,2	0,22	0,25	0,27	0,3	0,35
In II°	A	72	144	231	361	455	577	722	909	909	1155	1443	1804	2309	2887	3608	4547
Icc	A	1800	3600	5775	9025	11375	14425	18050	22725	15150	19250	24050	30067	38483	48117	60133	75783
Ri (75 °C)	%	1,7	1,4	1,16	1,04	1,11	0,91	0,98	0,83	0,89	0,88	0,9	0,85	0,81	0,8	0,84	0,81
Xi	%	3,62	3,75	3,83	3,86	3,84	3,9	3,88	3,91	5,93	5,94	5,93	5,94	5,95	5,95	5,94	5,95
DV cosfi 1	4/4 %	1,77	1,47	1,23	1,11	1,18	0,99	1,06	0,91	1,07	1,06	1,08	1,03	0,99	0,98	1,02	0,99
	cosfi 0,9	3,14	2,93	2,76	2,66	2,72	2,57	2,62	2,5	3,51	3,5	3,52	3,48	3,45	3,44	3,47	3,45
	cosfi 0,8	3,55	3,39	3,25	3,18	3,22	3,1	3,14	3,04	4,36	4,36	4,37	4,33	4,31	4,3	4,33	4,31
Q o	KVAR	0,9	1,4	1,9	2,4	2,9	3,2	4,1	4,4	4,5	5,8	6,2	6,6	6,8	8,5	10,7	13,6
Q fi	KVAR	1,4	3,1	5,2	8,4	10,4	13,9	17	22	34,6	43,6	55	68,9	89,1	111,2	138,4	174,8

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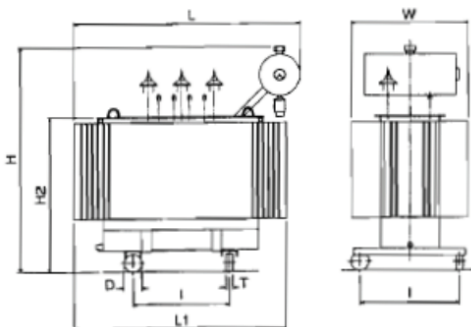
TECHNICAL DATA

DONNEES TECHNIQUES

TECHNISCHE DATEN

Pot.	KVA	(50)	100	160	250 (315)	400 (500)	630	630 (800)	1000	1250	1600	2000	2500	3150			
DIMENSIONI		OVERALL DIMENSIONS - DIMENSIONS - MABE															
L	mm.	1200	1150	1270	1380	1400	1500	1550	1570	1650	1700	1730	1950	2020	2020	2400	2700
W	mm.	570	740	720	800	750	910	830	900	960	1020	1050	1150	1250	1260	1300	1500
H	mm.	1260	1300	1410	1400	1500	1560	1620	1680	1570	1720	1760	1850	2020	2170	2220	2420
L1	mm.	910	850	960	1200	1220	1450	1400	1450	1570	1620	1730	1850	1940	2000	2150	2420
H1	mm.	1210	1230	1290	1330	1450	1500	1520	1585	1480	1590	1640	1800	1960	1960	1980	2150
H2	mm.	810	830	890	930	1060	1100	1120	1200	1080	1190	1240	1400	1560	1600	1750	
L x l	mm.	420	520	520	520	670	670	670	670	670	670	620	620	820	1070	1070	1070
D	mm.	100	125	125	125	125	125	125	125	125	125	150	150	150	200	200	200
T	mm.	45	40	40	40	40	40	40	40	40	40	60	60	60	70	70	70
PESI		WEIGHTS - MASSE - GEWICHT															
Tot.	Kg	440	600	800	1050	1250	1420	1650	1970	1950	2250	2750	3200	3700	4300	5300	6400
Oil	Kg	80	85	130	160	190	220	240	280	290	400	480	600	650	800	950	1150
P.E.	Kg	250	400	520	700	830	1000	1100	1350	1300	1450	1700	1900	2270	2500	2950	3500

CON CONSERVATORE - OIL CONSERVATOR
AVEC LE CONSERVATEUR - AUSDEHNUNGSGEFÄSS



TIPO ERMETICO - HERMETICALLY SEALED
HERMETIQUE - HERMETISCHE AUSFÜHRUNG

