1

**TQ 3.1** calculate the touch voltage for a single phase final sub circuit having $4mm^2$ active conductor having a percent impedance of 1.0Ω and $2.5mm^2$ earthing conductor having a percent impedance of 2.4Ω where the operating voltage of installation is 230V.

$$V_t = \frac{V_0 \times Z_{PE}}{(Z_A + Z_{PE})} =$$

$V_t$ = Touch voltage
$V_0$ = operating voltage
$Z_A$: Impedance of active conductor

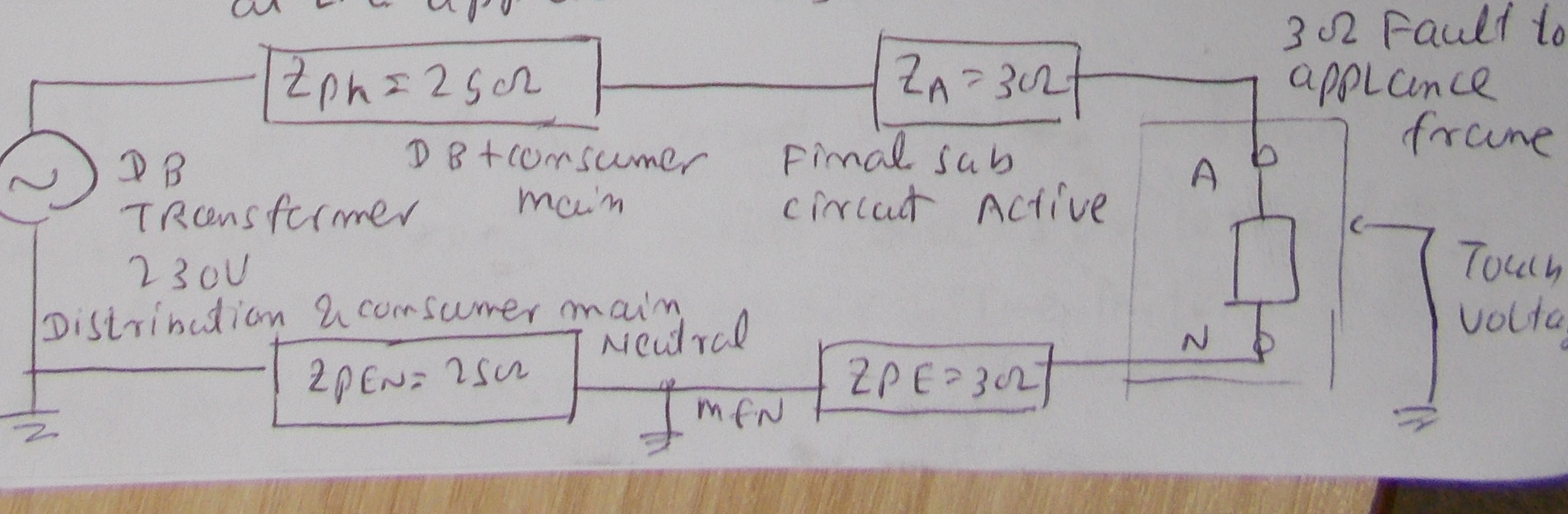
$Z_{PE}$ = ~~Percent~~ Protective earthing impedance conductor (Percent impedance

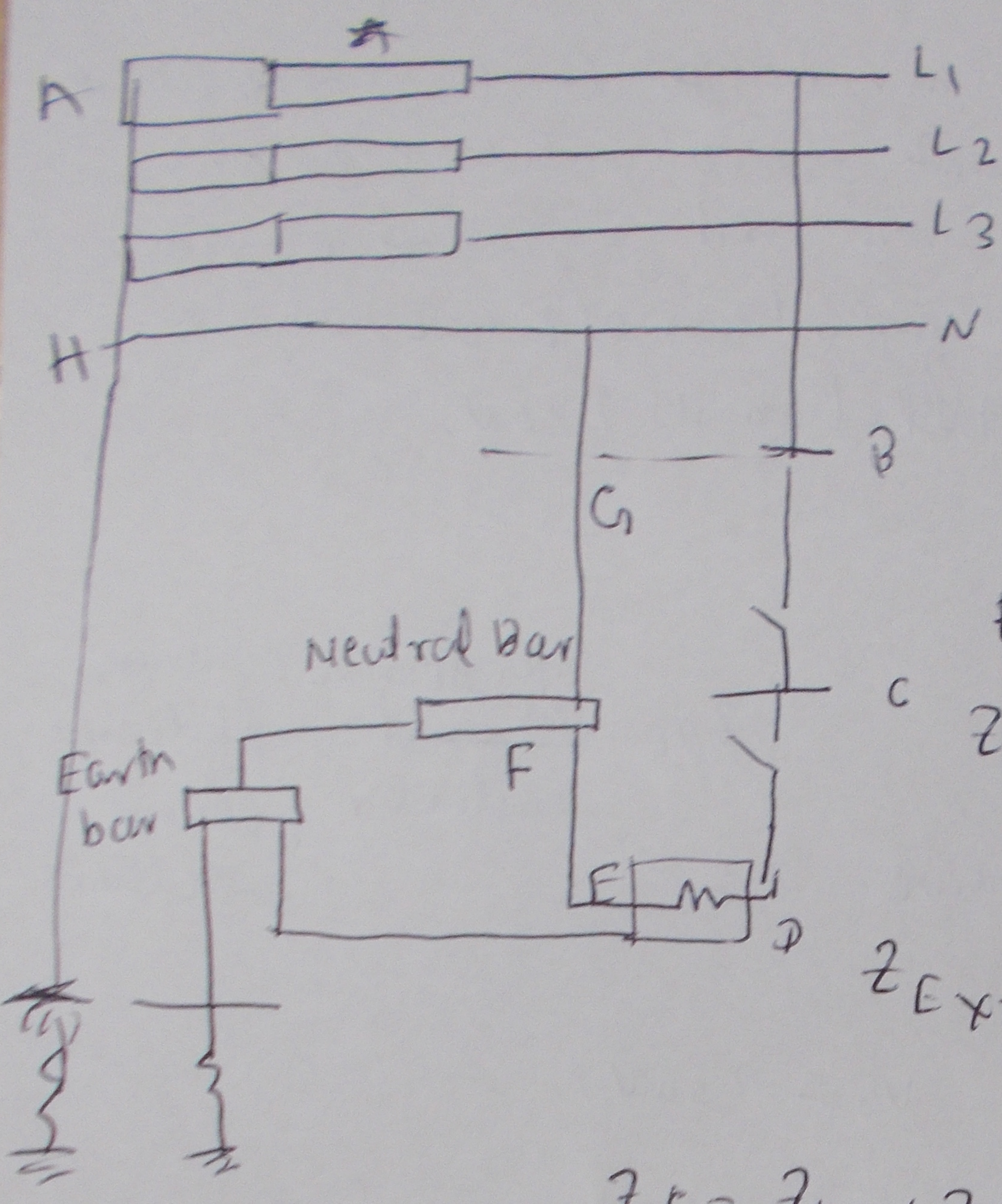
$Z_A = 1\Omega$, $Z_{PE} = 2.4\Omega$, $V_0 = 230V$

$$\therefore V_t = \frac{230 \times 2.4}{(1+2.4)} = \frac{230 \times 2.4}{3.4} =$$ ✓

**TQ 3.2** List 4 methods to protect against direct contact

**TQ 3.11** For the loop shown below
ⓐ calculate the fault loop impedance
ⓑ The maximum fault current that will flow in the circuit
ⓒ The fault current if the fault resistance at the appliance is 3Ω






point of supply

Fault loop Impedance

$$Z_S = Z_{AB} + Z_{BC} + Z_{CD} + Z_{EF} + Z_{GH} + Z_{HA}$$

$$Z_{Ext} = Z_{AB} + Z_{BC} + Z_{CD} + Z_{FG} + Z_{GH} + Z_{HA}$$

$$Z_S = Z_{Int} + Z_{Ext}$$

$$Z_{fault\ loop} = 0.25\Omega + 3\Omega + 3\Omega + 3\Omega + 0.25\Omega$$

$$= 9.5\Omega$$

$$I_{fault} = \frac{230}{6.5} \approx 35.3A$$

If fault resistance at appliance is $3\Omega$

$$I_{fault} = \frac{230}{9.5} = 24.2A$$

for TQ 3.12

Find cable resistence by referring the table on page 15.

Source = 0.028 Ω

$25mm^2$ - 50m → 0.0330 Ω

$6mm^2$ - 25m → 0.0755 Ω

$4mm^2$ - 25m → 0.1130 Ω

$35mm^2$ - 50m → 0.0257 Ω

$Z_{fault\ Loop}$ = 0.0330 + 0.0755 + 0.1130 + 0.0257 + 0.022

= 0.2472 Ω + 0.022

= 0.2752 Ω

$I_{fault} = \frac{230V}{0.2752Ω} = 835A$

fault resistence 3Ω → $\frac{230}{3.2752} ≑ 70.22A$

TQ 3.13 A final sub circuit supplies a load consisting of 10A socket outlet and is protected by a 20A type c circuit breaker. Determine the maximum fault loop impedance of the final subcircuit based on 230V, when supply is unavailable.

Table 8.1 page 10 20A - CB → Type(C) 1.53 Ω

TQ 3.14 A final sub circuit supplies a load consisting of 10A socket outlet and is protected by a 16A type c circuit breaker. The internal fault loop impedance measured at the further most socket outlet is 1.2Ω. Determine whether this value of internal fault loop impedance based on 230V satisfies the requirements of AS/NZS3000:

Table 8.1 page 10

16A, Type C, 230V    Z fault loop = 1.92Ω

Now 1.2Ω is lower than 1.92Ω

It satisfies AS3000.

TQ 3.15, TQ 3.16 Do it yourself

TQ 3.17 HRC fuse

A final subcircuit supplies a load consisting of 15 A socket outlet and is protected by a 25A HRC Fuse. Determine the maximum internal fault loop impedance of the final subcircuit based on 230V when supply is unavailable.

Table 8.1 page 10

25A HRC fuse → 1.64Ω

TQ 3.18 Determine the maximum route length of a circuit in accordance with AS/NZS 3000:2007 for a single phase circuit that has an active conductor size of 6mm2 and a 2.5mm2 earthing conductor if the circuit is protected by a 40A circuit breaker with a type D curve

(5)

$$L_{max} = \frac{0.8\, U_o\, S_{ph}\, S_{pe}}{I_a\, \rho\, (S_{ph} + S_{pe})}$$

$L_{max}$ = maximum ~~ble~~ route length in metre

$U_o$ = Nominal phase voltage (230V)

$\rho$ = Resistivity $\Omega$-mm$^2$/m → $22.5 \times 10^{-3}$ (copper)
$36 \times 10^{-3}$ (Aluminium)

$I_a$ = Trip current setting

$S_{ph}$ = Cross sectional Area of active conductor

$S_{pe}$ - cross sectional area of protective earthing conductor.

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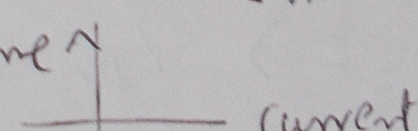
Table B1 page 460 / of AS/NZS 3000:2016

| Active / Neutral conductor | Earth conductor | CB | C-curve | 2.5% volt drop |
|---|---|---|---|---|
| 6mm$^2$ | 2.5mm2 | 40A | 60m | 14<br>31m |




Type D

0.46Ω Table B.1

TQ 3.14 , TQ 3.20 Do it yourself

TQ 3.29 Given a 11kV/ 400V (Delta / star) 600 KVA transformer has an impedance of 4%, determine the (a) rated current (b) fault current at the transformer secondary terminals (c) fault level at transformer secondary terminals (d) transformer impedence in ohms

$$\text{Rated current} = \frac{KVA}{\sqrt{3} \times E} = \frac{600 \times 10^3}{1.7321 \times 11 \times 10^3} = 31.49A$$

$$\text{secondary current} = \frac{KVA}{\sqrt{3} \times E} = \frac{600 \times 10^3}{1.7321 \times 400} = 866A$$

$$\text{Fault current} - I_{sn} = \frac{I_{fL}}{\% Z} \times 100 = \frac{866}{4} \times 100 = 21650 A$$

$$\text{fault level} = MVA_{sn} = \frac{MVA_{fL}}{\% Z} \times 100$$

$$= \frac{600}{4} \times 100 = 15\ MVA$$

$$\% Z = \frac{I_{fL} \times Z_{ph}}{E_{ph}} \times 100 \qquad \Delta = 11kV = E_{ph}$$

$$4 = \frac{31.49 \times Z_{ph}}{11 \times 10^3} \times 100 \Rightarrow Z_{ph} = \frac{4 \times 11000}{31.44 \times 100} = 13.99\ \Omega$$

TQ 3.30 A 11kV, ($\Delta$/$\curlywedge$), 500kVA transformer has a nominated fault level of 10MVA, determine
- Prospective fault current at the transformer
- transformer impedance in ohms.

$$I_{sn} = \frac{MVA_{sn}}{\sqrt{3}\, E} = \frac{10 \times 10^6}{1.7321 \times 11 \times 10^3} = 524.8A$$

Primary

$$I_{fL} = \frac{500 \times 10^3}{\sqrt{3} \times 11 \times 10^3} = 26.24A$$

$$I_{ph} = \frac{26.24}{\sqrt{3}} = 15.15A$$

$$I_{sn} = \frac{I_{fL}}{\% Z_{ph}} \times 100 \rightarrow 524.8 = \frac{\cancel{26.24}\ 15.15}{\% Z_{ph}} \times 100$$

(7)

$$\%Z = \frac{524.3}{15.15 \times 100} = 0.346\%$$

$$\%Z = \frac{I_{SL} \times Z_{ph}}{E_{ph}} \times 100$$

$$0.346 = \frac{15.15 \times Z_{ph}}{11 \times 10^3} \times 100$$

$$Z_{ph} = \frac{0.346 \times 11 \times 10^3}{15.15 \times 100} = 2.51\,\Omega$$

TQ 3.31, do it yourself

TQ 3.32 for the installation shown below determine the prospective fault current at each relevant point within the installation.

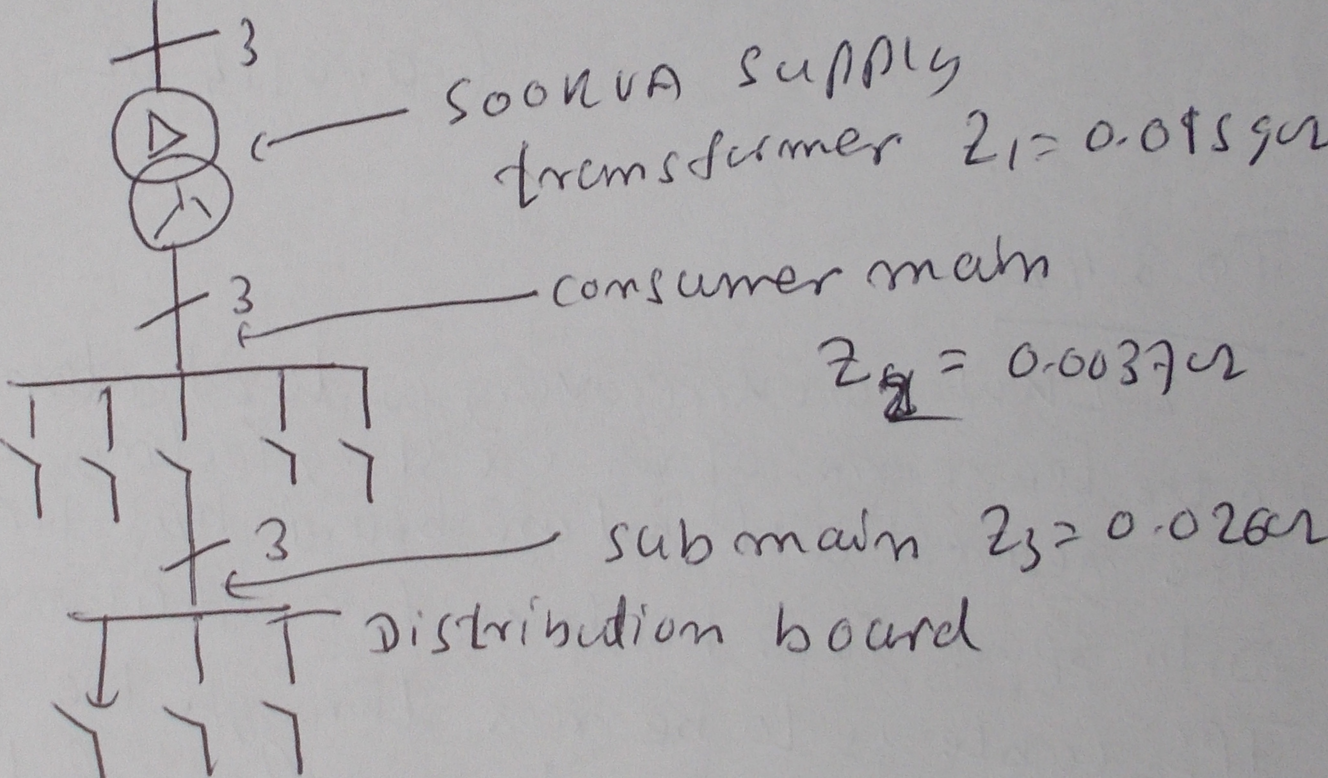



Fig 3.3.3

$Z_1$ $0.0159\,\Omega \rightarrow$ 3 kA

$Z_2 = 0.0037\,\Omega$ 5 kA

$Z_3 = 0.028\,\Omega =$ 5 kA

TQ 3.33

A 3 phase 400/230V service supplies the main switchboard to a block of factory units. The supply authority advises that the fault level at the consumer's terminals is 18 KA. The consumer's mains consist of 50mm2 active conductors and a 35mm2 neutral conductor having a length of 30meters. Determine the theoretical fault current at the main switchboard. Use the table from Fig 3.3.4 to determine cable impedance.

Active 50mm2 Neutral 35mm2, 30m

(0.0114 Ω)

TQ 3.42

2.2KW quickrecovery water heater is tobe installed in the tea room of an existing factory.
The nearest distribution board has HRC fuses fitted with spare fuse holders for additional circuits. The TPS cable is to be run through the roof space of the tea room which has terminal insulation installed.

ⓐ Determine maximum demand current
ⓑ select a fuse to protect the circuit
ⓒ current carrying capacity of cable, assume cable is partially surrounded
ⓓ Do the values of current comply with $I_B < I_N < I_Z$?
ⓔ Does the arrangement comply with $I_2 < 1.45 \times I_Z$?
ⓕ what is required to ensure the circuit will comply?
ⓖ Assuming 1.5mm2 cable is used, will the arrangement provide