PROTECTION MECHANISM

- THERMAL
- MAGNETIC
- THERMAL MAGNETIC
- ELECTRONIC

FAULT CURRENT LIMITERS

HRC FUSES CAN BE UTILIZED AS CURRENT LIMITERS TO TAKE OVER THE PROTECTION.

SURGE DIVERTERS

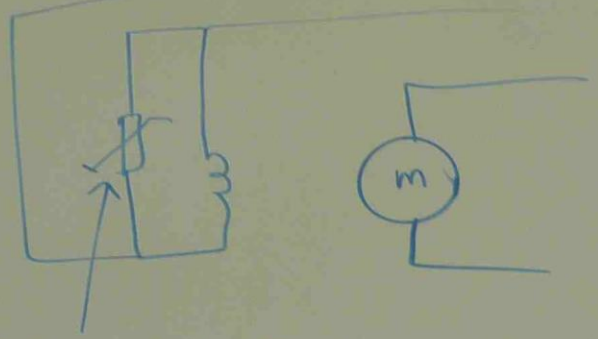
THE SURGE DIVERTER HAS TWO MAJOR IMPORTANT FUNCTIONS. IT MUST DISCHARGE THE HIGH VOLTAGE SURGE TO EARTH. IT MUST PREVENT ANY FOLLOW UP CURRENT AT NORMAL LINE VOLTAGE.

TWO BASIC TYPES

- VALVE TYPE
- EXPULSION TYPE

INTERNALLY GENERATED OVER VOLTAGE

- SWITCHING TRANSIENT CAUSED BY SWITCHING
- VOLTAGE SPIKES THAT OCCUR WHEN A FUSE (OR) CIRCUIT BREAKER OPERATES
- MODERN ELECTRONIC EQUIPMENTS THAT INJECT HARMONIC VOLTAGE



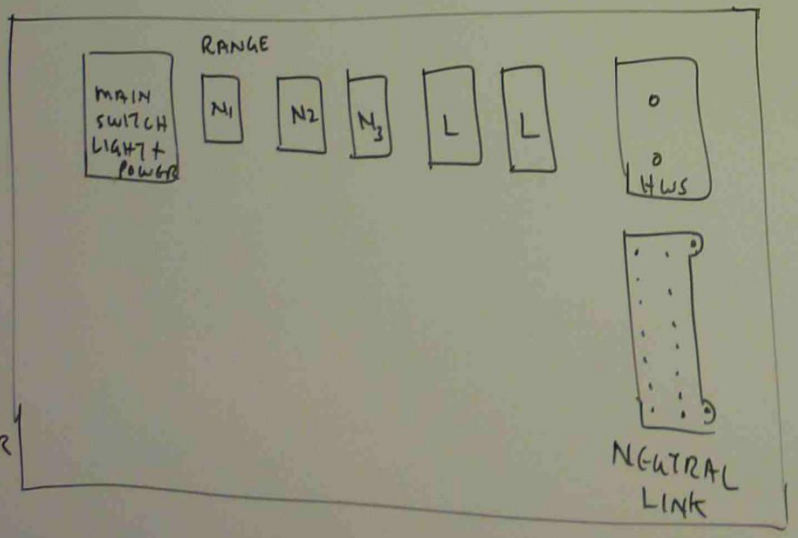
CURRENT LIMITING RESISTOR

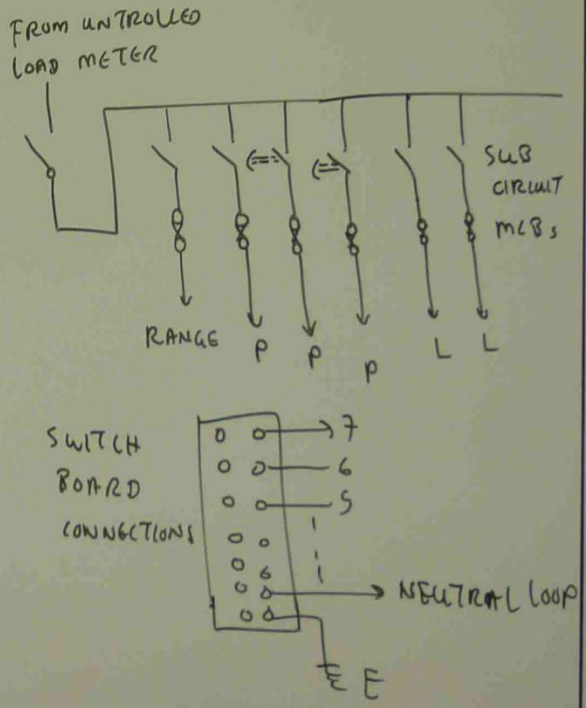
N_1 - RANGE
N_2 - POWER(1)
N_3 - POWER(2)
L - LIGHT
HWS - HOT WATER SYSTEM

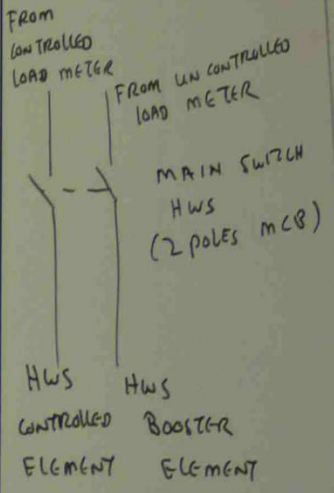
MOTOR PROTECTION

- PROTECTION FROM ENVIRONMENT → METAL CUTTING, WOOD WORKING, CONVEYOR DRIVES, REFRIGERATION, AIR CONDITIONING, TEXTILE,
- PROTECTION FROM OVER HEATING → MECHANICAL & ELECTRICAL OVER LOAD
  TOO FREQUENT STARTING
  ELECTRICAL FAULT WITH IN WINDING
  SINGLE PHASING.

SWITCH BOARD LAYOUT, WIRING & MARKING







SWITCH BOARDS FOR NON DOMESTIC INSTALLATIONS

WITH COMMERCIAL AND INDUSTRIAL TYPE INSTALLATIONS AND IN COMMON WITH MOST OTHER INSTALLATION TYPES, THE CONSUMER'S MAIN TERMINATE AT A MAIN CONTROL POINT.

THE NATURE AND ELECTRICAL RATING OF THE LOAD DETERMINE THE NUMBER AND LOCATIONS OF VARIOUS DISTRIBUTION CENTRES AS NECESSARY.

CLIPSAL SWITCH — SUPPLIED WITH 150A 3ϕ MAIN SWITCH

BUS BAR RATING

150A ⟶ 400A TESTED FOR 16KA & 20KA

SPECIFICATION

AS 3000, AS 3439

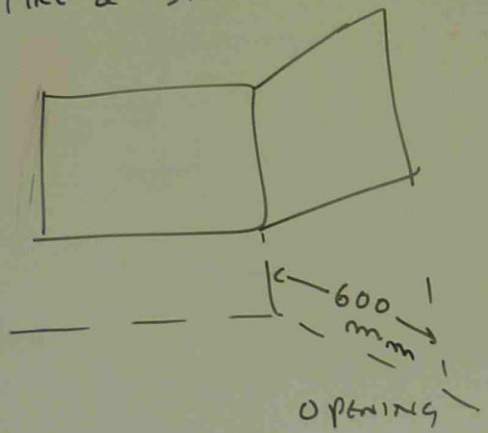
LOCATION & ACCESS

MAIN SWITCH MUST BE READILY ACCESSIBLE. IT MUST NOT BE HIGHER THAN 2m ABOVE GROUND, FLOOR (OR) OPERATION PLATFORM

MAIN SWITCH ACCOMODATES FUSES, CIRCUIT BREAKERS AND SWITCHES.

- A SWITCH BOARD SHOULD NOT BE LOCATED IN BATH ROOM, TOILET, LAUNDRY, KITCHEN OF A DOMESTIC INSTALLATIONS.

- FIRE & SMOKE PROTECTION MUST BE PROVIDED



ARRANGEMENT OF EQUIPMENTS

FUSES AND CIRCUIT BREAKERS MUST BE ARRANGED SO THAT A PERSON LOOKING AT SWITCH BOARD CAN SEE INSTANTLY THEIR INTERRELATIONS.

- NO FUSE OR CIRCUIT BREAKER AT THE BACK of SWITCH BOARD
- APPROPRIATE CLEARANCES FOR LIVE PARTS & BARE CONDUCTORS

NEUTRAL LINK

MINIMUM SIZE AS SPECIFIED IN AS 3000 MUST BE FOLLOWED

MARKING

LEGIBLE AND INDELIABLE

WIRING

WIRING MUST BE RUN AT THE BACK OF SWITCH BOARD PANEL

PANEL SWING

60 → 90° SWING

RATING

FAULT LEVEL 1 KA FOR REWIRABLE FUSE
1-5 KA FOR PLUG IN C.B
8 KA FOR MCB (MAIN CIRCUIT BREAKER)

AS3000:2007 RULE BOOK EXERCISE

FIND THE RELEVANT CLAUSES FOR THE FOLLOWINGS: -

- SURGE DIVERTERS, MOTOR PROTECTION, SWITCH BOARD, ARRANGEMENT OF EQUIPMENTS IN SWITCH BOARD
- SWITCH BOARD WIRING
- NEUTRAL LINK, MARKING, RATING OF SWITCH BOARD.

G008 | G008 GENERAL NOTE (1) PART (4)

G008 | G008 GENERAL NOTE (2) PART (1)

G003 | G004 HAZARD LIGHTING PANEL.ZIP (PART 1)

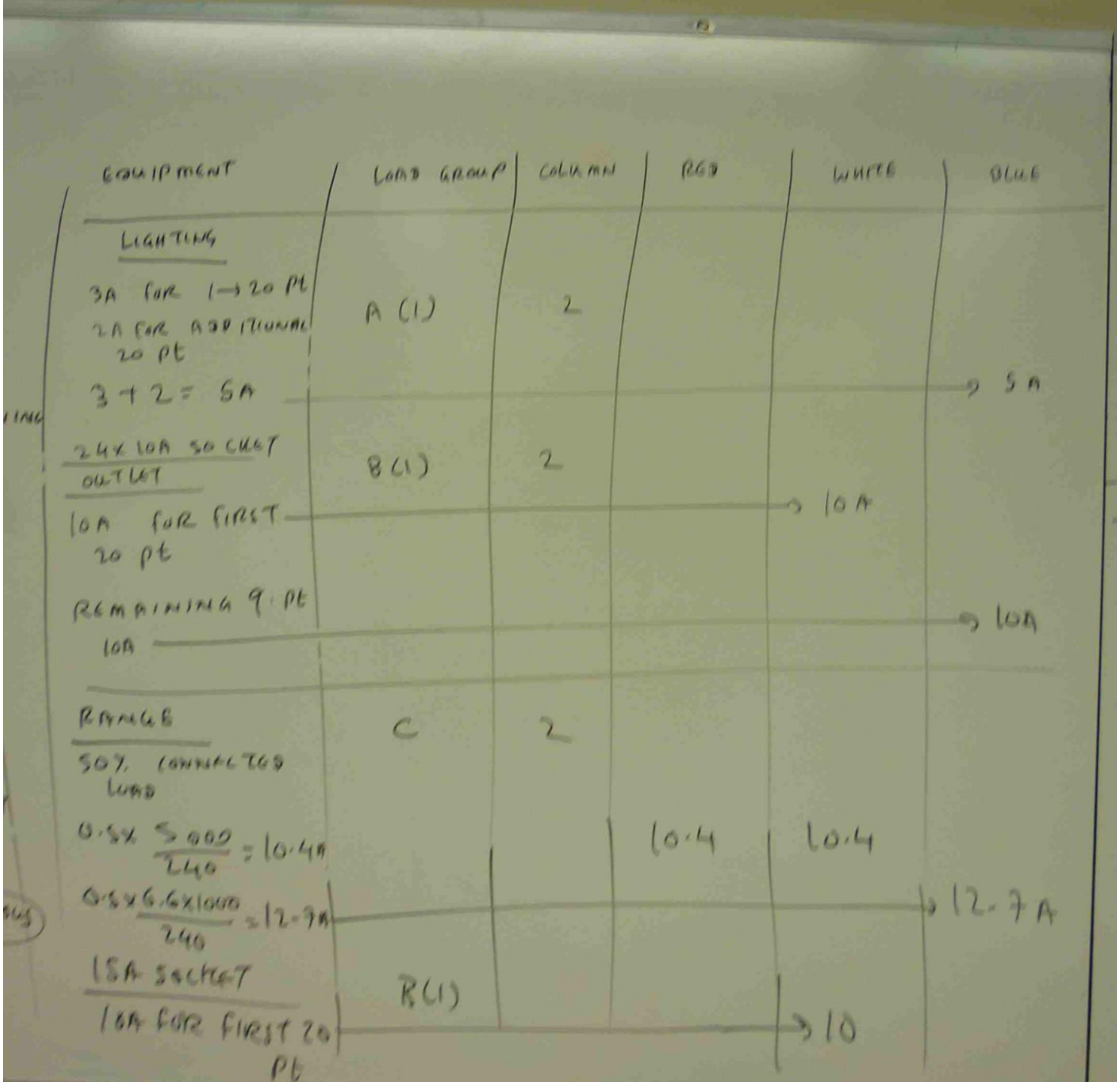
AS3000 — AS3008 TABLE EXTRACT - ZIP

pb (2) DETERMINE THE MAXIMUM DEMAND OF THE HEAVIEST LOADED PHASE IN A DOMESTIC ELECTRICAL INSTALLATION COMPRISING:

- 26 LIGHTING POINTS ——— BLUE
- 24 x 10A SINGLE SOCKET OUTLET (15 IN WHITE, THE REMAINING IN BLUE
- 1 x 15A SOCKET OUTLET (WHITE)
- 1x 6.6 KW RANGE
- 1x 4 KW AIR CONDITIONING UNIT (RED)
- 1x 12.96 KW INSTANTANEOUS WATER HEATER
- 1x 3.6 KW CLOTH DRYER

AND ARRANGED FOR CONNECTION ACROSS A 3φ SUPPLY AS FOLLOWS

RED	WHITE	BLUE
15A SOCKET OUTLET	15 x 10A SOCKET OUTLET	26 LIGHT
5KW HOT PLATE	5 KW HOT PLATE	4 x 10A SOCKET OUTLET
4KW AIR CON:	4-3 KW INSTANTANEOUS WATER HEATER	6.6 KW OVEN
4-3 KW INSTANTANEOUS WATER HEATER	3.6 KW CLOTH DRYER	4-3 KW INSTANTANEOUS WATER HEATER


EQUIPMENT
LOAD GROUP
COLUMN
RED
WHITE
BLUE
LIGHTING
3A FOR 1 → 20 PT
2A FOR ADDITIONAL 20 PT
A (1)
2
3 + 2 = 5A
5A
24X 10A SOCKET OUTLET
B (1)
2
10A FOR FIRST 20 PT
10A
REMAINING 9 PT
10A
10A
RANGE
C
2
50% CONNECTED LOAD
0.5X 5000/240 = 10.4A
10.4
10.4
0.5X 6.6X1000/240 = 12.7A
12.7A
15A SOCKET
10A FOR FIRST 20 PT
B (1)
10

EQUIPMENT	LOAD GROUP	COLUMN	RED	WHITE	BLUE
4 KW AIR CON					
75%	D	2			
$0.75 \times \frac{4 \times 1000}{240} = 12.5A$			12.5A		
INSTANTANEOUS WATER HEATER					
33%					
$0.33 \times \frac{4.3 \times 10^3}{240} = 7.5A$			7.5	7.5	7.5
CLOTH DRYER 3.6KW					
LAUNDRY					
50% LOAD					
$0.5 \times \frac{3.6 \times 10^3}{240} = 7.5$				7.5	
		TOTAL	38.4A	33.4A	34.7A

HEAVIEST LOAD (RED) = 38.4A

pb (3) DETERMINE THE MAXIMUM DEMAND OF THE HEAVIEST LOADED PHASE OF A BLOCK OF 80 UNITS COMPRISING THE FOLLOWING LOADS.

- ✓ LIGHTING – 80 UNITS
- ✓ 10A SOCKET OUTLET – 80 UNITS
- ✓ ELECTRIC RANGE – 17 UNITS
- ✓ 2.5 KW (10.4A) PERMANENT STRIP HEATER – 80 UNITS
- QUICK RECOVERY WATER HEATER – 80 UNITS

LOADING NOT ASSOCIATED

- 90 – 60W LIGHTING POINTS
- 21 – 100W LIGHTING POINTS
- TOTAL LIGHTING = 7.5 KW
- 20 – 10A SINGLE SOCKET OUTLETS
- 10 – 3.6 KW CLOTH DRYERS
- 2 – 12 KW LIFT MOTOR
- 1 – 5.5 KW 3φ PUMP MOTOR
- 1 – 4 KW 3φ WATER SUPPLY MOTOR

INDIVIDUAL UNITS/PHASE = $\frac{80}{3}$ = 27 UNIT

RANGE/PH = $\frac{17}{3}$ = 6

(1) INDIVIDUAL UNIT, REFER TABLE C1

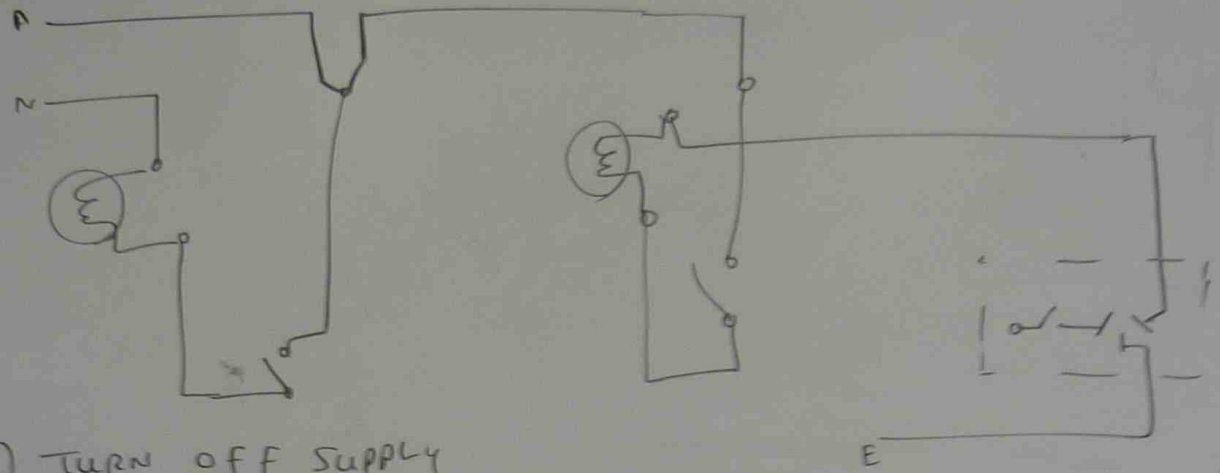
EQUIPMENT	LOAD GROUP	COLUMN	CALCULATION	RESULT (AMP)
LIGHTING	A (1) 21 (OR) MORE × 0.5 AMP / UNIT 27 × 0.5	5	27 × 0.5	13.5 Amp
10A SOCKET OUTLET	B (1) 50A + 1.9 / UNIT × UNIT	5	50 + 1.9 × 27	101.3 Amp
ELECTRIC RANGE	6 → 10 UNIT 2.8A / UNIT × NO. OF UNIT	4	2.8 × 6	16.8 Amp.
STRIP HEATER	SPACE HEATING 75% LOAD	5	$\frac{0.75 \times 2.5 \times 10^3}{240} \times 27$	210.6 Amp

EQUIPMENT	LOAD GROUP	COLUMN	CALCULATION	RESULT
WATER HEATER	STORAGE HEATER	5		
	21 UNITS OR MORE		100 + 0.8 × 27	121.6 Amp
	100A + 0.8A/UNIT × UNIT		TOTAL	463.8 Amp.
II COMMON LOAD	(H)	3/4/5	$\frac{7.5 \times 10^3}{240 \times 3}$	10.4 A
COMMUNAL LIGHTING	FULL LOAD			
10A SINGLE OUTLET	$\frac{20}{3} \simeq 7 \times 1A/UNIT$	4	1 × 7	7 A
3.6 KW CLOTH DRYER	J	3/4/5	$\frac{0.5 \times 3.6 \times 10^3 \times 4}{240}$	30 A
$\frac{10}{3} \simeq 4$ LIFT	50% OF LOAD			N/A
MOTOR	TABLE C2	COL 3/4/5	$\frac{5.5 \times 10^3}{240} + \frac{0.5 \times 4 \times 10^3}{240}$	14.6A
5.5 KW 3ϕ Pump	HIGHEST + 50% OF REMAIN-DER			
4 KW 3ϕ WATER SUPPLY			TOTAL	62A

TOTAL CURRENT I_R = 463.8 + 62

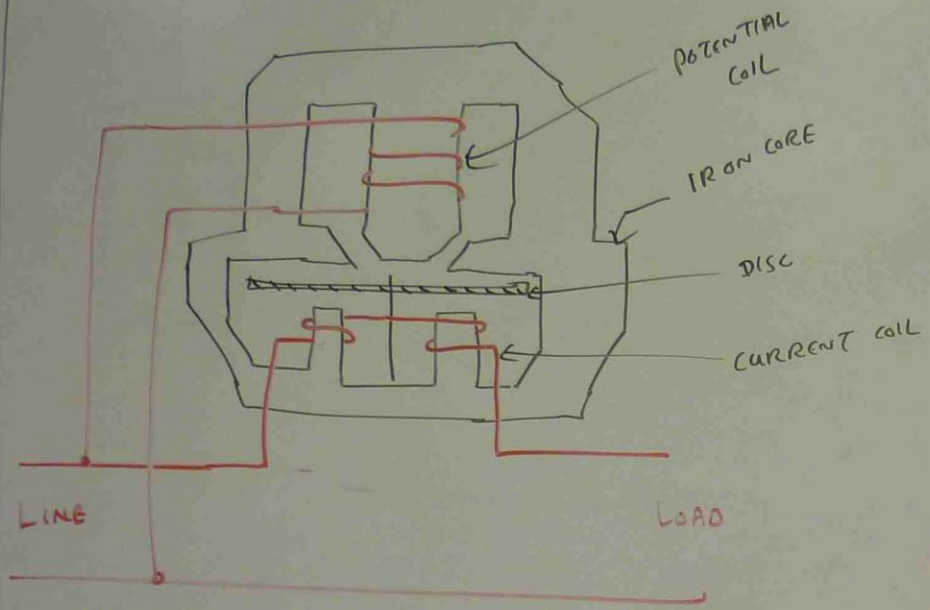
= 525.8 AMP

INSTALLATION AND RCD TESTING



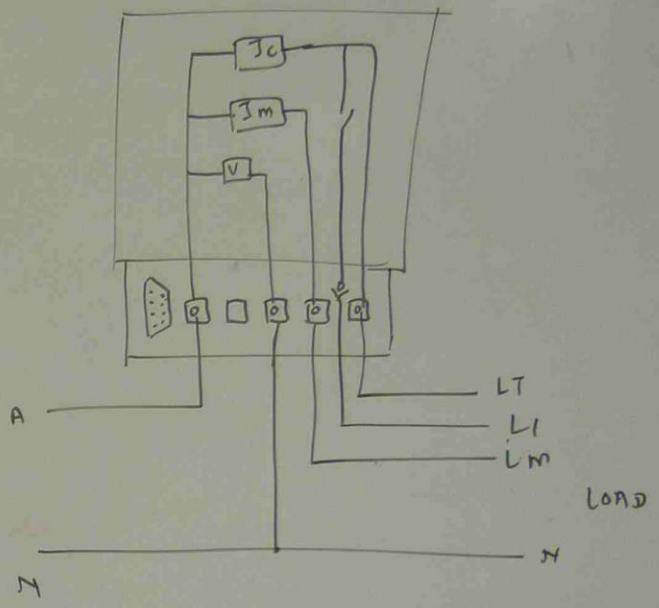
1. TURN OFF SUPPLY
2. DISCONNECT THE MAIN EARTH AND MAIN NEUTRAL FROM NEUTRAL LINK
3. TEST EACH APPLIANCE INDIVIDUALLY.
4. TEST BETWEEN THE LOAD SIDE OF THE MAIN SWITCH AND THE MAIN EARTH AND BETWEEN NEUTRAL LINK AND MAIN EARTH
5. IF LOW READING IS OBTAINED, REMOVE FUSE (OR) SWITCH OFF CIRCUIT BREAKER, TEST AGAIN.

ENERGY DEMAND METERING



THE ENERGY METER CONSISTS OF CURRENT COIL WHICH IS TO BE CONNECTED IN SERIES WITH THE CIRCUIT AND POTENTIAL COIL WHICH IS CONNECTED IN PARALLEL WITH THE CIRCUIT. THE MAGNETIZING FORCE PRODUCED BY TWO COILS ROTATES THE DISC

CONNECTION OF ENERGY DEMAND METERS



I_c = CT FOR ELEMENT 2

I_m = CT FOR ELEMENT 1

V = VOLTAGE SENSOR

A = ACTIVE (125 Amp MAX)

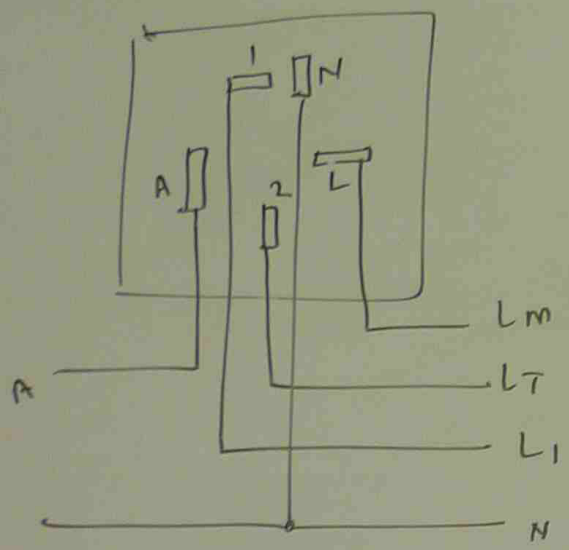
N - NEUTRAL

L_M - ELEMENT 1 LOAD (UNCONTROLLED)

L_2 - ELEMENT 2 LOAD (CONTROLLED)

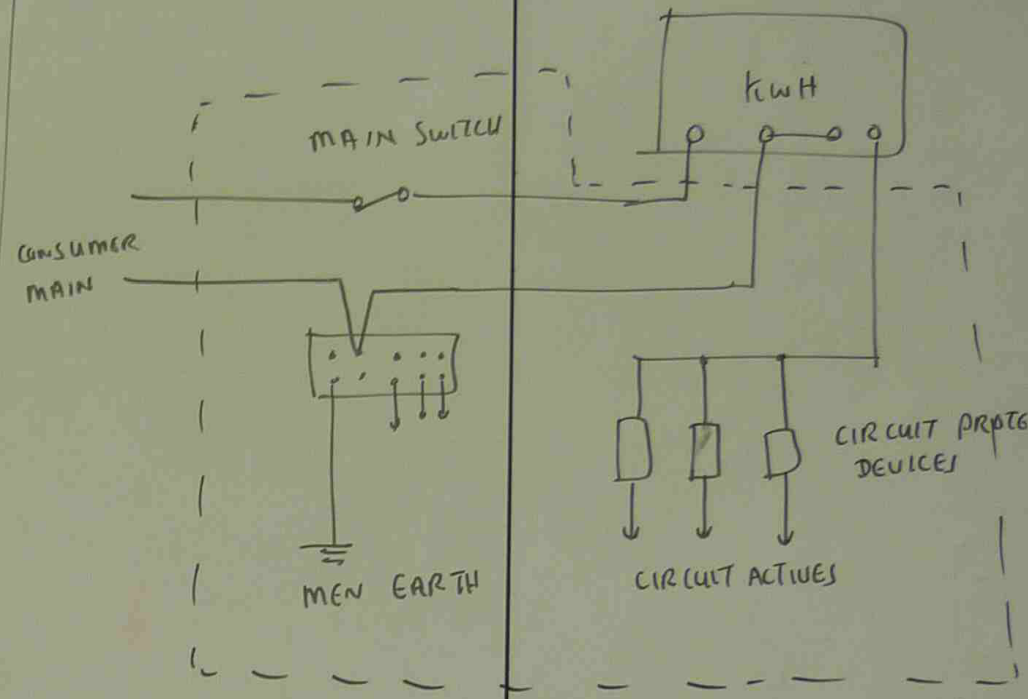
ERS

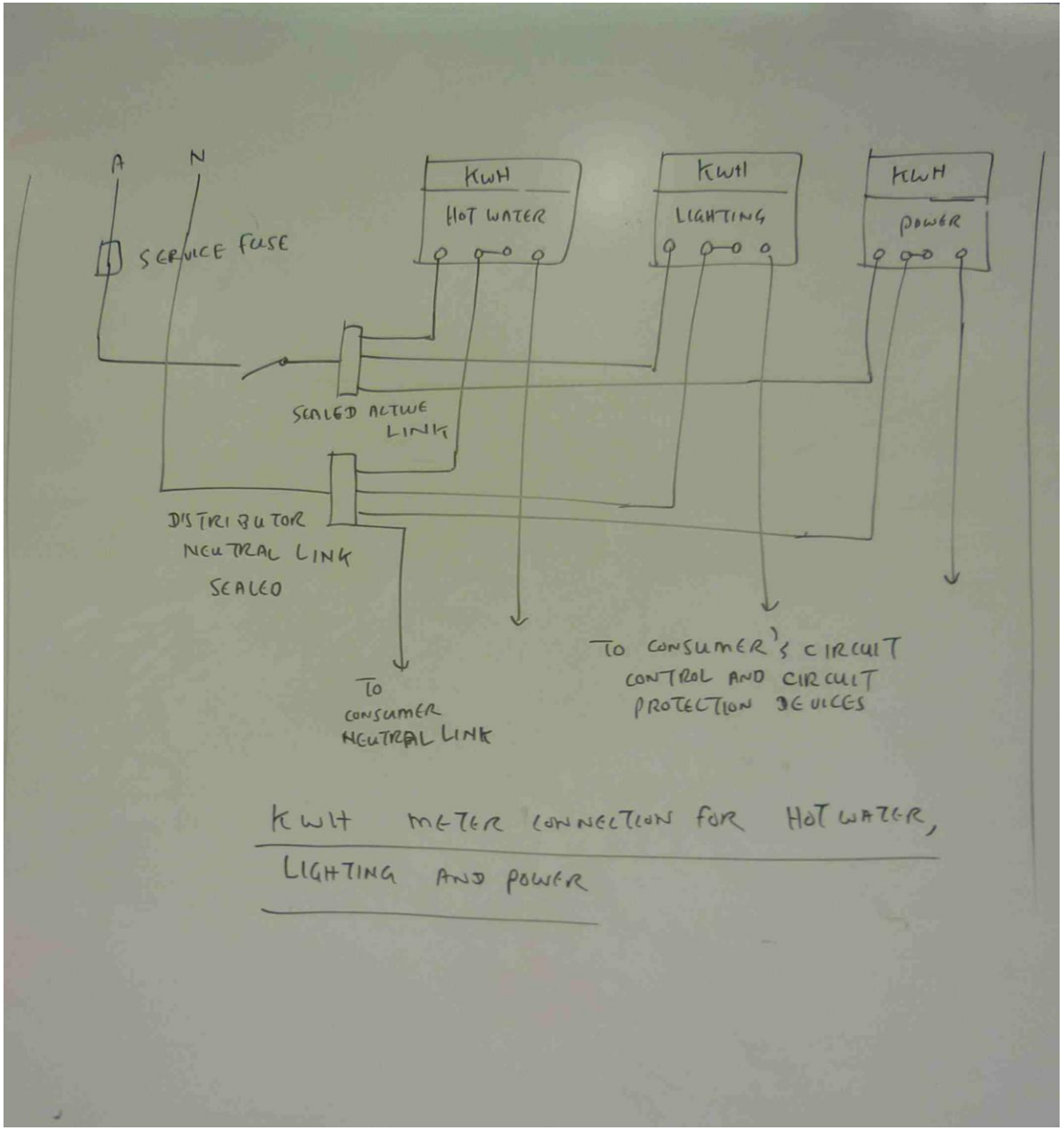
SOCKET



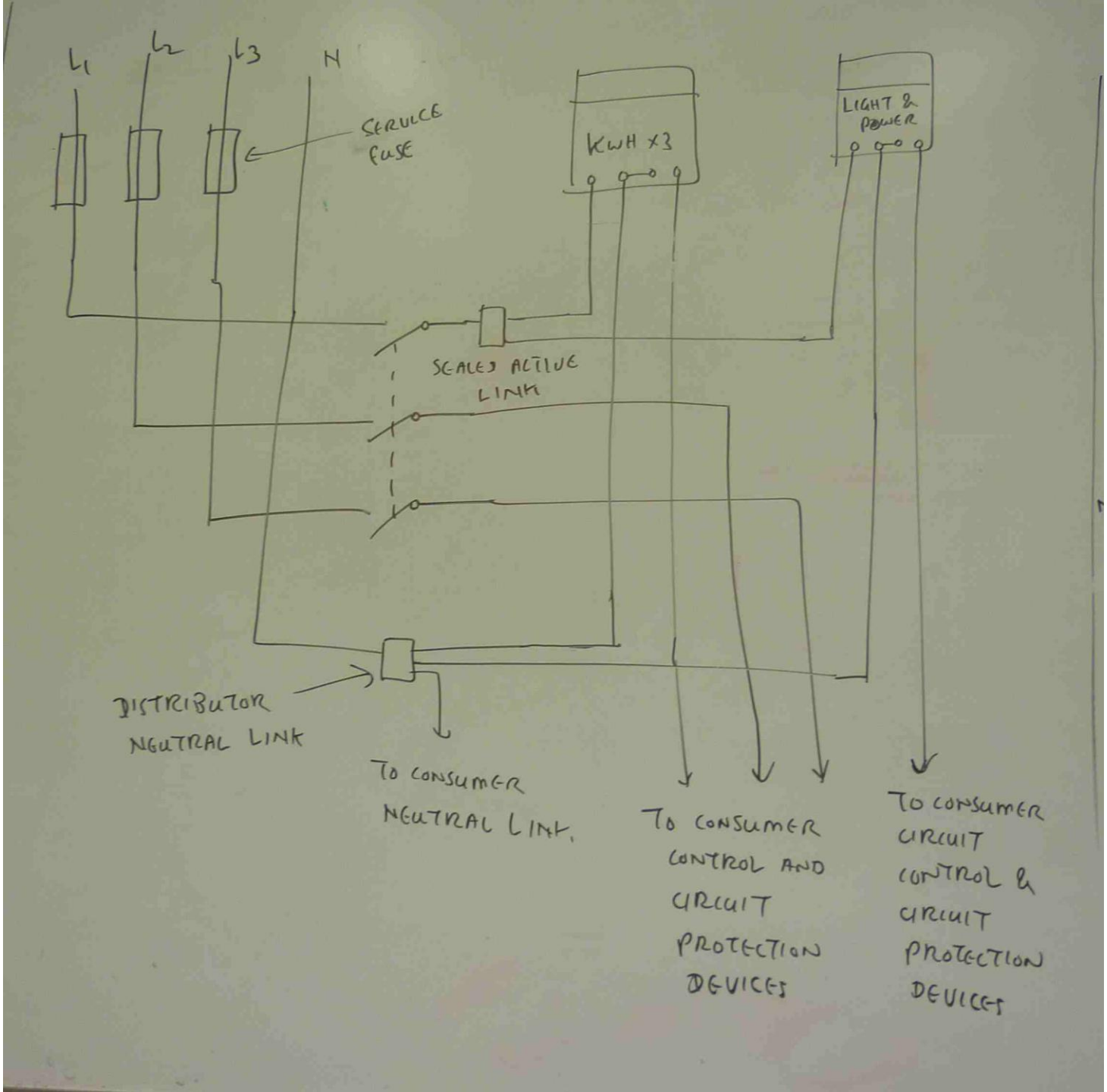
ID

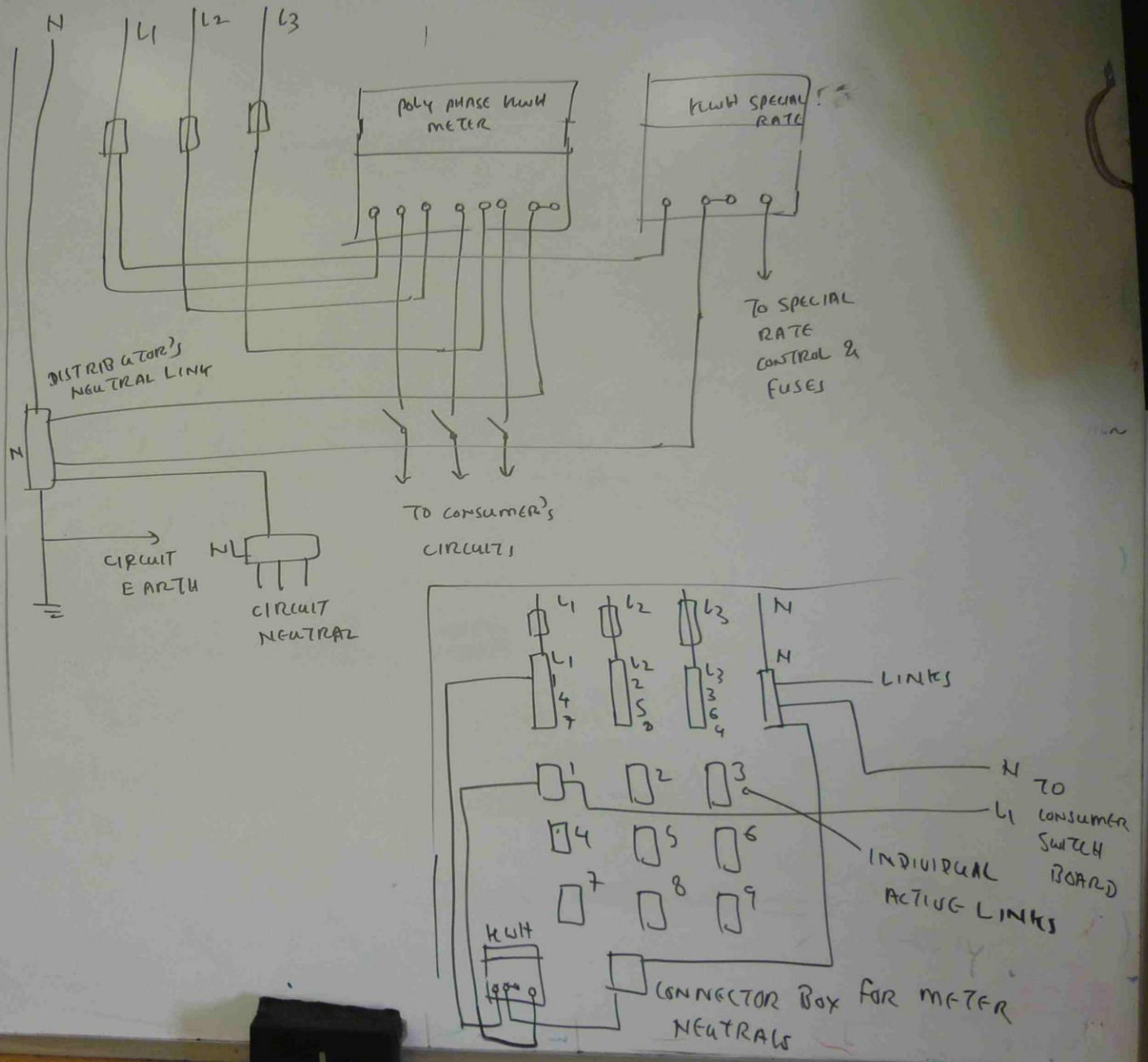
CONNECTING KWH METER TO SUPPLY

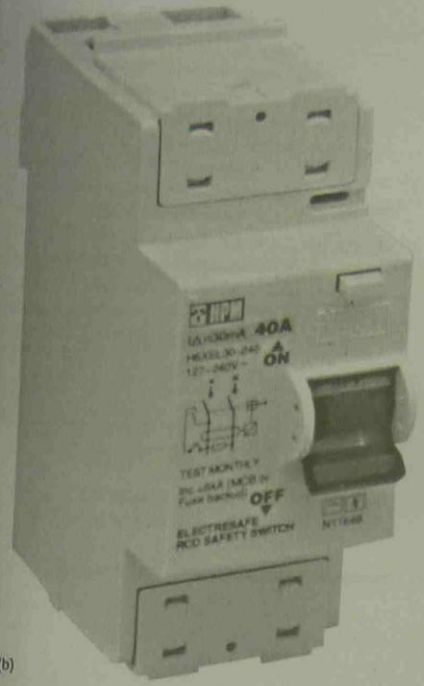




KWH METER CONNECTION FOR HOT WATER, LIGHTING AND POWER


L1
L2
L3
N
SERVICE FUSE
KWH x3
LIGHT & POWER
SEALED ACTIVE LINK
DISTRIBUTOR NEUTRAL LINK
TO CONSUMER NEUTRAL LINK
TO CONSUMER CONTROL AND CIRCUIT PROTECTION DEVICES
TO CONSUMER CIRCUIT CONTROL & CIRCUIT PROTECTION DEVICES


N
L1
L2
L3
POLY PHASE KWH METER
KWH SPECIAL RATE
TO SPECIAL RATE CONTROL & FUSES
DISTRIBUTOR'S NEUTRAL LINK
N
TO CONSUMER'S CIRCUITS
CIRCUIT EARTH
N
CIRCUIT NEUTRAL
L1
L2
L3
N
N
LINKS
1
4
7
2
5
8
3
6
9
N TO CONSUMER SWITCH BOARD
L1
INDIVIDUAL ACTIVE LINKS
KWH
CONNECTOR BOX FOR METER NEUTRALS



(b)

(c)

(d)

(e)

Fig. 14.6(b)–(e) (b) *Type II two-pole RCD*

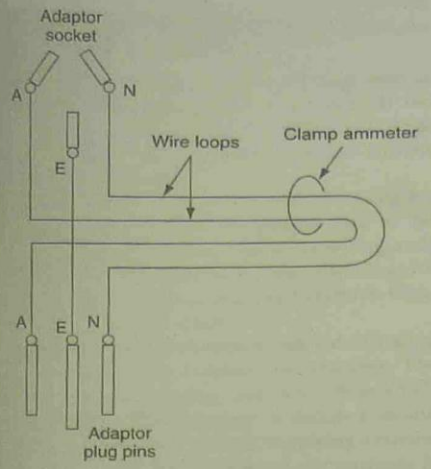


Fig. 14.9(b) *Wiring diagram of the control adaptor arrangement*

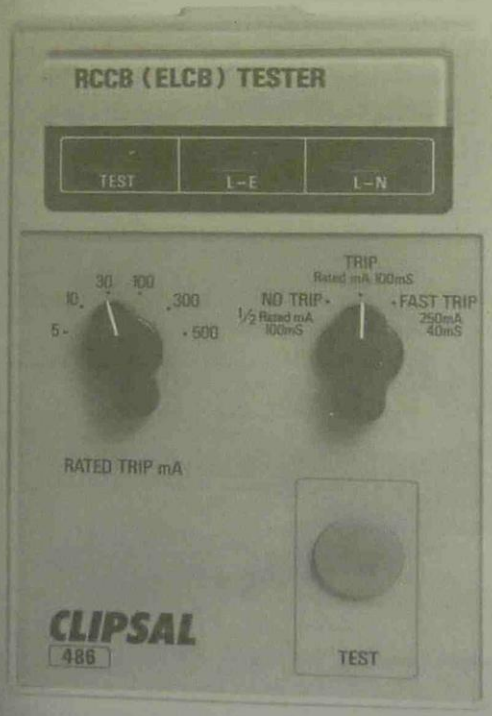


Fig. 14.10 *RCD calibration tester* GERARD INDUSTRIES

14.7 Installation arrangements for RCD protection

There are a number of installation arrangements for providing residual current protection. The factors governing these options are:

- the level of protection required by regulations;
- additional protection specified by the consumer;
- installation limitations; and
- overall cost.

The first three of these factors will be discussed here.

Level of protection required by regulations

Residual current protection is mandatory for most GPOs in new domestic installations in Australia (*Clause 4.14.9*) and for socket outlets in medical treatment areas (AS 3003). As mentioned in section 14.4, RCD protection for socket outlets supplying equipment in damp situations is mandatory in New Zealand. The installation arrangements in medical treatment areas are fairly well defined in AS 3003, which specifies the location of RCDs for easy access and restricts the number of outlets connected to an RCD-protected circuit (see Chapter 19 for more details on areas in which electromedical equipment is used).

In a domestic installation, a number of options are available for the provision of RCD protection to GPO circuits. Installing an RCD-protected socket outlet (see Fig. 14.11) in place of a standard outlet will also provide earth-fault protection on all GPOs installed downstream from the device. Figure 14.12 shows this arrangement where a GPO is left unprotected for the connection of a refrigerator or food freezer, both of which are exempt from a mandatory requirement, while all other GPOs are protected. In an existing installation it will be necessary to determine the location of the first GPO on a circuit, as any GPOs or wiring upstream of the RCD will not be protected.

The other options in a domestic installation involve the installation of devices at the main switchboard, and include the following:

- *Four-pole RCD installed on the load side of the circuit protection devices* (as shown in Fig. 14.13). This arrangement is easy to install, particularly in existing installations, as little modification to the switchboard is required. However, this setup is limited to protected installations with two protected power circuits only; any additional power circuit installed at a later date will require an additional RCD, unless it is a dedicated circuit for a refrigerator or freezer. Also, a fault on either circuit will trip both circuits.
- *Two-pole RCD installed on the line side of the circuit protection devices* (as shown in Fig. 14.14). With this

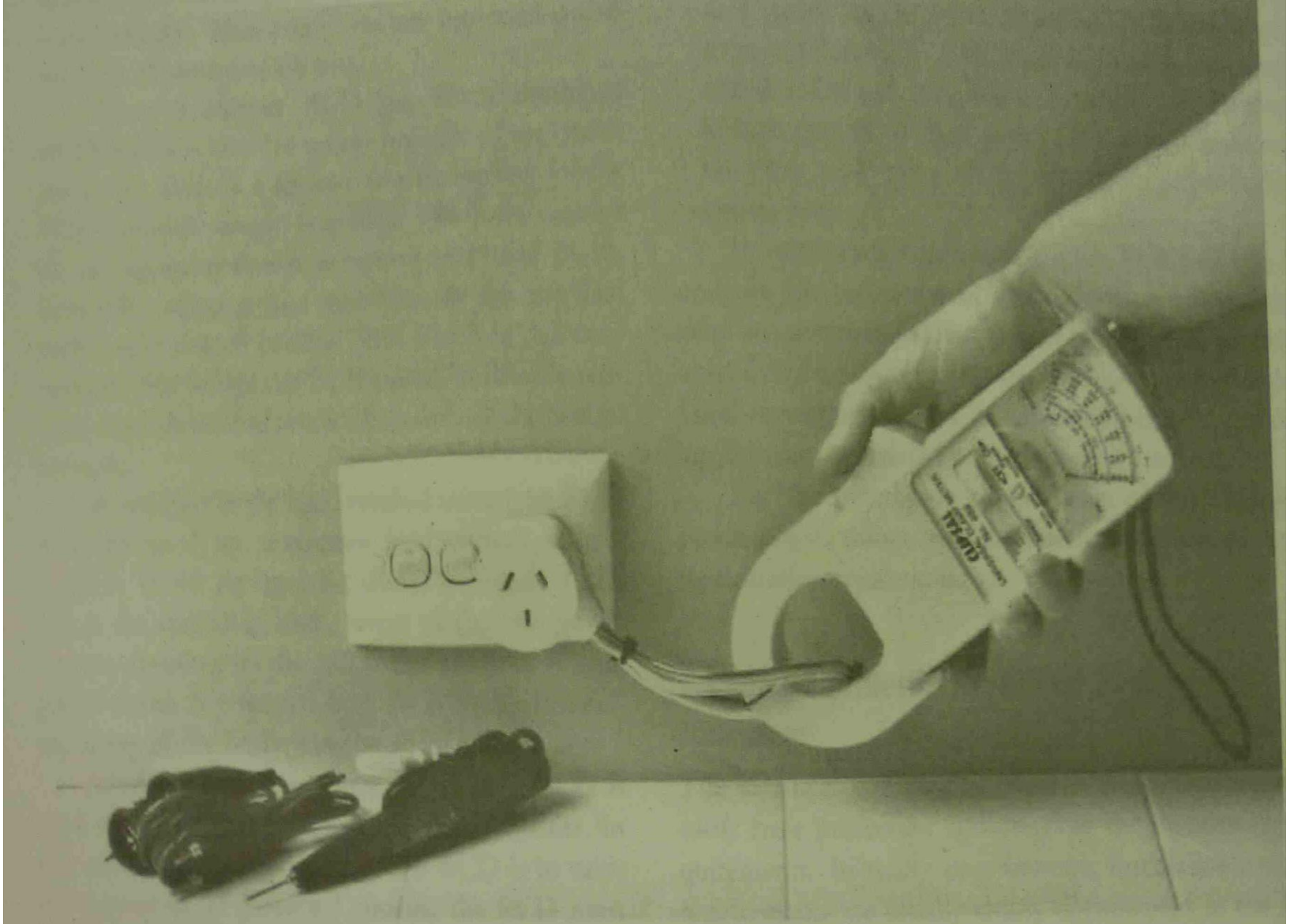
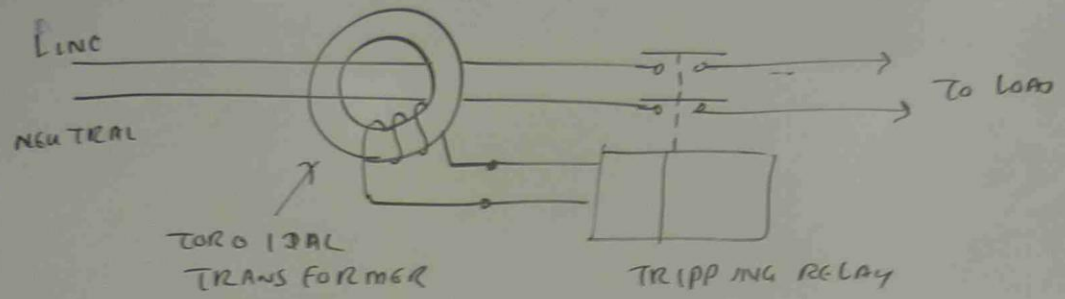
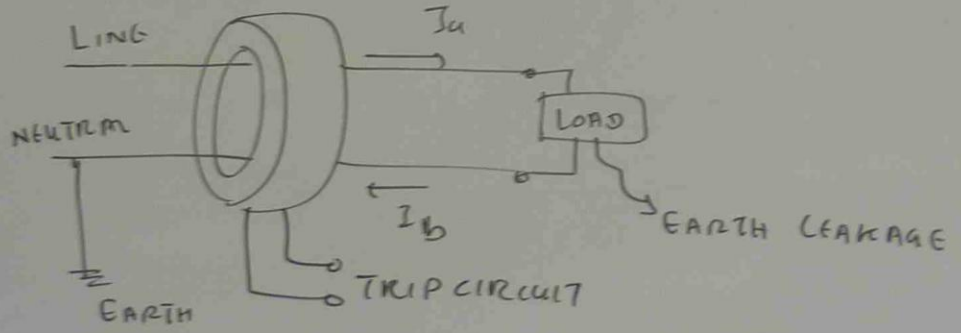


Fig. 14.9(a) *Low-reading clamp ammeter used with a control adaptor to detect leakage current in an appliance* GERARD INDUSTRIES

RESIDUAL CURRENT DEVICE (RCD)





THE RCD USES A TOROIDAL TRANSFORMER SIMILAR TO CURRENT TRANSFORMER TO DETECT EARTH LEAKAGE CURRENT. THE SECONDARY WINDING IS SENSING WINDING.

WHEN I_a & I_b ARE NOT EQUAL DUE TO LEAKAGE CURRENT, RCD TRIPS C.B.

RCD CLASSIFICATION

TYPE I — RESIDUAL CURRENT NOT EXCEEDING 10mA

TYPE II — RESIDUAL CURRENT BETWEEN 10mA & 30mA

TYPE III — RESIDUAL CURRENT BETWEEN 30mA & 300mA

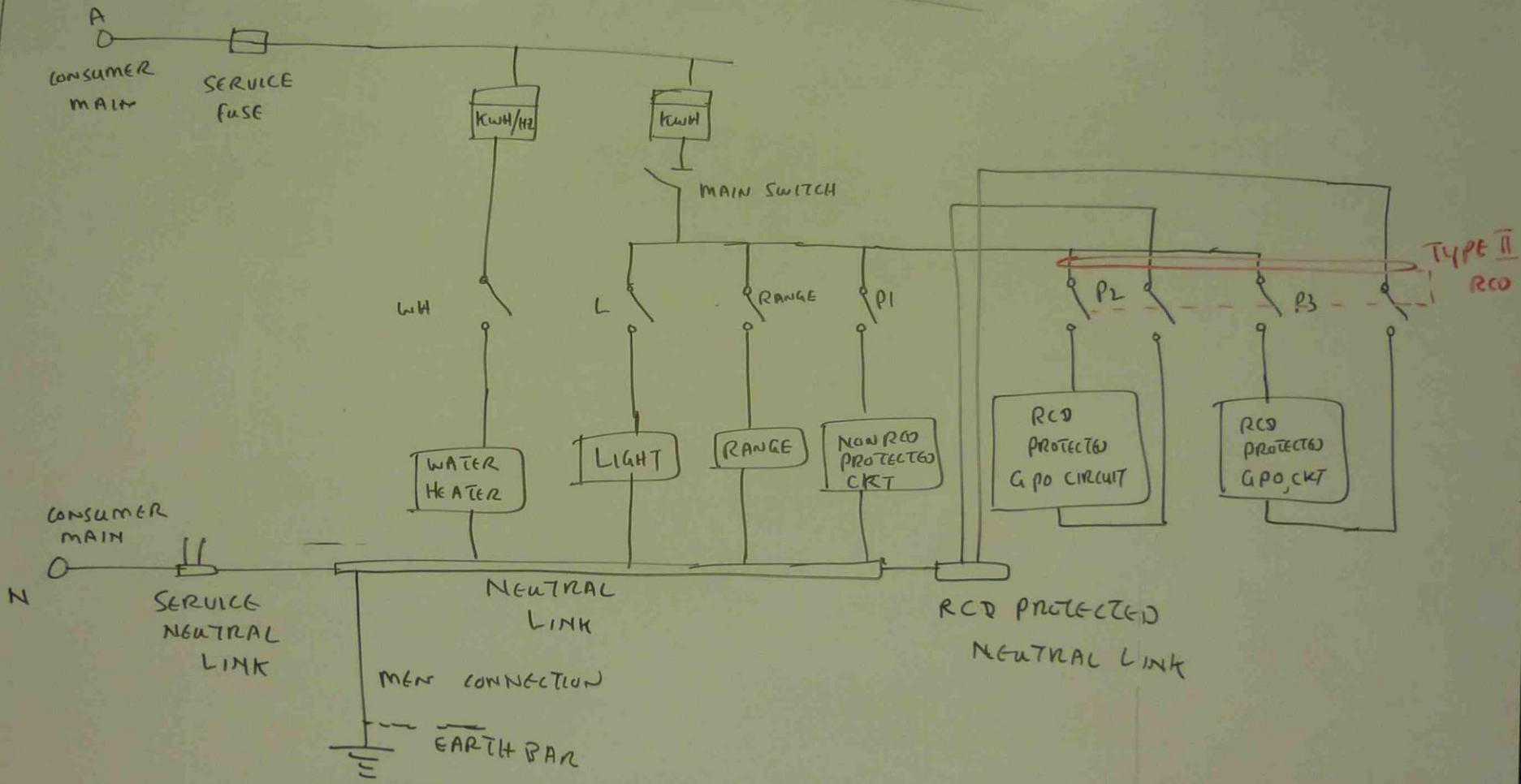
TYPE IV — TYPE III WITH SELECTIVE TRIPPING TIME DELAY

PORTABLE RCD

CLASS L - HOUSE HOLD / GENERAL USE

CLASS H - GENERAL INDUSTRIAL USE

TYPICAL INSTALLATION CIRCUIT ARRANGEMENT



RCD CLASSIFICATION

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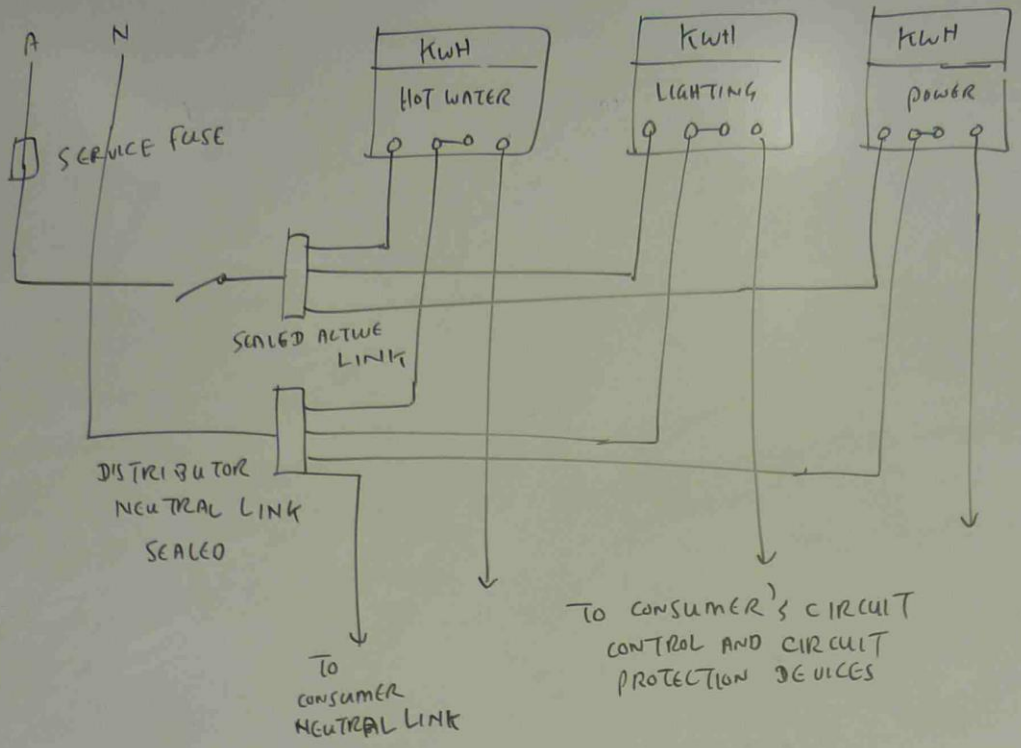
TYPE IV — TYPE III WITH SELECTIVE TRIPPING TIME DELAY

PORTABLE RCD

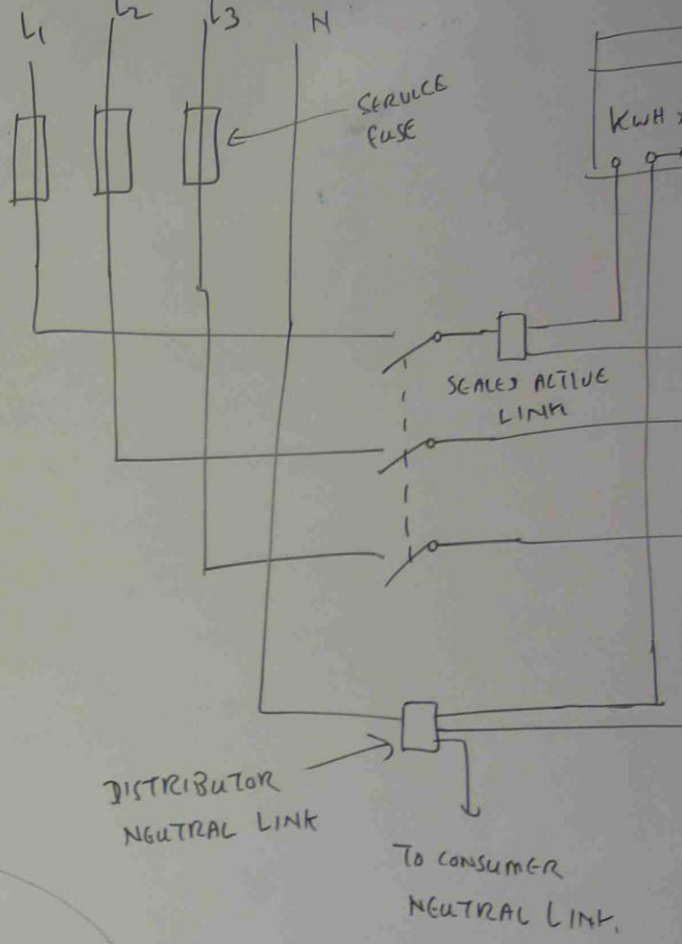
CLASS L - HOUSE HOLD / GENERAL USE

CLASS H - GENERAL INDUSTRIAL USE

GOOG / GOOG GENERAL NOTE (2) PART (3)

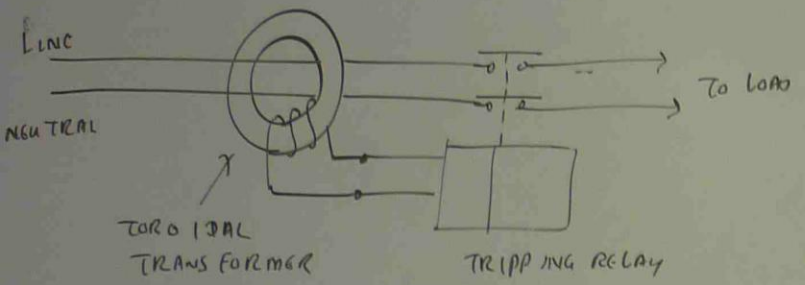


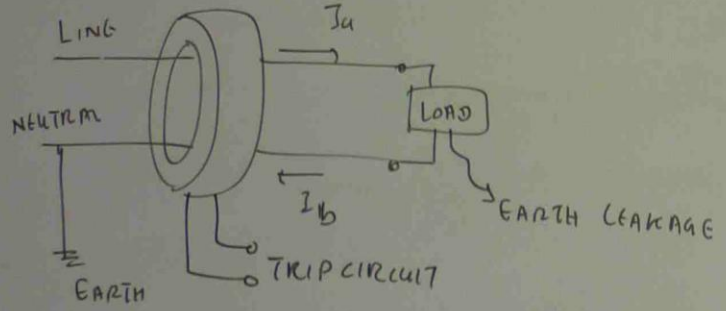
KWH METER CONNECTION FOR HOT WATER, LIGHTING AND POWER



GOOG | METERING.ZIP

RESIDUAL CURRENT DEVICE (RCD)





THE RCD USES A TOROIDAL TRANSFORMER SIMILAR TO CURRENT TRANSFORMER TO DETECT EARTH LEAKAGE CURRENT. THE SECONDARY WINDING IS SENSING WINDING.

WHEN I_a & I_b ARE NOT EQUAL DUE TO LEAKAGE CURRENT, RCD TRIPS C.B.

RCD CLASSIFICATION

TYPE I	RESIDUAL CURRENT NOT EXCEEDING 10mA
TYPE II	RESIDUAL CURRENT BETWEEN 10mA & 30mA
TYPE III	RESIDUAL CURRENT BETWEEN 30mA & 300mA
TYPE IV	TYPE III WITH SELECTIVE TRIPPING TIME DELAY

PORTABLE RCD

CLASS L - HOUSE HOLD / GENERAL USE

CLASS H - GENERAL INDUSTRIAL USE

GOO8 / GOO8 GENERAL NOTE (2) PART (3)

NOT EXCEEDING 10mA

TWEEN 10mA & 30mA

EEN 30mA & 300mA

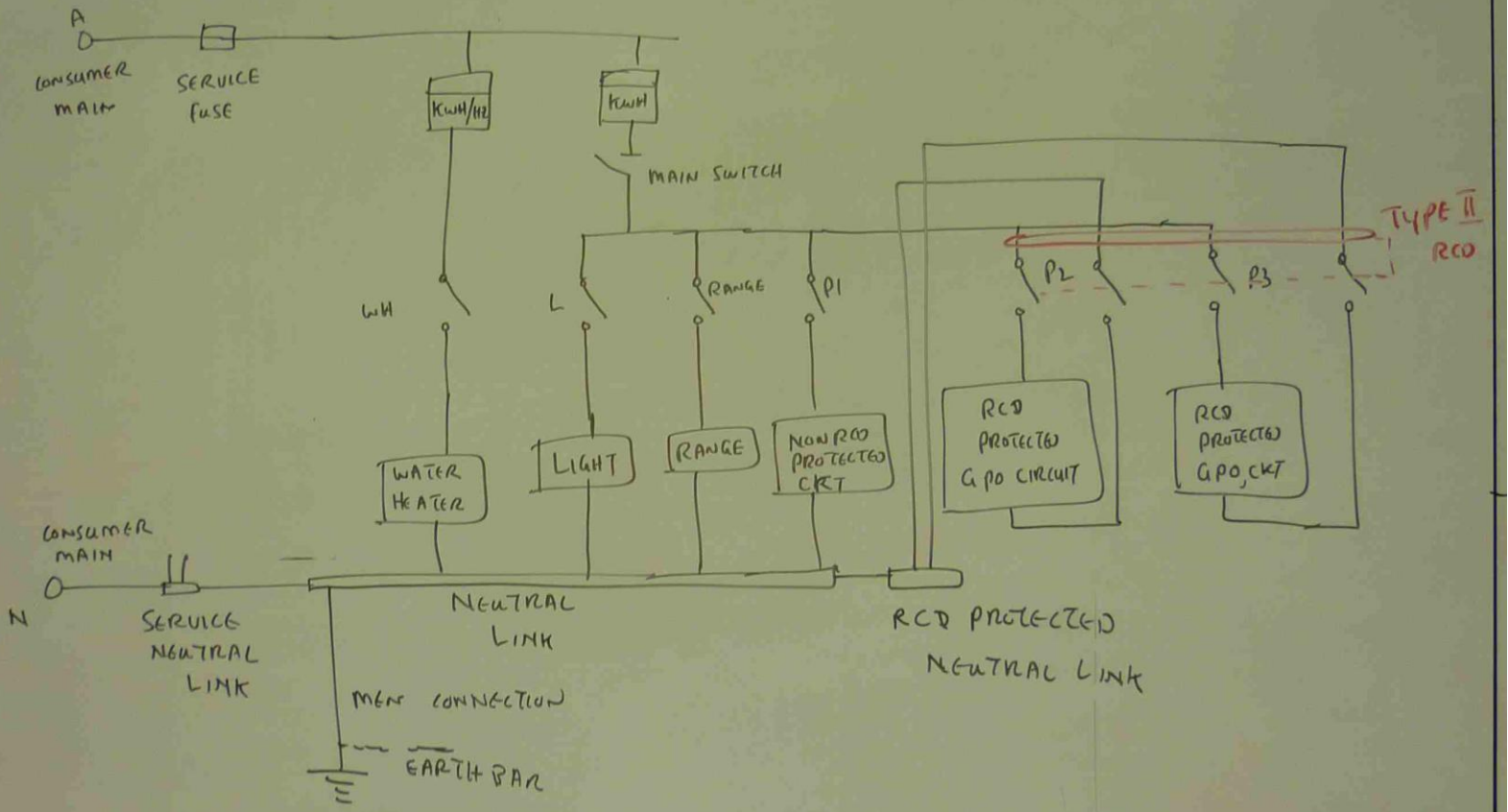
UE TRIPPING TIME

RAL USE

TRIAL USE

2) PART (3)

TYPICAL INSTALLATION CIRCUIT ARRANGEMENT

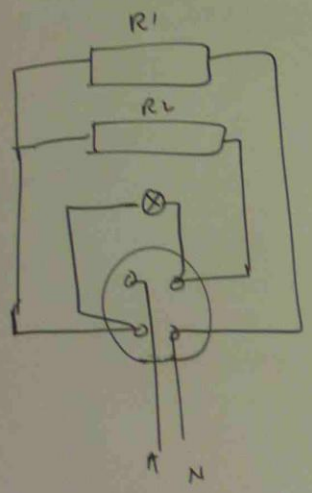


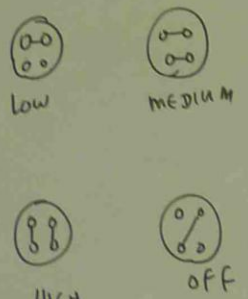
(5)

HOT WATER SYSTEM

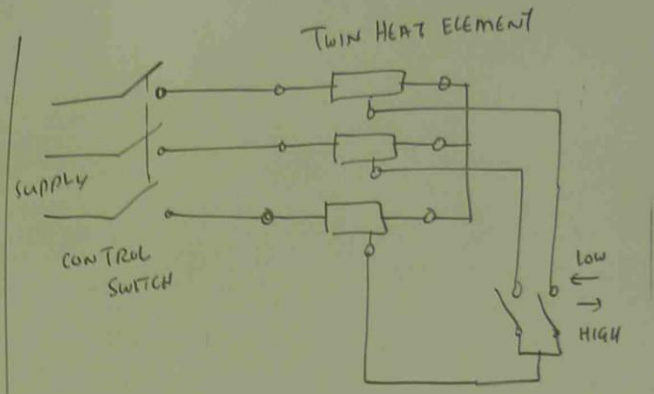
G008/ G008 GENERAL NOTE(2) PART(2)

TEMPERATURE CONTROL → MANUAL SWITCHING
→ AUTOMATIC





MANUAL CONTROL SWITCH



WATER HEATER WITH TWIN HEAT ELEMENT

THERMOSTAT
BOOST ELEMENT
THERMOSTAT
MAIN ELEMENT

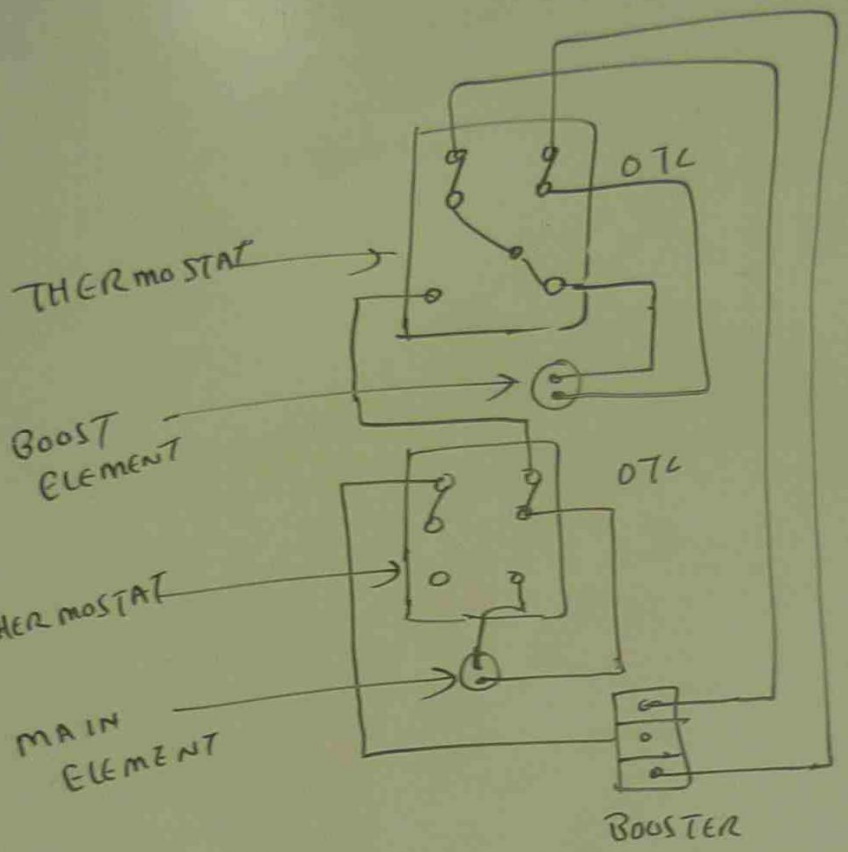
AUTOMATIC CONTROL

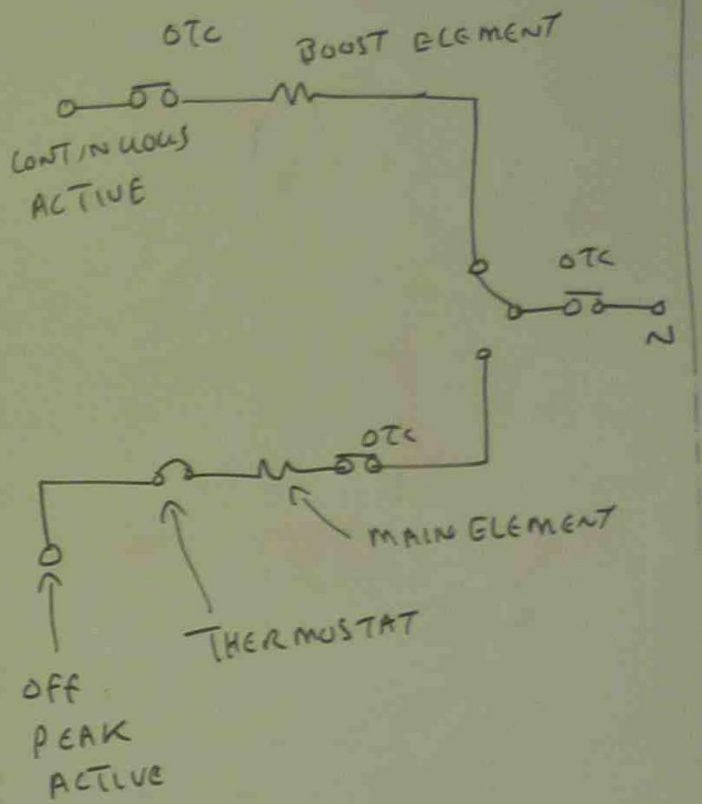
THERMOSTATIC CONTROL
- BIMETAL
- EXPANDING TUBE
- VAPOUR PRESSURE

SIMMERSTATIC (PROPORTIONAL ENERGY REGULATOR) CONTROL

CLASSIFICATION OF WATER HEATER

- INSTANTANEOUS
- STORAGE

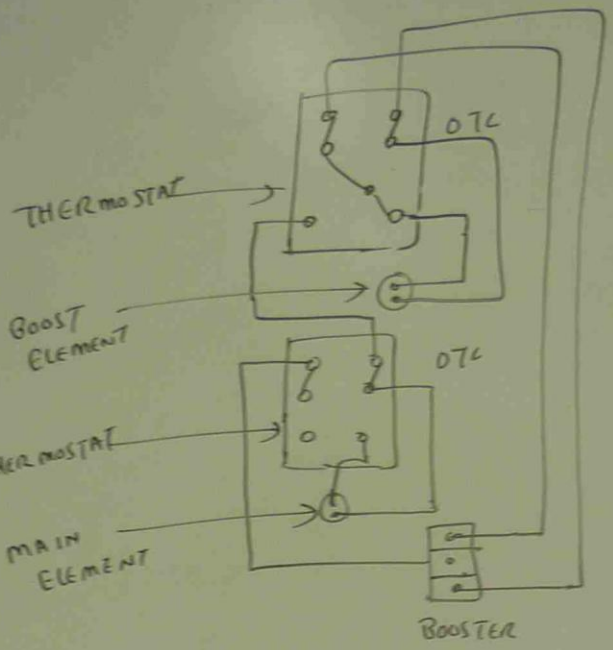


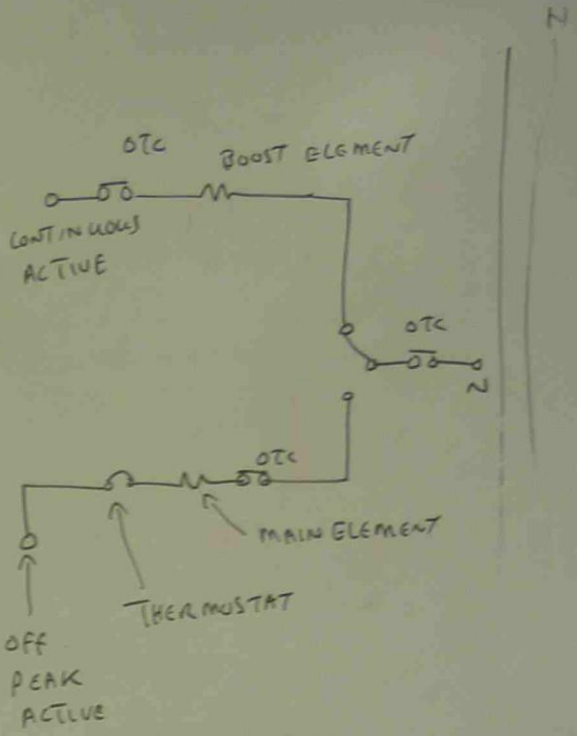


L

ING TUBE

R PRESSURE





AL

ING TUBE

R PRESSURE

FIND THE CLAUSES RELATED TO

RCD

HOT WATER SYSTEM

WATER HEATER

RCD TESTING

RCD PROTECTED CIRCUIT