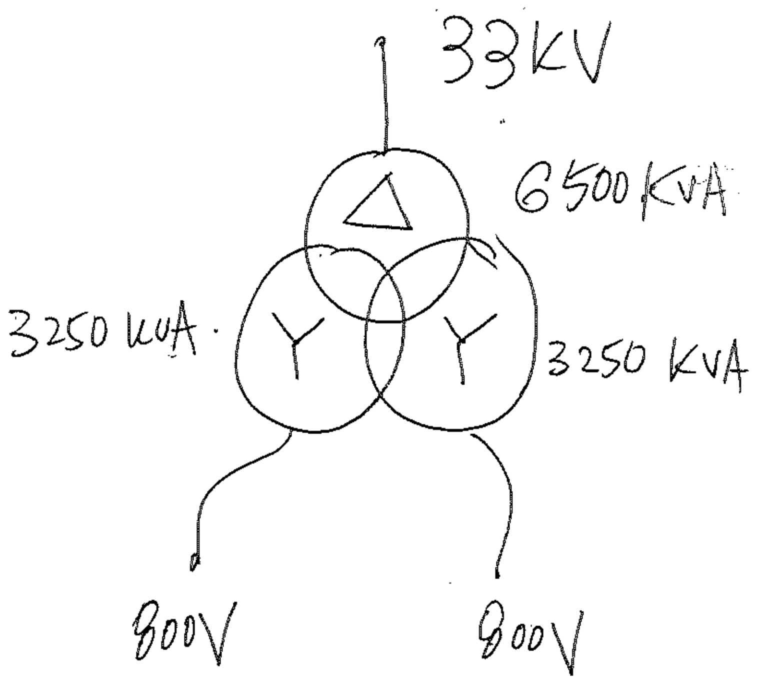
APPENDIX 5 - STS-6000K TRANSFORMER DATASHEET

3.4 LV/MV Transformer

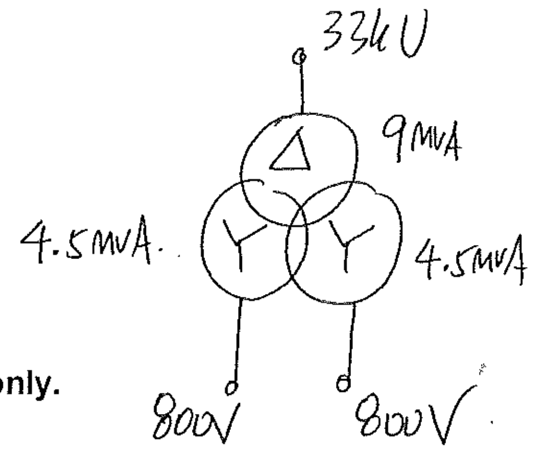
3.4.1 Transformer Data

LV/MV transformer in STS-6000K-H1 is an oil-immersed transformer 6500 kVA @40°C, and the transformer is Eco-design type with lower transformer loss, the transformer PEI is in compliance with tier 2 efficiency of (EU) 548/2014 amended by Regulation (EU) 2019/1783.

Item	Parameter
Applicable Standard	IEC 60076, EN 50588-1
Type/Design Code	Oil-immersed Conservator type
Cooling Type	ONAN
Rated Power	6500 kVA@40°C
Output Voltage	33 kV
MV Insulation Level	LI 170 / AC 70 kV
DETC Tappings	± 2 x 2.5%
Low Voltage	0.8 kV
Low Voltage Insulation Level	LI-/AC10 kV
Rated Frequency / No. of Phases	50 Hz / 3
Transformer Phase Sequence	MV: 1U-1V-1W; LV1: 2U-2V-2W; LV2: 3U-3V-3W
Impedance(HV-LV1, LV2)	8% (0 ~+ 10%) @6,500 kVA
Impedance(HV-LV1 / HV-LV2)	14%(0~+10%) @6,500 kVA
Vectoring Group	Dy11-y11
PEI	99.574%
Rated Load Loss	42.6 kW
Rated No-Load Loss	4.5 kW
Oil Type	Mineral Oil (PCB Free)
Winding Material	Al



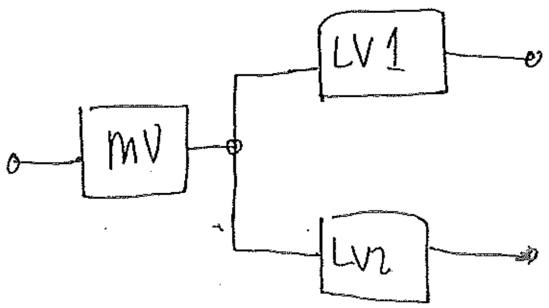
APPENDIX 9 - NEW TRANSFORMER IMPEDANCES



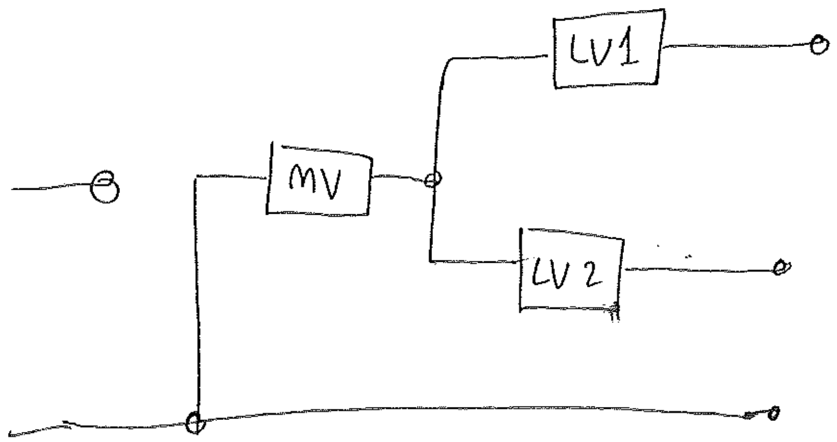
Note: The following data are design calculations only.

Calculated Transformer Impedance STS-9000K-H1

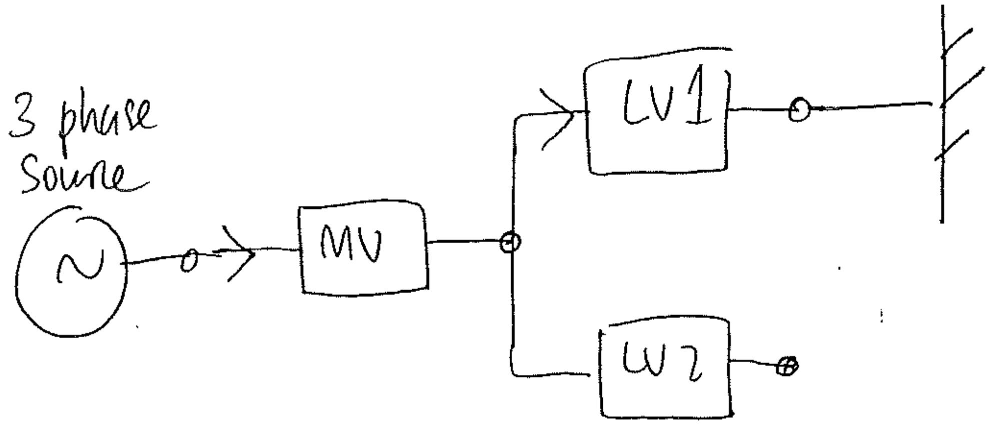
STS-9000K-H1 9000kVA AA efficiency, For Europe ONLY			Positive / Negative Sequence					Zero Sequence			
			Impedance (%)	Reactance (%)	Resistance (%)	X/R	Load loss kW	Impedance (%)	Reactance (%)	Resistance (%)	X/R
STS-9000K-H1 9000kVA AA efficiency For Europe ONLY	MV-LV1&LV2 capacity base:9000kVA	MAX.	11.82	11.80	0.61	19	55.3	10.05	10.03	0.52	19
		RAT.	11.9	11.88	0.62	19	55.7	10.12	10.10	0.53	19
		MIN.	11.98	11.96	0.63	19	56.7	10.18	10.17	0.54	19
	MV-LV1 or MV-LV2 capacity base:4500kVA	MAX.	9.51	9.48	0.72	13	32.3	8.08	8.06	0.61	13
		RAT.	9.55	9.52	0.73	13	32.8	8.12	8.09	0.62	13
		MIN.	9.59	9.56	0.74	13	33.2	8.15	8.13	0.63	13
	LV1-LV2 capacity base:4500kVA	RAT.	15.2	15.18	0.76	20	34.4	12.92	12.90	0.65	20



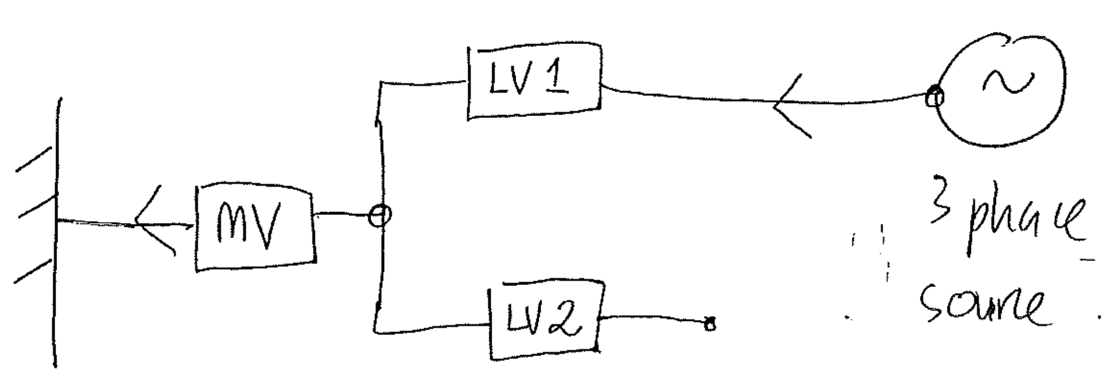
positive OR negative sequence impedance.



negative sequence impedance.

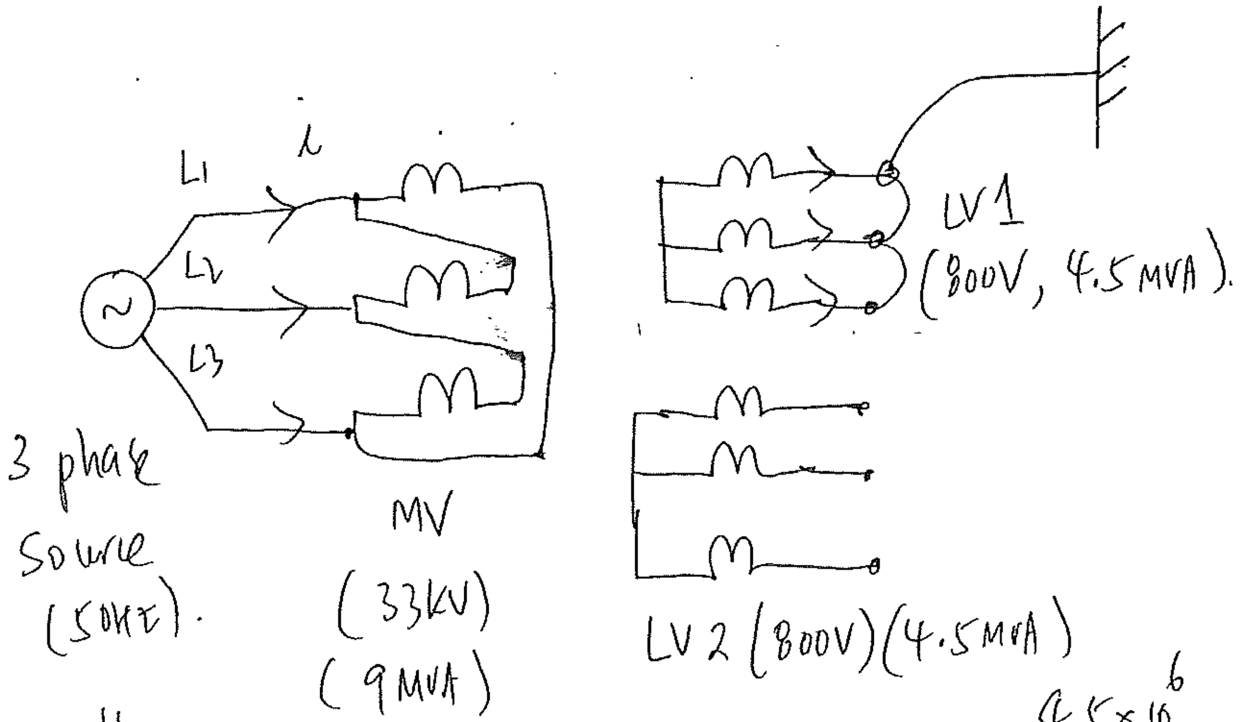


OR



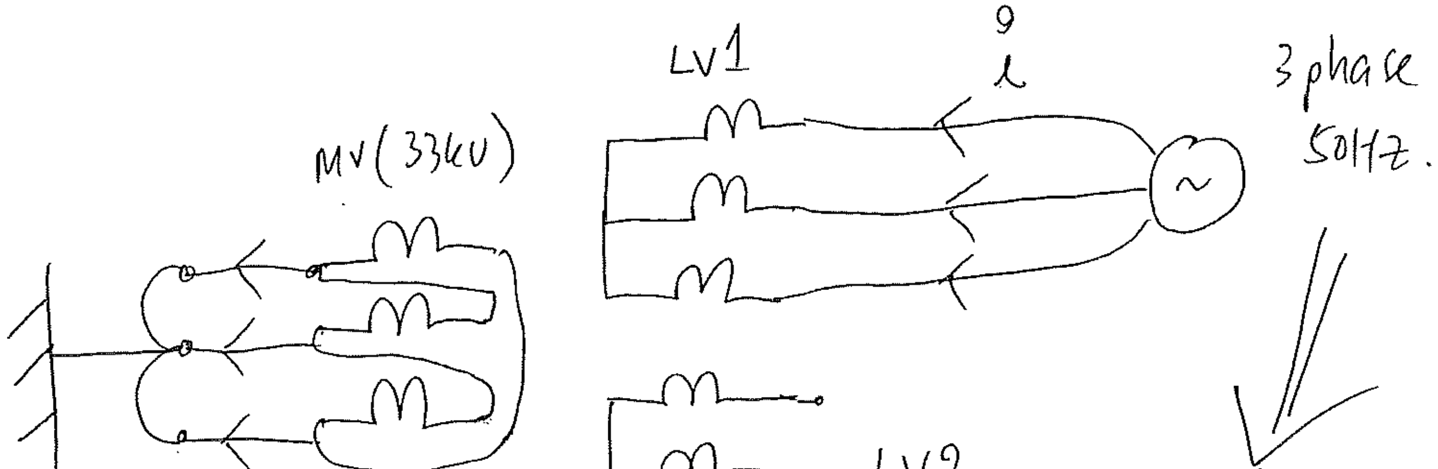
$Z1 = MV + LV1$
$= 9.55\%$ ON 4.5MVA.

$Z1 = MV + LV1$
$= 9.55\%$ ON 4.5 MVA.



Voltage $= 9.55\% \times 33kV$
$= 3.2kV$

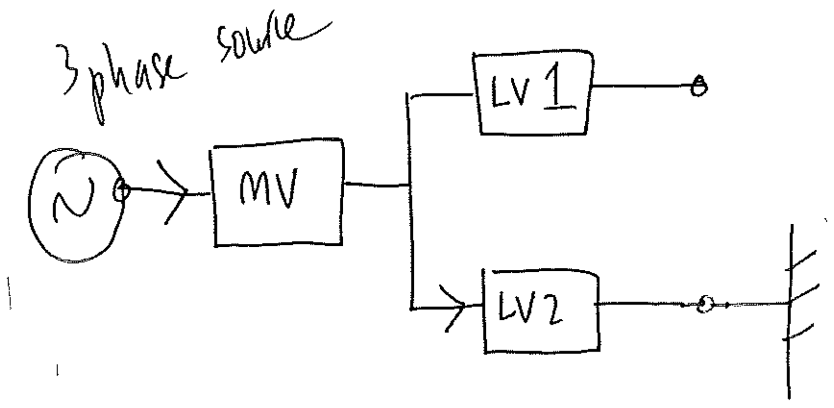
$$i = \frac{4.5 \times 10^6}{\sqrt{3} \times 33 \times 10^3}$$
$$= 79A.$$



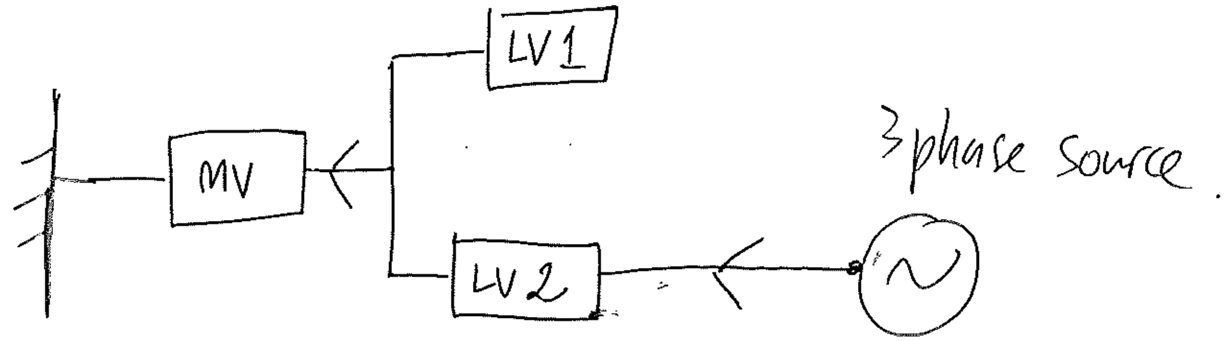
Voltage
$= 9.55\% \times 800V$
$= 76$ volts.

$$i = \frac{4.5 \times 10^6}{\sqrt{3} \times 800} = 3248A$$

positive sequence impedance (Z_{MV_LV1}).

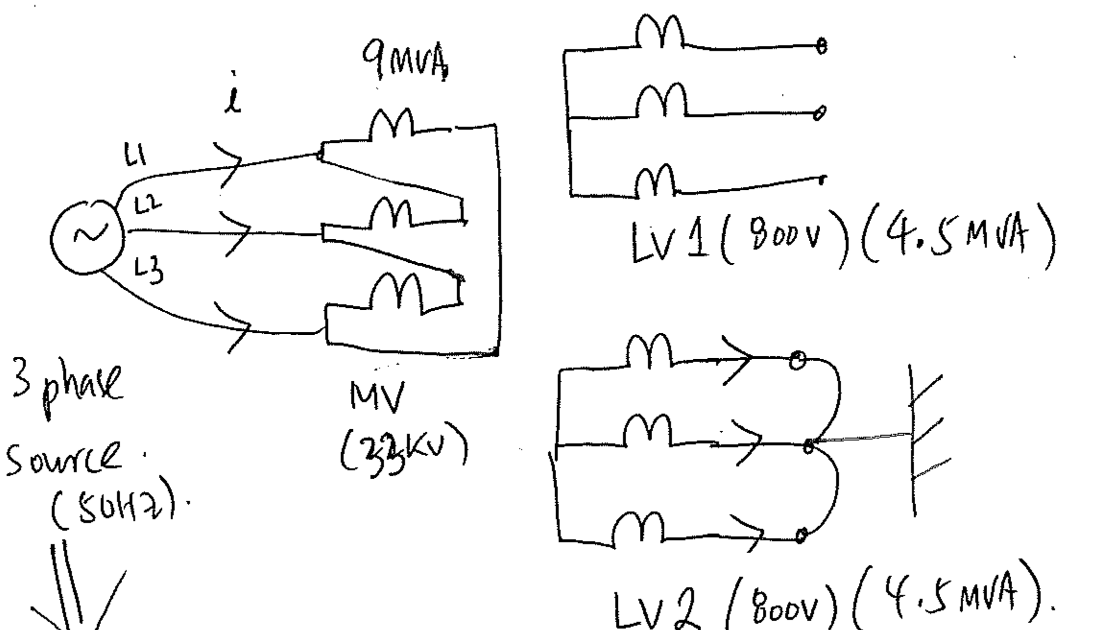


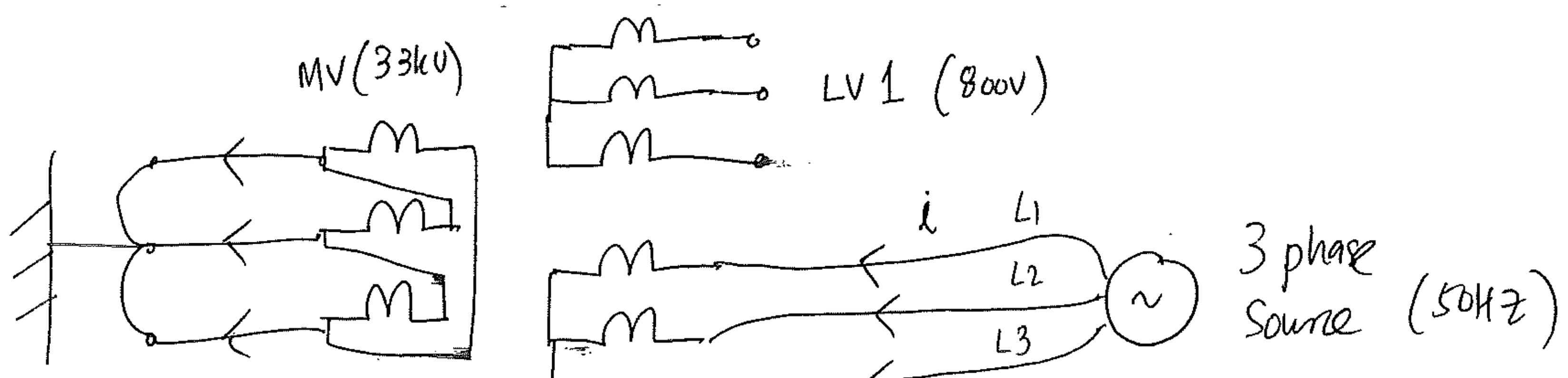
OR



$Z1 = MV + LV2$
$= 9.55\%$ ON 4.5 MVA.

$Z1 = MV + LV2$
$= 9.55\%$ ON 4.5 MVA





Voltage
$= 9.55\% \times 33$ kV
$= 3.2$ kV

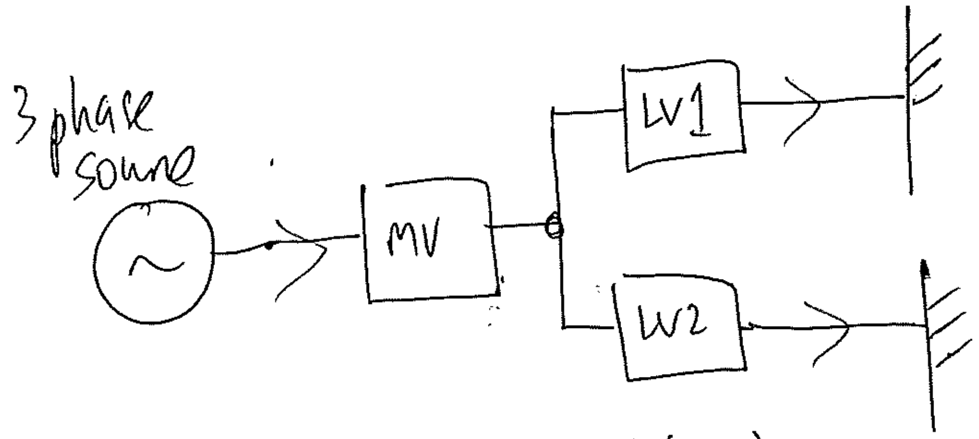
$$i = \frac{4.5 \times 10^6}{\sqrt{3} \times 33 \times 10^3}$$
$= 79$ A

Voltage $= 9.55\% \times 800$V
$= 76$ volts.

$$i = \frac{4.5 \times 10^6}{\sqrt{3} \times 800} = 3248 \text{ A}.$$

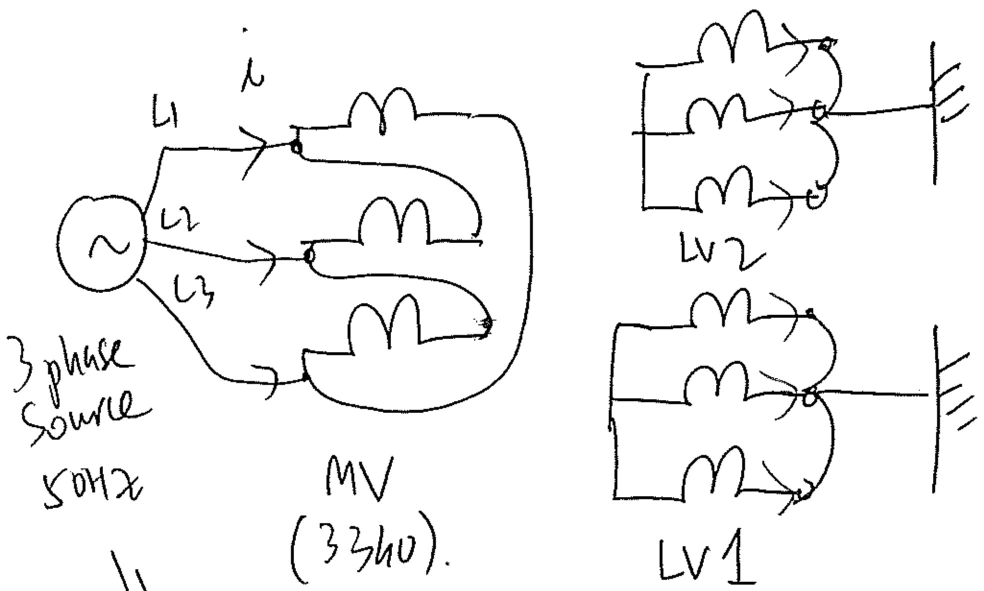
4

positive sequence impedance (Z_{MV_LV2})



$$Z_1 = MV + \frac{(LV1)(LV2)}{LV1 + LV2}$$

$$= 11.9\ \%\ \text{ON } 9\ \text{MVA}.$$



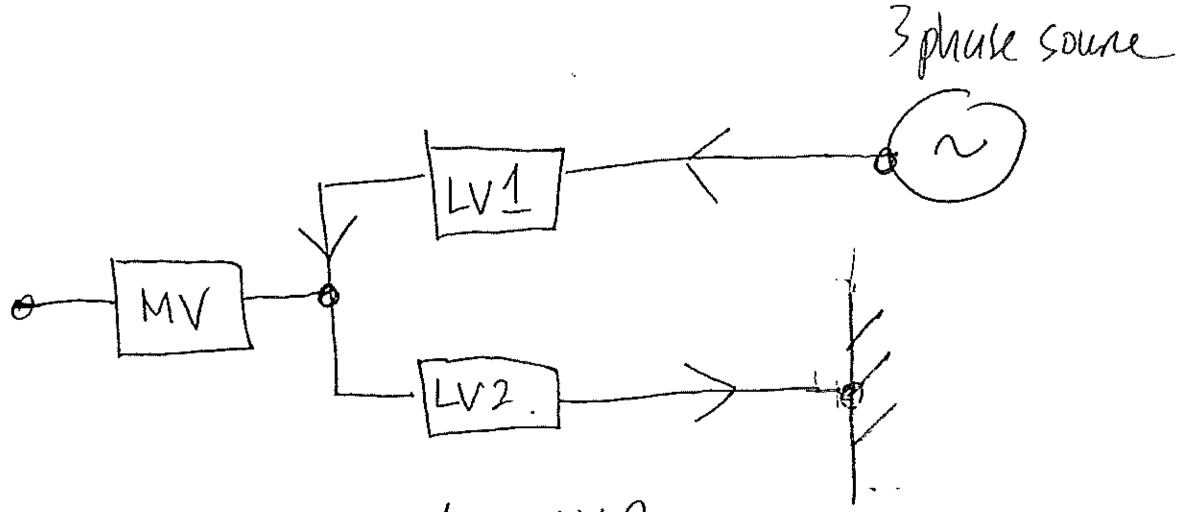
$$i = \frac{9 \times 10^6}{\sqrt{3} \times 33 \times 10^3}$$

$$= 155A$$

$$\text{Voltage} = 11.9\% \times 33kV$$

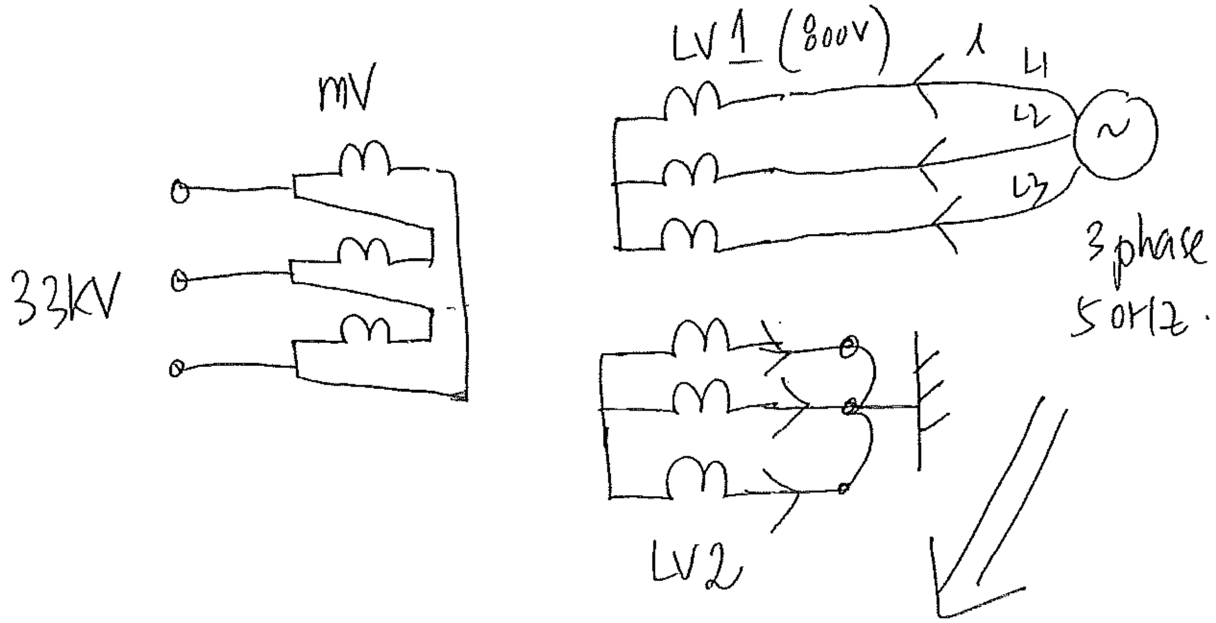
$$= 3.9kV$$

Positive sequence impedance ($Z_{MV\_(LV1//LV2)}$)



$Z_1 = LV1 + LV2$

$= 15.2\%$ ON $4.5MVA$



Voltage

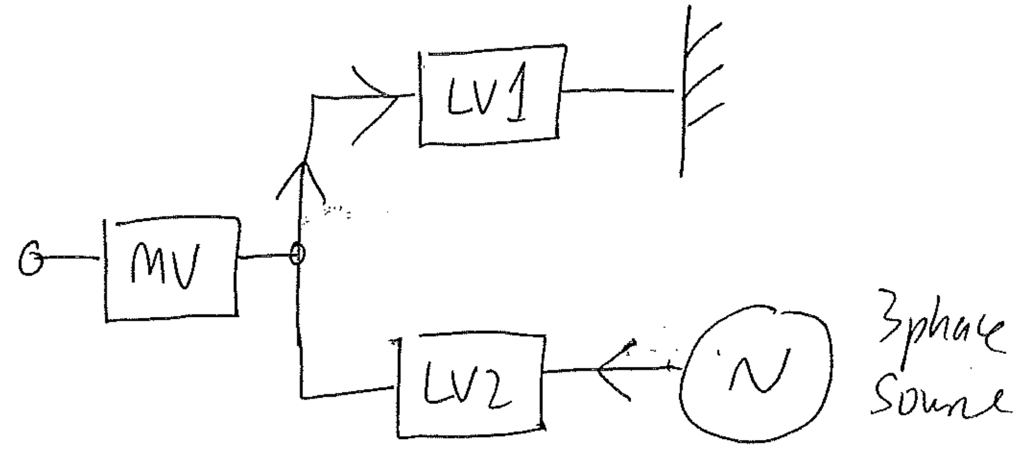
$= 15.2\% \times 800V$

$= 122\ V$

$$i = \frac{4.5 \times 10^6}{\sqrt{3} \times 800}$$

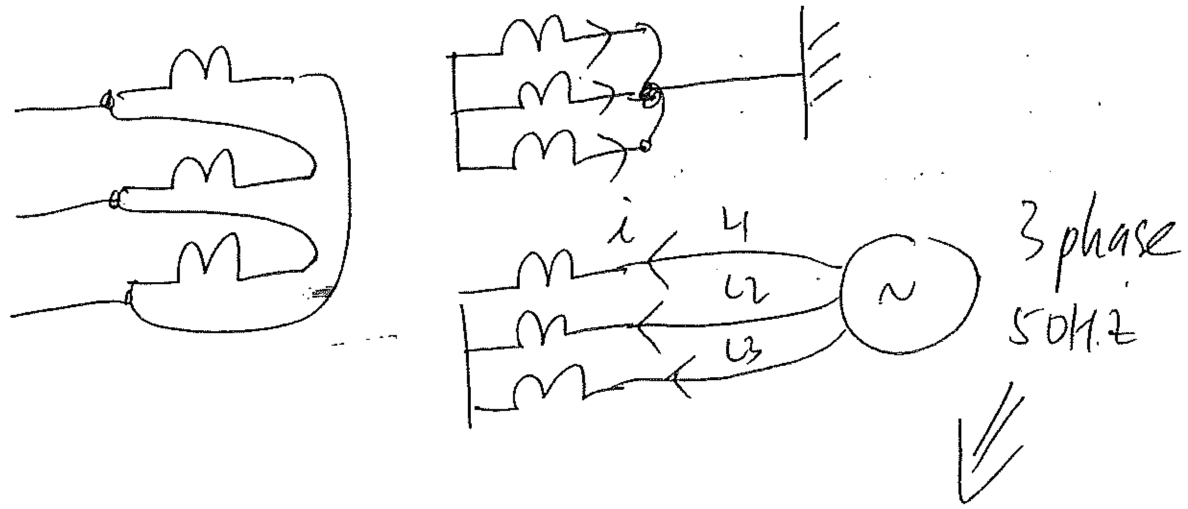
$= 3248A$

OR



$Z_1 = LV1 + LV2$

$= 15.2\%$ ON $4.5MVA$.

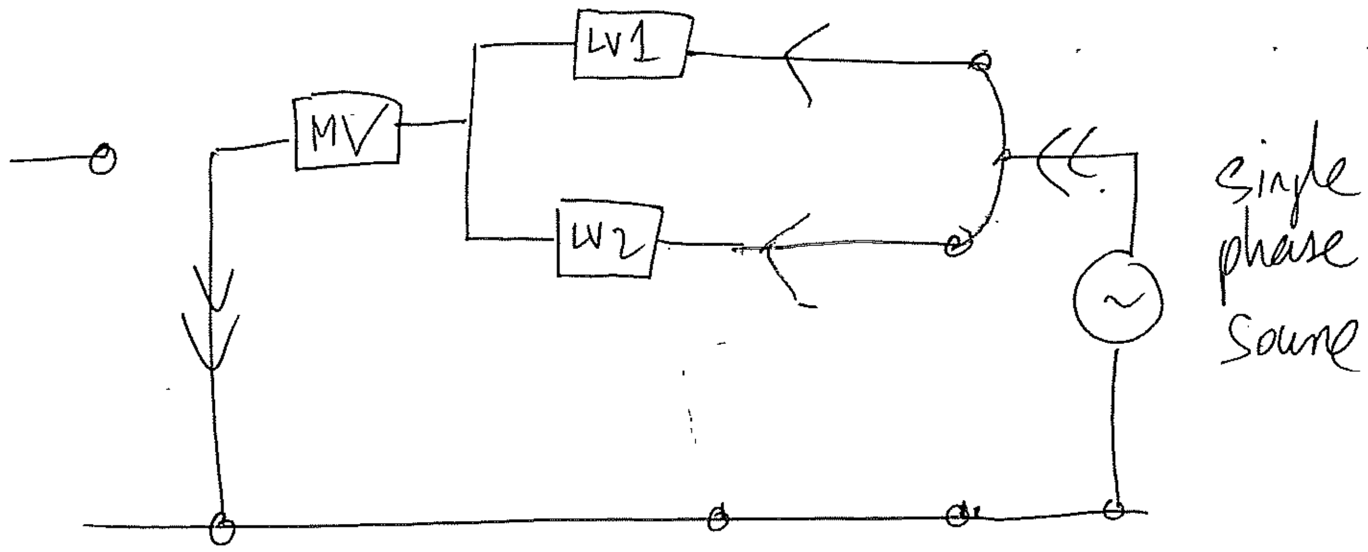


Voltage $= 15.2\% \times 800V$

$= 122V$

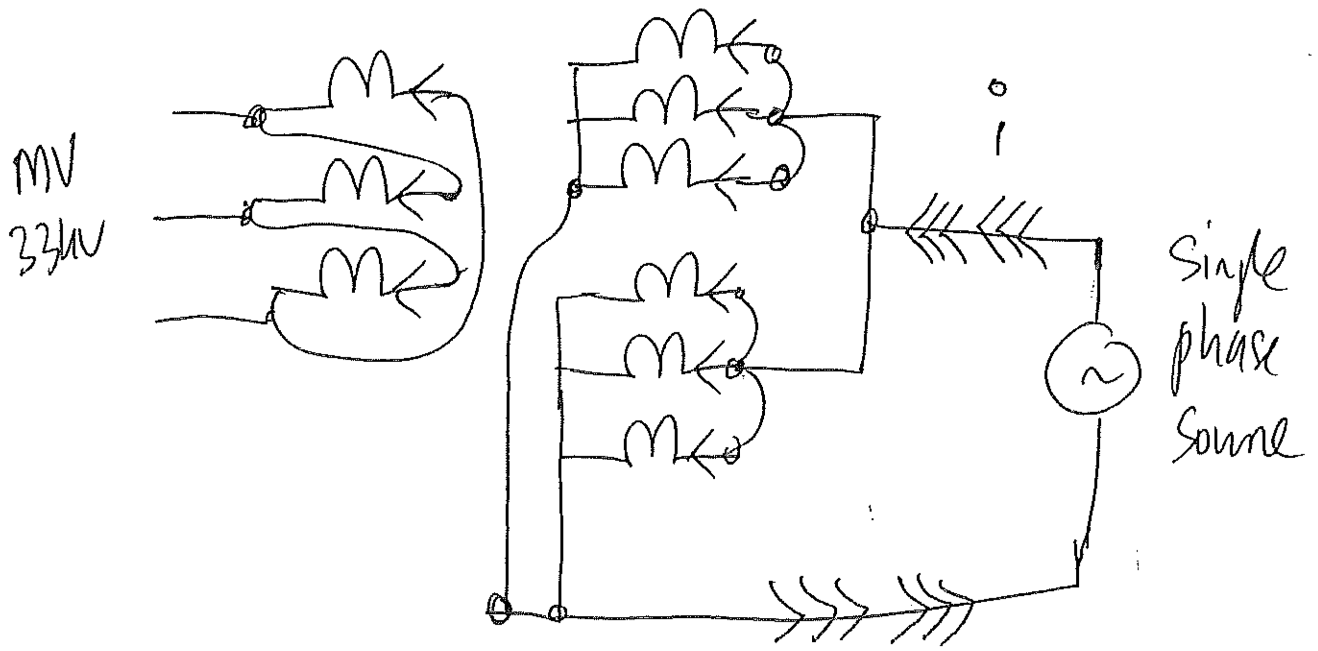
$$i = \frac{4.5 \times 10^6}{\sqrt{3} \times 800} = 3248A.$$

positive sequence impedance (Z_{LV1_LV2})

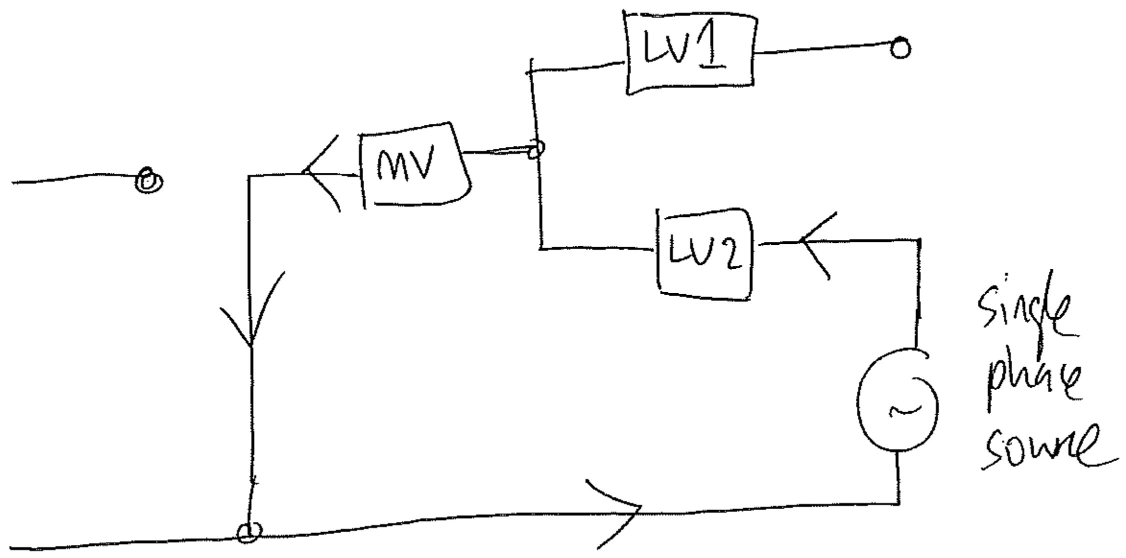


$$Z_0 = MV + \frac{(LV1)(LV2)}{(LV1 + LV2)}$$

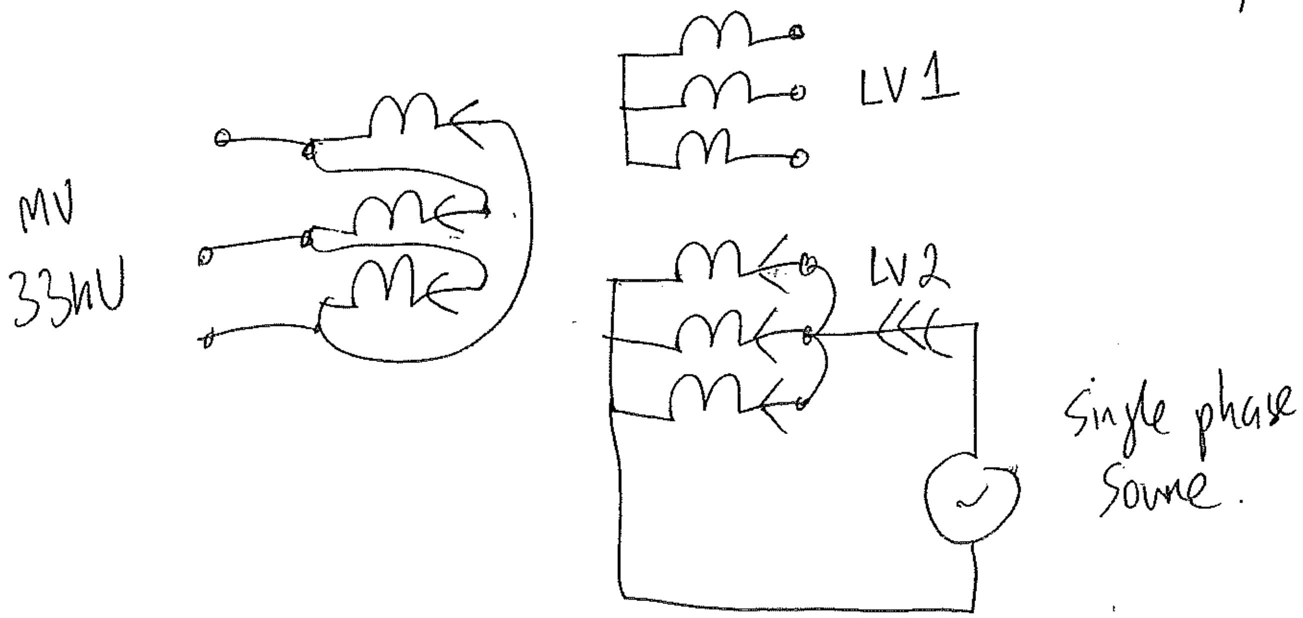
$$= 10{\cdot}12\% \text{ on } 9\,MVA.$$

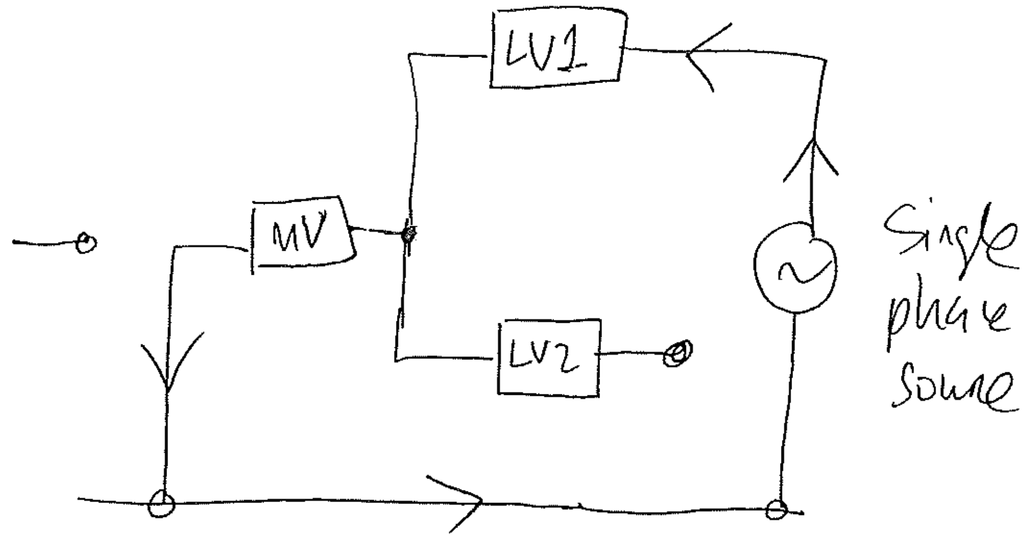


Zero sequence impedance (MV - (LV1 // LV2))

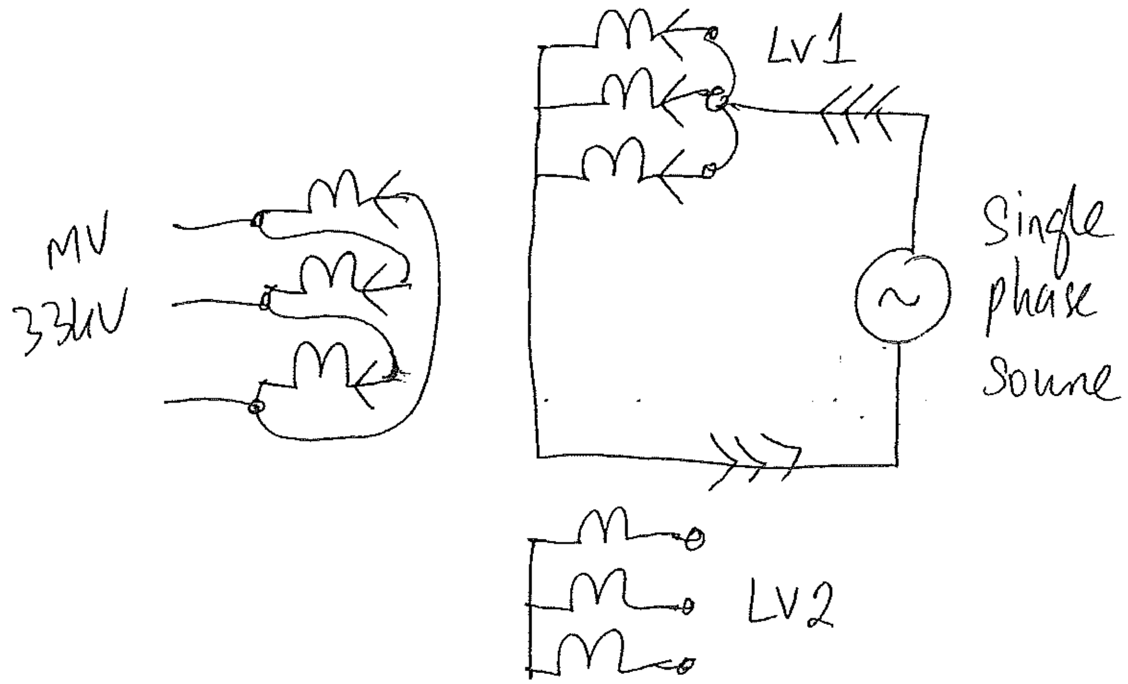


$$Z_0 = MV + LV2 = 8.12\% \text{ ON } 4.5\,MVA$$
$$= 16.24\% \text{ ON } 9\,MVA$$





$$Z_0 = MV + LV1$$
$$= 8.12\% \text{ ON } 4.5\,MVA.$$
$$= 16.24\% \text{ ON } 9\,MVA$$



zero sequence impedance (MV+LV1) and (MV+LV2)

$MV + LV2 = 0.1624$ — ①

$MV + LV1 = 0.1624$ — ②

$\Rightarrow LV1 = LV2$.

also $0.1012 = MV + \dfrac{(LV1)(LV2)}{(LV1 + LV2)}$

$0.1012 = (0.1624 - LV1) + \dfrac{LV1}{2}$

$LV1 = 0.1224$

$= 12.24\%$ ON 9 MVA.

then $LV2 = 12.24\%$ ON 9 MVA.

$MV = 4\%$ ON 9 MVA.

$MV = 2\%$ ON 4.5 MVA.

$LV1 = 6.12\%$ ON 4.5 MVA

$LV2 = 6.12\%$ ON 4.5 MVA

then $(LV1 + LV2)$ on 4.5 MVA

$= 12.24\%$ on 4.5 MVA

(compare with data sheet value of 12.92% on 4.5 MVA).

<u>Calculation of zero sequence impedance</u>