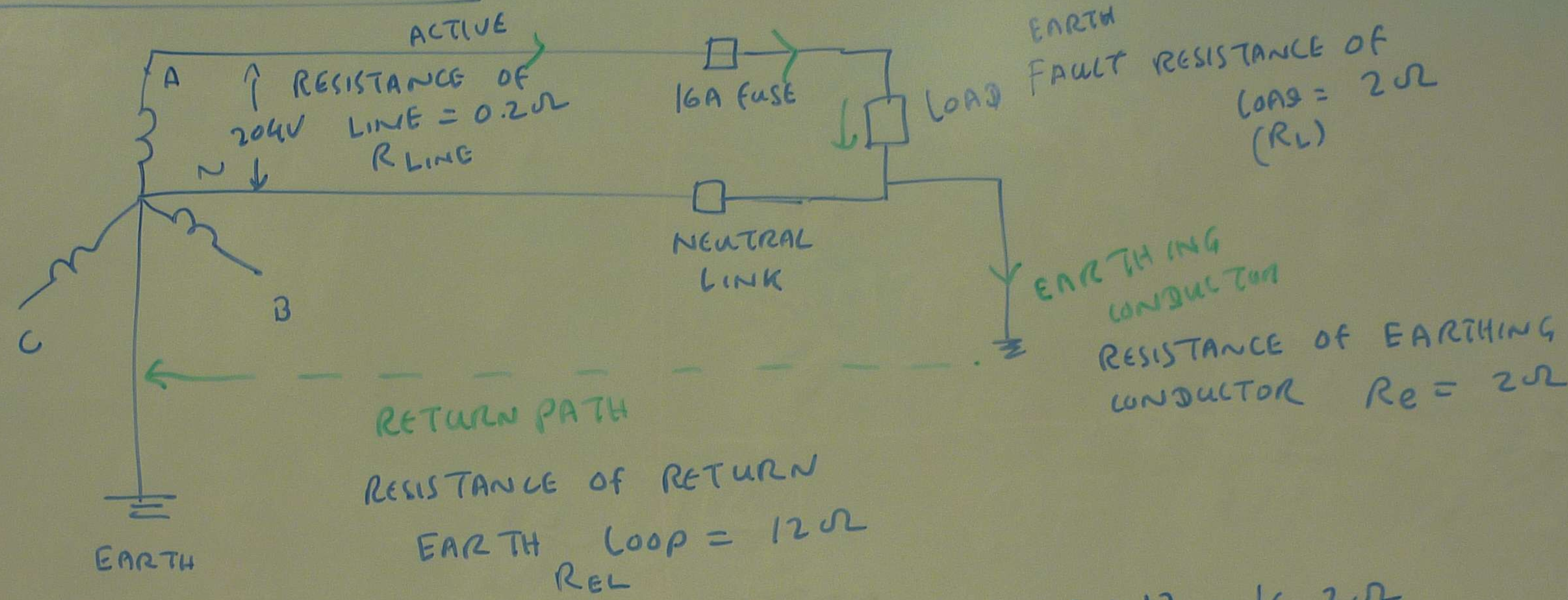
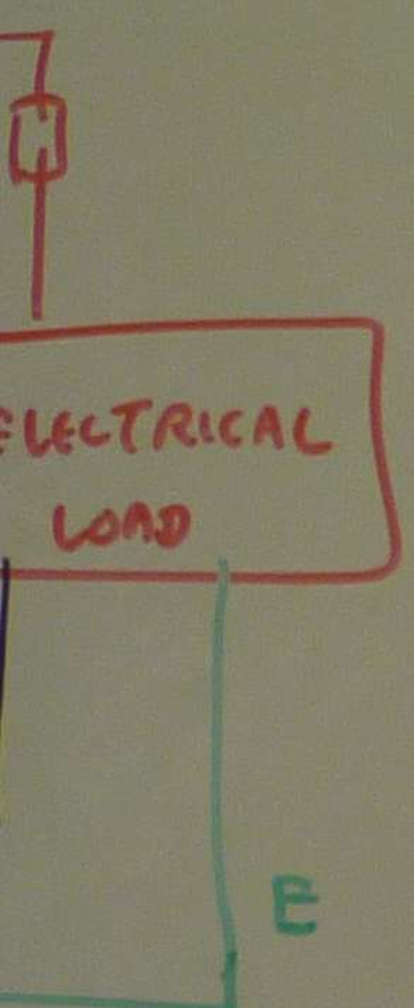
FAULT LOOP IMPEDANCE





$$R_{TOTAL} = R_{LINE} + R_{LOAD} + R_{E} + R_{EL} = 0.2 + 2 + 2 + 12 = 16.2\Omega$$

$$I_{EARTH} = \frac{\text{VOLTAGE}}{R_{TOTAL}} = \frac{204}{16.2} = 14.5\text{ A}$$

IT NEEDS TO KNOW EARTH FAULT LOOP IMPEDANCE TO CALCULATE EARTH FAULT CURRENT.

situation as defined by *Clause 0.5.42*, it must be earthed.
In general, the earthing of equipment is achieved by

missible size for a single-insulated copper earthing conductor is 2.5 mm², but 1.5 mm² copper conductors may

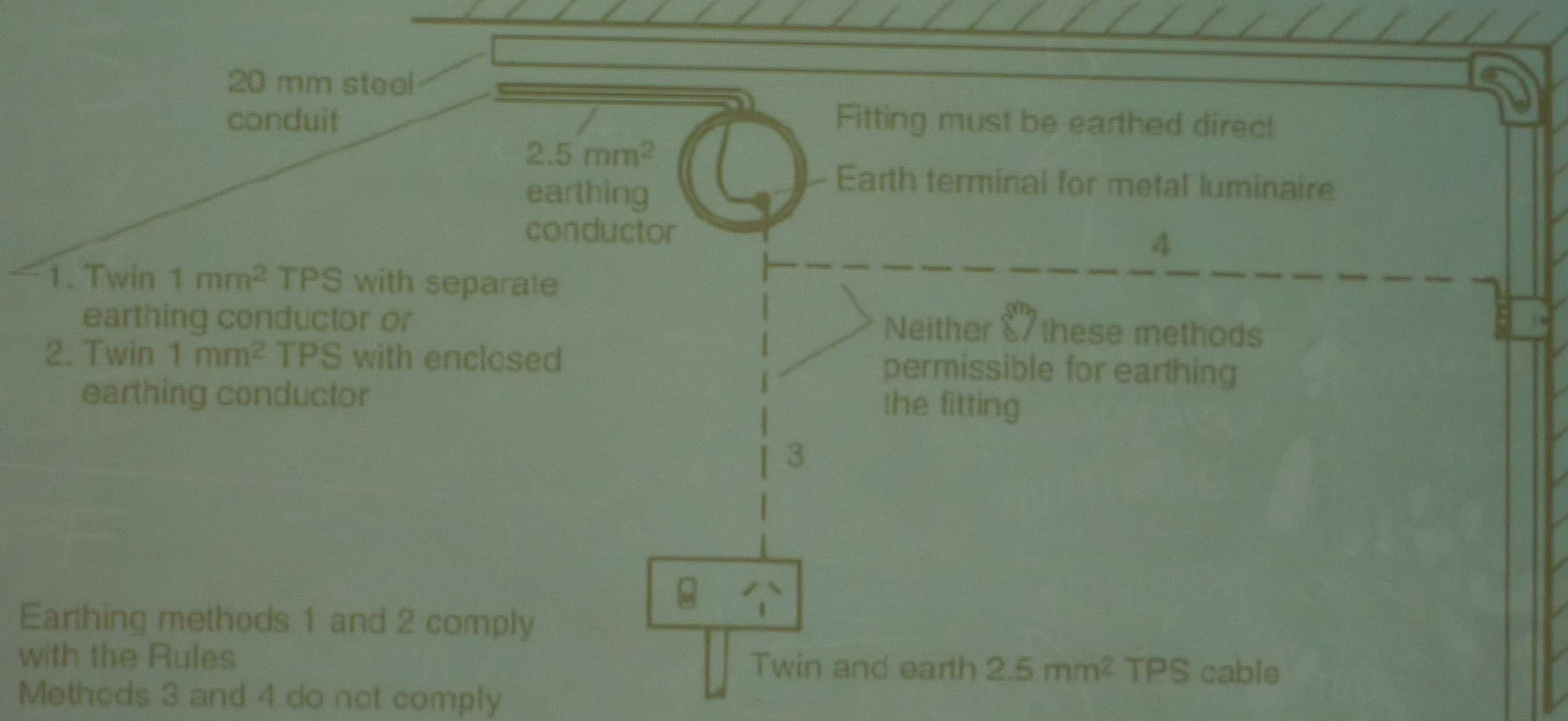


Fig. 12.15 *Correct and incorrect earthing provisions*

supply cables). If it is not available Z_{int} may be determined by either of the following methods:

(a) When the length and cross-sectional area of conductors are known:

$$Z_{int} = Z_{CD} + Z_{EF} \quad \ldots \text{B5}$$

Where

Z_{CD} = impedance of the active conductors (C to D in Figure B5)

Z_{EF} = impedance of the protective earthing conductors (E to F in Figure B5)

NOTES:

1 Consumers mains (Z_{BC} and Z_{FG}) form part of Z_{ext}.

2 Impedances for conductors are given in the AS/NZS 3008.1 series.

(b) When the length and cross-sectional area of the supply conductors are not known, it may be assumed that there will always be 80% or more of the nominal phase voltage available at the position of the circuit protective device. Therefore, Z_{int} should be not greater than 0.8 Z_s. This may be expressed as follows:

$$Z_{int} = 0.8\, U_o/I_a \quad \ldots \text{B6}$$

TABLE 8.1

MAXIMUM VALUES OF EARTH FAULT-LOOP IMPEDANCE (Z_s at 230 V)

Protective device rating	Circuit-breakers			Fuses	
	Type B	Type C	Type D		
	Disconnection times				
	0.4 s			0.4 s	5 s
A	Maximum earth fault-loop impedance Z_s Ω				
6	9.58	5.11	3.07	11.50	15.33
10	5.75	3.07	1.84	6.39	9.20
16	3.59	1.92	1.15	3.07	5.00
20	2.88	1.53	0.92	2.09	3.59
25	2.30	1.23	0.74	1.64	2.71
32	1.80	0.96	0.58	1.28	2.19
40	1.44	0.77	0.46	0.96	1.64
50	1.15	0.61	0.37	0.72	1.28
63	0.91	0.49	0.29	0.55	0.94
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 8.1

MAXIMUM VALUES OF EARTH FAULT-LOOP IMPEDANCE (Z_s at 230 V)

Protective device rating	Circuit-breakers			Fuses	
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6	9.58	5.11	3.07	11.50	15.33
10	5.75	3.07	1.84	6.39	9.20
16	3.59	1.92	1.15	3.07	5.00
20	2.88	1.53	0.92	2.09	3.59
25	2.30	1.23	0.74	1.64	2.71
32	1.80	0.96	0.58	1.28	2.19
40	1.44	0.77	0.46	0.96	1.64
50	1.15	0.61	0.37	0.72	1.28
63	0.91	0.49	0.29	0.55	0.94

FINAL SUB CIRCUIT FAULT LOOP IMPEDANCE

pb (1)

A FINAL SUB CIRCUIT SUPPLIES A LOAD CONSISTING OF A RANGE IN A DOMESTIC INSTALLATION AND IS PROTECTED BY 32A TYPE (C) CIRCUIT BREAKER. DETERMINE THE MAXIMUM INTERNAL FAULT LOOP IMPEDANCE OF FINAL SUB CIRCUIT BASED ON 230V WHEN SUPPLY IS UNAVAILABLE.

REFERENCE APPENDIX B CLAUSE 5.2.1
AS3000:2007 PAGE 365

Z_S → TABLE 8.1 AS3000:2007 PAGE 343

APPENDIX CLAUSE 5.2.1 → $Z_{INT} = 0.8\,Z_S$

↑ INTERNAL FAULT LOOP IMPEDANCE

FROM TABLE 8.1, for 32A TYPE (C) C.B → $Z_S = 0.96\,\Omega$

$Z_{INT} = 0.8\,Z_S$

$= 0.8 \times 0.96 = 0.768\,\Omega$

pb (2)

A F…
SOCKET …
DETERM…
OF FIN…
IS UNA…
OP…
TABLE …
APPEN…
Flow of …
ACTIVE …

...of A RANGE !
...y 32A TYPE (C)
...TERNAL FAULT
...230 V WHEN

...5.2.1
...2007 PAGE 365

PAGE 343

...8 Z_S

...EDANCE

...B → $Z_S = 0.46\Omega$

...6 = 0.768Ω

pb (2)

A FINAL SUB CIRCUIT SUPPLIES A LOAD CONSISTING OF 15A SOCKET OUTLET AND IS PROTECTED BY 25A HRC FUSE.

DETERMINE THE MAXIMUM INTERNAL FAULT LOOP IMPEDANCE OF FINAL SUB CIRCUIT BASED ON 230V WHEN THE SUPPLY IS UNAVAILABLE.

OPERATING TIME OF HRC FUSE → 0.4 S
↓
HIGH RUPTURING CAPACITY

TABLE 8.1 — 25A HRC FUSE (0.4 sec) → $Z_S = 1.64\Omega$

APPENDIX B, CLAUSE 5.2.1 — $Z_{INT} = 0.8\,Z_S = 0.8 \times 1.64 = 1.312\Omega$

Flow of EARTH FAULT CURRENT

ACTIVE → SWITCH → EARTH LINK → NEUTRAL LINK → NEUTRAL

pb (3)

TABLE 8.1

MAXIMUM VALUES OF EARTH FAULT-LOOP IMPEDANCE (Z_s at 230 V)

Protective device rating	Circuit-breakers			Fuses	
	Type B	Type C	Type D		
	Disconnection times				
	0.4 s			0.4 s	5 s
A	Maximum earth fault-loop impedance Z_s Ω				
6	9.58	5.11	3.07	11.50	15.33
10	5.75	3.07	1.84	6.39	9.20
16	3.59	1.92	1.15	3.07	5.00
20	2.88	1.53	0.92	2.09	3.59
25	2.30	1.23	0.74	1.64	2.71
32	1.80	0.96	0.58	1.28	2.19
40	1.44	0.77	0.46	0.96	1.64
50	1.15	0.61	0.37	0.72	1.28
63	0.91	0.49	0.29	0.55	0.94
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

of 15A
C FUSE.
IMPEDANCE
THE SUPPLY

1.64Ω

→ NEUTRAL

Pb ③

A FINAL SUB CIRCUIT SUPPLIES A LOAD CONSISTING OF FLOURESCENT LUMINAIRES AND IS PROTECTED BY A 10A TYPE (C) CIRCUIT BREAKER

DETERMINE THE MAXIMUM INTERNAL FAULT LOOP IMPEDANCE OF THE FINAL SUB CIRCUIT BASED ON 230V WHEN THE SUPPLY IS UNAVAILABLE.

10A TYPE (C) C·B → $Z_S = 3.07\Omega$

$Z_{INT} = 0.8\,Z_S = 0.8 \times 3.07$

$= 2.46\,\Omega$

Pb

Δ Y — CONSUMER MAIN — MAIN SWITCH

0.0007Ω

22kV / 415V

0.02Ω/Ph

500kVA 3ϕ

FIND FAULT CURRENT

$X_T = 0.02 + 0.0007 = 0.0207\Omega$

$I_{FL} = \frac{kVA \times 10^3}{\sqrt{3}\,E_L} = \frac{500 \times 10^3}{1.7321 \times 415} = 695A$

CALCULATION OF FAULT CURRENT

$$\%\ IMPEDANCE = \frac{\text{FULL LOAD CURRENT} \times \text{IMPEDANCE}\ (\Omega)}{\text{PHASE VOLTAGE}} \times 100$$

$$\%X = \frac{I_{FL} \times X_{ph}}{E_{ph}} \times 100$$

$$\text{FULL LOAD CURRENT} = \frac{\text{FULL LOAD kVA} \times 10^3}{\sqrt{3} \times \text{LINE VOLTAGE}}$$

$$I_{FL} = \frac{kVA \times 10^3}{\sqrt{3} \times E_L}$$

$\%X = \frac{I_{FL} \times X_{ph}}{E_{ph}} \times 100$

$= \frac{695 \times 0.0207}{\left(\frac{415}{\sqrt{3}}\right)} \times 100$

$= 5.94\%$

$I_{sh} = \frac{I_{FL}}{\%X} \times 100$

$= \frac{695}{5.94} \times 100$

$= 11602A$

FAULT C

C

E

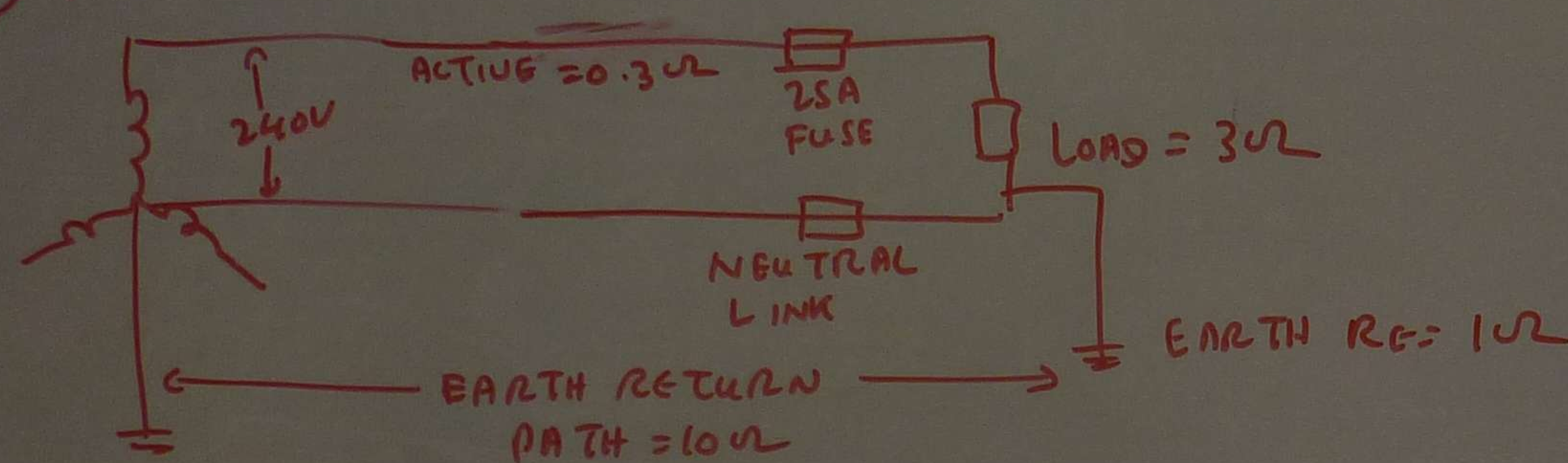
$R_{TOTAL} =$

I_{EA}

IT N
EARTH

TUTORIAL

① FIND THE EARTH FAULT CURRENT

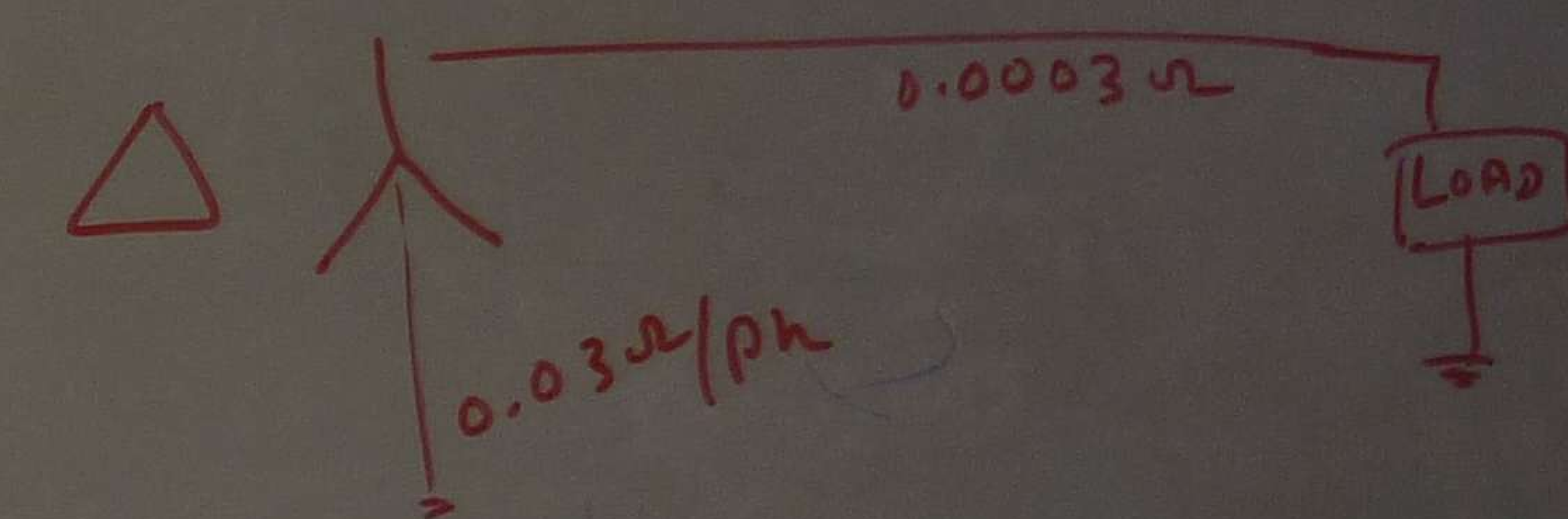


② FIND INTERNAL FAULT LOOP IMPEDANCE

(a) HRC FUSE 16A

(b) TYPE D CIRCUIT BREAKER 40A

③ FIND FAULT CURRENT



400kVA 3φ

11kV | 400V

METER CONNECTION DIAGRAM
IN ACCORDANCE WITH NSW ELECTRICAL SERVICE RULES

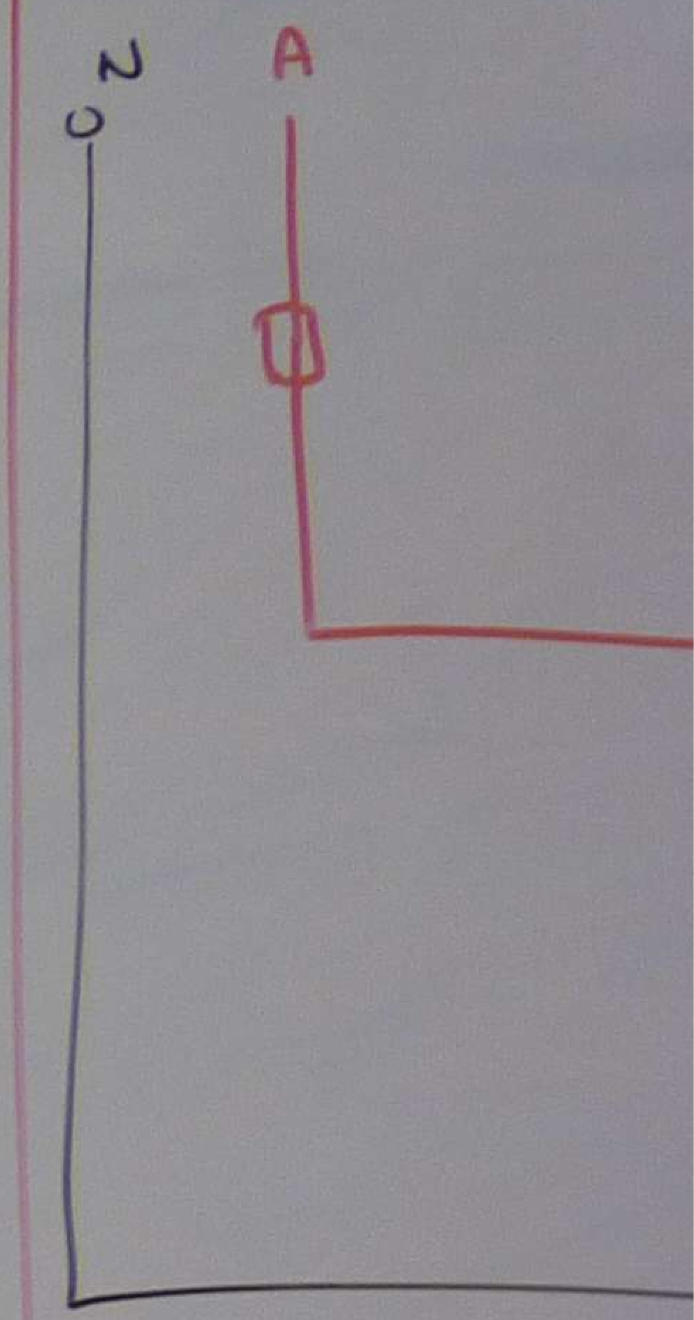
NSW ELECTRICAL SERVICE RULE   www. google .com

TYPE NSW ELECTRICAL SERVICE RULE

SECTION (4) SERVICE & METERING EQUIPMENTS.

PAGE 15 – WIRING DIAGRAM FOR BOTTOM CONNECTED METERING

CIRCUIT CONN

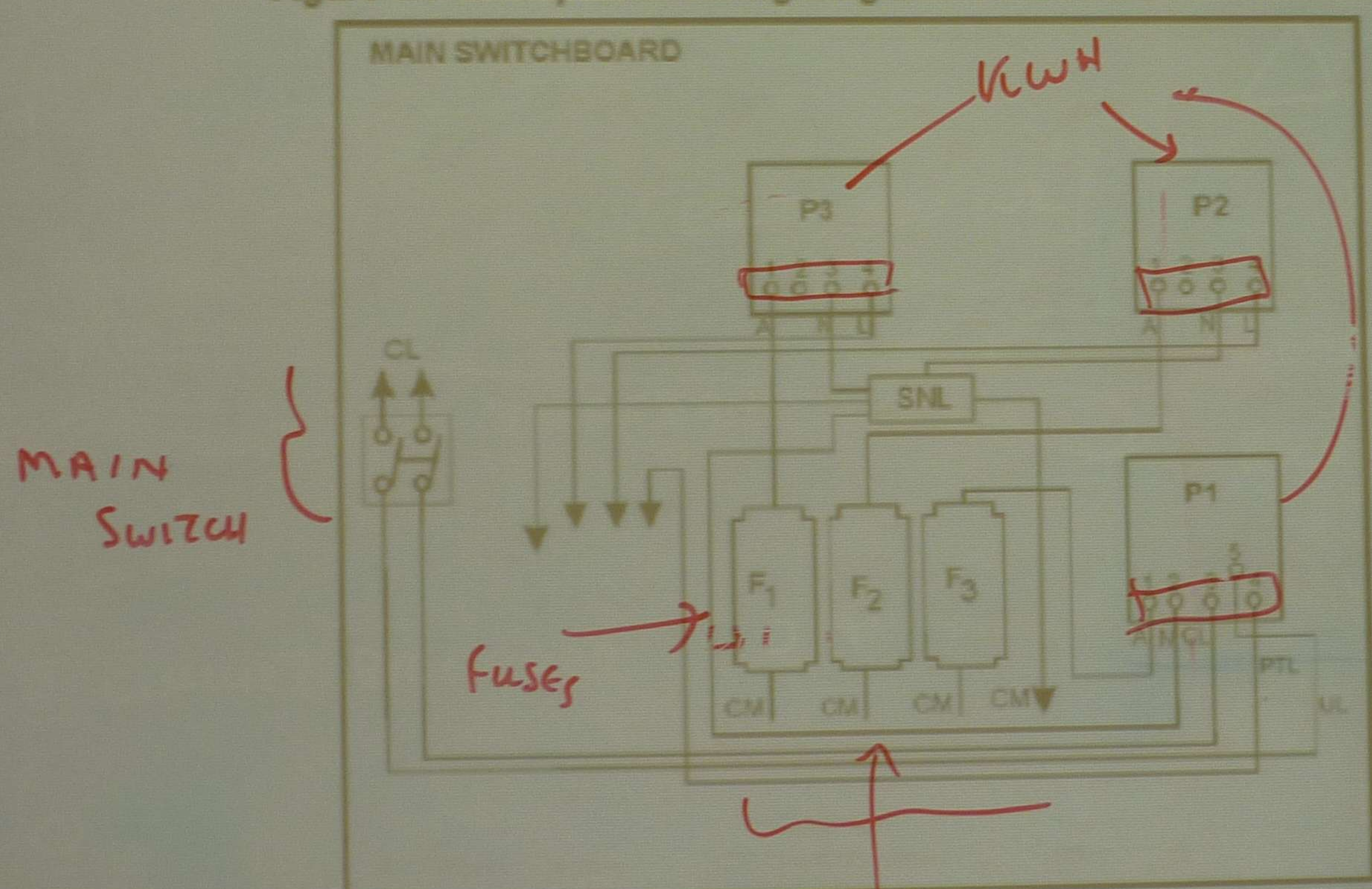


DIS

N


CIRCUIT CONNECTION DIAGRAM
N
A
KWH 1
HOT WATER
KWH 2
LIGHTING
KWH3
POWER
A
A
SEALED
ACTIVE
LINK
A
A
A
DISTRIBUTOR
NEUTRAL
LINK
TO CONSUMER
NEUTRAL
LINK
TO CONSUMER'S CIRCUIT CONTROL
AND PROTECTION DEVICES.

Figure 4.4: Examples of Wiring Diagrams for Bottom Connected Metering



EXAMPLE THREE PHASE AND OFF-PEAK INSTALLATION
(P1 IS AN ELECTRONIC METER)

LEGEND

A	Active terminal
C	Load-control device
F	Service Protective Device
L	Load terminal
M	Meter
MC	Controlled load meter
N	Neutral terminal
SNL	Service neutral link on back of panel
P	Positions
PTL	Principal Tariff Load
P1	First position used in each layout
CL	Connection to controlled-load main switch or contactor
CM	consumers mains/underground service mains
UL	Uncontrolled Load

MAIN SWITCHBOARD


ELECTRICAL ENGINEERING
STUDENTS' DESIGN
PLEASE DO NOT
WITHOUT
JOE
P3
P2
P1
N
CM
CM
SNL
012


PRIMARY WINDING
240V G.P.O.
250V D.C
RESET


ELECTRICAL ENGINEERING
STUDENTS' DESIGN
N
LEASE DO NOT
P3
P2
P1
WITHOUT
OTIFYING
JOE
CM
SNL
012

TUTORIAL

DESIGN THE MAIN SWITCH BOARD TO INSTALL 3 KWH METERS FOR HOT WATER, LIGHTING AND POWER BY APPLYING NSW ELECTRICAL SERVICE RULE - SERVICE AND METERING EQUIPMENTS INSTALLATION.