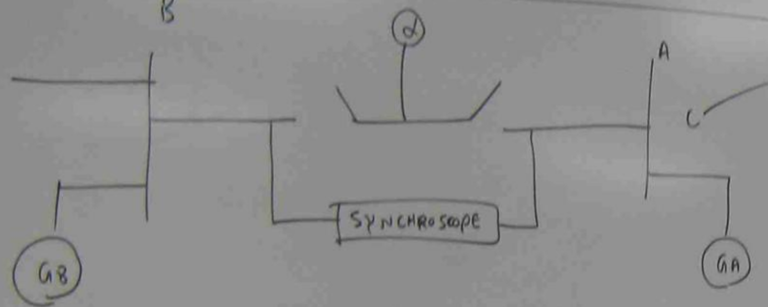
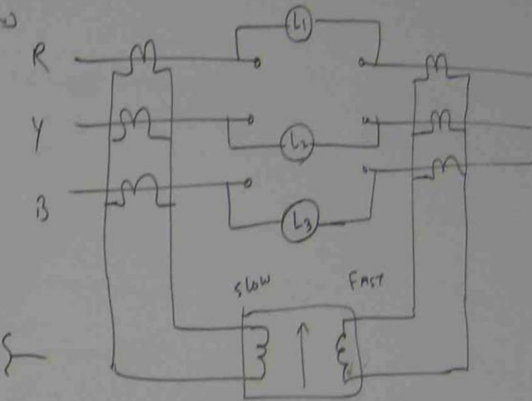
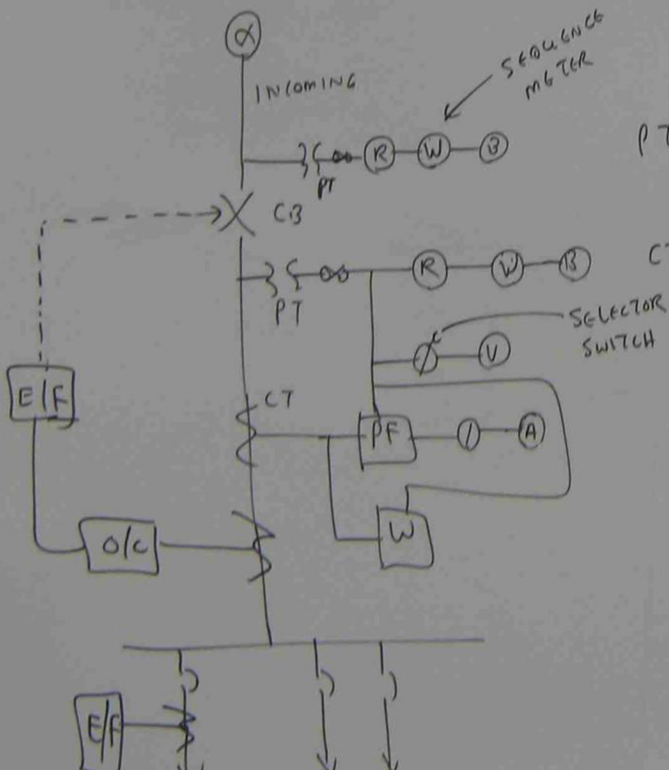
BASIC METERING ARRANGEMENT IN SUBSTATION



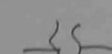
R W B
A B C



SYNCHROSCOPE CONNECTION



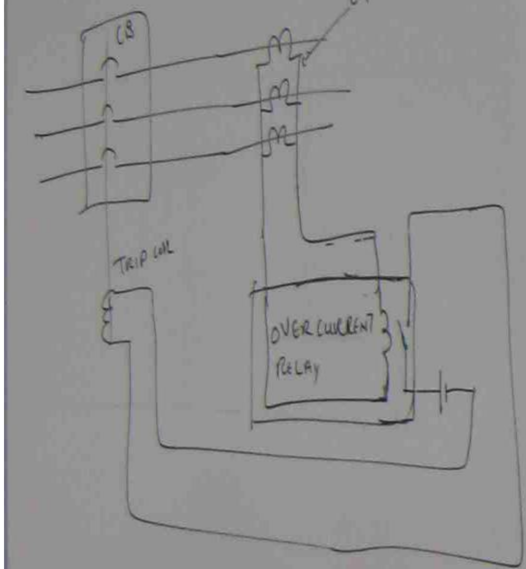
PT - POTENTIAL TRANSFORMER

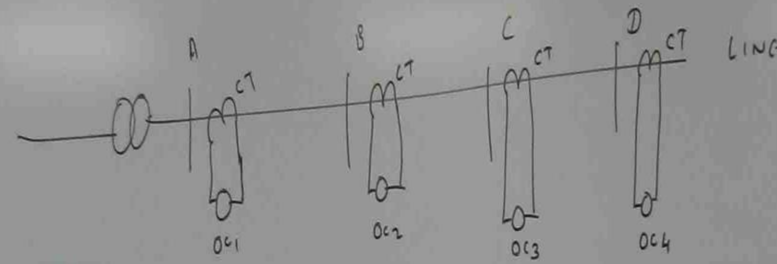


CT - CURRENT TRANSFORMER

E/F EARTH FAULT RELAY

LOCATION OF CURRENT TRANSFORMERS IN POWER SYSTEM



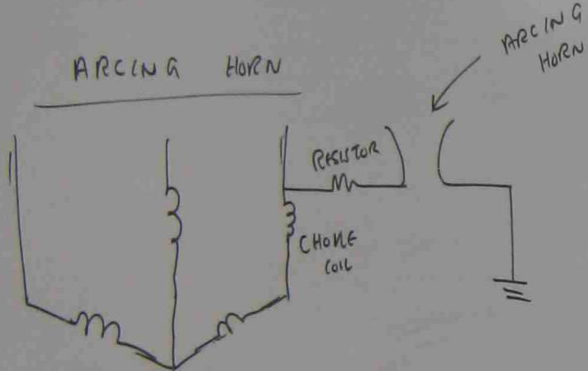


THE OVER CURRENT RELAYS ARE ALLOCATED AT LINE SECTIONS. THEY PROVIDE THE PROTECTION FOR THE SECTIONS OF THE LINE.

POWER SURGE PROTECTION FOR TRANSMISSION LINE

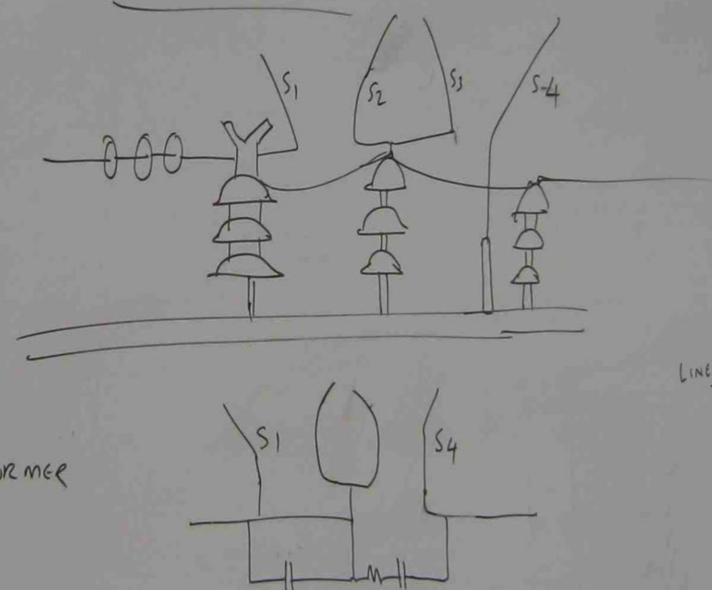
ARCING HORN, LIGHTNING ARRESTER, SURGE ABSORBER

ARCING HORN

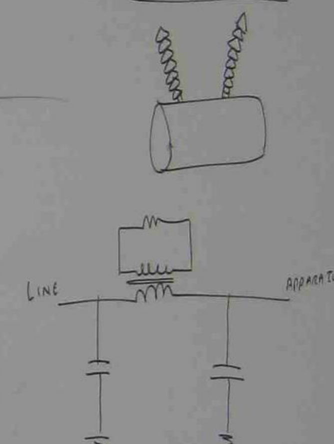


POWER TRANSFORMER

LIGHTNING ARRESTER



SURGE ABSORBER

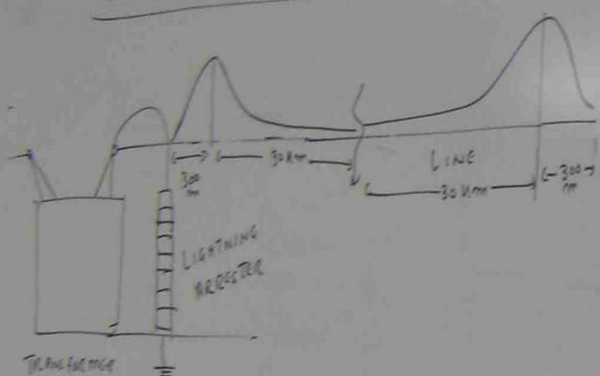


LIGHTNING STRIKE NEAR POWER TRANSFORMER IS PROTECTED BY ARCING HORN.

LIGHTNING ARRESTERS PROVIDE THE LIGHTNING PROTECTION FOR POWER LINE.

WHEN POWER SURGE OCCURS DUE TO SWITCHING OR UNBALANCED VOLTAGE, SURGE ABSORBER ABSORBS IT.

GROUNDING IN POWER SYSTEM



BASIC IMPULSE INSULATION LEVEL FOR ELECTRICAL EQUIPMENTS (BIL)

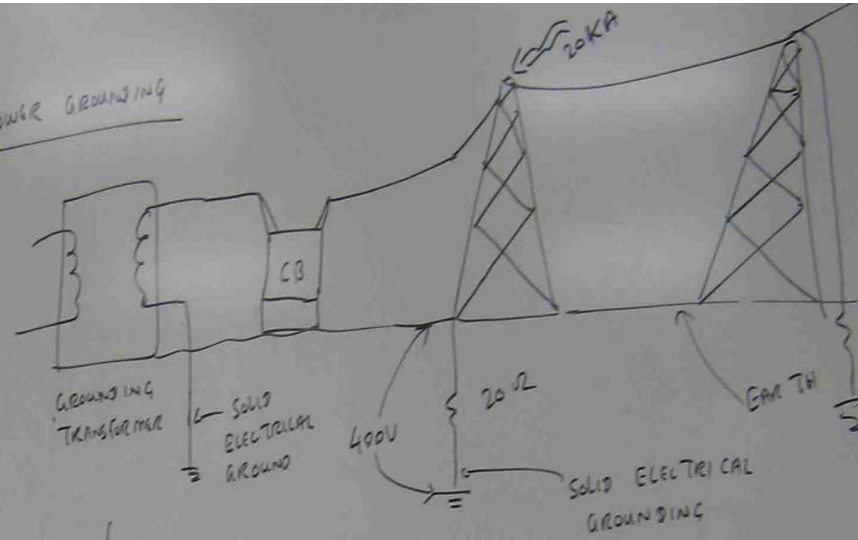
TRANSFORMER INSULATION SHOULD WITHSTAND THE HIGH VOLTAGE FOR A SMALL PERIOD DURING WHICH THE LIGHTNING ARRESTER DIVERTS THE SURGE VOLTAGE INTO GROUND

60 HZ BIL = 46 kV Rms

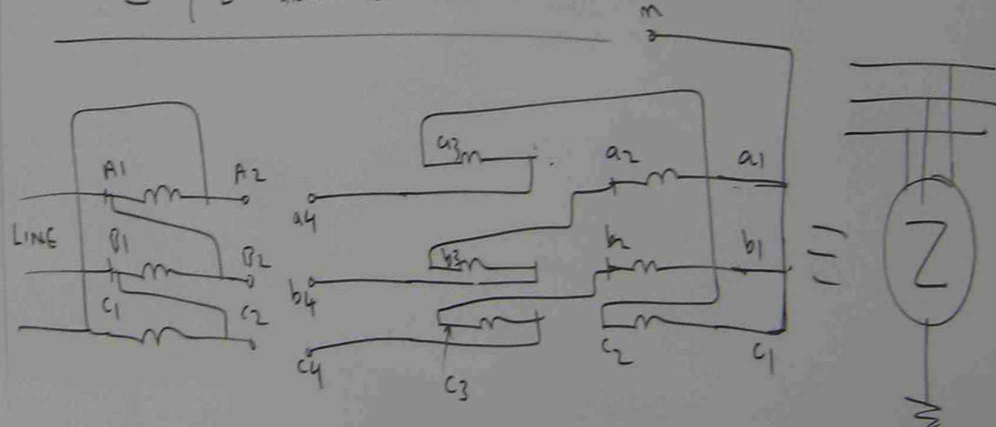
(OR)

65 kV (PEAK)

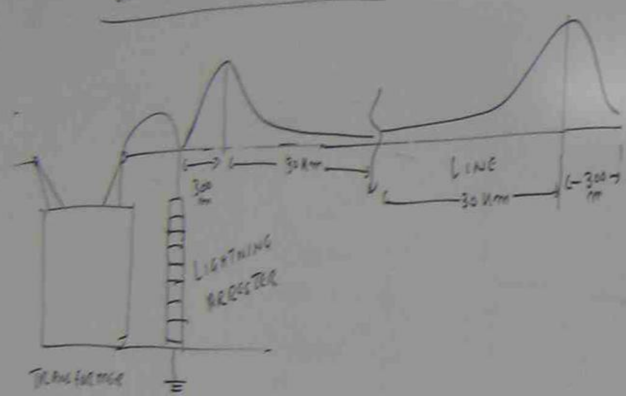
TOWER GROUNDING



Δ / Z GROUNDING TRANSFORMER



GROUNDING IN POWER SYSTEM



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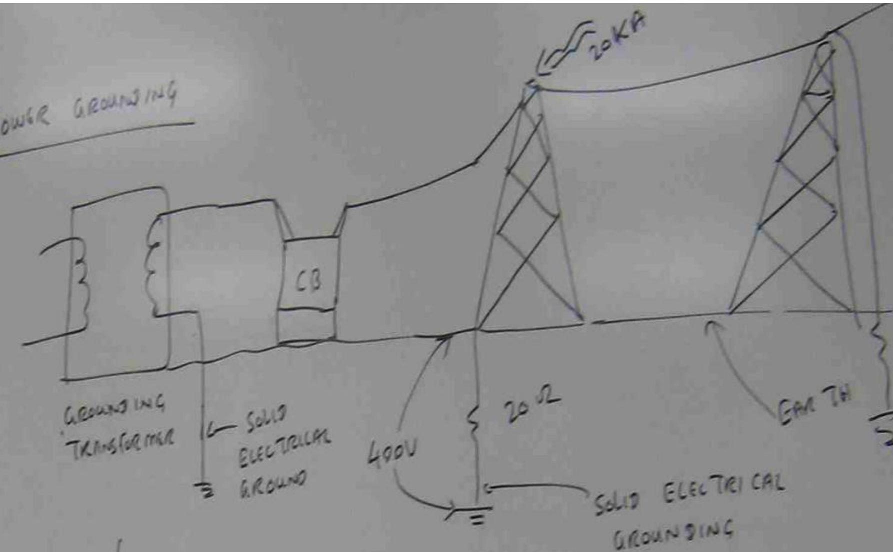
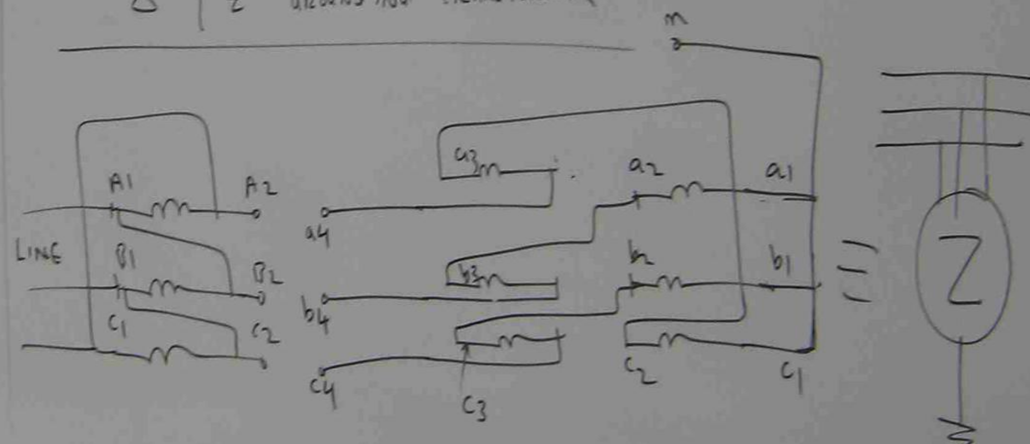


Δ / Z GROUNDING TRANSFORMER



$P_T = P_1 + P_3 + P_5$

P5 / A voltage given by

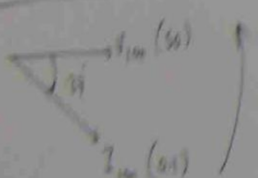
$e = 50 \sin \omega t + 20 \sin(3\omega t + 30) + 10 \sin(5\omega t - 90)$ volt is applied to

a circuit and the resulting current is given by

$i = 0.5 \sin(\omega t - 37) + 0.1 \sin(3\omega t - 15) + 0.09 \sin(5\omega t - 150)$ amp

Find the total power applied and over all power power factor.

Fundamental

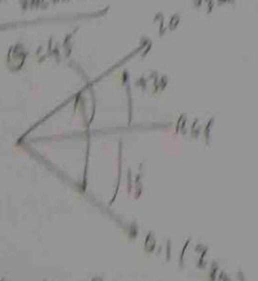


$$P_1 = \frac{V_{1m} I_{1m}}{2} \cos\theta \quad \frac{V_{1m}}{I_{1m}}$$

$$= \frac{50 \times 0.5}{2} \cos 37$$

$$= 10W$$

3rd harmonic

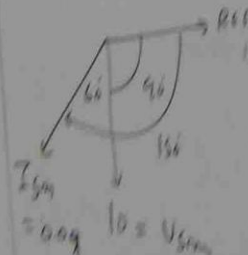


$$P_3 = \frac{V_{3m} I_{3m}}{2} \cos\theta \quad \frac{V_{3m}}{I_{3m}}$$

$$= \frac{20 \times 0.1}{2} \cos 45$$

$$= 0.707W$$

5th harmonic



$$P_5 = \frac{V_{5m} I_{5m}}{2} \cos\theta \quad \frac{V_{5m}}{I_{5m}}$$

$$= \frac{10 \times 0.09}{2} \cos 60$$

$$= 0.23W$$

$$P_T = P_1 + P_3 + P_5 = 10 + 0.707 + 0.23 = 10.9\,W$$

$$v = \sqrt{\frac{V_{1m}^2 + V_{3m}^2 + V_{5m}^2}{2}} = \sqrt{\frac{50^2 + 20^2 + 10^2}{2}} = 38.8V$$

$$i = \sqrt{\frac{I_{1m}^2 + I_{3m}^2 + I_{5m}^2}{2}} = \sqrt{\frac{0.5^2 + 0.1^2 + 0.09^2}{2}} = 0.365\ \text{amp}$$

$$VI = v \times i = 38.8 \times 0.365 = 14.142\ VA$$

$$PF = \cos\theta = \frac{10.9}{14.142} = 0.77$$

EFFECTIVE VALUE OF DISTORTED WAVE

E_H = EFFECTIVE VALUE OF HARMONICS VOLTAGE

E_F = EFFECTIVE VALUE OF FUNDAMENTAL VOLTAGE

E = EFFECTIVE VALUE OF DISTORTED VOLTAGE

$$E^2 = E_F^2 + E_H^2$$

$$E = \sqrt{E_F^2 + E_H^2}$$

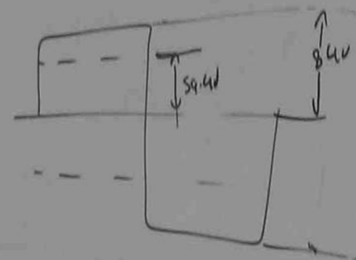
TOTAL HARMONIC DISTORTION (THD) $= \dfrac{E_H}{E_F}$

ph) A SQUARE WAVE HAS AN AMPLITUDE OF 66 V. THE FUNDAMENTAL IS 84 V.

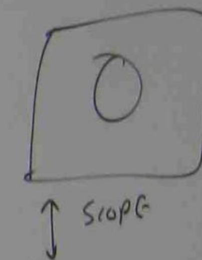
CALCULATE (a) THE EFFECTIVE VALUE OF SQUARE WAVE

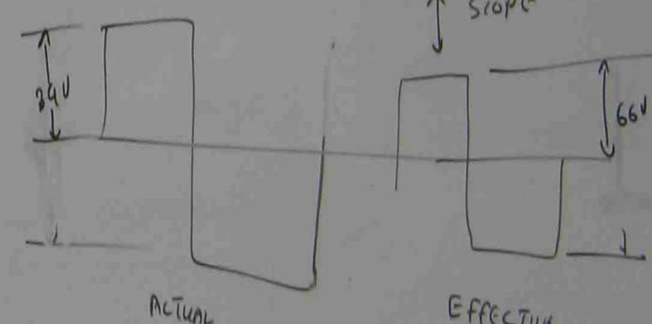
(b) EFFECTIVE VALUE OF FUNDAMENTAL

(c) TOTAL HARMONIC DISTORTION



(E) = EFFECTIVE VALUE = 66V





$$E_F = \frac{E_{max}}{\sqrt{2}} = \frac{84}{\sqrt{2}} = 59.4V$$

$$E^2 = E_F^2 + E_H^2$$

$$66^2 = 59.4^2 + E_H^2$$

$$E_H = \sqrt{66^2 - 59.4^2} = 28.8V$$

$$THD = \frac{E_H}{E_F} = \frac{28.8}{59.4} = 0.48$$

EFFECTIVE VALUE OF DISTORTED WAVE

E_H = EFFECTIVE VALUE OF HARMONICS VOLTAGE

E_f = EFFECTIVE VALUE OF FUNDAMENTAL VOLTAGE

E = EFFECTIVE VALUE OF DISTORTED VOLTAGE

$$E^2 = E_f^2 + E_H^2$$

$$E = \sqrt{E_f^2 + E_H^2}$$

TOTAL HARMONIC DISTORTION (THD) $= \dfrac{E_H}{E_f}$

pb A SQUARE WAVE HAS AN AMPLITUDE OF 66 V. THE FUNDAMENTAL IS 84 V.

CALCULATE (a) THE EFFECTIVE VALUE OF SQUARE WAVE

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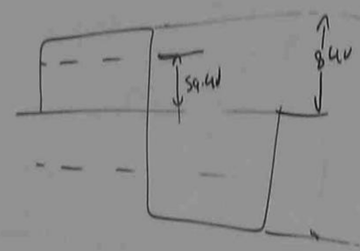
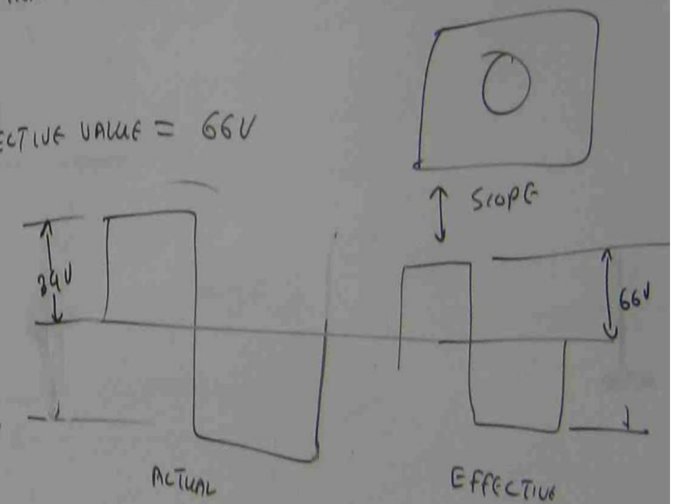
(c) TOTAL HARMONIC DISTORTION



(E) = EFFECTIVE VALUE = 66V



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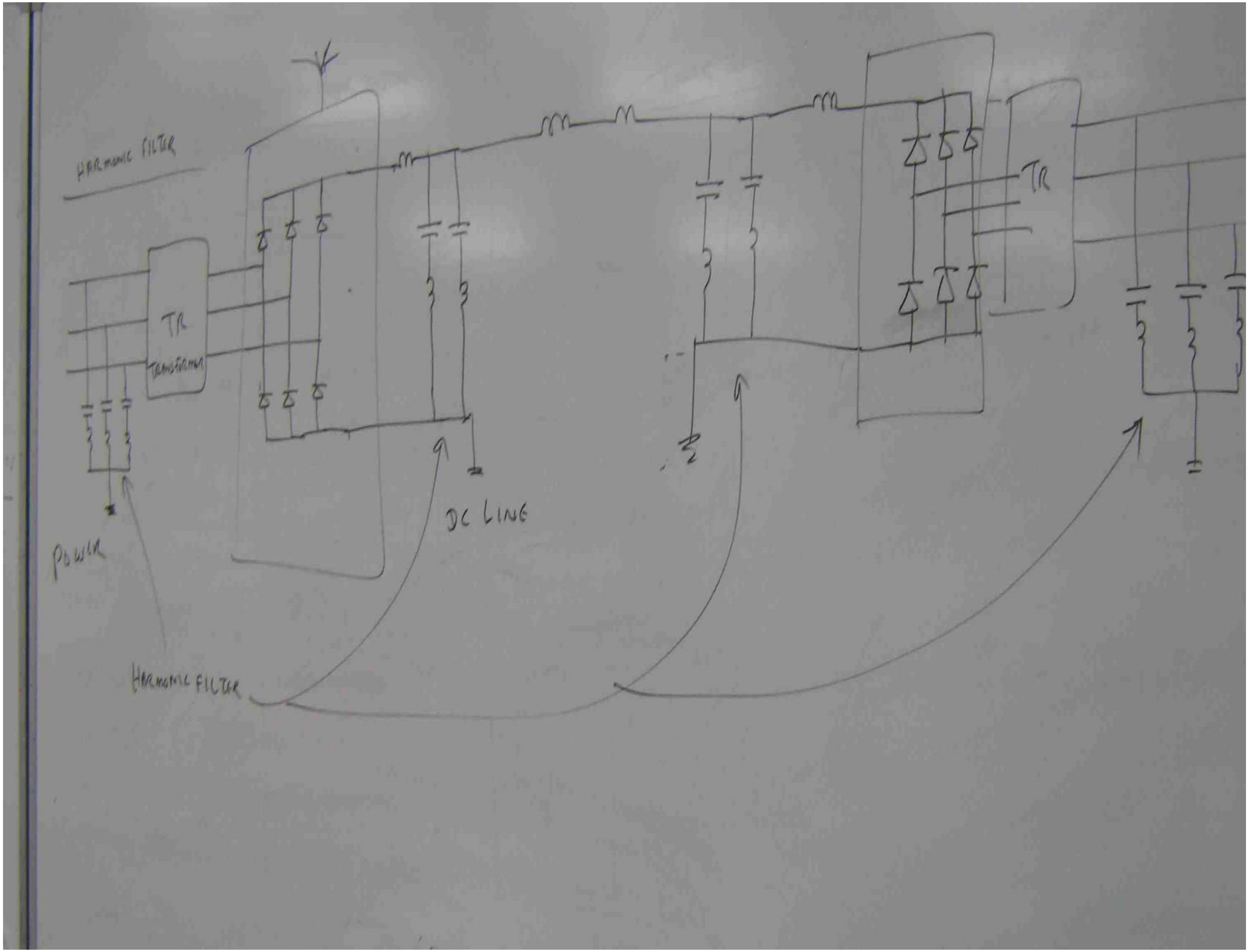
HARMONIC FILTER
TR
TRANSFORMER
POWER
DC LINE
TR
HARMONIC FILTER