

**UEE30811 - Certificate III
Electrotechnology Electrician**

**Course 30811V3
Chullora TAFE**

Unit UEENE107A

**USE DRAWINGS,
DIAGRAMS, SCHEDULES,
STANDARDS, CODES AND
SPECIFICATIONS**

KS01-EE107A

KS02-EE107A

innovate_educate

Class Orientation

Introduction:

- Introduce yourself.
- Welcome to Electrical Trades Miller TAFE.
- Miller is part of SWSI Institute.
- Check enrolment forms.
- Discuss the requirement to carry TAFE Card

General Induction:

- Discuss location of:
 - Toilets
 - Building exits
 - Evacuation area
 - Fire extinguishers
 - First aid
 - Emergency Stop buttons (class room induction)
- Refer to the STUDENT CALENDAR (in front of book) and discuss the following:
 - Use for important dates, exams, holidays etc.
 - Schedule exam make-up dates etc. (only in consultation with the class teacher)
- Refer to the STUDENT CONTACTS page (in front of book) and discuss the following:
 - Head Teachers phone number and office number
 - Teachers phone number and office number
 - College support unit contacts and phone number
 - Other college phone numbers
- Refer to the EVACUATION PLAN and discuss the following:
 - Fire and Bomb threat procedures
 - The evacuation procedure
 - The requirement to check the roll at the evacuation area
- Refer to the COLLEGE MAP and discuss the following:
 - Car parking
 - Canteen & operating hours
 - Phone (in canteen – free for local calls only)
 - Student Association (in canteen area)
 - Library & operating hours
 - Main Office
- Refer to the MINIMUM STUDENT REQUIREMENTS page and discuss the following:
 - Each item listed in the document
 - Break times and punctuality
 - Emphasise employer correspondence for non-adherence
 - Always have required PPE. ie: clear safety glasses, correct footwear etc.
 - Always carry required resources eg: pens, calculators, drawing instruments & standards

Class Orientation

- Refer to the USEFUL LINKS page and discuss the following:
 - Available websites and services
 - Login procedures for varying services and sites
 - Recording of students DEC User ID and Password
 - Procedure for downloading Australian Standards
 - Accessing Moodle courses
 - Refer to the EQUATION SHEET and discuss the following:
 - Every new student workbook has an equation sheet
 - Only new / clean equation sheets will be permitted in exams
 - Not all exams require the use of an equation sheet
 - Refer to the WORK PERFORMANCE EVIDENCE page and discuss the following:
 - A broad overview of workplace training
 - The need to collect evidence whilst at work
 - Skills Tracker recording – Login details etc.
 - Skills Tracker orientation will be done during the year
 - You cannot course complete without adequate work performance evidence
 - Refer to the COURSE OUTLINE and discuss the following:
 - Four year apprenticeship (in general)
 - Three years at TAFE, fourth year in the workplace
 - The IMPORTANCE of evidence collection for Workplace Performance (Skills-tracker)
 - Options for failed units and repeat classes
 - Failing a unit twice
 - Refer to the **UNIT GUIDE** and discuss the following:
 - Prerequisites, and the possible need to repeat a unit or part thereof before advancing
 - Student Assessment Guidelines and signing of guidelines for each unit
 - **Consequences for Cheating**
 - Contacting the class teacher for missed exams
 - Explain the SAGs assessment table and the timing / weighting of exams
 - Successful completion of a unit is only achieved when a student shows sufficient Essential Knowledge & Associated Skills (EKAS) contained within the unit, whereby;
 - Essential Knowledge is determined by the KS associated with the unit, and
 - Skills are demonstrated by consistent performance across a representative range of contexts.
- NOTE: Evidence of skills may be collected in a number of ways. Examples include:
- Skills-tracker portfolios
 - Workbook UNIT portfolios
 - In class simulated workplace activities, documented in the class roll by the teacher
 - A combination of all of the above.

Tour of Campus: - For new classes, visit required locations listed above

Electrical Trades Section - Chullora

1. **SHOES / PPE** Fully enclosed leather-top shoes must be worn at all times in all parts of the building. **Definitely no thongs or sandals.**
2. **ATTIRE** Clean tidy clothing is required. Tops are required to have sleeves. **No singlet-style tops.**
3. **EYES / PPE** **Clear, non-tinted safety glasses** must be provided by the student and worn where required e.g. workshop classes.
4. **BOOKS** Each student must have his/her own text, tutorial and workbooks as well as any required accessories e.g. pens, drawing instruments, calculator, AS3000 rule book.
5. **ATTENDANCE** Students are expected to be punctual and attend classes for the entire duration. In the event of not being able to attend a class or classes, the student should inform the class teacher and their employer.
Non-attendances will result in employers being notified.
6. **ASSESSMENTS** Students that miss exams for ANY reason must where possible contact their class teacher beforehand. Acceptable supporting evidence as to why the exam was missed **MUST** be provided. e.g. doctor certificate for illness. Refer to the 'student assessment guidelines' for further important information.
- 'SCHOOLIES' is not an acceptable reason to miss exams.
- Cheating and Plagiarism will not be tolerated
7. **SMOKING** Smoking is not permitted on the College grounds at any time except in designated areas.
8. **EATING** The consumption of food or drink is not permitted in any part of any building within the College (with the exception of the College Canteen).
9. **MOBILE PHONES** **Mobile phones are to be turned off** prior to entering any classroom, workshop or wiring room. Mobile phones are not to be accessed during class.
10. **DISCIPLINE** Students must be familiar with, and adhere to, the Code of Conduct which is printed in the Student Handbook that is available from the main office.

Useful Links

Skills-Tracker www.skills-tracker.com Email: info@skills-tracker.com Phone: +612 9543 1100	An online resource used by individuals to gather and record their work performance evidence. Chullora student access information: LOGIN: your student number. PASSWORD: your surname (in lower case letters).
Miller Electrical WIKI space http://electricaltrades-miller.swsi.wikispaces.net	Find information about enrolments, calendars, contacts, help with maths, work performance evidence databases and lots more.
Moodle http://swsi.moodle.tafensw.edu.au	Access unit information for some classes (see your teacher). You may also need a specific 'enrolment key' to access your teachers class work on Moodle. LOGIN: your DEC Username PASSWORD: your DEC password
South Western Sydney Institute of TAFE www.swsi.tafensw.edu.au	Find information about enrolments, college contacts and locations, courses, additional services and much more.
TAFE NSW Website https://www.tafensw.edu.au	Find information about courses, colleges, assessment, a range of student services, career advice, and much more. NOTE: Log onto student 'eServices' to find results etc. Click on the 'student login' link. LOGIN: your DEC Username PASSWORD: your DEC password
State Training Services http://www.training.nsw.gov.au/index.html Vocational Training Tribunal (VTT) – 02 9266 8450	For information regarding Skills Recognition, Craft Certificates, Certificates of Proficiency (COP), check apprenticeship registrations, access to Australian apprenticeship support services etc.
NSW Fair Trading www.fairtrading.nsw.gov.au	Find electrical licensing information. Go to the 'Tradespeople' link from the homepage.
NSW Industrial Relations www.industrialrelations.nsw.gov.au	Find information for pay rates, long service and general award conditions.

USE THIS SPACE TO RECORD LOGIN DETAILS FOR SPECIFIC SITES

Password to log on to the TAFE computers

User name:	MIFG15-11 (e.g. ONLY)
Password:	tafestudent (all one word)
Log on to:	SOUTH_WESTERN

Password to log on to the Internet at TAFE

User name:	Your DEC User ID
Password:	Your DEC password

Password to log on for library resources

* My DEC User ID is:		Changes yearly. See library staff
* My DEC password is:		

* It is strongly suggested that you record your User ID and password somewhere secure. Such as in your phone.

Useful Links

How to access Standards Online Premium

Access to SAI Global to download AS/NZS 3000 and other AS Standards.

1. Go to http://www.swsi.tafensw.edu.au/library	
2. Left click on Standards Online Indexes	
3. Consult library staff for this years' User ID and Password	
4. Left click on Standards Online Indexes	
5. Type in the Standard that you want to access <u>Examples:</u> AS/NZS 3008.1.1 AS/NZS 3000:2007	
6. From the search results, click on the required standard. You can open and view the file. <u>Saved files expire after 2 days</u>	



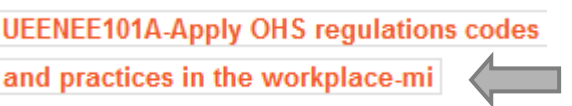
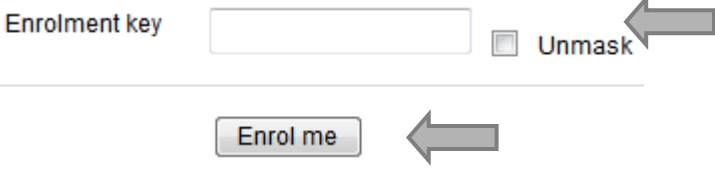
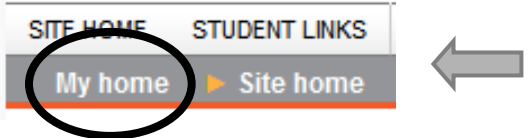
**** Library staff can also assist you to access Standards Online Premium on library computers ****

Useful Links

How to access Moodle

The following is a guide to login to Moodle from an external computer (example: from home)

If you are accessing Moodle from a TAFE computer, you will need to login to the TAFE computer first. See the instructions on the first page of 'Useful Links'.

<p>1. Go to http://www.swsi.moodle.tafensw.edu.au</p>	
<p>2. Login using your portal username and password.</p> <p>Note: This is your DEC Username and password.</p>	
<p>3. New users – search for the course name (or part thereof) given to you by your class teacher.</p> <p>Example: 'UEENEEE101A' or 'OHS'</p>	
<p>4. If multiple courses of the same name appear, be sure to select the course name ending in '-mi' for Miller TAFE</p> <p>Left click to enter course</p>	
<p>5. Enter the enrolment key as given to you by your class teacher.</p> <p>Left click on the 'Enrol me' icon and access your course material.</p>	
<p>6. Existing or returning users – left click on the 'My home' tab to see your previously registered courses. Access your course as per step 4. No enrolment key required.</p>	

Stage 1: This list does not contain all equations in the course and transposition may be required.

	A	B	C	D	E
1	$Q = It$	$F = ma$	$W = Pt$	$W = Fs$	$W = mgh$
2	$V = IR$	$I = \frac{V}{R}$	$R = \frac{V}{I}$		$P = \frac{2\pi nT}{60}$
3	$P = VI$	$P = I^2R$	$P = \frac{V^2}{R}$		$\eta \% = \frac{\text{output}}{\text{input}} \times \frac{100}{1}$
4	$R = \frac{\rho l}{A}$	$R_2 = \frac{R_1 A_1 l_2}{A_2 l_1}$	$R_h = R_c(1 + \alpha \Delta t)$		
5	$V_T = V_1 + V_2 + V_3$	$R_T = R_1 + R_2 + R_3$	$I_T = I_1 = I_2 = I_3$	$V_1 = V_T \frac{R_1}{R_1 + R_2}$	
6	$V_T = V_1 = V_2 = V_3$	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$	$I_T = I_1 + I_2 + I_3$	$I_2 = I_T \frac{R_1}{R_1 + R_2}$	$R_T = \frac{R_1 R_2}{R_1 + R_2}$
7	$C = \frac{Q}{V}$	$C = \frac{A \epsilon_o \epsilon_r}{d}$	$\tau = RC$	$C_T = C_1 + C_2 + C_3$	$\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$
8	$L = N \frac{\Delta \Phi}{\Delta I}$	$L = \frac{N^2}{S}$	$\tau = \frac{L}{R}$	$V = N \frac{\Delta \Phi}{\Delta t}$	$V = L \frac{\Delta I}{\Delta t}$
9	$e = Blv$	$F = Bil$	$F_m = IN$	$B = \frac{\Phi}{A}$	$S = \frac{l}{\mu_o \mu_r A}$
10	$E_g = k \Phi n$	$T = k \Phi I_a$	$T = Fr$	$H = \frac{F_m}{l}$	$\Phi = \frac{F_m}{S}$

Stage 2: This list does not contain all equations in the course and transposition may be required.

Stage 1: equations are also used during stage 2

	A	B	C	D	E
11	$V_{ave} = 0.637V_{max}$	$V_{RMS} = 0.707V_{max}$	$v = V_{max} \sin \theta$	$V_L = \sqrt{3}V_P$	$f = \frac{nP}{120}$
12	$I_{ave} = 0.637I_{max}$	$I_{RMS} = 0.707I_{max}$	$i = I_{max} \sin \theta$	$I_L = \sqrt{3}I_P$	$t = \frac{1}{f}$
13	$I = \frac{V}{Z}$	$V = IZ$	$Z = \frac{V}{I}$		
14	$Z = \sqrt{R^2 + X^2}$	$Z = \sqrt{R^2 + (X_L - X_C)^2}$	$X_L = 2\pi fL$	$X_C = \frac{1}{2\pi fC}$	$\cos \theta = \frac{R}{Z}$
15	$P = VI \cos \theta$	$S = VI$	$Q = VI \sin \theta$	$P = \sqrt{S^2 - Q^2}$	$\cos \theta = \frac{P}{S}$
16	$P = \sqrt{3}V_L I_L \cos \theta$	$S = \sqrt{3}V_L I_L$	$Q = \sqrt{3}V_L I_L \sin \theta$	$\tan \theta = \sqrt{3} \left(\frac{W_1 - W_2}{W_1 + W_2} \right)$	$\theta = \cos^{-1} \lambda$
17	$V' = 4.44\phi fN$	$\frac{V_1}{V_2} = \frac{N_1}{N_2}$	$\frac{I_2}{I_1} = \frac{N_1}{N_2}$	$V_{reg} \% = \frac{(V_{NL} - V_{FL})}{V_{FL}} \times \frac{100}{1}$	
18	$N_{syn} = \frac{120f}{P}$	$f_r = \frac{S\% \times f}{100}$	$S\% = \frac{(n_{syn} - n)}{n_{syn}} \times \frac{100}{1}$	$V_{reg} \% = \frac{(V_{NL} - V_{FL})}{V_{NL}} \times \frac{100}{1}$	$T = k\phi Ia$
19					
20			$P = \frac{2\pi nT}{60}$	$\eta \% = \frac{output}{input} \times \frac{100}{1}$	

Stage 2a: This list does not contain all equations in the course and transposition may be required.

Stage 1: equations are also used during stage 2

	A	B	C	D	E
21					
22	$V_T = E_G - (I R_i)$	$E = \frac{F}{A}$	$E = \frac{I}{d^2}$	$E = \frac{I}{d^2} \times \cos \theta$	$\eta = \frac{F}{P}$
23			$Q_c = P(\tan \theta_1 - \tan \theta_2)$	$X_c = R(\tan \theta_1 - \tan \theta_2)$	
24					

Stage 3: This list does not contain all equations in the course and transposition may be required.

	A	B	C	D	E
25	$V_P Y = 57.7\% V_P \Delta$	$I_P Y = 57.7\% I_P \Delta$	$I_{motor\ st} = \left(\frac{\%TAP}{100}\right) \times I_{DOL}$	$I_{line\ st} = \left(\frac{\%TAP}{100}\right)^2 \times I_{DOL}$	
26	$I_{ST} = \frac{1}{3} \times I_{DOL}$	$T_{ST} = \frac{1}{3} \times T_{DOL}$	$V_{st} = \left(\frac{\%TAP}{100}\right) \times V_{DOL}$		
27	$I_{ST} = \left(\frac{V_{st}}{V}\right) \times I_{DOL}$	$T_{ST} = \left(\frac{V_{st}}{V}\right)^2 \times T_{DOL}$	Constant = $\frac{V}{f}$		
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Work Performance Evidence (WPE)

IMPORTANT:

Students should bring this to the attention of their employers as soon as possible.

Work Performance Evidence is required to be collected for each unit of study. This evidence is used to help measure the effectiveness of your learning and to demonstrate that the required work related practical skills have been obtained and used to consolidate the academic component of your study. That is, you possess both the theory knowledge AND practical ability to complete a task to a competent level.

For some units of study, your class teacher will collect this evidence on your behalf by setting tasks that realistically 'simulate' the workplace environment. The college will record and store this information. You should confirm with your class teacher at the commencement of each new unit of study whether he or she is going to collect work performance evidence on your behalf.

However, for the most part, YOU will be required to collect the evidence that demonstrates your progress in the workplace and that the required electro-technology skills are being achieved.

The electrical trades section of Miller TAFE has set-up on your behalf a 'Skills-Tracker' online portfolio account for you to collect and record all of your workplace learning. In due time, you will be given instruction and tuition on the use of the Skills-Tracker portfolio system.

In the meantime, log onto www.skills-tracker.com and have a look at the 'learner guides' and 'supervisor guides' found in the 'downloads' tab of the navigation bar.

<p>Skills-Tracker www.skills-tracker.com</p> <p>Email: info@skills-tracker.com Phone: +612 9543 1100</p>	<p>Chullora student access information:</p> <p>LOGIN: your student number.</p> <p>PASSWORD: your surname (in lower case letters).</p>
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Note: Units that require you to collect WPE by the Skills-tracker portfolio will show a NC (Not Yet Competent) result on your transcript until your portfolio is complete and verified by the college. This will be the case even if you have passed all of your in class assessments. In most cases, the NC result will not be updated to a unit pass result of AC (Achieved Competence) until your work evidence portfolio is checked and verified toward the end of your course / apprenticeship.

******* REMEMBER *******

YOU are responsible for collecting your own workplace evidence

Course Outline



TAFE NSW
SWSi
South Western Sydney Institute

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Unit Guide – Summary

FULL unit guides can be accessed online at www.training.gov.au

The following information is summarised and is intended to provide a broad overview only.

Unit:

UEENEEE107A Use drawings, diagrams, schedules, standards, codes and specifications

Unit Descriptor

This unit covers the use of drawings, diagrams, cable schedules, standards, codes and specifications as they apply to the various electrotechnology work functions. It encompasses the rudiments for communicating with schematic, wiring and mechanical diagrams and equipment and cable/connection schedules, manuals, site and architectural drawings and plans showing the location of services, apparatus, plant and machinery and understanding the use and format of compliance standards and job specifications.

Pre-Requisites

Pre-requisites are units of study that must be completed prior to commencing a new unit of study. That is, you must pass subject 'X' before you are allowed to commence subject 'Y'. In some instances, pre-requisite units may be studied concurrently with new units of study.

Pre-requisites for this unit of study are:

- UEENEEE101A Apply Occupational Health and Safety regulations, codes and practices in the workplace

Unit Guide – Summary *continued*

Literacy and numeracy skills indicators for this unit – NRS Level 3:

Participants are best equipped to achieve competency in this unit if they have reading, writing and numeracy skills at a level indicated by the following NRS levels.

The National Reporting System (NRS) is a nationally recognised mechanism for determining adult English language, literacy and numeracy levels.

In context for this unit of study these Indicators of Competence (IoC) are not an assessment system, but merely a guide to the specific reading writing and numeracy levels for this unit.

Further information pertaining to the description of each scale is given in Volume 2, Part 3 'Literacy and Numeracy', of the UEE11 training package, available at <http://training.gov.au>

Skill	IoC	Indicator of Competence
Reading: Level 3	3.1	Reads and interprets texts of some complexity, integrating (where relevant) a number of pieces of information in order to generate meaning.
	3.2	Displays awareness of purpose of text, including unstated meaning.
	3.3	Interprets and extrapolates from texts containing data which is unambiguously presented in graphic, diagrammatic, formatted or visual form.
Writing: Level 3	3.4	Communicates relationships between ideas through selecting and using grammatical structures and notations, which are appropriate to the purpose.
	3.5	Produces and sequences paragraphs according to purpose of text.
Numeracy: Level 3	3.10	Selects appropriate mathematical information embedded in a real life activity, item or text
	3.11	Selects and applies a range of mathematical strategies to solve problems in a number of contexts which are familiar and may be interrelated.
	3.12	Reflects on and questions reasonableness and appropriateness of the purpose, process and outcomes of a mathematical activity.
	3.13	Uses oral and written informal and formal language and representation including symbols and diagrams to communicate mathematically.

Unit Guide – Assessment

Student Assessment Guidelines – (SAG's)

Assessment is an important part of learning at TAFE NSW.

TAFE NSW provides comprehensive information for students regarding assessment. A copy of 'Every Student's Guide to Assessment in TAFE NSW' can be obtained by visiting:

<https://www.tafensw.edu.au/courses/assessment/index.htm>

The following information provided in this workbook is to assist you in your understanding of the assessment process, by providing an overview of assessment for this unit. Any questions regarding assessment can be addressed by your class teacher.

Course: National Course Code: UEE30811

Qualification and name: Certificate III in Electrotechnology Electrician

TAFE NSW course number: 20222. Version: 1

Requirements to receive the qualification:

To achieve UEE30811 Certificate III in Electrotechnology, learners are required to complete all units from the core and elective units to a weight of 140 points. Core and elective units are shown in the 'Course Outline' contained in the preceding pages of this workbook.

Recognition: If you have completed other relevant training you may be eligible to have units of competency from previous training counted towards completion for this course. Talk to your teacher or head teacher if you think you may be eligible for recognition for units previously completed.

Learner Support: Students who require support to meet their learning goals should discuss their options by talking to their teacher or Teacher/Consultant for students with a disability.

Assessment Results: Results will be made available to you by your class teacher after each assessment event. Results may also be viewed online (final unit results only) by visiting TAFE 'eServices'. See the 'Useful Links' on the 'student contacts' page in the front of this workbook for further information on TAFE eServices. Concerns you may have about your assessment results should be addressed to your class teacher within 3 weeks of receiving a result.

Unit Guide – Assessment

Meeting Competency Requirements:

In order to be deemed 'competent' in a unit of study, you will be required to achieve a minimum Knowledge and Skills (KS) percentile mark AND satisfactorily complete the Work Performance Evidence (WPE) requirements (ie: Skills-tracker or in-class evidence collected by your teacher). In all other cases participants will be deemed as 'not yet competent' (NC).

Units in this course are ungraded. Your TAFE transcript will record your result as follows:

- **AC** - A Unit result code of **AC** (achieve competency) will be issued if all associated KS specification(s) and work performance evidence have been passed and/or completed.
- **NC** - A Unit result code of **NC** (not yet competent) will be issued if either the KS specification or work performance evidence has not been passed and/or completed.

Note: Units that require you to collect WPE by the Skills-tracker portfolio will show a NC result on your transcript until your portfolio is complete and verified by the college. In most cases this will not be done until you approach the end of your course / apprenticeship.

Assessment Events:

Assessment events are varying methods of assessment used to collect information and measure an individual's level of learning. Below is a table listing typical event methods.

Quizzes:	May consist of multiple choice questions, short answer questions, descriptive questions, calculations and diagram completion questions
Tutorial:	May consist of section review questions, projects, class assignments, research etc.
Skills Practice:	May consist of diagram completion questions, circuit and component connections, motor connections, cabling connections, safe isolation procedures, meter and test equipment connections and measurements and the like
Practical Exam:	May consist of diagram completion questions, circuit and component connections, motor connections, cabling connections, safe isolation procedures, meter and test equipment connections and measurements and the like
Theory Exam:	May consist of multiple choice questions, short answer questions, descriptive questions, calculations and diagram completion questions
Work Performance Evidence:	May consist of actual workplace evidence collected and recorded by profiling (eg: skill-tracker) or simulated workplace evidence collected in the classroom by your teacher or a combination of both

Assessment events used in this particular unit of study are 'weighted' and shown on the following page.

Unit Guide – Assessment

Required skills and knowledge

This describes the essential skills and knowledge and their level, required for this unit.

Evidence shall show that knowledge has been acquired of safe working practices, rationale and solving problems in the relevant unit. The knowledge and skills shall be contextualised to current industry standards, technologies and practices.

View the section title page in your class workbook or the complete unit guide for a full list of the fundamentals covered by each topic within this unit.

Below is a list indicating the content areas to be covered by the required skills and knowledge specification for this unit:

Note: Topics may not be delivered in the order indicated by the full unit guide.

Additional information pertinent to your learning may also be included during unit delivery.

KS01 - EE107A –Drawings, diagrams and schedules.

KS02 - EE107A – Introduction to regulations, compliance, standards and codes.

WORKBOOK SECTION NUMBER	CONTENT	TOPIC NUMBER AS LISTED IN THE FULL UNIT GUIDE
Section 1	Regulations for undertaking electrical work Standards philosophy and format	KS02 – T1 KS02 – T2
Section 2	Purpose, format and content of typical job specifications	KS02 – T3
Section 3	Architectural drawings	KS01 - T1
Section 4	Electrical drawings and Wiring Diagrams	KS01 – T2 KS01 – T4
Section 5	Circuit diagrams	KS01 – T3
Section 6	Building construction drawings and diagrams	KS01 – T5

Unit Guide – Assessment

Student Assessment Guide for this unit:

Evidence for competence in this unit shall be considered holistically. The required skills and knowledge relating to this unit will be assessed in following manner:

Unit Number	UEENEEE107A
KS Number(s)	KS01-EE107A & KS02-EE107A
Unit Title	Use drawings, diagrams, schedules, standards, codes and specifications.
Superseded	UEENEEE007B - Use drawings, diagrams, schedules and manuals

		Event #	Event Name / Timing / Duration	Evidence Method	Wgt.	Out Of %
KS02-EE107A	Regulations	1	Quiz - Weekly	Formative Assessment	5	100
		2	Tutorial & Project research - Weekly	Formative Assessment	10	100
		3	Theory Exam 1 - After Section 2 - 0.5 Hrs - MUST PASS 60%	Summative Assessment	15	100
		4	Work Performance Evidence (Pass / Fail)	Profiling / Skills Tracker		P/F
KS01-EE107A	Drawings	5	Quiz - Weekly	Formative Assessment	10	100
		6	Tutorial - Weekly	Formative Assessment	5	100
		7	Skills Practice - Weekly	Formative Assessment	10	100
		8	Practical exam 1 - After Section 7 - 1 Hrs	Formative Assessment	15	100
		9	Theory Exam 1 - After Section 7 - 1 Hrs - MUST PASS 60%	Summative Assessment	30	100
		10	Work Performance Evidence (Pass / Fail)	Profiling / Skills Tracker		P/F

* ALL 'MUST PASS' events must be passed AND Total Cumulative KS mark must be 60% or greater

* Work Performance Evidence (WPE) has been reviewed and satisfies requirements (Pass / Fail)

* Final Competency Result (AC) Achieved competency OR (NC) Not Yet Competent. See note below.

Note: Only award AC if ALL "MUST PASS" events are passed, KS mark 60% or greater AND WPE is Passed

KS MARK
WPE
AC / NC

Unit Guide – Assessment

Absence from a class assessment:

All students are expected to sit class assessments at the normal scheduled time.

If due to ill health or other unforeseen and acceptable circumstances you are not able to attend a scheduled class test, it is **your responsibility** to make contact with your class teacher or the section head teacher and inform them of your reason for missing the assessment.

NOTE: This contact must be made, prior to, but certainly no later than 24 hours after the scheduled assessment.

Failure to contact the class teacher or section head teacher within the specified time will be taken as your withdrawal from the assessment and a **zero mark** will be recorded.

‘Schoolies’ is not an acceptable reason to miss an assessment. Zero marks will be recorded.

Your Class Teachers Name: _____

Your Class Teachers Phone No: _____

Or Head Teachers No: 97420451 or 97420457 Fax No: 97420423

Workplace Health and Safety (WHS):

The laws protecting the Health and Safety of people at work apply to students who attend TAFE Colleges, either part time or full time. These laws emphasise the need to take reasonable steps to eliminate or control risk at work (this includes a TAFE College). TAFE NSW has the responsibility for the control, and where possible, the elimination of health and safety risk at the college. This includes bullying and harassment. You are encouraged to help in eliminating hazards by reporting to your teacher or other College staff, anything that you think may be a risk to you or other people.

Your teacher will encourage you to assist in hazard identification and elimination, and to devise control measures for any risks to yourself and other people that may arise during practical exercises. The WHS Act 2011 requires that teachers and students take reasonable steps to control and monitor risk in the classroom, workshop or workplace.

Individuals failing to observe and follow ALL Workplace Health and Safety requirements in any part of the college, not limited to but including, hall-ways, class rooms, laboratories, wiring rooms and workshops will be promptly removed for their own safety and for the safety of others. Breaches will be recorded on your TAFE record.

[illegible]

Work Performance Evidence (WPE)

IMPORTANT:

Students should bring this to the attention of their employers as soon as possible.

Work Performance Evidence is required to be collected for each unit of study. This evidence is used to help measure the effectiveness of your learning and to demonstrate that the required work related practical skills have been obtained and used to consolidate the academic component of your study. That is, you possess both the theory knowledge AND practical ability to complete a task to a competent level.

For some units of study, your class teacher will collect this evidence on your behalf by setting tasks that realistically 'simulate' the workplace environment. The college will record and store this information. You should confirm with your class teacher at the commencement of each new unit of study whether he or she is going to collect work performance evidence on your behalf.

However, for the most part, YOU will be required to collect the evidence that demonstrates your progress in the workplace and that the required electro-technology skills are being achieved.

The electrical trades section of Miller TAFE has set-up on your behalf a 'Skills-Tracker' online portfolio account for you to collect and record all of your workplace learning. In due time, you will be given instruction and tuition on the use of the Skills-Tracker portfolio system.

In the meantime, log onto www.skills-tracker.com and have a look at the 'learner guides' and 'supervisor guides' found in the 'downloads' tab of the navigation bar.

<p>Skills-Tracker www.skills-tracker.com</p> <p>Email: info@skills-tracker.com Phone: +612 9543 1100</p>	<p>Chullora student access information:</p> <p>LOGIN: your student number.</p> <p>PASSWORD: your surname (in lower case letters).</p>
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Note: Units that require you to collect WPE by the Skills-tracker portfolio will show a NC (Not Yet Competent) result on your transcript until your portfolio is complete and verified by the college. This will be the case even if you have passed all of your in class assessments. In most cases, the NC result will not be updated to a unit pass result of AC (Achieved Competence) until your work evidence portfolio is checked and verified toward the end of your course / apprenticeship.

******* REMEMBER *******

YOU are responsible for collecting your own workplace evidence

Stage 1: This list does not contain all equations in the course and transposition may be required.

	A	B	C	D	E
1	$Q = It$	$F = ma$	$W = Pt$	$W = Fs$	$W = mgh$
2	$V = IR$	$I = \frac{V}{R}$	$R = \frac{V}{I}$		$P = \frac{2\pi nT}{60}$
3	$P = VI$	$P = I^2R$	$P = \frac{V^2}{R}$		$\eta \% = \frac{\text{output}}{\text{input}} \times \frac{100}{1}$
4	$R = \frac{\rho l}{A}$	$R_2 = \frac{R_1 A_1 l_2}{A_2 l_1}$	$R_h = R_c(1 + \alpha \Delta t)$		
5	$V_T = V_1 + V_2 + V_3$	$R_T = R_1 + R_2 + R_3$	$I_T = I_1 = I_2 = I_3$	$V_1 = V_T \frac{R_1}{R_1 + R_2}$	
6	$V_T = V_1 = V_2 = V_3$	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$	$I_T = I_1 + I_2 + I_3$	$I_2 = I_T \frac{R_1}{R_1 + R_2}$	$R_T = \frac{R_1 R_2}{R_1 + R_2}$
7	$C = \frac{Q}{V}$	$C = \frac{A \epsilon_o \epsilon_r}{d}$	$\tau = RC$	$C_T = C_1 + C_2 + C_3$	$\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$
8	$L = N \frac{\Delta \Phi}{\Delta I}$	$L = \frac{N^2}{S}$	$\tau = \frac{L}{R}$	$V = N \frac{\Delta \Phi}{\Delta t}$	$V = L \frac{\Delta I}{\Delta t}$
9	$e = Blv$	$F = Bil$	$F_m = IN$	$B = \frac{\Phi}{A}$	$S = \frac{l}{\mu_o \mu_r A}$
10	$E_g = k \Phi n$	$T = k \Phi I_a$	$T = Fr$	$H = \frac{F_m}{l}$	$\Phi = \frac{F_m}{S}$

Stage 2: This list does not contain all equations in the course and transposition may be required.

Stage 1: equations are also used during stage 2

	A	B	C	D	E
11	$V_{ave} = 0.637V_{max}$	$V_{RMS} = 0.707V_{max}$	$v = V_{max} \sin \theta$	$V_L = \sqrt{3}V_P$	$f = \frac{nP}{120}$
12	$I_{ave} = 0.637I_{max}$	$I_{RMS} = 0.707I_{max}$	$i = I_{max} \sin \theta$	$I_L = \sqrt{3}I_P$	$t = \frac{1}{f}$
13	$I = \frac{V}{Z}$	$V = IZ$	$Z = \frac{V}{I}$		
14	$Z = \sqrt{R^2 + X^2}$	$Z = \sqrt{R^2 + (X_L - X_C)^2}$	$X_L = 2\pi fL$	$X_C = \frac{1}{2\pi fC}$	$\cos \theta = \frac{R}{Z}$
15	$P = VI \cos \theta$	$S = VI$	$Q = VI \sin \theta$	$P = \sqrt{S^2 - Q^2}$	$\cos \theta = \frac{P}{S}$
16	$P = \sqrt{3}V_L I_L \cos \theta$	$S = \sqrt{3}V_L I_L$	$Q = \sqrt{3}V_L I_L \sin \theta$	$\tan \theta = \sqrt{3} \left(\frac{W_1 - W_2}{W_1 + W_2} \right)$	$\theta = \cos^{-1} \lambda$
17	$V' = 4.44\phi fN$	$\frac{V_1}{V_2} = \frac{N_1}{N_2}$	$\frac{I_2}{I_1} = \frac{N_1}{N_2}$	$V_{reg} \% = \frac{(V_{NL} - V_{FL})}{V_{FL}} \times \frac{100}{1}$	
18	$N_{syn} = \frac{120f}{P}$	$f_r = \frac{S\% \times f}{100}$	$S\% = \frac{(n_{syn} - n)}{n_{syn}} \times \frac{100}{1}$	$V_{reg} \% = \frac{(V_{NL} - V_{FL})}{V_{NL}} \times \frac{100}{1}$	$T = k\phi Ia$
19					
20			$P = \frac{2\pi nT}{60}$	$\eta \% = \frac{output}{input} \times \frac{100}{1}$	

Stage 2a: This list does not contain all equations in the course and transposition may be required.

Stage 1: equations are also used during stage 2

	A	B	C	D	E
21					
22	$V_T = E_G - (I R_i)$	$E = \frac{F}{A}$	$E = \frac{I}{d^2}$	$E = \frac{I}{d^2} \times \cos \theta$	$\eta = \frac{F}{P}$
23			$Q_c = P(\tan \theta_1 - \tan \theta_2)$	$X_c = R(\tan \theta_1 - \tan \theta_2)$	
24					

Stage 3: This list does not contain all equations in the course and transposition may be required.

	A	B	C	D	E
25	$V_P Y = 57.7\% V_P \Delta$	$I_P Y = 57.7\% I_P \Delta$	$I_{motor\ st} = \left(\frac{\%TAP}{100}\right) \times I_{DOL}$	$I_{line\ st} = \left(\frac{\%TAP}{100}\right)^2 \times I_{DOL}$	
26	$I_{ST} = \frac{1}{3} \times I_{DOL}$	$T_{ST} = \frac{1}{3} \times T_{DOL}$	$V_{st} = \left(\frac{\%TAP}{100}\right) \times V_{DOL}$		
27	$I_{ST} = \left(\frac{V_{st}}{V}\right) \times I_{DOL}$	$T_{ST} = \left(\frac{V_{st}}{V}\right)^2 \times T_{DOL}$	Constant = $\frac{V}{f}$		
28					

[illegible]

Introduction to Regulations, Compliance Standards & Codes.

PURPOSE:

In this section you will develop your knowledge of the legislative requirements in relation to electrical work and the associated standards.

TO ACHIEVE THE PURPOSE OF THIS SECTION:

At the end of this section the student will be able to:

- State the scope of work covered by licensing in the electro-technology industry.
- State the legislative requirements for ensuring electrical or electronic equipment is safe i.e. compliance requirements of electrical installations.
- State the difference between performance and prescriptive requirements.
- Describe the purpose of technical standards and how they are developed.
- Describe the role of Standards Australia/New Zealand, International Organisation for Standardisation (ISO) and the International Electrotechnical Commission (IEC).
- State how standards are used in compulsory and accreditation compliance schemes.
- Explain the arrangement and use of technical standards in relation to electrical and electronic work.
- Read and apply a standard mandated under regulation (e.g. Wiring Rules)
- Read and apply a standard mandated by an authority, deemed-to-comply standard and local service requirements (e.g. Service Rules)
- Describe Codes applicable to electrical safe working practices (e.g. Building Code of Australia).

REFERENCES:

- Hampson, J. *Electrical Trade Principles (2nd Edition)*, Pearson Education, Frenchs Forest NSW.
- Hampson, J. *Electrotechnology Practice*, Pearson Education, Frenchs Forest NSW.
- AS/NZS 3000:2007 Wiring Rules.

1. LICENSING

To work in certain electrical trades in Australia you must register and/or have a _____ from the relevant State or Territory electrical registration and licensing authority. Licenses are issued in various grades which define the work you can do.

A separate license is required in each State and Territory in which you may wish to work. However, there are arrangements for the mutual recognition of interstate licences which facilitate the issue of similar licenses in different States and Territories.

A person who is working on fixed electrical wiring must hold an electricians license.

Licensing is only required for work on the fixed and permanent electrical wiring in premises or structures. This also includes temporary electrical wiring on building sites. (NSW).

Therefore appliance repairmen such as washing machine mechanics don't need to be licenced. Nor do persons who are deemed 'competent' to test and tag power tools – but special conditions and restrictions apply

NSW licenses

Certificate of Registration

- ❑ Enables the holder to work under the supervision of a **Qualified Supervisor Certificate**.

Qualified Supervisor Certificate (Electricians Licence)

Is endorsed to:

- ❑ Entitle the holder to carry out and/or supervise all types of electrical work, or,
- ❑ Entitle the holder to carry out restricted electrical work, such as under the National Restricted Electrical License in the fields of; Office Equipment, Domestic Equipment, Plumbing/Gas fitting Equipment, Industrial Equipment, Refrigeration/Air conditioning Equipment, Instrumentation/Process Control Equipment, Communication Equipment and Laboratory/Scientific Equipment.

Qualified Electrical Contractors Licence

- ❑ Permits the carrying out and supervision of, and the Contracting of Electrical wiring work.

2. LEGAL REQUIREMENTS

The legal requirements for all electrical installations are formed from the act of parliament called **The Electricity Development Act**. Regulations are issued under this Act and one of interest to us is **The Electrical Installations Safety Regulations**. Specific reference is made to The Wiring Rules as a mandatory requirement and Licensing for persons who contract and/or carry out any electrical work.

Performance and Prescriptive requirements:

There has been a trend away from regulations that were prescriptive-based towards performance-based. The performance-based approach places the 'duty of care' responsibilities on enterprises and individuals. This in turn is said to promote self-monitored quality assurance. It does not preclude third party scrutiny, as is still required for hazardous areas by legislation in most jurisdictions. Performance-based standards are said to result in greater compliance with requirements than in the case with the purely inspectorial methods, which accompany prescriptive-based regulations.

Specifications, or standards, are the basis to verify quality and maintain product uniformity. Conformance to standards can be determined using either prescriptive or performance specifications. A prescriptive specification gives physical or chemical requirements that are indirectly related to performance. A performance specification sets limits for physical test results only. In the U.S., specifications for cement have had both prescriptive and performance features. Performance features have included requirements for setting time, strength, and durability. Prescriptive features have included limits on chemical composition, some physical properties, and restrictions on ingredients.

In some ways, performance based requirements meet the legal requirement of a 'fit-for-purpose' installation or job. Nowadays, many contracts are written in such a way to get the subcontractors to deliver equipment, installations and services that do the job required, not just comply to a standard and nothing more.

Generally, a prescriptive process sets the minimum requirements and may often limit flexibility of meeting the need of an unusual situation.

3. STANDARDS

The purpose of a '**Standard**' is to set the _____ requirements for the design and use of products and provision of services without stifling innovation or placing barriers on trade between enterprises, states or countries.

Standards are frequently called up by a _____ regulation, and when this occurs they, in fact, become part of the regulation and must be complied with. _____ apply to those who don't comply.

The current rules are the accepted Australian Rules; they are the **minimum** legal requirements, and their provisions are enforceable by law.

The current version of the electrical standard is:

AS/NZS 3000:2007

These are commonly known as the “Australian/New Zealand Wiring Rules” or just the “Wiring Rules”.

4. REASONS FOR THE AS3000

The wiring rules (AS3000) was first published in 1923, and has grown and developed over the last _____ years. There are normally new issues when there is a jump in technology or after an error that results in deaths is found. It is compulsory for electricians to carry out work in accordance with the regulations, standards and codes.

There are a number of reasons why all electricians follow the AS3000:

- Legal obligation: fines, loss of licence and _____ time (in case of electrical deaths)
- Cost: to re-do or pay any electrician to redo unsafe or unsatisfactory works, loss of business (due to bad name), loss of livelihood (no licence), increase insurance premiums, and court fees.
- Personal: _____ of causing death, fire, etc.
- Advantage of easy determination of appropriate materials, design, estimating, planning and execution.

Other commonly used standards and codes in the electrical industry include:

AS/NZS 3760:2003 – In service safety inspection and testing of electrical equipment (‘Test and tag power tools & appliances’)

AS/NZS 1670.6:1997 – Part 6: Smoke Alarms

AS/NZS 2293.1:2005 – Emergency escape lighting and exit signs for buildings.

AS/NZS3008.1.1:1998 – Electrical installations – Selection of cables.

AS/NZS 3017:2007 – Electrical installations – Testing and inspection guidelines.

NSW Service and installation rules – 2008

- ❑ These are the recognised industry code outlining requirements of electrical distributors when connecting a customer to the distribution system of NSW.

Codes of practice

- An approved _____ code of practice is a practical guide to employers and others who have duties under the OHS Act 2000 and the OHS Regulation 2001 with respect to occupational health, safety and welfare.
- These are issued and administered by _____ and apply the wiring rules to particular industries. Relevant electrical industry codes of practice include:
 - Code of Practice – Low Voltage Electrical Work
 - Code of Practice - Electrical Practice for Construction Work
 - Additional requirement to AS 3000
- Ensure the installation conforms to the requirements of the supply authorities' reticulation system and the supply authority's equipment.
- Generally do not affect sub-circuit cabling, although local authority rules may still apply (service and metering equipment.)

5. SCOPE OF AS/NZS 3000:2007

The scope of the standard is stated in clause 1.1. Open your book to page 21 and copy the clause to your notes.

[illegible]

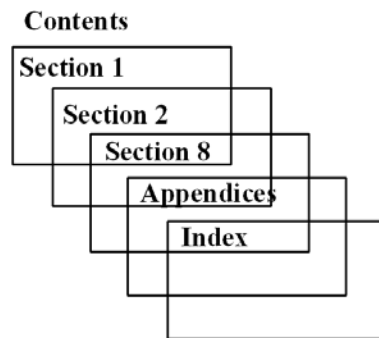
It is not necessary to know all the rules but, as stated previously, all work must comply. Therefore it is necessary to be able to find and understand the rule which applies to the work being done.

“Ignorance of the rules is no excuse”.

And will not save you as a defence in court proceeding.

6. FORMAT OF THE AS3000

The format of AS3000 is as follows:



- Contents (pg 9-11) shows each section and the main clauses of each section
- List of Tables (pg 12-14). AS3000 relies heavy on the use of tables to show a lot of information in a quick and easy way.
- List of Figures (pg 15-18). AS3000 relies heavy on the use of figures and drawings to show a lot of information in a quick and easy way.
- Foreword (pg 19) highlights how to understand the AS3000
- Sections 1-8 (pg 21-326) Covers almost all aspects of electrical works
- Appendices A-M (pg 327-445) less used tables and examples are stored
- Index (pg446-458) Can be the fastest way to locate information on the rules.

7. STRUCTURE OF THE SECTIONS

In simple terms, the AS3000:2007 is, like most books, broken into chapters. However the chapters are called Sections, and each section deals with a particular aspect of the electrical industry.

Open to page 9 of the SA3000 and write down the heading of each section of the wiring rules:

Section 1:

Section 2:

Section 3:

Section 4:

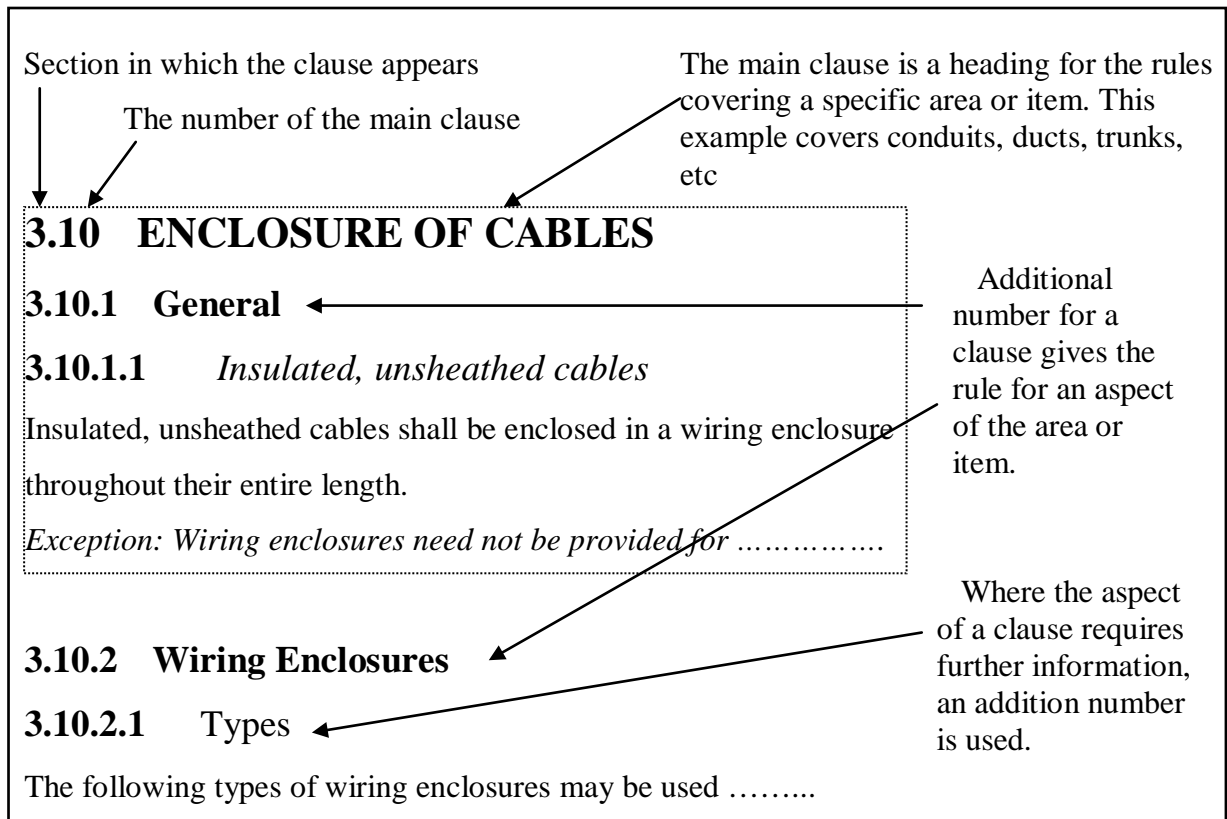
Section 5:

Section 6:

Section 7:

Section 8:

8. NUMBERING SYSTEM OF THE AS3000



9. TYPEFACE SYSTEM OF THE AS3000

Since the AS3000 is a _____ book under the law of Australia, it is written in legal terms in “lawyers speak”. Certain words have a _____ legal meaning under the law. No matter what you would like the word to mean, its’ legal meaning will be used in _____. The same can be said about the typefaces (**bold**, normal, *italic*, etc). Typefaces are how the letters and words are printed on the pages.

10. FINDING THE RIGHT CLAUSE IN THE RULE BOOK

1. Using the contents

Many electricians prefer to use the _____ to find the correct clause number and then the necessary information. The contents shows the logical format of the book and can be helpful in increasing your electrical vocabulary. The following steps will assist you in using the contents.

1. From the contents select the section most likely to contain the information required.
2. Read the clauses listed under the selected section in the contents listing.
3. Select a main clause that appears to deal with the aspect of the installation for which the information is required.
4. Turn to the _____ clause and scan the clauses listed until the specific information required is located.

These steps may need to be repeated until the correct information is found but with experience your speed in locating information will increase.

2. Using the index to find a clause

The index can also be used to find the correct _____ related to an installation. The index contains a list of **key words** in alphabetical order. The following steps will assist you to use the index.

1. Select a **key** word in the index that relates to the information required.
2. Scan the list under the selected key word to find a description that is specific to the information required.
3. Turn to the referred information and read the clauses, related notes, tables and cross references as required.
4. Apply the information to the inquiry in question.

11. WIRING RULES – PROJECT RESEARCH

1. RCDs are a requirement for protection against electric shock. What residential circuits require RCD protection?

➤ Look in the CONTENTS for words similar to *fault, protection, protective devices, RCDs. Etc*

- ❑ Section 2, clause 2.6 (page 96) contains some of these words.
- ❑ Turn to the section and browse through headings.

➤ Look in index

- ❑ Under **residual current devices**; where needed – clauses 2.6.3, 2.6.3.2 and 2.6.3.4.

- ❑ Residential electrical installations, 2.6.3.1 – “*final subcircuits supplying – a) one or more socket and b) lighting and c) directly connected electrical equipment, etc.*”

2. What is the minimum size allowed for a **main earth conductor**?

➤ Contents

- ❑ Look for Earthing (Earthing arrangements and earthing conductors, section 5)
- ❑ Clause 5.3, Earthing system parts.
- ❑ Turn to section and browse through headings

➤ Index

- ❑ Earthing, conductors, main – 5.3.3.2, 5.5.1
- ❑ Clause 5.3.3.2 gives the minimum size as 4mm²

3. Can joints be made in flexible cords? If they can by what means can this be achieved?

➤ Contents

- ❑ Look for **Electrical Connections**, found in Section 3, clause 3.7.
- ❑ Turn to section and browse through headings

➤ Index

- ❑ Cables, connecting – 3.7 or Conductors, cords – 1.4.36 and 3.7.2.8
- ❑ Clause 1.4.36 defines flexible cords and 3.7.2.8 states joints cannot be made in flexible cords except:
 - Where used as installation wiring (3.7.2.2 to 3.7.2.7); or
 - By means of suitable cable couplers (plugs and sockets)

Using the Wiring rules, AS/NZS 3000:2007, answer the following questions.
Write down the clause number and the information asked for in each question

1. The scope and application of AS/NZS 3000:2007 requires that:
 - (a) All electrical installations adhere to the safety requirements of AS/NZS 3000:2007
 - (b) The supply authority supplies the book free of charge
 - (c) It be compulsory reading for all trade students
 - (d) Electricians know all wiring rules
2. Electricians have a legal responsibility to ensure that:
 - (a) They install wiring Systems that conform with AS/NZS 3000:2007
 - (b) Power is always available
 - (c) The switchboard is locked
 - (d) They purchase the Wiring Rules
3. Electrical installations have to comply with AS/NZS 3000:2007 and:
 - (a) Licensing regulations
 - (b) Supply authority service rules
 - (c) Electrician's safe working codes
 - (d) Building codes

4. What is a *distribution* board?

Clause number: _____

Answer: _____

5. What is the general requirement of a main switch?

Clause number: _____

Answer: _____

6. How should circuit breakers be oriented on a switchboard?

Clause number: _____

Answer: _____

7. What is the definition of a *fuse*?

Clause number: _____

Answer: _____

8. What are the requirements for the location of the *earth electrode*?

Clause number: _____
Answer: _____

9. Which section covers testing and verification of electrical installations?

Clause number: _____
Answer: _____

10. When and why would a visual inspection of an electrical installation be carried out prior to completion of the installation?

Clause number: _____
Answer: _____

11. What are the six sub-clause headings from the check list for visual inspections?

Clause number: _____
Answer: _____

12. What is the *minimum insulation resistance* allowed between live and earthed parts of an electrical installation?

Clause number: _____
Answer: _____

13. What is the definition of

a) *Low voltage*? _____

b) *Extra low voltage*? _____

c) *High voltage*? _____

14. What is the general requirement for the electrical connection of conductors?

Clause number: _____
Answer: _____

15. What is an Exposed conductive part?

Clause number: _____
Answer: _____

16. Are isolating switches required for an electric motor supply circuit?

Clause number: _____

Answer: _____

17. How is a *damp situation* defined?

Clause number: _____

Answer: _____

18. How must an “Edison Screw” lamp holder be connected to the supply?

Clause number: _____

Answer: _____

12. ELECTRICAL INSTALLATION

A simple _____ is shown in figure 1.1 below, it shows that you need a supply (battery), a circuit protection device (fuse), control device (switch), a load (lamp) and connecting wires.

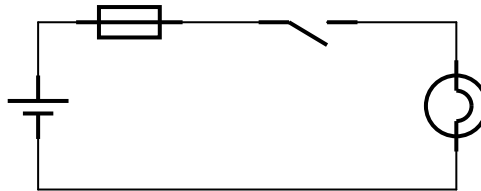


Figure 1.1: Simple Electric circuit

In a _____ installation, these basic parts are changed slightly. Their purpose remains the same but they take on a new form, which can be seen in figure 1.2

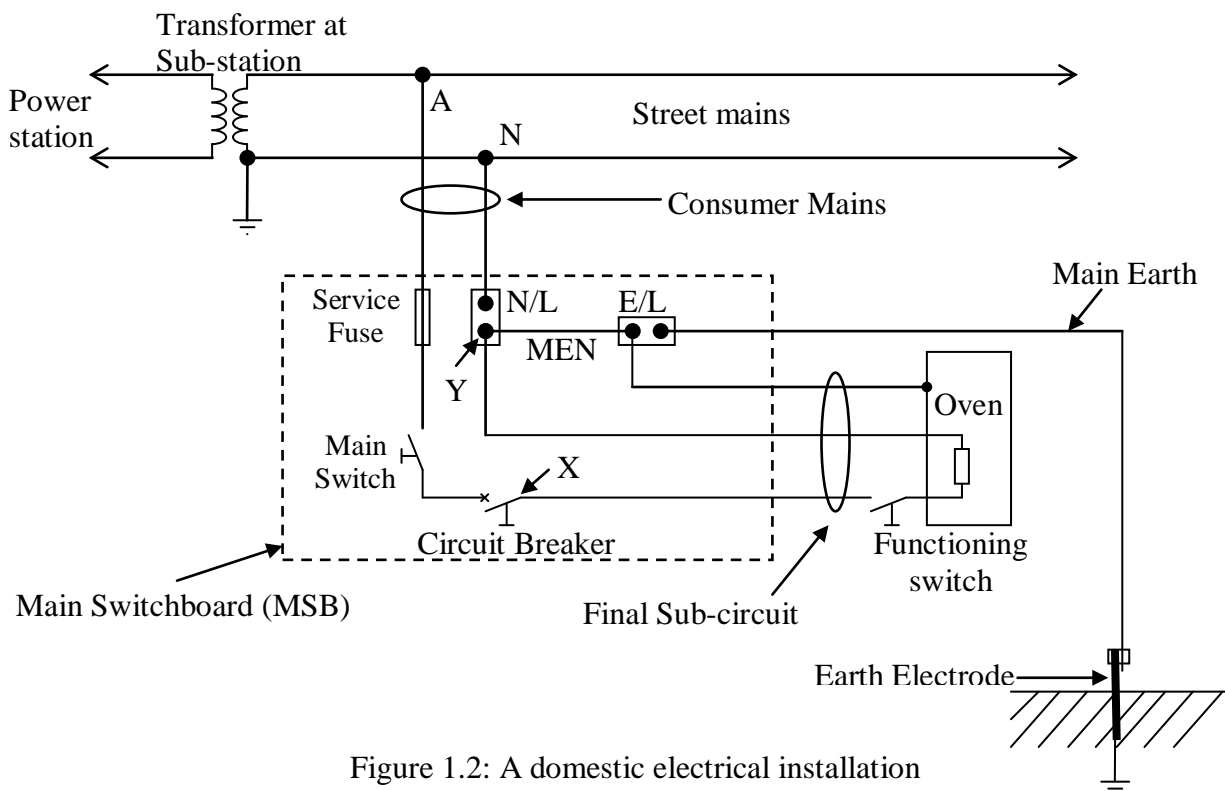


Figure 1.2: A domestic electrical installation

The simplified domestic circuit above consists of a Source (A&N), Isolating switch (Main switch), Protection device (fuse) and a Load (Oven). The main earthing conductor is connected to the Neutral via the Neutral link. This provides a M.E.N. (Multiple Earth Neutral) earthing system.

The _____ difference present between Active and Earth terminals of the single phase AC circuit is usually 240V (the 'nominal' voltage in AS/NZS3000:2007 for Australia is 230/400 V +10% to -6% 1.6.2.(c).(a)). A normal circuit like a 240V 10A socket outlet (power point) is connected with a three wire system (Active, Neutral and Earth)

A domestic circuit consist of:

Item / part	Complete Installation	Final Circuit
Supply	Active conductors (A & N)	Point X(A) & Y(N)
Protective device	Service Fuse	Circuit breaker
Control device	Main (isolating) switch	Functioning Switch

Although figure 1.2 is more complex than figure 1.1, the various parts are the same.

The differences are important:

- a) The _____ connection between the Neutral link (N/L) and the Earth link (E/L) is the way of providing every installation with thousands of _____ connections, in case of any fault current. By using the MEN connection system, a fault current (in your house) can also travel to 'earth' through the neutral conductor & main earth in the adjacent properties. By having many parallel pathways to 'earth', the overall resistance is greatly reduced to the fault current flowing. Thus keeping touch voltages as low as possible until the protective devices can open circuit, and reducing the operating time for the protective devices.
- b) The Installation and the Oven circuit have a protection device and control device each.

Block Diagram of electrical installation

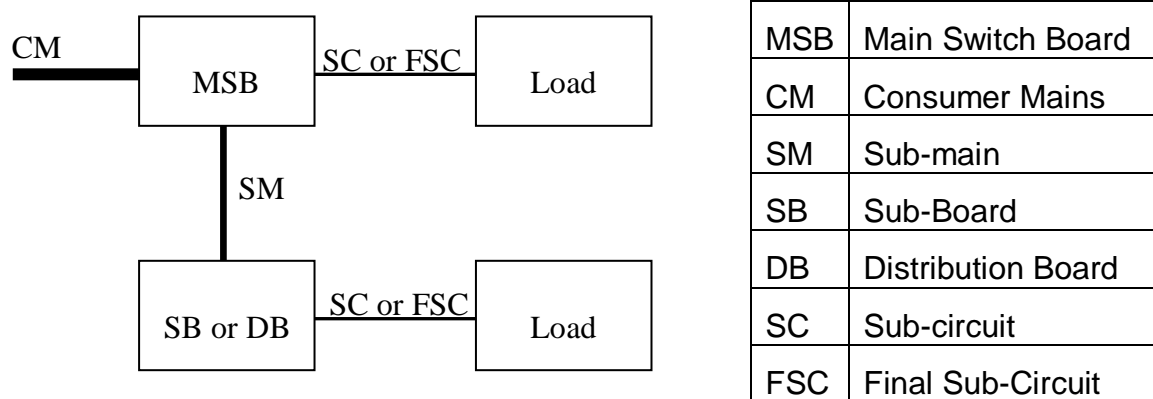


Figure 1.3: Block diagram of an electrical installation

13. PROTECTION DEVICES

Protection Devices are designed to create an open circuit, automatically if excessive current flows. Fuses and Circuit breakers are designed to protect the circuit (cable/conductor).

i) Fuses – Re-wireable (known as wired or _____)

- Totally enclosed (known as HRC – High _____ Capacity)

ii) Circuit Breakers - Thermal

- Magnetic

- Thermal/Magnetic

iii) Residual Current Devices – Technology only developed since 1990 - Protects life by detecting the _____ of current (from the active or neutral), which may be passing through the body to earth.

14. CIRCUIT CONTROL

All circuits will have a switch (functional switch) to control the circuit, like a light switch or a switch on a power point (socket outlet). These are different to a true - _____ Switches (which normally can be locked 'off'). Normally the supply is stopped by a functional switch or protective device (circuit breaker) and the Isolating Switch is then locked or secured in the open position ('off') when personnel are working on the machine or equipment. Large machinery will often have a lockable isolating switch located near the control panel, especially when the protective device is out of sight. Some protective devices (mainly circuit breakers) have the ability to be locked or "wired" in the open position. This is also very useful for securing any _____ tag or notification tag for the circuit.

Some essential services such as fire services **MUST** be locked on.

15. CIRCUIT IDENTIFICATION

Each circuit must be correctly labelled for easy identification.

AS3000-2007 Safety is the main reason for this type of rule

Rule 2.3.3.4 – Identification of Main Switches

Rule 2.9.2.4 – Identification of Main Switchboards

Rule 2.9.5 – Equipment Identification

Introduction to Regulations, Compliance Standards & Codes.

There is No Practical session for this section.

– REMEMBER –
– WORK SAFELY AT ALL TIMES –
Observe correct isolation procedures

Introduction to Regulations, Compliance Standards & Codes.

*These questions will help you revise what you have learnt in Section 1.
Write down the AS/NZS 3000:2007 reference with each answer when it is used.*

1. Name one device that can be used for the automatic disconnection of supply for the protection against indirect contact.

_____ AS/NZS 3000 Rule No: _____

2. What is the maximum permissible percentage voltage drop allowed?

_____ AS/NZS 3000 Rule No: _____

3. How can access to live parts of a switchboard be protected against direct contact?

1)_____ 2)_____ 3)_____

4)_____ AS/NZS 3000 Rule No: _____

4. What is the recommended colour for an active conductor?

_____ AS/NZS 3000 Rule No: _____

5. How close to a cooking appliance should a functional switch be installed?

_____ AS/NZS 3000 Rule No: _____

6. Is it necessary to provide an earthing conductor at each lighting point?

_____ AS/NZS 3000 Rule No: _____

7. How shall main switches be identified on a switchboard?

_____ AS/NZS 3000 Rule No: _____

8. What is the operating temperature of V 75 thermoplastic cables for normal use?

_____ AS/NZS 3000 Rule No: _____

9. Is it permissible to join aerial cable by soldering if subject to tension?

_____ AS/NZS 3000 Rule No: _____

10. What are the percentages of green and yellow in an earth conductor?

_____ AS/NZS 3000 Rule No: _____

11. What is the rating of an RCD used to protect a socket outlet in residential installations?

_____ AS/NZS 3000 Rule No: _____

Job Specifications.

PURPOSE:

In this section you will develop your skills and knowledge in understanding the purpose, format and content of typical job specifications, including the NATSPEC specification system.

TO ACHIEVE THE PURPOSE OF THIS SECTION:

At the end of this section the student will be able to:

- Describe the purpose and importance of a job specification
- List different types of Specification clauses.
- .

REFERENCES:

- Hampson, J. *Electrical Trade Principles (2nd Edition)*, Pearson Education, Frenchs Forest NSW.
- Hampson, J. *Electrotechnology Practice*, Pearson Education, Frenchs Forest NSW.
- AS/NZS 3000:2007 Wiring Rules.
- www.natspec.com.au

1. INTRODUCTION

Job specifications relate to the work we do. As electricians, someone makes a decision on what work they want, we send them a quote, and if successful, go and do the job. This someone is usually the customer however larger jobs including government tenders use different engineering departments, quantity surveyors, estimators and other very specific people to assist in preparing tenders and Job specifications. As subcontractors, we have to quote on the electrical aspects of the tender to win the job. The purpose of using job specifications in addition to drawings, diagrams, codes and standards is to ensure we give the customer what they have asked for. If we do not understand what we are quoting on, we may face costly rework, hefty penalties and possible financial ruin.

An example of a NSW Public Works job specification may be “the electrical system is required to be rewirable” This may mean you have to install all cables in a wiring enclosure (conduit, ducking, troughing, trunking or skirting). It may also mean that there are no wiring connections in junction boxes so you can pull the cables from the fittings to the sub board! Another example may be a job specification requirement of screws to lock every mechanical switch in place so the tenants cannot push the mech switch into the wall cavity.

There are many design decisions which cannot be expressed in drawn form. These must rely on being expressed in words. There are also many design decisions which would be too tedious, or too impractical for some other reason, to be recorded in drawings. The job specification is thus created to compliment the drawings so that together they convey all the design decisions.

The specification links the drawings with the general conditions of contract. It compliments, without duplication, the information in the drawings or the general conditions of contract. Drawings are graphic descriptions which primarily define quantity, position and sometimes quality. Specifications are written descriptions which define quality. Together they express the designer's intentions.

2. USERS

Designers, clients, certifying authorities, estimators, tenderers, contractors and sub-contractors, contract administrators, legal representatives, project managers, construction managers and facilities managers all have an interest in the specifications.

3. TYPES OF SPECIFICATION CLAUSES

Descriptive – describes in detail the material, workmanship and installation required to be used by the contractor or tradesperson. For example; Piping – 3mm diameter beads with core.

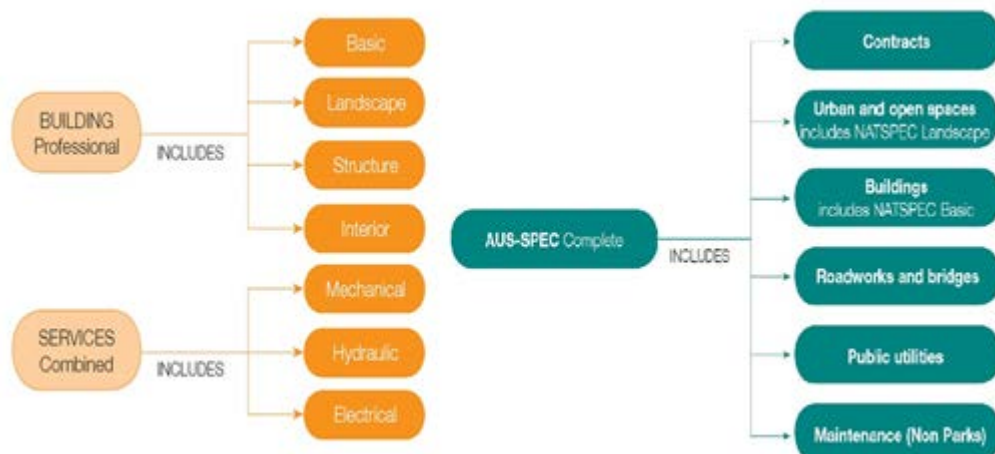
Reference – to a published document, with which process and products must comply. It is incorporated by a reference to the title or other identification of the document which may be a standard or a manufacture's manual. For example; Grading – DD to AS/NZS2269.0, Bond type A.

Performance – specifies an item in a construction project by prescribing a desired end result and the criteria by which the result will be judged for its acceptability. For example; Pole Taper – maximum 1 in 120.

Direct/Proprietary – specification clauses nominate an item in a construction project by reference to a proprietary trade name. For example; Coating Systems – apply Dulux paints coating systems to the Exterior painting schedule and the Interior painting schedule.



NATSPEC is just one commercially available product that provides a comprehensive national specification system endorsed by government and professional bodies. The specification is for all building structures with specialist packages for architects, interior designers, landscape architects, structural engineers, service engineers and domestic owners. There are ten NATSPEC specification packages available to suit any project type



In the majority of Australian States and Territories, NATSPEC specifications are required for major building works. Government Departments and clients prefer documented job specifications so that they are assured of a baseline level of project quality and control. Whilst drawings and schedules only provide the form and materials, it is a properly constructed (written) specification that outlines the quality desired.

NATSPEC is commercially available in electronic form. NATSPEC is a National Master Specification for use with projects of many types and sizes. As a master specification it will not contain all the technical requirements for every project, the specifier will need to select the appropriate NATSPEC “worksections” and edit the material to suit the project.

NATSPEC is just one of the many job specifications commercially available in electronic form “Aus-Spec” and “SpecBuilder” are others. It has a section for electrical services containing relevant information for engineers engaged on the electrical installations of projects of all complexities. It also includes separate basic versions of common worksections pre-edited for fast production of specifications for smaller, straightforward projects. Demolition, tendering and contract preliminaries are also covered. The content is informed by the Building Code of Australia deemed-to-satisfy provisions.

SIMPLE DOMESTIC has been developed for those projects simple enough not to require the engagement of an architect or building designer by the owners. It defines what is deemed to be the minimum level of workmanship for satisfactory work. architects and building designers should use the Domestic digital package when engaged for Domestic work.

The primary function of the drawings and specification is to give effect to design decisions. Many design decisions cannot be expressed in graphic form and therefore rely on words for their expression. Other decisions would be too tedious or impractical to be conveyed in graphic form. The drawings and specification compliment each other.

The quality of a building project is dependent on the documentation provided. The contract documentation includes the conditions of contract, the drawings, the schedules and the specification. Whilst the specification is a multi-purpose document, its primary function is to define precisely and succinctly the quality required and the processes necessary for achieving it. Its role includes but extends beyond the selection of materials by providing the baseline for acceptable quality of construction.

Why a NATSPEC Domestic 6-pack

NATSPEC Simple Domestic Specification is provided individually or in packs of six to satisfy the needs of the project: generally three copies as required by your local council, a copy for your records, copies for tendering purposes.

<http://www.natspec.com.au/Documents/Books/Domestic.pdf> (See attached)

Price as at 22/1/2013 Domestic \$33 inc GST / Domestic 6-pack \$99 inc GST

NATSPEC Electrotechnology Specifications

Electrical Services (including sound, security, fire and telecommunications)

For engineers engaged on the electrical installations of projects of all complexities. It also includes separate basic versions of common worksections pre-edited for fast production of specifications for smaller, straightforward projects. Demolition, tendering and contract preliminaries are also covered. The content is informed by Volume One of the Building Code of Australia and Volume Two, Housing provisions has also been taken into account.

0900r Reference - Electrical services

Reference - Electrical services includes the full text of the NATSPEC worksections listed in its Table of Contents, except for the following:

- ☐ **Selections** (schedules) in the respective NATSPEC worksections.
- ☐ Prompts, indicated by [complete/delete] in the full electronic versions of the respective NATSPEC worksections.
- ☐ *Guidance* (green hidden text) and *Commentary* included in the full electronic versions of NATSPEC worksections.

0900s Schedules - Electrical services

Schedules - Electrical includes the following:

- ☐ Selections (schedules) in the respective NATSPEC worksections.
- ☐ Prompts, indicated by [complete/delete] in the full electronic versions of the respective NATSPEC worksections.

Schedules - Electrical does not include:

- ☐ *Guidance* (green hidden text) other than the worksection abstract.

0901 Electrical systems

This full worksection *Template* covers electrical services systems, performance requirements and standards. It includes a summary of the systems, design parameters relating to the electrical systems and details, common to more than one electrical worksection.

0902 Electrical design and install

This full worksection *Template* is applicable to simple electrical installations in which the specification will be prepared by the architect and the electrical design will be undertaken by the contractor without the involvement of a specialist electrical consultant.

0911 Cable support and duct systems

This full worksection *Template* is applicable to cable support and duct systems that are common to a number of worksections such as *Low voltage power systems* and *Telecommunications cabling*. These include metallic and non-metallic conduits, cable trays and ladders. This worksection includes systems for use both within buildings and externally.

0921 Low voltage power systems

This full worksection *Template* is applicable to the provision of low voltage power systems, the associated low voltage power cables and conductors and the connected outlets and accessories.

0931 Power generation - engine driven

This full worksection *Template* is applicable to the provision of proprietary packaged generating sets powered by reciprocating diesel or gas engines, and includes controls and ancillary equipment. They may be self-contained, enclosed external units, or installed singly or in groups inside a building.

0933 Power generation - photovoltaic

This full worksection *Template* is applicable to the provision of photovoltaic generating systems incorporating storage batteries, inverter, protection, controls and ancillary equipment. It may be used for grid connected or stand alone systems by the deletion of irrelevant sections.

0937 Uninterruptible power supply

This full worksection *Template* is applicable to battery driven, static uninterruptible power supplies (UPSs) designed to provide an instantaneous, short term 50 Hz power supply in the event of interruption to the normal power supply. It is not intended for direct grid connection purposes.

0937 EATON ELECTRICAL uninterruptible power supply

This branded worksection *Template* is applicable to EATON ELECTRICAL battery driven, static uninterruptible power supplies (UPSs) designed to provide an instantaneous, short term 50 Hz power supply in the event of interruption to the normal power supply. It is not intended for direct grid connection purposes.

0941 Switchboards - proprietary

This full worksection *Template* is applicable to proprietary, off-the-shelf low voltage distribution switchboards using standard proprietary components. It should be used in conjunction with the *Switchboard components* worksection.

0942 Switchboards - custom-built

This full worksection *Template* is applicable to custom-built, low voltage switchboards. It should be used in conjunction with the *Switchboard components* worksection.

0943 Switchboard components

This full worksection *Template* is applicable to protective and control devices and for the selection of switchboard accessories.

0943 EATON ELECTRICAL switchboard components

This branded worksection *Template* is applicable to EATON ELECTRICAL protective and control devices and for the selection of switchboard accessories.

0947 Power factor correction

This full worksection *Template* is applicable to microprocessor controlled power factor correction equipment.

0951 Lighting

This full worksection *Template* is applicable to the components of the lighting system and includes proprietary (and refurbished proprietary) luminaires, lighting control systems and wiring requirements. In most cases, proprietary luminaires will be specified and incorporated in a schedule.

0961 Telecommunications cabling

This full worksection *Template* is applicable to the provision of a telecommunication cabling network in commercial (non-industrial) buildings and relies on the Australian Communications and Media Authority (ACMA) technical standards AS/ACIF S008 and AS/ACIF S009.

0962 Television distribution systems

This full worksection *Template* is applicable to the provision of RF analogue and digital television and sound system distribution systems and relies on AS/NZS 1367

0963 Sound systems

This full worksection *Template* is applicable to systems used for medium quality sound reinforcement for public address systems across campuses and sites and in simple halls and lecture theatres. It also includes the necessary provisions to comply with the BCA requirements for the hearing impaired.

0971 Emergency evacuation lighting

This worksection *Template* is applicable to the provision of emergency evacuation lighting and exit signs in buildings. It relies on AS 2293. It is expected that the emergency lighting system has been designed and luminaires selected that meet the project requirements for lighting performance and electrical characteristics.

0972 Fire detection and alarms

This full worksection *Template* is applicable to the provision of fire detection and alarm systems in buildings connected to a remote monitoring network, and is to be used in conjunction with AS 1670.1.

0973 Emergency warning and intercommunication

This full worksection *Template* is applicable to the provision of building emergency sound and intercommunication systems (EWIS) and relies on AS 1670.4, AS 60849 and AS 4428.4. It should also be used for occupant warning systems (OWS) which are a requirement of the BCA wherever a fire alarm system is included.

0979 Lightning protection

This full worksection *Template* is applicable to the provision of lightning protection systems for buildings. It relies on AS/NZS 1768 and assumes that a system is required either by this standard or by a decision taken regardless of the calculated risk management assessment.

0981 Electronic security

This full worksection *Template* is applicable to the provision of access control and security alarm systems in buildings. It relies generally on AS 2201, and includes local alarm systems, centrally monitored systems, access control systems and closed circuit television.

0981 KABA electronic security access controls

This branded worksection *Template* is applicable to the provision of KABA access control and security alarm systems in buildings. It relies generally on AS 2201, and includes local alarm systems, centrally monitored systems, access control systems and closed circuit television.

Refrigeration and Air-conditioning

NATSPEC includes RAC as part of Mechanical Services.

0700s Schedules - Mechanical services

Schedules - Mechanical includes the following:

- ☐ Selections (schedules) in the respective NATSPEC worksections.
- ☐ Prompts, indicated by [complete/delete] in the full electronic versions of the respective NATSPEC worksections.

Schedules - Mechanical does not include:

- ☐ *Guidance* (green hidden text) other than the worksection abstract.

0701 Mechanical systems

This full worksection *Template* covers mechanical services systems, performance requirements and standards. It includes a summary of the systems, design parameters relating to the mechanical systems and details common to more than one mechanical worksection

0702 Mechanical design and install

This full worksection *Template* is applicable to simple mechanical installations in which the specification will be prepared by the architect and the mechanical design will be undertaken by the contractor without the involvement of a specialist mechanical consultant. It deals with packaged air conditioning systems (ducted and non-ducted) and straightforward mechanical ventilation.

0703 Mechanical design and construct

This full worksection *Template* is applicable to the design component of mechanical services projects in which the design will be undertaken by the mechanical contractor. It covers the design process relating to design and construct with the design parameters covered in the respective worksections.

0711 Chillers - combined

This full worksection *Template* is applicable to factory assembled proprietary electric motor driven reciprocating, centrifugal, screw and scroll chiller sets including air cooled and water cooled, conventional and heat recovery types.

0712 Water heating boilers

This full worksection *Template* is applicable to boilers not intended to produce steam, in which water is heated to less than its normal atmospheric boiling temperature. Water heating boilers are used in space heating systems, indirect domestic hot water heating and similar applications.

0713 Cooling towers

This full worksection *Template* is applicable to cooling towers normally used in commercial buildings. It is not intended for large specialised towers for heavy industrial plant. Evaporative condensers and closed circuit fluid coolers are also included in this worksection and fall within the meaning of cooling tower as defined in AS/NZS 3666.1.

0714 Mechanical pumps

This full worksection *Template* is applicable to end-suction centrifugal, inline circulating and submersible pumps. There are no comprehensive reference standards.

0715 Tanks, vessels and heat exchangers

This full worksection *Template* is applicable to pressurised vessels and non-pressurised tanks. It includes head tanks (open and closed), water storage tanks for chilled and heating water, calorifiers and ice tanks. It also covers plate heat exchangers.

0716 Chillers - centrifugal

This full worksection *Template* is applicable to factory assembled proprietary electric motor driven water cooled centrifugal chiller sets.

0717 Chillers - water cooled screw

This full worksection *Template* is applicable to factory assembled proprietary electric motor driven water cooled chiller sets with screw compressors.

0718 Chillers - air cooled screw and scroll

This full worksection *Template* is applicable to factory assembled proprietary electric motor driven air cooled chiller sets with screw or scroll compressors.

0721 Packaged air conditioning

This full worksection *Template* is applicable to one piece and split, direct expansion (DX) packaged air conditioning plant with nominal cooling capacities greater than 7.5 kW. It includes air cooled and water cooled types, variable refrigerant flow (VRF), conventional comfort plant and close control packaged plant.

0722 Room air conditioning

This full worksection *Template* is applicable to one piece and split, direct expansion (DX), air cooled room air conditioning plant with cooling capacities less than 7.5 kW.

0723 Evaporative coolers

This full worksection *Template* is applicable to proprietary, non-refrigerated evaporative coolers intended for ducted and free discharge applications. The reference standard is AS 2913.

0724 Air handling plant - combined

This full combined worksection *Template* is applicable to all types of air handling plant from small room fan coil units to large built-up air handlers. It deals with proprietary air handling plant, site erected air handling units and site erected plenums associated with proprietary air handling plant.

0725 Air handling plant - built up

This full worksection *Template* is applicable to site erected air handling units and site erected plenums.

0726 Air handling plant - minor

This full worksection *Template* is applicable to small room fan coil units.

0727 Air handling plant - packaged

This full worksection *Template* is applicable to proprietary factory assembled air handling plant and includes site erected plenums associated with these.

0731 Fans

This full worksection *Template* is applicable to centrifugal, axial flow, mixed flow and propeller fans, roof mounted fans and window/wall mounted fans of the type commonly used in air conditioning and ventilation systems.

0731 FANTECH fans

This branded worksection *Template* is applicable to FANTECH centrifugal, axial flow, mixed flow and propeller fans, roof mounted fans and window/wall mounted fans of the type commonly used in air conditioning and ventilation systems.

0732 Air filters

This full worksection *Template* is applicable to air filters commonly used in mechanical systems. It includes dry media dust filters (including HEPA, viscous impingement and electrostatic), grease filters and gas phase absorbers (e.g. activated carbon). It is based on AS 1324.1, AS 1324.2 (general air conditioning filters) and AS 4260 (HEPA and MEPA types).

0733 Air coils

This full worksection *Template* is applicable to coils used in heating and cooling systems and includes water and refrigerant coils.

0734 Humidifiers

This full worksection *Template* is applicable to proprietary self-generating electric steam humidifiers that produce steam at atmospheric pressure. It may also be applied to humidifiers in packaged computer room air conditioning units. It does not apply to humidifiers that use a boiler within the definition boilers in AS 1228.

0741 Ductwork

This full worksection *Template* is applicable to ductwork fabricated from galvanised steel, stainless steel and aluminium. It includes ductwork ancillaries such as flexible duct, duct fire rating, dampers, fabricated hoods and canopies. The reference standard is AS 4254. PVC-U ductwork, which is not covered by AS 4254, is also included in the worksection.

0744 Ductwork insulation

This full worksection *Template* is applicable to acoustic and thermal insulation and sheathing of ductwork. Insulating materials include glass wool, rock wool, polyester fibre, polyolefin foam and elastomeric foam (e.g. Armaflex). Facing materials include aluminium foil laminate and sheet metal. The worksection references AS 4254.

0745 Attenuators and acoustic louvres

This full worksection *Template* is applicable to duct mounted sound attenuators and wall mounted acoustic louvres.

0745 FANTECH attenuators and acoustic louvres

This branded worksection *Template* is applicable to FANTECH duct mounted sound attenuators and wall mounted acoustic louvres.

0746 Air grilles

This full worksection *Template* is applicable to fixed and adjustable grilles and diffusers used in air conditioning and ventilation systems. It also includes weatherproof (exterior) louvres. The reference standard is AS 4254.

0747 Variable air volume terminals

This full worksection *Template* is applicable to variable air volume (VAV) terminals (also called VAV boxes). It covers series and parallel fan assisted types and non-fan, pressure independent boxes. Also included are hot water and electric heating associated with VAV terminals. The reference standard is AS 4254.

Job Specifications

There is No Practical session for this section.

– REMEMBER –
– WORK SAFELY AT ALL TIMES –
Observe correct isolation procedures

Job Specifications.

These questions will help you revise what you have learnt in Section.

1. Briefly describe the purpose of job specifications?

2. List 4 people who may have an interest in Job Specifications?

3. List the 4 types of job specification clauses and give examples of each.

1st Clause: _____

Description: _____

2nd Clause: _____

Description: _____

3rd Clause: _____

Description: _____

4th Clause: _____

Description: _____

Architectural Drawings.

PURPOSE:

In this section you will develop your skills in interpreting the information contained in architectural drawings.

TO ACHIEVE THE PURPOSE OF THIS SECTION:

At the end of this section the student will be able to:

- Identify and distinguish between site plans, floor plans, detailed drawings and standard drawings.
- Use an architectural floor plan to determine the power and lighting layouts required in a domestic installation
- Use a site plan to locate the service point, consumers mains, main switchboard, distribution boards and/or builders supplies
- Use standard drawing scales to determine the actual lengths represented by dimensions on an architectural drawing
- Draw given dimensions to scale
- Read and interpret a floor plan to determine the location of the electrical accessories and appliances
- Use Australian standard symbols on a floor plan to show the location of accessories and appliances as detailed in an electrical schedule.

REFERENCES:

- HAMPSON, J. *ELECTRICAL TRADE PRINCIPLES (2ND EDITION)*, PEARSON EDUCATION, FRENCHS FOREST NSW.
- HAMPSON, J. *ELECTROTECHNOLOGY PRACTICE*, PEARSON EDUCATION, FRENCHS FOREST NSW.
- AS/NZS 3000:2007 WIRING RULES.

1. INTRODUCTION

The installation of electrical services is an essential part of any building and includes:

•	•
•	•
•	•

Eventually, as the person responsible for the connection of electrical services, it is your skill of correctly reading, understanding and interpreting architectural drawing that will be used to carry out the installation of wiring and equipment. Since all drawings are to scale, and sometimes quotes are calculated off the drawing, it is necessary for you to be conversant with the conventions and dimensioning of architectural drawing and scales.

These are two levels of drawing:

- **Design drawings:** These rough drawings are where ideas on room relationships and sizes, as well as stylistic treatment are considered. These drawings facilitate agreement between the architect and the client, and are of little interest to us as electricians
- **Working drawings – “Approved Plans”:** These are the finished drawings of an installation. They set down the finalised design together with all the information a builder or tradesperson needs to know in order to construct the work.

2. THE PLAN (WORKING DRAWING)

Some project-home builders use standard drawings extensively. They build the same basic structure on many different sites.

Sometimes, because of the orientation of the site, the actual building is a mirror image of the standard drawing. The electrician must be able to work from standard drawings even though the structure is the reverse of that shown on the plan.

The working drawing is usually made up of a group of drawings, sometimes as a group of drawing sheets but often on the one large sheet.

In order to understand the plan layout, it is necessary to know the parts of a complete working plan as shown in Fig1. These parts are:

- | | |
|--------------------------------------|-----------|
| • Site plan | Sectional |
| • Floor plan | Detail |
| • Elevations (Front, rear and sides) | |

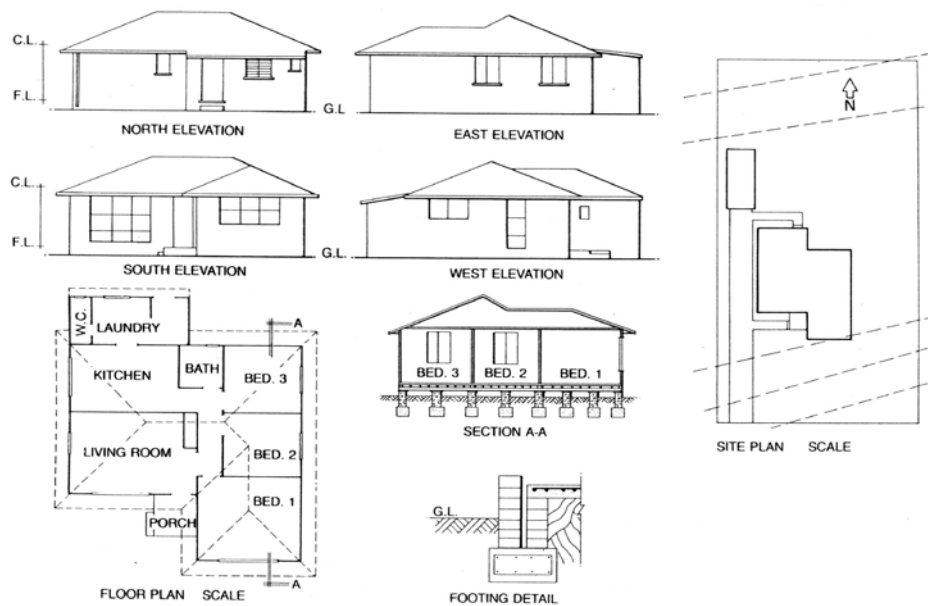


FIGURE 1

THE SITE PLAN

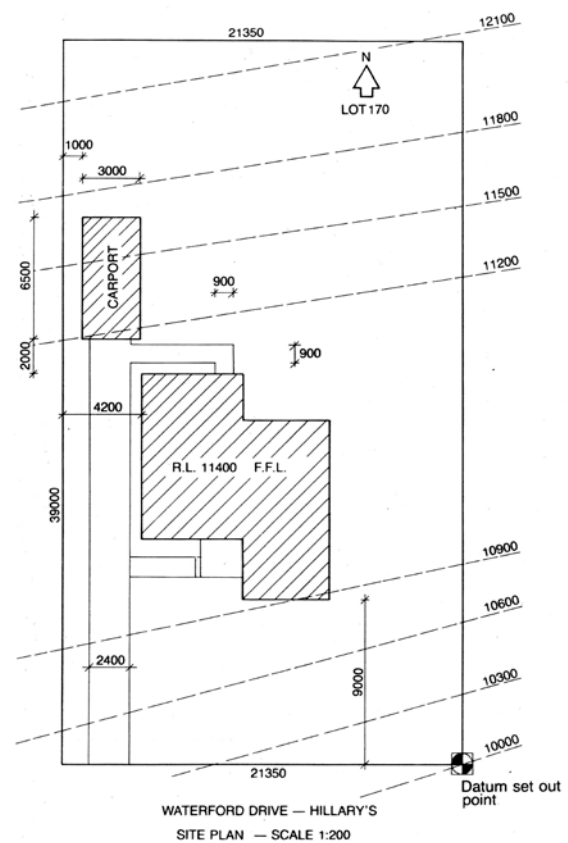
The site plan shows the outline of the building lot and the position (orientation) of the building on the lot.

The external walls are shown in heavy outline with the eaves marked with a dashed line. Typically shows details such as:

- ❑ Scale of the plan
- ❑ Surveyors datum location
- ❑ Northerly direction (orientation)
- ❑ Land contours
- ❑ Street name
- ❑ Lot number and the numbers of adjacent lots in order to clearly identify the correct site on which to construct the building.
- ❑ Deposited plan (DP) number.
- ❑ Exterior building dimensions and distances from the property lines.
- ❑ Site coverage of building(s).
- ❑ Location and dimensions of any easements.

Any existing buildings on the site.

Other details include particulars of the mains for services such as electricity, gas, water, sewerage and telephone as well as drive ways, paths and existing trees.

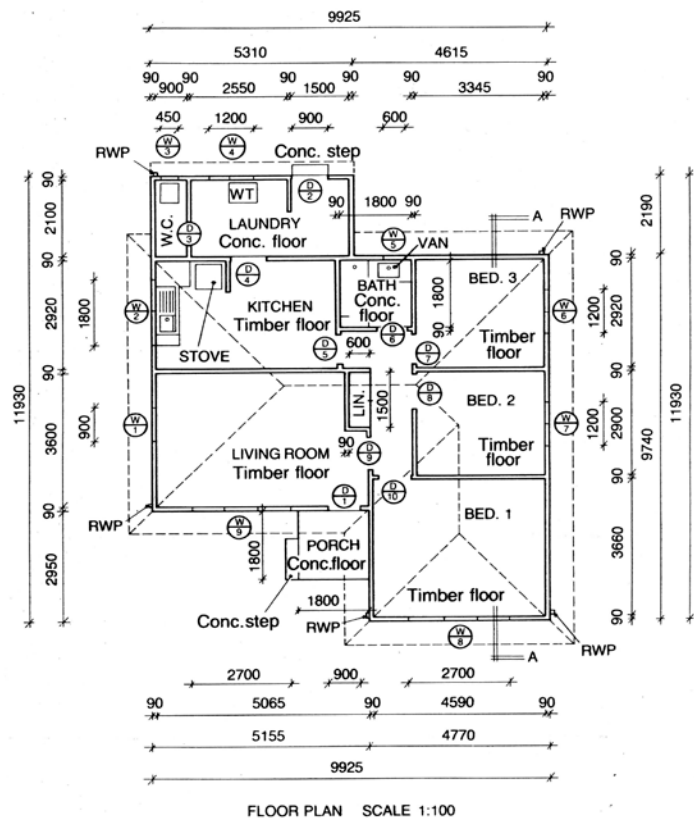


The Floor Plan

This is a drawing of the house, viewed from above, with the roof, ceiling and part of the walls removed. It shows the outline and shape of the building and the position of all the internal walls.

Floor plans are the most useful drawing to an electrician, and a detailed floor plan will generally show:

- ❑ All dimensions
- ❑ Type of wall construction and thickness
- ❑ Position of windows, doors and archways.
- ❑ Width of openings
- ❑ Position of electrical accessories, appliances and other equipment
- ❑ Position of kitchen, laundry and bathroom fittings.
- ❑ Location of eaves, steps and downpipes.



In order to avoid congestion and possible confusion by superimposing electrical symbols over building fittings, a separate **electrical floor plan** is usually prepared.

Other trades, for example plumbers, will often be supplied with a separate drawing as well.

List 2 advantages of knowing exactly where sinks, tubs and vanities are to be installed.

1. _____

2. _____

Elevations

Drawings of the various sides of a building viewed at right angles (usually only four views). The views are mostly named in relation to their geographic orientation, e.g. *North Elevation*. They show:

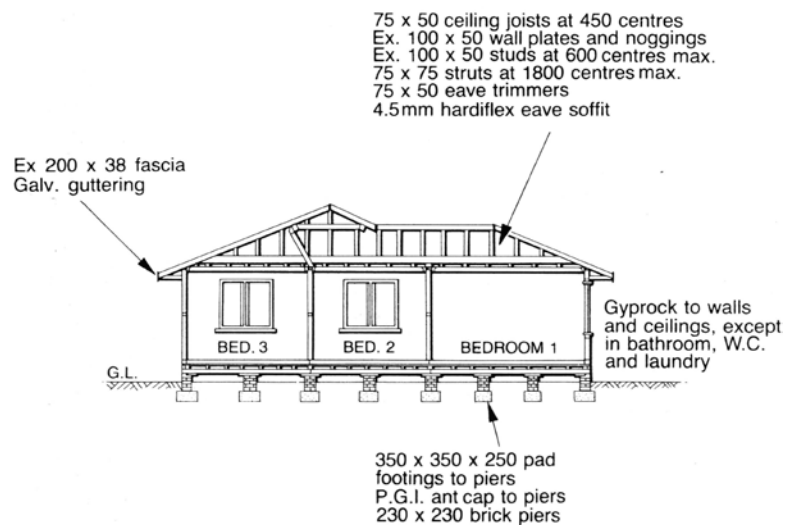
- ❑ Overall shape of the dwelling
- ❑ Roof pitch and shape
- ❑ Floor to ceiling heights
- ❑ Position of doors and windows

Refer to the sample working drawing on the previous pages.

Section view(s)

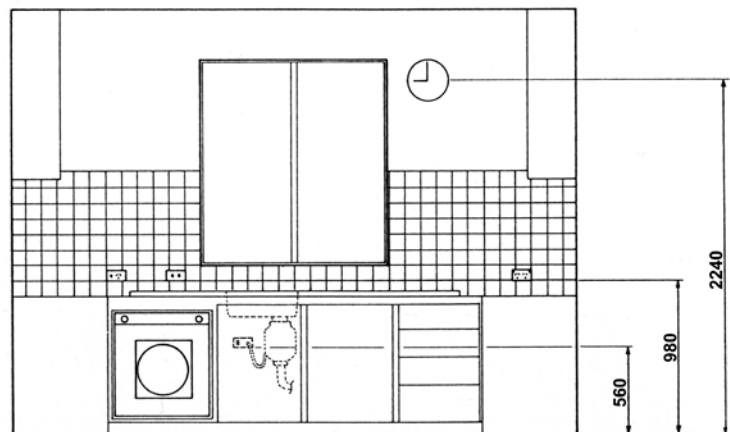
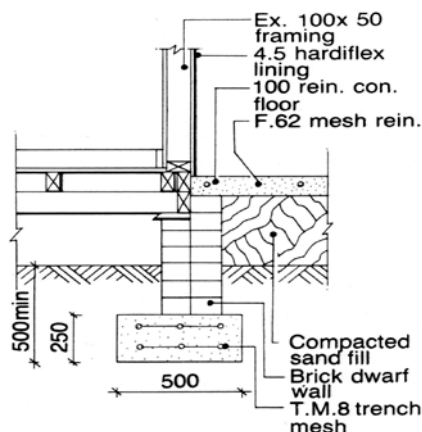
Drawings showing the internal features of the building as if it had been cut vertically and the structure closest the viewer removed.

These drawings are used to show constructional details not available on other views (e.g. height of wall fittings, shape and height of arches, sub-floor and/or roof structures, etc.).



Detail drawings

These are larger scale drawings, used to clearly show details of specific areas of construction where greater detail needs to be shown, for example the footings and installation of electrical accessories.



Answer the following:

The kitchen detail drawing above, assists us to determine the location and placement of how many electrical accessories/items?

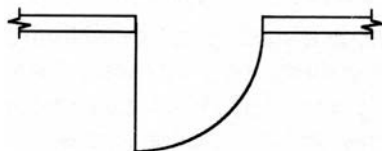
What height is the single power point on the splashback installed?

The detail drawing indicates that the splashback wall will have what type of finish?

3. ARCHITECTURAL CONVENTIONS

Certain conventions (symbols) are used to illustrate the constructional features on a floor plan. For example:

- Hinged doors are always drawn in the open position and the arc traced by the edge of the door shown.

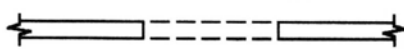


Single swing door



Double swing door

- Archways are shown as openings between rooms in the floor plan, but if there is a solid wall above the archway it is shown in hidden detail (as dotted lines).

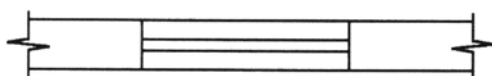


To arch or lintel

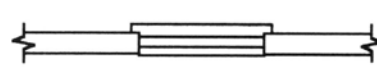


To the top of the wall

- Windows are drawn as if glass panes were single sheets of glass cut into the section.

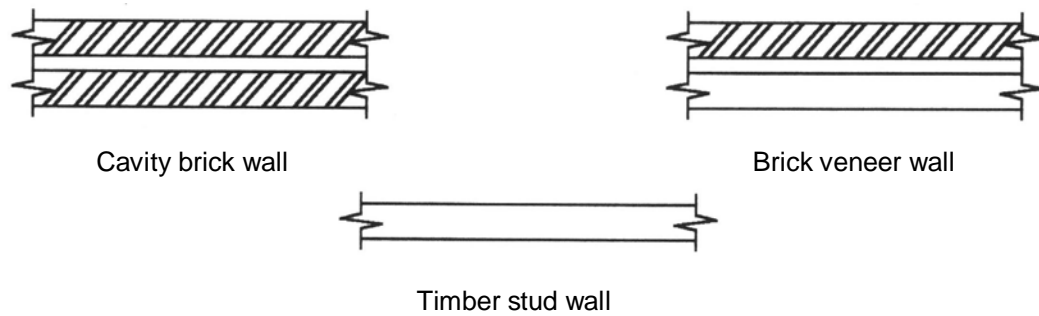


A window in a cavity wall

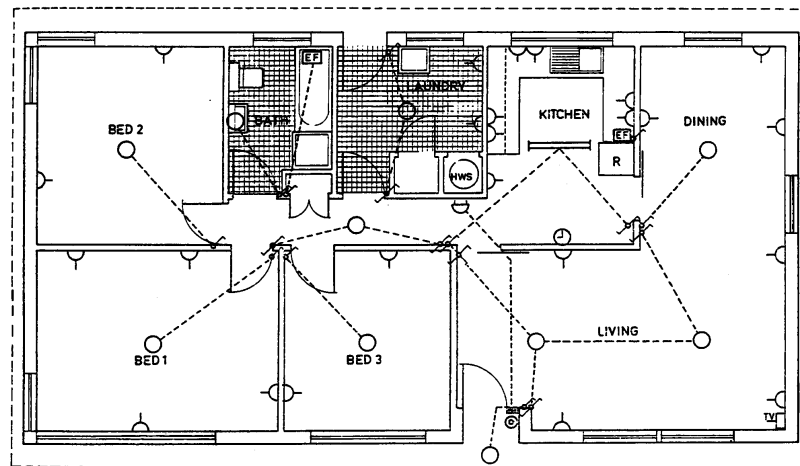


A window in a single wall

- The type of wall construction is shown using different conventions.



- Using the symbols shown above, study the floor plan below.



4. ARCHITECTURAL SCALES

It is impossible to produce full size drawings of a building or its components. Building plans are drawn to a reduced size to a fixed scale. This means that on a single view or drawing every part is drawn to the same reduction ratio.

The standard for linear measurement is millimetres both on the plan and on the job.

The basic scale used for a drawing is expressed as a ratio of two numbers. The first number is always Unity (1) and the second number is a multiple of 1. An example of a scale is shown below:

$$\text{SCALE } 1 : 100 = 1 \text{ millimetre on the plan} = 100 \text{ millimetres on the job.}$$

This means that a wall measured with a rule to be 34mm in length on the plan will in actual construction be 3400mm (3.4m) long. Other examples include:

Length measure from the drawing	Scale	Length on the job
63 mm	1:100	6300 mm
32 mm	1:50	1600 mm
14 mm	1:200	2800 mm


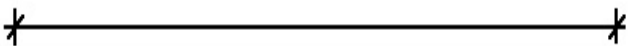
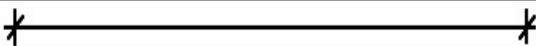
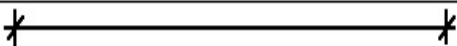
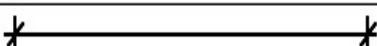
The most common scales used in the construction industry include:

Site plans	1:1000	1:500	1:200	
Floor plans	1:200	1:100	1:50	1:20
Elevations	1:200	1:100	1:50	1:20
Sections	1:200	1:100	1:50	1:20
Details	1:10	1:5	1:2	1:1 (full size)

Note: Care should be taken when scaling from a plan. The plan may have been reduced or enlarged thus giving a false measurement when transferring it to the actual job.

Student exercise 1

The lines shown in the table represent dimensions from a drawing. For each line, measure the length in millimetres between the dimensioning symbols then determine the actual size of the dimensions.

No.	Dimensioned line	Scale		
		1:50	1:100	1:20
1				
2				
3				
4				
5				

Student exercise 2

Determine the scale size of the dimension given in the table for the scale specified.

No.	Length dimension	Scale	Scale size
1	10500	1:100	
2	890	1:10	
3	12000	1:500	
4	2460	1:20	
5	1300	1:50	

Student exercise 3

On the grid below, draw a line, to scaled length, for each of your results from student exercise 2.

1														
2														
3														
4														
5														

5. ELECTRICAL SERVICES

In order to satisfactorily carry out the installation of the electrical services for a building, an electrician will be required to read and interpret:

The site plan: provides information for the position of:

- ☐ Service point (point of attachment)
- ☐ Consumer's mains and submains
- ☐ Main and other switchboards
- ☐ Temporary builder's supply
- ☐ Other services such as gas, water and sewerage and telephone.

For further information on the location of switchboards reference should be made to:

- ☐ Location and accessibility of switchboards – AS/NZS 3000:2007 – clause 2.9.2
- ☐ Service and Installation rules of NSW – October 2006: Sections 4.2 – 4.4

The floor plan: Will aid in the positioning of:

- ☐ Main and other switchboards
- ☐ Power outlets, light points and switches
- ☐ Telephone and television (aerial) outlets
- ☐ Appliances such as ranges, hot water systems, air conditioners, etc.

Detail drawings: to install accessories or appliances at specific positions such as the height of a socket outlet for a refrigerator, air conditioner, above kitchen bench tops, in a cupboard for the dishwasher/garbage disposal etc.

6. ELECTRICAL ARCHITECTURAL SYMBOLS

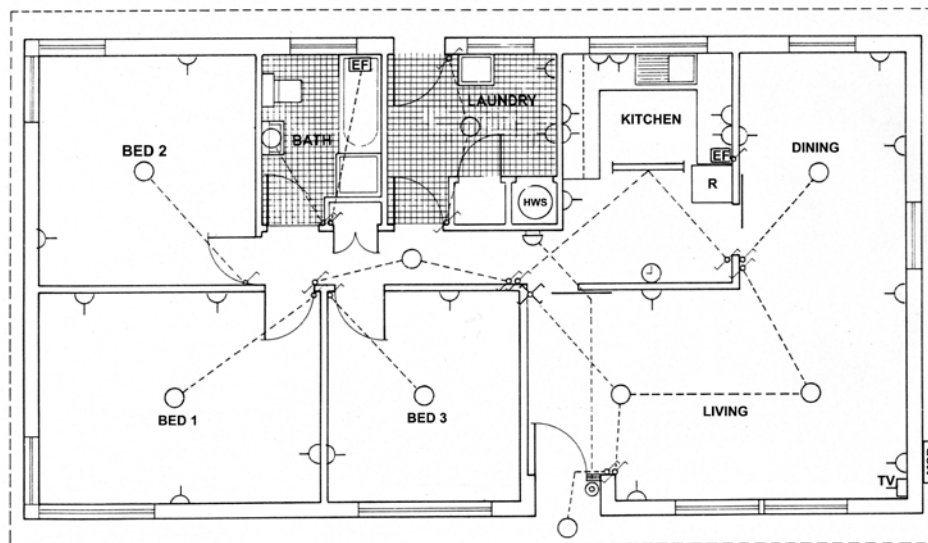
These are standard symbols used to represent points in an electrical installation. A point may be a light, socket outlet or an appliance. Different symbols are used to represent lights and power points, and a variety of symbols are used for appliances depending upon their type.

Electrical architectural symbols bare little, if any, resemblance to the items they actually represent, and are used to identify and show the location of accessories and other equipment. These symbols are called location symbols.




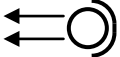


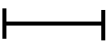
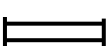
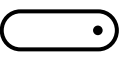





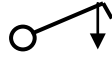
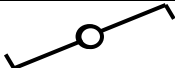
Location symbols are drawn, with instruments, superimposed on the architectural floor plan so that the centre of the symbol is positioned at the approximate positioning centre of the accessory or appliance represented. The actual position of the equipment will depend on building and equipment construction.

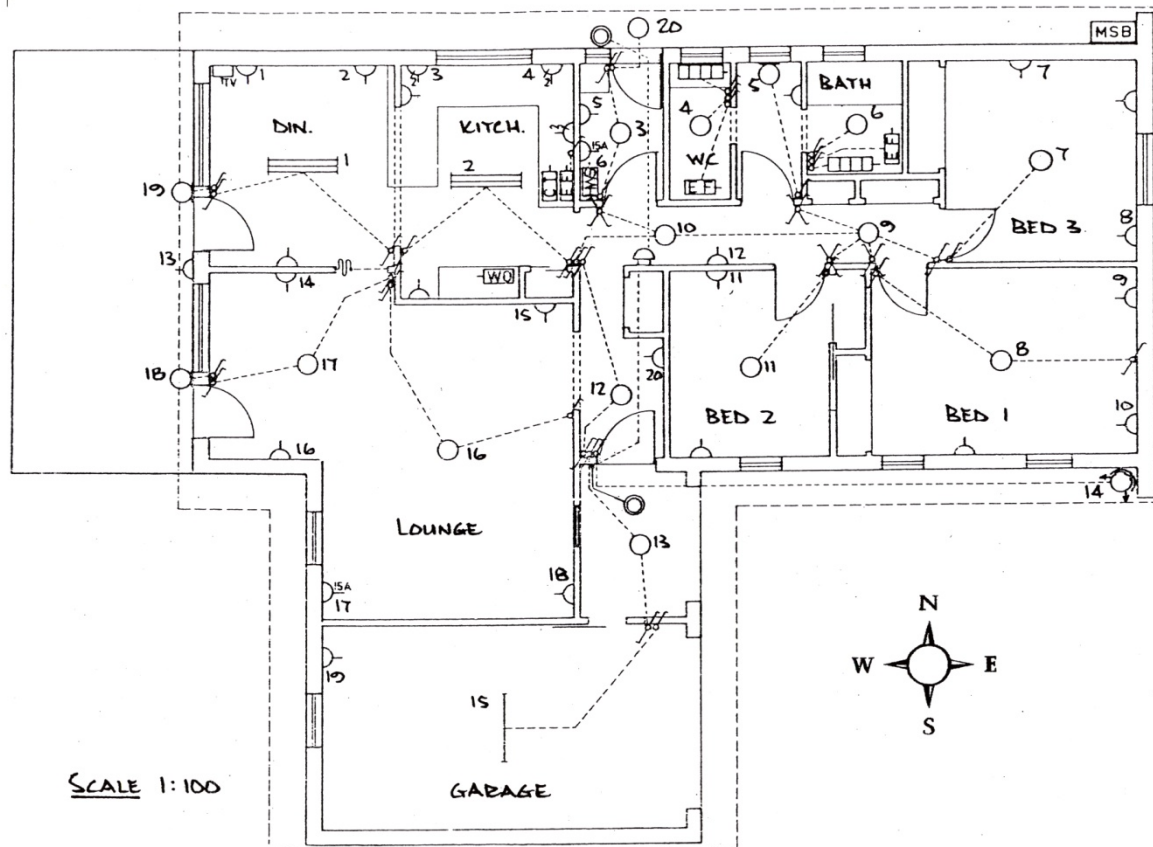
For example, in timber frame walls light switches and socket outlets are usually positioned at the wall stud nearest to the symbol position. The final positioning of these accessories is left to the discretion of the installing electrician.

The diagrams on the following page show examples of the architectural symbols used on electrical floor plans.



The location of all appliances and accessories, which form part of the electrical installation, are shown with the use of symbols on the floor plan. The symbols used are specified in AS 1102, and are listed below.

LIGHTING			
Incandescent	1	Luminaire – general symbols or luminaire outlet	
	2	Luminaire fixed to a wall	
	3	Number & power of lamps in a group may be specified	3 x 15w 
	4	Spot light	
	5	Flood light	
	6	Signal Light	
Fluorescent	7	Tubular Fluorescent Luminaire – one Lamp	
	8	Tubular Fluorescent Luminaire – two Lamp	
	9	Discharge Lamp – general symbol	
SWITCHBOARD	10	General symbol: within the symbol the type of switchboard should be nominated. MSB = Main Switch Board MB = Meter Board	
APPLIANCE	11	General symbol: within the symbol is placed the accepted abbreviation for the appliance. HSW = Hot water system EF = Exhaust fan	
	12	Air Conditioner (an example of Number 11)	
	13	Electric Heater	
SWITCH	14	Single pole (one-way) switch	
	15	Single pole pull switch	
	16	Two way switch	



Student exercise 4

From the floor plan above (scale 1:100) determine the location of the first 10 power outlets shown numbered. List and record in table 1 on the following page the following information for each outlet:

- ☐ Outlet details (e.g. single 10A or double 10A)
- ☐ Room in which the outlet is located (e.g. lounge, kitchen, bedroom 1 etc)
- ☐ Location details (e.g. western wall, 500mm from the north-west (NW) corner)

Student exercise 5

From the same floor plan (scale 1:100) determine the location of the first 10 light points shown numbered. List and record in table 2 on the following page the required information for each point:

- ☐ Switching details (e.g. single way, two way)
- ☐ Room in which the point is located (e.g. lounge, kitchen, bedroom 1 etc)
- ☐ Location details (e.g. middle of ceiling)
- ☐ Switching details

Table 1 – Socket outlet details

Outlet no.	Outlet details	Room in which outlet is located	Location details
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Table 2 – Light point details

Point no.	Switching details	Room in which point is located	Location details
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Student exercise 6

From the same floor plan (scale 1:100) determine the location of the hot water service, 3 exhaust fans, 2 heaters, cook top and the wall oven. List and record in table 3 below the required information for each point:

- Point type (eg. HWS)
- Room in which the point is located (e.g. lounge, kitchen, bedroom 1 etc)
- Location details (e.g. south wall)

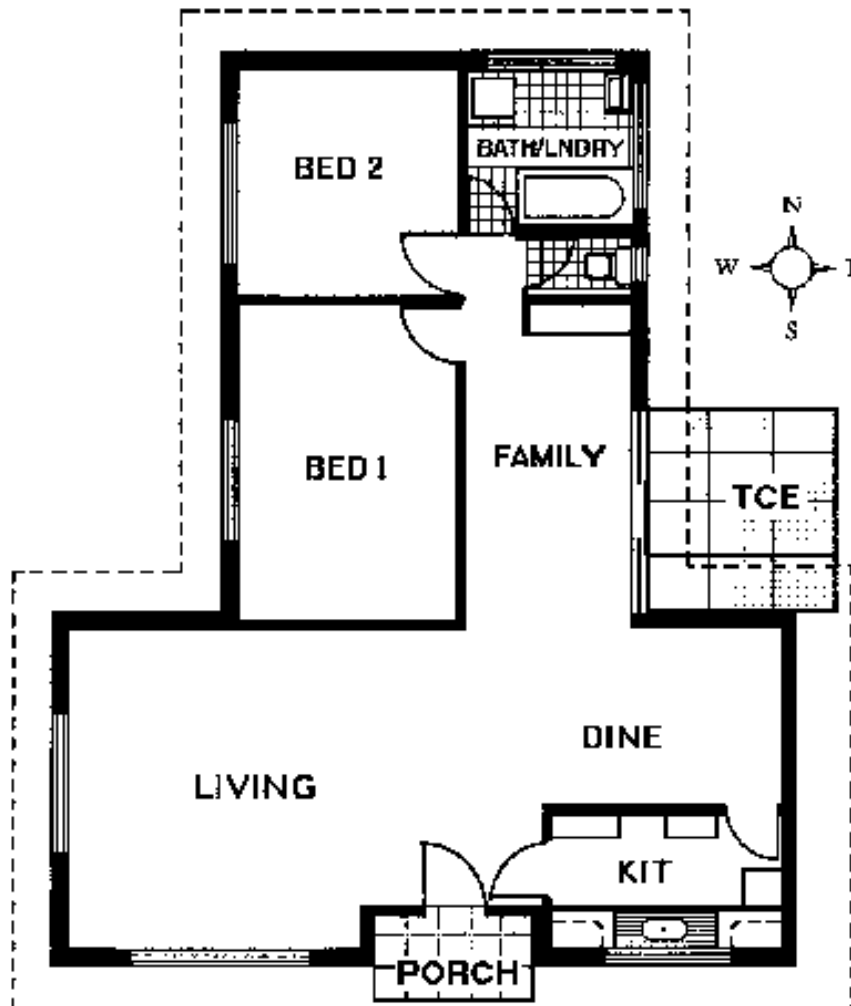
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Student exercise 7

Step 1 - Freehand drawing

At the end of this section is an A4 drawing sheet with border and title block. On it, draw a free hand sketch of the house plan below.

Be sure to make the plan as big as possible as you will be using it in future exercises.



Step 2 - Lighting Points and Switching Positions

1. On the floor plan that you have just drawn, draw the locations of all lighting points and switching positions as detailed in the lighting schedule provided.
2. When locating symbols make the centre line of the symbol correspond to the centre line of the lighting point.
3. Show switching positions for all lighting points, taking into account the type of switching required according to the schedule and the practical location for switches.

Electrical Schedule - Lighting			
Room	No of Points	Switching	Location Details
Porch	2	one-way	wall brackets each side of door
Living	1	two-way	room centre
Dining	1	one-way	room centre
Kitchen	1	two-way	room centre
Family	1	two-way	wall bracket, centre western wall
Terrace	1	one-way	terrace centre
Carport	1	one-way	carport centre
Toilet	1	one-way	room centre
bath-laundry	1	one-way	room centre
bedroom 2	1	one-way	room centre
bedroom 1	1	one-way	room centre

Step 3 - Power Outlets

1. On your floor plan draw the locations of all power outlets as detailed in the electrical schedule below.
2. When locating symbols make the centre line of the symbol correspond to the centre line of the outlet.
3. Be sure to correctly distinguish between single and double 10A outlets and 15A outlets, by the use of appropriate symbols.

Electrical Schedule - Power Outlets			
Room	No of Outlets	Type	Location Details
kitchen	1	double 10A	southern wall 300mm from SE corner
	1	double 10A	southern wall 300mm from SW corner
	1	single 10A	centre northern wall
dining	1	single 10A	eastern wall 500mm from NE corner
	1	single 10A	southern wall 300mm from SW corner
living	1	double 10A	western wall 450mm from SW corner
	1	double 10A	northern wall 300mm from NW corner
	1	single 10A	northern wall 300mm from NE corner
	1	single 15A	western wall 300mm from NW corner
family	1	single 10A	eastern wall NE corner
	1	single 10A	western wall 300mm from SW corner
bedroom 1	1	double 10A	centre eastern wall
	1	single 10A	western wall 500mm from NW corner
bedroom 2	1	double 10A	centre southern wall
	1	single 10A	centre northern wall
Bath-laundry	1	double 10A	centre eastern wall
carport	1	single 15A	western wall 300mm from NW corner

Step 4 - Appliances

1. On the floor plan provided in Fig.2 draw the locations of the following appliances:
 - a) range - located in kitchen on the northern wall in the NW corner
 - b) hot water service - located in kitchen under sink
 - c) door bell - located in family room, operated by an illuminated pushbutton at the front door
 - d) exhaust fan - located in kitchen above range
 - e) exhaust fan - located in bath-laundry, mounted on ceiling above bath

		DRAWN		MILLER COLLEGE OF TAFE	
		CHECKED			
		DATE		SCALE	DRAWING NO.
					A4

		DRAWN		MILLER COLLEGE OF TAFE	
		CHECKED			
		DATE		SCALE	DRAWING NO.
					A4

ARCHITECTURAL DRAWINGS

PURPOSE:

After interpreting architectural drawings and electrical floor plans, electricians are required to transfer the information from the plans and drawings into the workplace by installing a suitable wiring system. To aid you in such an installation, you will be required to develop and display some of the generic electrical skills that are often required during the installation of electrical wiring.

TO ACHIEVE THE PURPOSE OF THIS SECTION:

At the end of this practical assignment the student should be able to:

- Install the accessories required to terminate earthing conductors for a variety of applications.
- Solder various size earthing conductors to a main earthing conductor with the aid of a portable gas bottle and flame.
- Join Twin and Earth TPS cable with the installation of a junction box.
- Check continuity and resistance of joined cables.

EQUIPMENT:


The equipment needed for this exercise will be determined by you as part of the exercise. Refer to the job specifications.

REFERENCES:

- HAMPSON, J. *ELECTRICAL TRADE PRINCIPLES (2ND EDITION)*, PEARSON EDUCATION, FRENCHS FOREST NSW.
- HAMPSON, J. *ELECTROTECHNOLOGY PRACTICE*, PEARSON EDUCATION, FRENCHS FOREST NSW.
- AS/NZS 3000:2007 WIRING RULES.

NOTE:

This practical segment is to be completed by students on an individual basis.

<u>UEENEEE107A</u> Architectural Drawings - Practical Section		
1		
2		
3		

1. JOB SPECIFICATION - Earthing Terminations

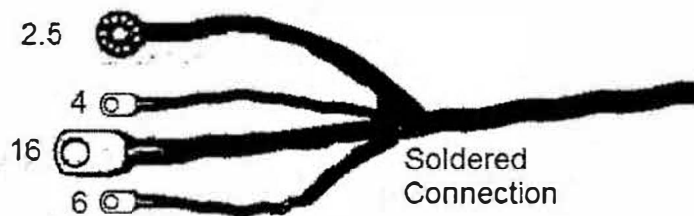
1. Cut 300mm of each of the following earth conductors:

2.5 sq mm

4 sq mm

6 sq mm

16 sq mm

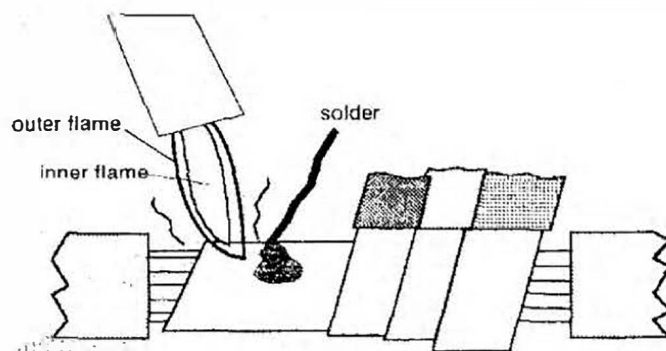


2. Use a knife to remove the insulation from one end of each cable 2.5, 4, 6, 16 sq mm
3. Fit a crimp lug to the end of the 4, 6 and 16 sq mm cable
4. Fit a cross crimp to the end of the 2.5 sq mm cable
5. Strip the other end of the 2.5, 4 and 6 sq mm cable ready to solder (approx 50 mm)
6. Strip approx 50 mm from the centre of the 16 sq mm cable
7. Wrap the 2.5, 4 and 6 sq mm cable around the 16 sq mm cable

8. *Have your teacher check your work*

checked	
---------	--

9. Use the porta gas lamp to solder the cables together



10. *Have your teacher check your work*

checked	
---------	--

2. JOB SPECIFICATION - Cable joining and testing (2.5mm²)

Table 1
Visual Inspection

Workmanship	Fixing Accessories	Fixing Cable	Terminations	Connections

Table 2
Continuity Test Results

Meter Used	Setting	Active	Neutral	Earth

Table 3
Earth Resistance Results

Meter Used	Meter Setting	Earth Resistance	Cable Condition

Table 4
Short Circuit Results

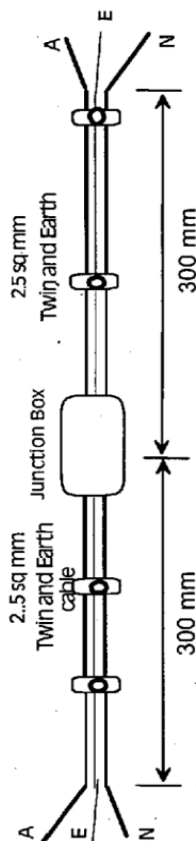
Meter	Setting	A - N	Cable Condition

Table 5
Insulation Resistance Results

Meter	Setting	A - E	N - E	Cable Condition

Results Checked

1. Fix TPS cable to the board
2. Fix junction box to the board
3. Cut TPS cable to size and pin clip the cables to the board
4. Connect the TPS cables in the junction box



Have Teacher check your work

Circuit Checked

- Conduct a visual inspection of the cables and enter the results in table 1
- Conduct a continuity of the cables and enter the results in table 2
- Conduct a earth resistance test of the cables and enter the results in table 3
- Conduct a short circuit test of the cables and enter the results in table 4
- Conduct an insulation resistance of the cables and enter the results in table 5

Architectural Drawings.

These questions will help you revise what you have learnt in Section.

1. Briefly describe the difference between a site plan and a floor plan.

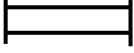


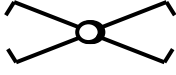

2. Briefly describe the function of a detailed drawing. Relate the answer to the installation of electrical services.

3. Draw a diagram showing the method used on a floor plan to show one light point controlled by three switches.

4. Indicate the actual lengths of the following drawing dimensions at the scales specified. Include the correct unit of measurement in your answer (m, mm etc)

- | | |
|------------------------------------|-------|
| a. Line length 75mm – scale 1:100 | <hr/> |
| b. Line length 68mm – scale 1:200 | <hr/> |
| c. Line length 32mm – scale 1:50 | <hr/> |
| d. Line length 4.5mm – scale 1:10 | <hr/> |
| e. Line length 115mm – scale 1:100 | <hr/> |

5. Identify the AS/NZS 1102 architectural electrical location symbols shown below.

a.		
b.		
c.		
d.		
e.		

6. Draw the AS/NZS 1102 architectural electrical location symbols for the following items of electrical equipment:

a.	luminaire, fixed to a wall	
b.	spotlight	
c.	distribution board	
d.	two pole switch	
e.	meter board	

7. Explain why the “point of entry” is not shown on the floor plan of a domestic installation.

8. Briefly explain the meaning of the term “standard drawing”.

9. Name five parts of an electrical installation that may have their location (or route) determined from the site plan.

1.

2.

3.

4.

5.

10. Who has the responsibility of determining the cable routes for the various circuits of a domestic installation?

Electrical Drawings & Wiring Diagrams.

PURPOSE:

In this section you will develop your skills in interpreting the information contained in electrical drawings.

TO ACHIEVE THE PURPOSE OF THIS SECTION:

At the end of this section the student will be able to:

- Identify and distinguish between block, circuit, wiring and ladder diagrams
- State the purpose and application of block, circuit and wiring diagrams
- Explain why standard symbols are used to represent components on electrical diagrams.
- List the conventions used in and the features of circuit diagrams
- Convert a circuit diagram to a wiring diagram
- Identify cable type, origin and route from a cable schedule.
- Develop a cable schedule for a given installation.

REFERENCES:

- HAMPSON, J. *ELECTRICAL TRADE PRINCIPLES (2ND EDITION)*, PEARSON EDUCATION, FRENCHS FOREST NSW.
- HAMPSON, J. *ELECTROTECHNOLOGY PRACTICE*, PEARSON EDUCATION, FRENCHS FOREST NSW.
- AS/NZS 3000:2007 WIRING RULES.

1. INTRODUCTION

Electrical diagrams are used in our industry as a means of communication, in which ideas, concepts or specific details are communicated. Electrical diagrams are very wide spread, and the understanding of, and competence in using them are essential for all electrical/electronic tradespeople.

There are five different types of diagram used in the electrical/electronic industry:

- block diagrams
- circuit diagrams
- wiring diagrams
- architectural diagrams
- ladder diagrams

2. BLOCK DIAGRAMS

A block diagram is a simple diagram intended to aid the understanding of the principle of operation of a circuit or system, while not providing detailed

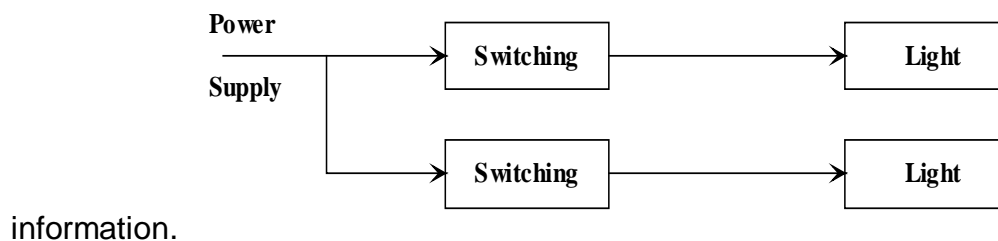


Fig. 1: Block diagram - basic light circuit

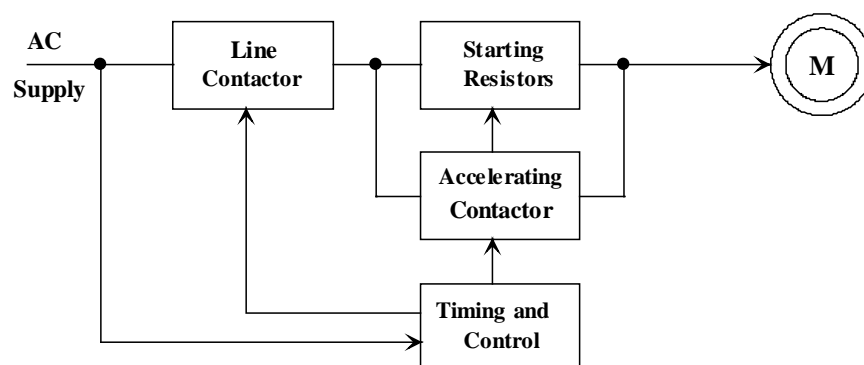


Fig. 2: Block diagram - Motor starter circuit

The block diagram is a much simplified version of a circuit diagram. However, the block diagram on its own is of little use as it displays limited information, but instead gives an overview of the circuit.

- to develop an idea or concept, and,
- to aid the understanding of the operation of a system.

A wiring diagram is a detailed diagram showing the manner in which a circuit or system is actually wired and assembled. Wiring diagram is not normally drawn to scale, although a scaled drawing may be required to permit construction of the panel or enclosures.



A number of conductors may be shown as being connected to a given terminal in a wiring diagram however in a circuit diagram only one conductor appears to terminate at any given terminal.

- used almost exclusively to construct or wire a circuit,
- along with a specification, it can specify all necessary connections, cable colour, type and size and,
- useful in fault finding in a circuit if it is suspected that the circuit has been subjected to some unauthorised or undocumented alterations or alternatively the actual circuit wiring has been proven to be faulty.

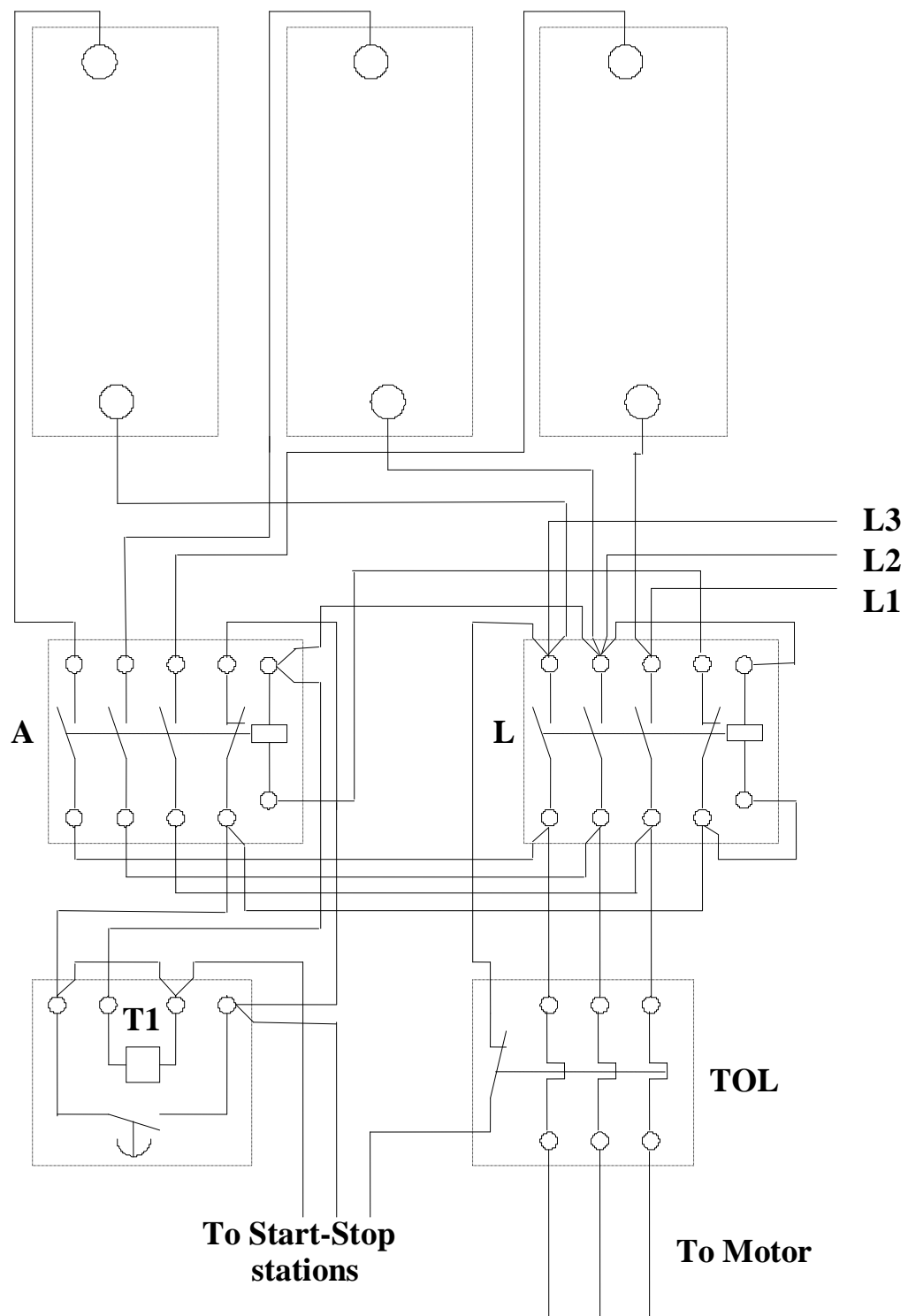
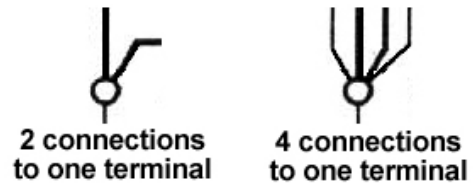


FIG. 4: WIRING DIAGRAM - MOTOR STARTER CIRCUIT

Unlike a circuit diagram each wire that is connected to a particular terminal is shown. Note the method used.



4. CIRCUIT DIAGRAMS

The circuit diagram is a detailed diagram intended to describe the operation of a circuit and is sometimes referred to as 'schematic diagrams'. Circuit diagram can be very complex and for a piece of equipment may in fact contain several circuits. All circuit diagrams contain symbols representing components, or items of equipment, interconnected by lines representing conductors.

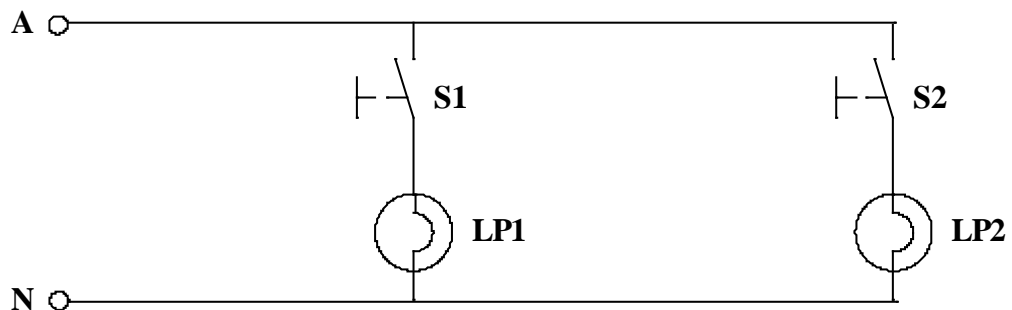


Fig. 3: Circuit diagram – basic light circuit

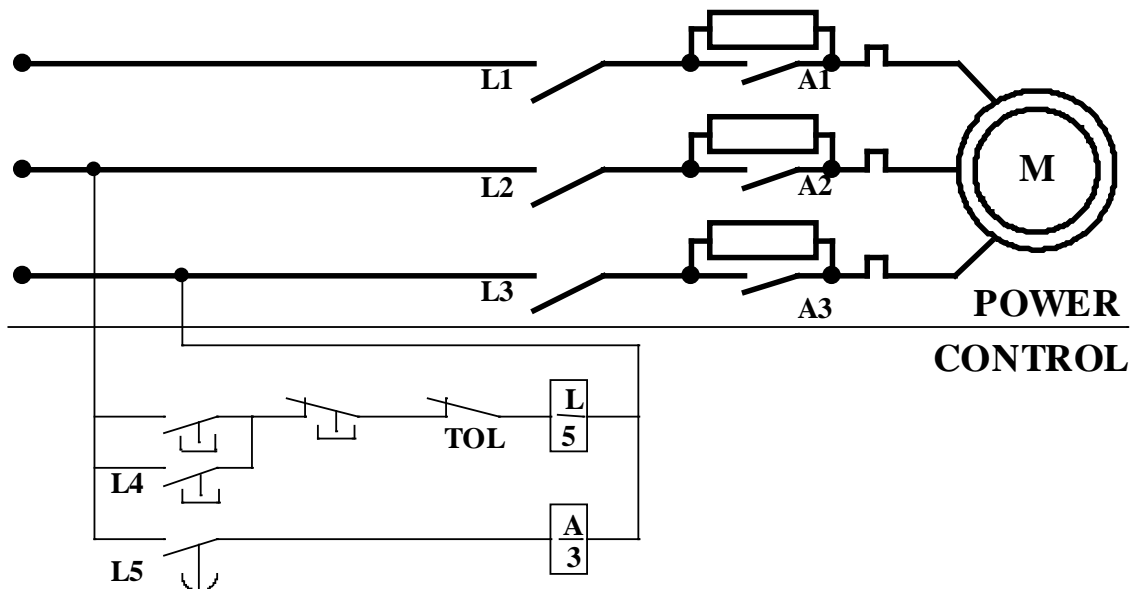


Fig. 4: Circuit diagram - Motor starter circuit

In circuit diagrams the circuit symbols do not necessarily represent the physical appearance of actual components. Similarly the layout of the diagram does not necessarily represent the actual physical layout of the equipment and wiring.

At this time it is not important to discuss the operation of the circuits, rather the features of a circuit diagrams

The purposes and applications of circuit diagrams are:

- to determine the operation of a circuit, and,
- to assist in fault finding.

The distinction between a block diagram and a circuit diagram, are:

- block diagrams provide an overview of the operation of a circuit or system, and,
- a circuit diagram provides detailed information on the operation of circuit/systems.

Compare the diagrams in Figs.2 and 4 to highlight these differences.

Circuit diagrams are intended to provide detailed information on the operation of a circuit or system, while a wiring diagram provides detailed information on the assembly and wiring of a circuit or system. Compare the diagrams in Figs.4 and 6, highlighting these differences.

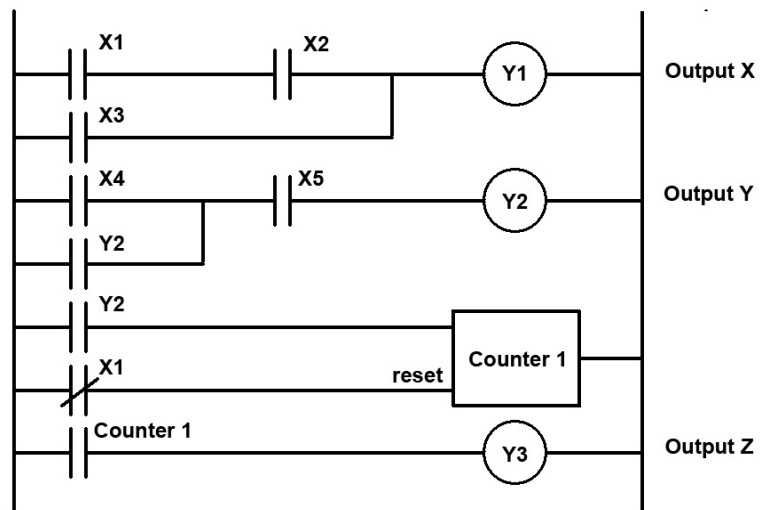
5. LADDER DIAGRAMS

Ladder diagrams are specialised circuit diagrams commonly used to illustrate industrial control systems.

They are so named because of their appearance which consists of two vertical lines symbolising the power rails (active and neutral), between which are placed the 'rungs' which contain input devices on the left and output

devices on the right. Each rung of the ladder corresponds to a

set of instructions that tells the load what to do in response to the status of each device connected to the rung.



PLC Ladder Diagram

These diagrams are usually associated with programmable logic controllers (PLC's) and are produced using computer software packages supplied by the particular plc manufacturer. The circuit is designed as the application program is developed.

6. STANDARD CIRCUIT SYMBOLS

A drawing symbol is a graphical representation of a component or item to be included in a diagram. The use of symbols is a convenient means of representing items in a diagram as this allows:

- Items to be included in a diagram in a simplified form (a symbol is simpler to draw than the actual item itself), and,
- Items, similar in appearance but differing in function can be easily distinguished in a diagram.

There is a need for a standard to be adopted when representing components in a circuit, wiring or block diagram. The use of standard symbols allows communication of ideas between individuals or organisations without the need for lengthy documentation accompanying every diagram.

The standard adopted in Australia for drawing symbols is the ISO (International Standards Organisation) standard. These symbols are laid out in Australian Standard AS 1102.

Some of these symbols will be required to complete the work in this section.

Student Exercise 1:

Using a pencil, draw what you think may be the Australian Standard symbols for each description given in Table 1 below:

Description	Your drawing	Correct drawing
Manually operated switch – Normally Open		
Manually operated switch – Normally Closed		
Fuse		
Circuit Breaker – single pole		
Lamp – illuminating		

7. CONVERTING CIRCUIT DIAGRAMS TO WIRING DIAGRAMS

This process is necessary to allow a circuit diagram to be converted to a form that will allow assembly and wiring of the equipment. This conversion may not be necessary for very simple circuits, it is essential when more complex circuits need to be wired.

The conversion of a circuit diagram into a wiring diagram also allows the wiring and assembly to be planned so that an efficient layout and routing of cables is achieved. This may in some cases allow cable types to be selected. By contrast, wiring a circuit directly from a circuit diagram often leads to problems such as:

- Cable waste
- Unnecessarily large cable looms.
- Too many conductors terminating at a given terminal.

It is important to adopt a numbering system for the identification of terminals and conductors. (Note that for the basic circuits dealt with in this module a numbering system for circuit conductors is not necessary, it is sufficient to number the terminals on the components.)

Student Exercise 2:

Convert the circuit diagram in Fig. 7 into a wiring diagram

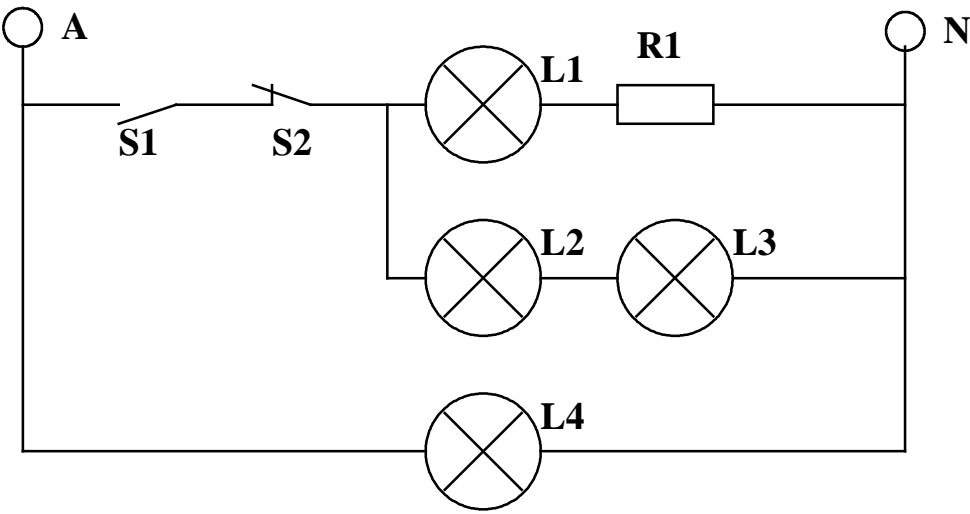


Fig. 7 Circuit diagram - Light Circuit

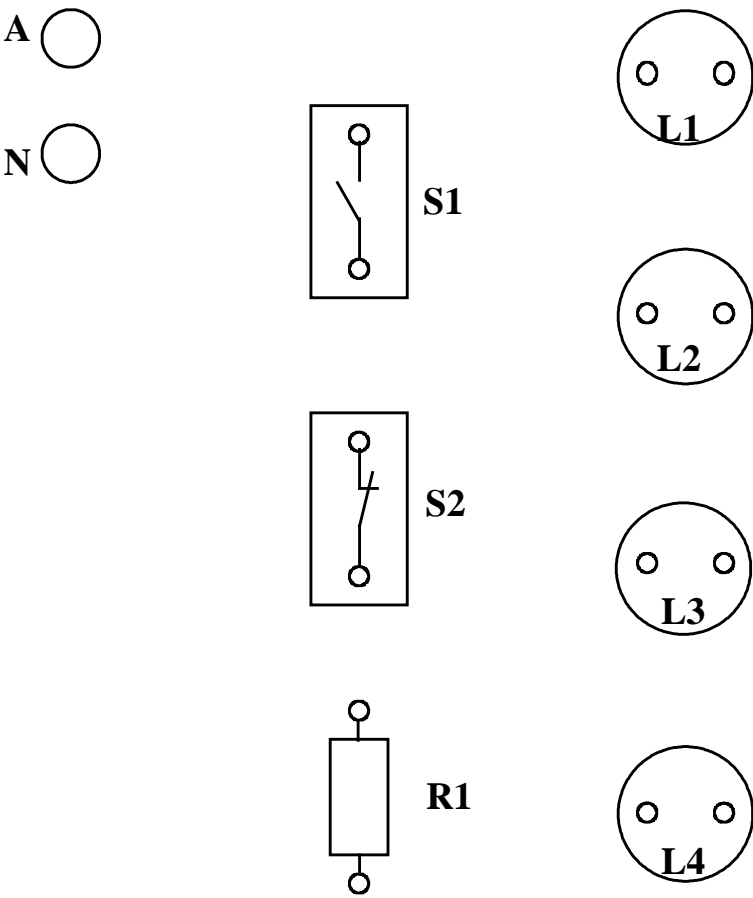


Fig. 8: Wiring diagram - Light Circuit

8. ELECTRICAL CABLE SCHEDULES

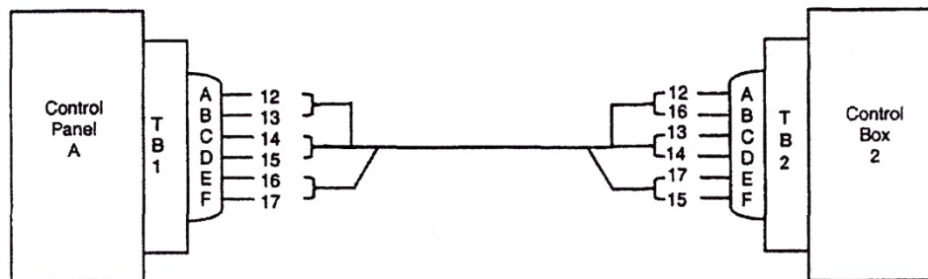
Electrical schedules are used and read in conjunction with electrical layout plans or wiring diagrams that have been greatly simplified for clarity. Schedules may be produced in a variety of forms:

- Cable schedule – provides specific details related to a cable installation.
- Outlet schedule – lists specific details regarding outlets, lighting points etc.
- Appliance schedule – details specific requirements related to the installation of appliances and equipment.

A schedule details supplementary information to the electrical specification and the diagram that it is read in conjunction with. To make interpretation of the schedule easy, it is prepared in the form of a table with column headings that vary with the type of installation

The table below shows a simple example of a cable schedule that is read in conjunction with the wiring diagram at the bottom.

Wire				Connection	
No.	Colour	Size	Type	From:	To:
12	RD	1.0mm ²	TPI	TB1:A	TB2:A
13	BK	1.5mm ²	TPI	TB1:B	TB2:C
14	RD	1.5mm ²	TPI	TB1:C	TB2:D
15	WH	2.5mm ²	TPI	TB1:D	TB2:F
16	BU	1.5mm ²	TPI	TB1:E	TB2:B
17	YL	1.0mm ²	TPI	TB1:F	TB2:E



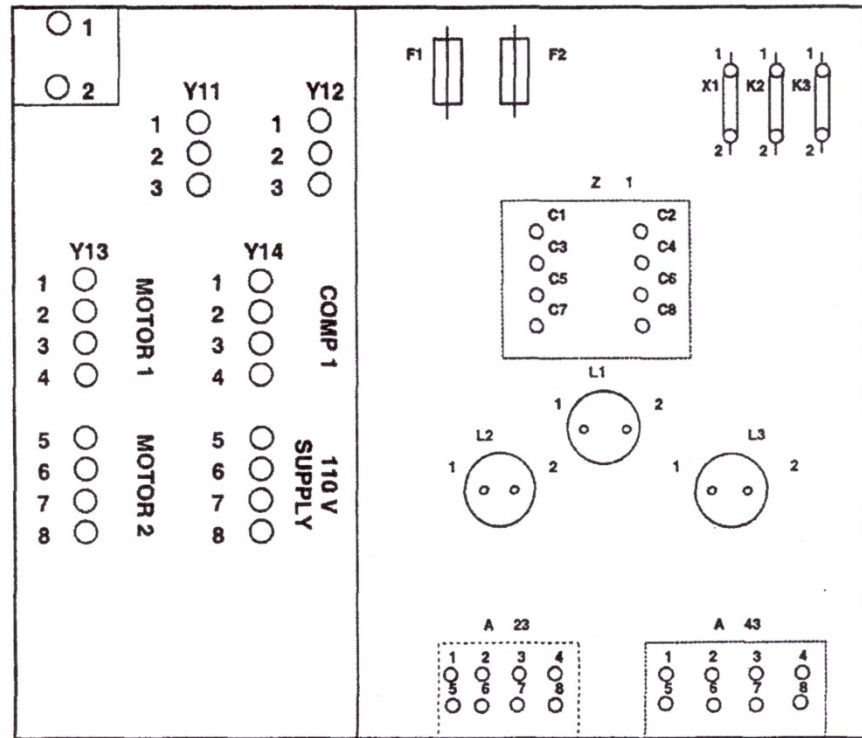
Schedules are usually supplemented with a diagram to show equipment layout information, such as the:

- Relative location of items.
- Terminal arrangement.
- Identification of unmarked terminals.
- Any special wiring arrangements.

Student exercise 3:

Using the cable schedule shown in the table draw, on the cabinet diagram, the cables with the following wire numbers:

- A1
- A3
- B4
- D1
- E23
- K12



Control cabinet

Wire		Connection		Wire		Connection	
No.	Colour	From:	To:	No.	Colour	From:	To:
A1	R	Y11:1	X1:1	D1	BK	Y14:5	A43:5
A2	W	Y11:2	K2:1	D2	BL	Y14:6	A43:6
A3	B	Y11:3	K3:1	D3	BR	Y14:7	A43:7
A4	BK	Y12:1	Z1:C1	D4	R	Y14:8	A43:8
A5	BK	Y12:2	Z1:C2				
A6	Y	Y12:3	Z1:C7	E23	Y	A23:1	L1:1
				E24	Y	A23:2	L2:1
B1	GY	Y13:1	A23:1	E25	Y	A23:3	L3:1
B2	GY	Y13:2	A23:2				
B3	GY	Y13:4	A23:3	K12	GY	A43:5	L1:2
B4	B	Y14:4	A23:4	K13	R	A43:6	L2:2
B5	R	Y14:4	L3:2	K14	B	A43:7	L3:2

Cable schedule

Electrical DRAWINGS

PURPOSE:

In this practical exercise you will develop your skills in converting drawing diagrams to wiring diagrams, wiring up the circuits and testing them

TO ACHIEVE THE PURPOSE OF THIS SECTION:

At the end of this practical assignment the student will be able to:

- Convert a circuit diagram to a wiring diagram
- Wire your converted circuit
- Test the operation of your converted circuit

EQUIPMENT:


- 24V AC power supply.
- Lamp panel – 4 lamps
- Switch panel – 4 Single pole, changeover switches
- Circuit testing device
- Connecting leads

REFERENCES:

- HAMPSON, J. *ELECTRICAL TRADE PRINCIPLES (2ND EDITION)*, PEARSON EDUCATION, FRENCHS FOREST NSW.
- HAMPSON, J. *ELECTROTECHNOLOGY PRACTICE*, PEARSON EDUCATION, FRENCHS FOREST NSW.
- AS/NZS 3000:2007 WIRING RULES.

NOTE:

This practical segment is to be completed by students on an individual basis.

<u>UEENEEE007A</u> WPS - Practical Section		
1		
2		
3		

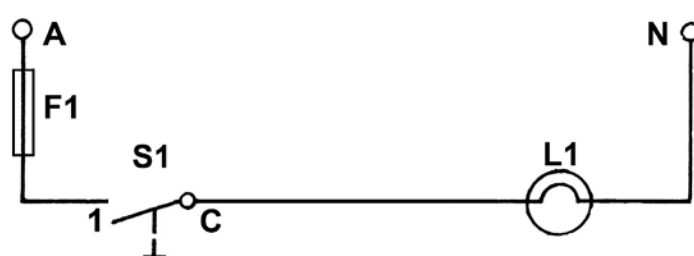
2. JOB SPECIFICATION - Cable joining and testing (2.5mm²)

JOB SPECIFICATION

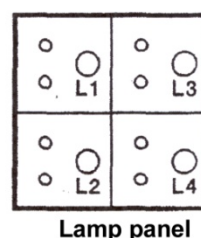
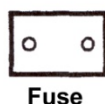
The task is to convert basic switching circuit diagrams to wiring diagrams and then to connect the circuit to check its operation.

PROCEDURE 1 – Single lamp controlled by a single switch

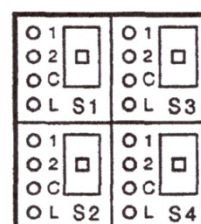
1. For circuit diagram 1 shown, neatly sketch the layout of wiring diagram 1 for the circuit.



Circuit diagram 1



Lamp panel



Switch panel

Wiring diagram 1

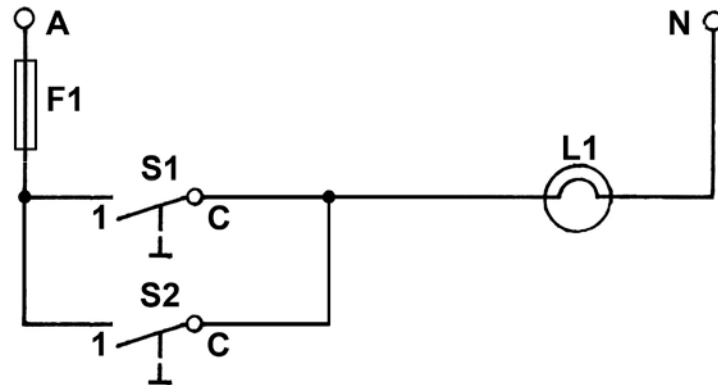
2. Connect the circuit according to the wiring diagram.
- 3.

Have your teacher check your circuit connections

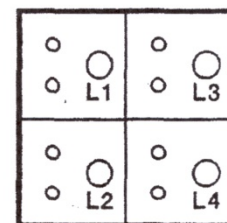
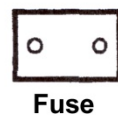
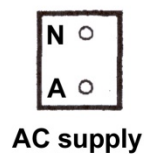
4. Apply power to the circuit and check that it operates correctly.
5. With the power turned off disconnect the circuit.

PROCEDURE 2 – Single lamp controlled by parallel connected switches

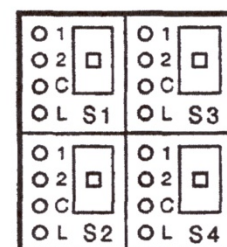
1. For circuit diagram 2 shown, neatly sketch the layout of wiring diagram 2 for the circuit.



Circuit diagram 2



Lamp panel



Switch panel

Wiring diagram 2

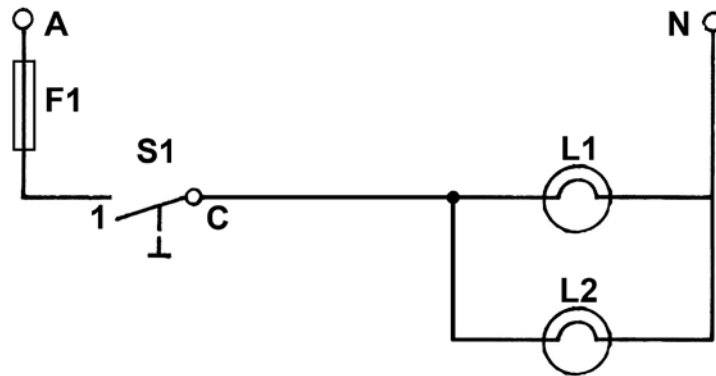
2. Connect the circuit according to the wiring diagram.

Have your teacher check your circuit connections

3. Apply power to the circuit and check that it operates correctly.
4. With the power turned off disconnect the circuit.

PROCEDURE 3 – Two parallel connected lamps controlled by a single switch

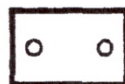
1. For circuit diagram 3 shown, neatly sketch the layout of wiring diagram 3 for the circuit.



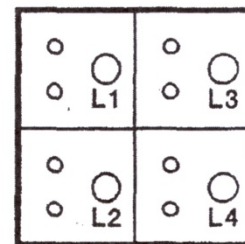
Circuit diagram 3



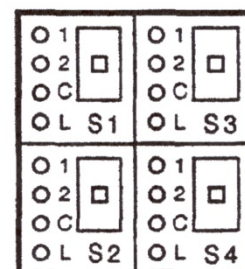
AC supply



Fuse



Lamp panel



Switch panel

Wiring diagram 3

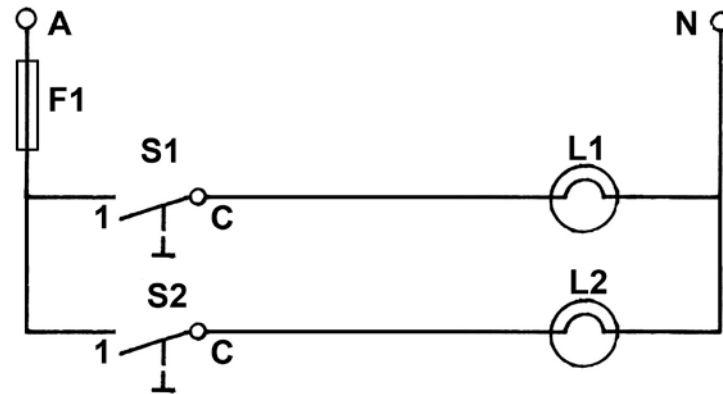
2. Connect the circuit according to the wiring diagram.

Have your teacher check your circuit connections

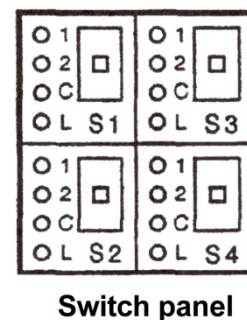
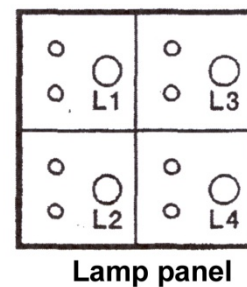
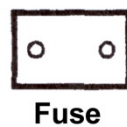
3. Apply power to the circuit and check that it operates correctly.
4. With the power turned off disconnect the circuit.

PROCEDURE 4 – Two parallel connected lamps individually controlled

1. For circuit diagram 4 shown, neatly sketch the layout of wiring diagram 4 for the circuit.



Circuit diagram 4



Wiring diagram 4

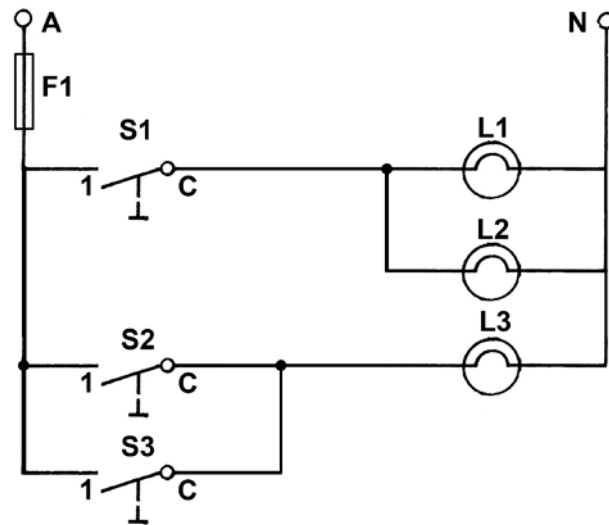
2. Connect the circuit according to the wiring diagram.

Have your teacher check your circuit connections

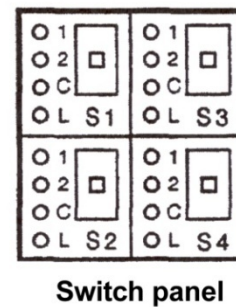
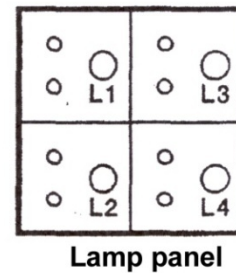
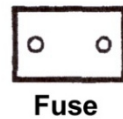
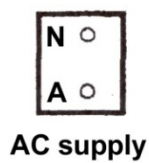
3. Apply power to the circuit and check that it operates correctly.
4. With the power turned off disconnect the circuit.

PROCEDURE 5 – Multiple lamp circuit

1. For circuit diagram 5 shown, neatly sketch the layout of wiring diagram 5 for the circuit.



Circuit diagram 5



Wiring diagram 5

2. Connect the circuit according to the wiring diagram.

Have your teacher check your circuit connections

3. Apply power to the circuit and check that it operates correctly.
4. With the power turned off disconnect the circuit.

Electrical Drawings.

These questions will help you revise what you have learnt in Section.

1. AS/NZS 3000:2007 provides a table of electrical symbols as used in the standard. Find and neatly sketch the electrical symbols for the following devices and write down their reference number to AS 1102.

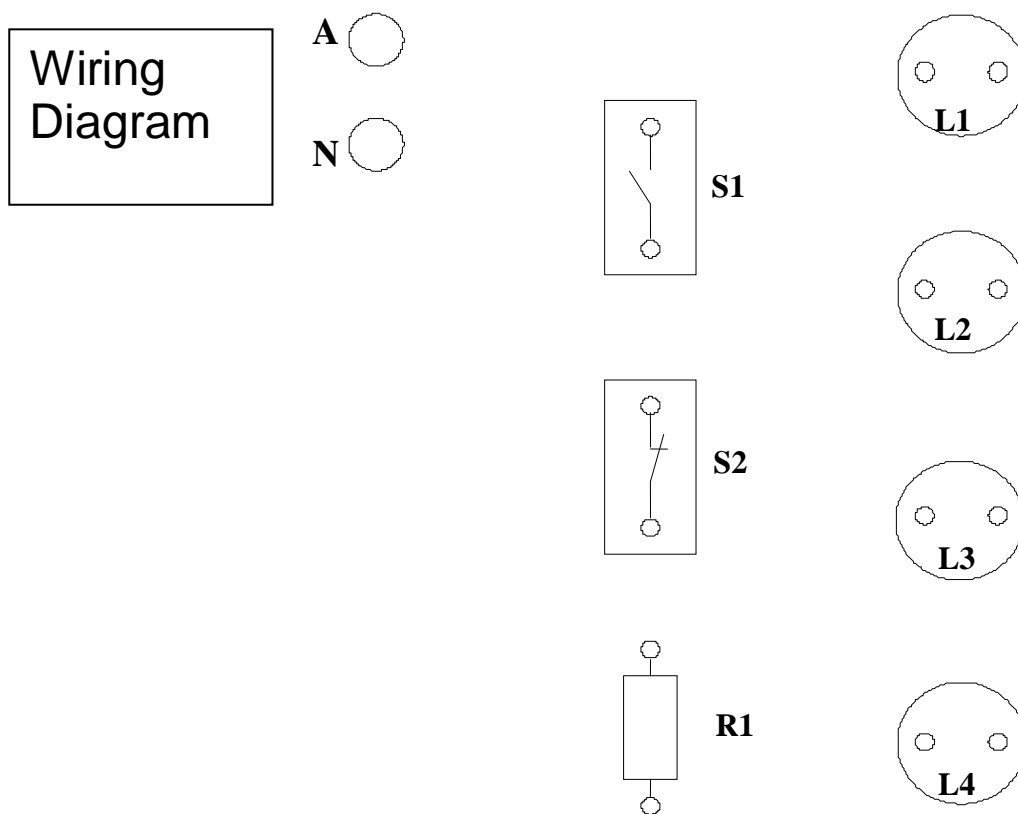
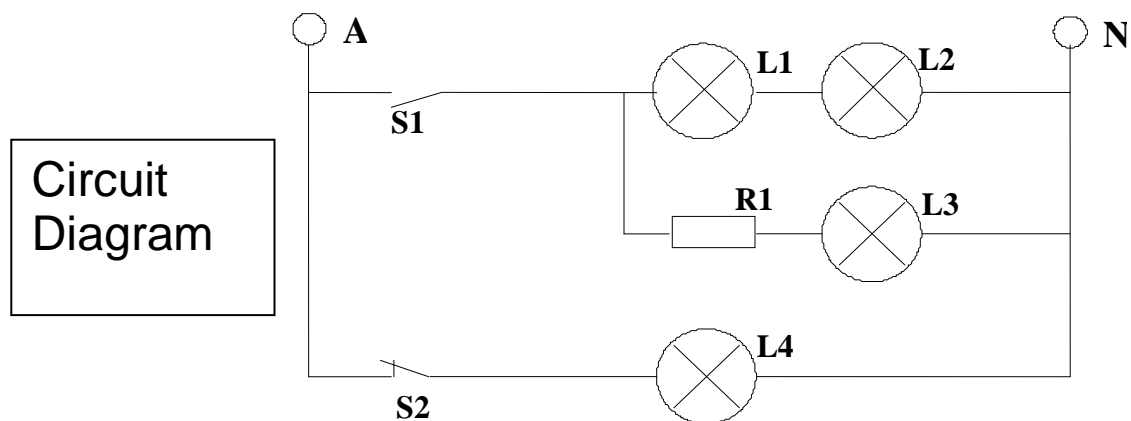
Description	Symbol	Reverence No.
A Switch (general Symbol)		
A fuse		
A circuit breaker		
An RCD		
A socket outlet		
The earth connection		

2. The best type of electrical diagram to use when fault finding electrical equipment is a/an:-
- a) circuit diagram;
 - b) wiring diagram;
 - c) block diagram;
 - d) architectural diagram.
3. What are the five different type of diagrams used in the electrical industry?
- a) _____
 - b) _____
 - c) _____
 - d) _____
 - e) _____

4. What is another name for a circuit diagram?

5. Draw the symbol for a connection of 2 wires to a terminal as used in a wiring diagram.

6. Convert the circuit diagram in below into a wiring diagram



Circuit Diagrams.

In this section you will develop your skills at drawing circuit diagrams, creating switching charts and connecting circuits from a circuit diagram

TO ACHIEVE THE PURPOSE OF THIS SECTION:

At the end of this section the student should be able to:

- Describe the purpose of circuit diagrams in the electrical industry
- List the conventions used in and the features of circuit diagrams
- Sketch basic circuit diagrams
- Identify a range of symbols from Australian Drawing Standard AS/NZS 1102
- Use a continuity testing device to construct a switching chart to identify the terminals of a switch
- Connect equipment according to a circuit diagram and confirm the operation of the circuit

REFERENCES:

- HAMPSON, J. *ELECTRICAL TRADE PRINCIPLES (2ND EDITION)*, PEARSON EDUCATION, FRENCHS FOREST NSW.
- HAMPSON, J. *ELECTROTECHNOLOGY PRACTICE*, PEARSON EDUCATION, FRENCHS FOREST NSW.
- AS/NZS 3000:2007 WIRING RULES.

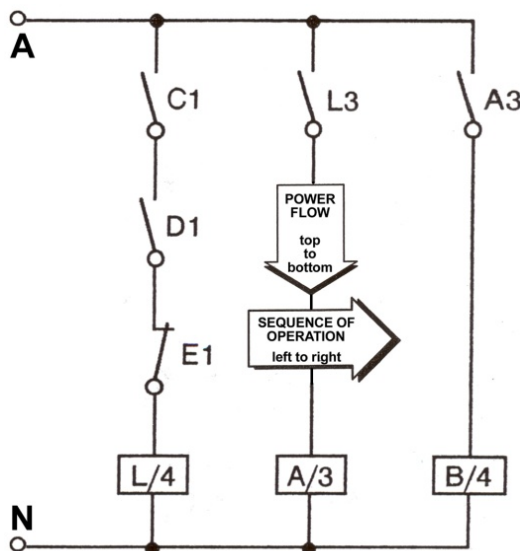
1. INTRODUCTION

The circuit diagram is a detailed diagram intended to describe the _____ of every component in the circuit and can also be used to assist with _____. Circuit diagrams are sometimes referred to as 'schematic diagrams'. Circuit diagrams can be very complex and for a piece of equipment may in fact contain several circuits. All circuit diagrams contain symbols representing components, or items of equipment, interconnected by lines representing conductors.

2. CIRCUIT DIAGRAM CONVENTIONS

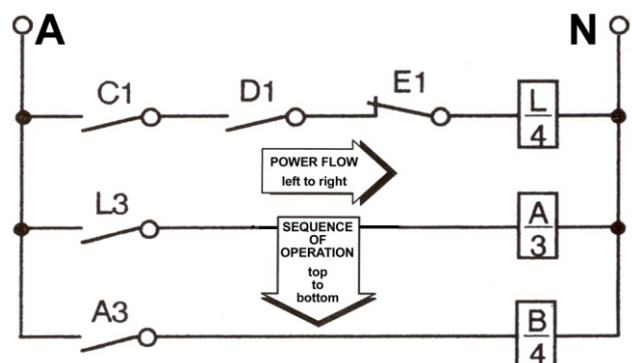
Power/Energy Flow and Operational Sequence

The figures below show the two accepted methods of aligning or arranging diagrams to show energy flow throughout a circuit. Although both are acceptable, the most common arrangement for circuit diagrams is the vertical representation.



Vertical Orientation

- ❑ Power flow top to bottom
- ❑ Sequence of operation left to right



Horizontal Orientation

- ❑ Power flow left to right
- ❑ Sequence of operation top to bottom

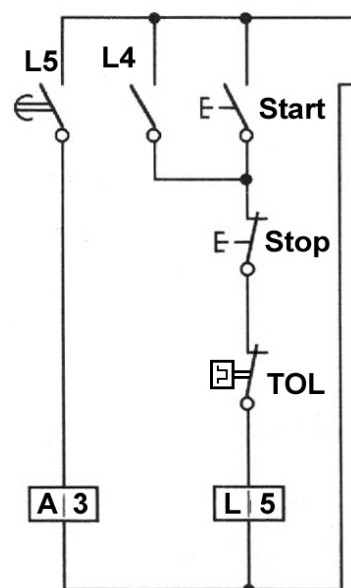
Symbol Relationships

Circuit diagrams are most commonly drawn as *detached representation* where component parts of an item are drawn _____ from each other. This method of presentation of symbols produces a _____ understood diagram compared to using the correct physical layout because the parts are drawn to show how they affect circuit operation (detached) rather than where they actually appear in the circuit (attached).

The example shown is the control part of the motor start circuit from the previous section.

It can be seen that there are five contacts being used on contactor 'L' and three on contactor 'A'.

Contacts L4 and L5 are being used to latch the start operation and control the timing of the energising of contactor A respectively.



Detached (remote) representation

Conductors crossing and joining

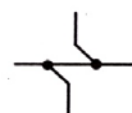
This is an area where _____ may easily occur and lead to the incorrect connection of equipment, or confusion about the operation of a circuit. In order to overcome or minimise these problems, the preferred methods for drawing conductors crossing and joining are shown below.



Conductors crossing but not joined



3 conductors joined



4 conductors joined

Reference condition of a circuit

Because the state or condition of circuit components can vary during the normal operation of the circuit or equipment, that is, switches can be switched on or off, it is not possible to draw a circuit diagram for every possible condition; even for that of a simple circuit.

Circuit diagrams are always drawn in a manner that electrically represents the:

- _____ or
- _____ or
- _____ .

This allows the state (on, off, open, closed) of all components to be determined when the circuit is turned off. This, in turn, simplifies the task of deciding the sequence of operation when power is applied.

3. FREEHAND SKETCHING OF CIRCUIT DIAGRAMS

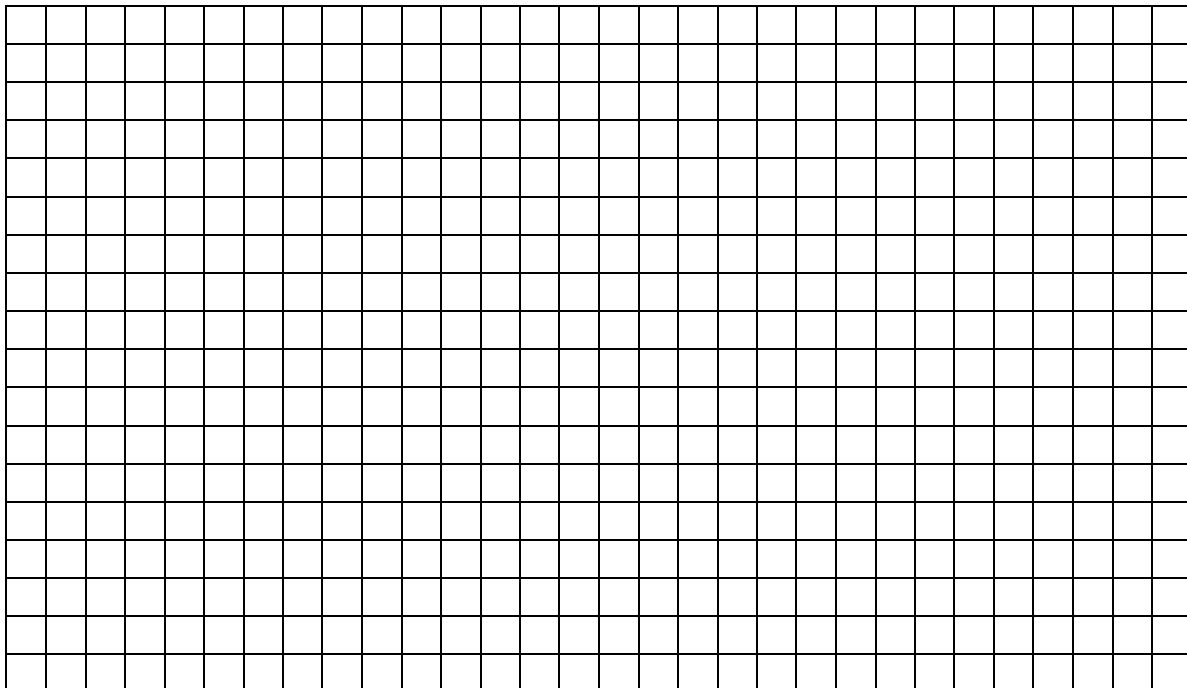
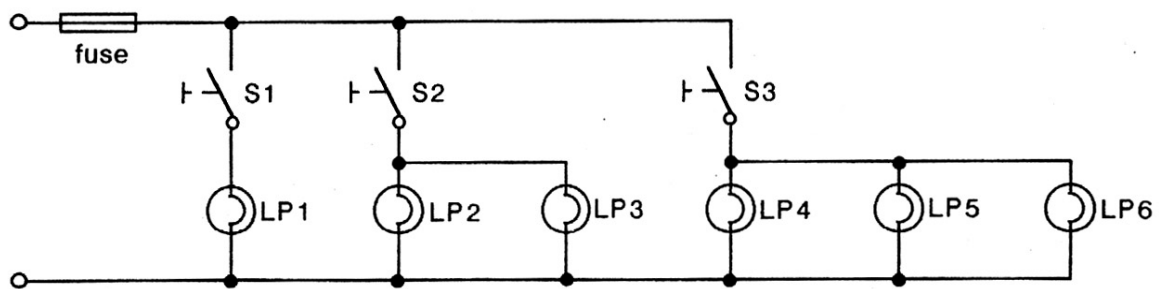
These diagrams are an important means of _____ and in order to convey clear messages, should be as accurate as possible at all times. Although there is a “correct” size for a symbol, often because the diagram is to be drawn freehand the correct shape or form of a symbol is more important. It is important to maintain the same size for symbols for the same types of devices and equipment throughout a diagram.

Unless working in a drawing office, most circuit diagrams produced by electricians will be freehand and on the most unlikely drawing medium (sheet of masonite, lunch wrapper, opened out accessories box, even sometimes in an exercise book!). This does not mean that the circuit has to be unreadable.

The circuits drawn in this subject should all be drawn freehand, but as an aid to developing accuracy in drawing, on a 5mm grid sheet.

Student exercise 1:

The drawing below is to be redrawn freehand on a 5mm grid sheet using standard symbols to the recommended sizes for an A4 sheet.



4. CIRCUIT SYMBOLS

Student Exercise 2: Using a pencil, draw what you think may be the Australian Standard symbols for each description given in Table 1 below (you may refer to your textbook):

Description	Your drawing	Correct drawing
Manually operated switch – Normally Open		
Manually operated switch – N/C		
Fuse		
Lamp – illuminating		
Lamp – signal or illuminating		
Single Pole, Double Throw (SPDT) – changeover switch		
Time Delay Contacts (switch – instant on/time delay off		
Circuit Breaker – single pole		
Double Pole Switch – switch both active and neutral. (used on construction sites for safety)		
Triple Pole Switch – 3 phase switch		
Single Pole, Multi Position – selector switch		
Push Button Switch – single pole, non latching (N/O)		
Push Button Switch – single pole, non latching (Stop)		
Push Button Switch – single pole, latching (N/C) – Emergency Stop		

5. STANDARD LIGHT SWITCHES

Typical Light Switch Types

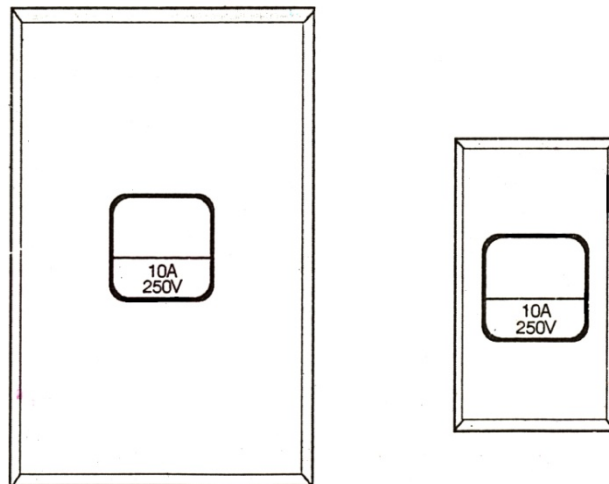
- Single pole/single throw (SPST)
- Single pole/double throw (SPDT) (changeover)

The SPDT switch is more common because:

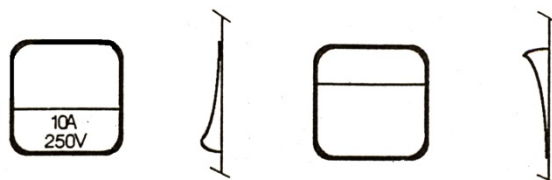
- It will operate as either a single or double throw type.
- No need to carry stock of N/O and N/C switch types

Switch mounting convention

The normal mounting position for these switches is that the switch rating information is visible when the operating device is in the “Toggle up” position.



Mounting positions – standard flush switches



Toggle up – switch off

Toggle down – switch on

Toggle positions – standard flush switches

NOTE: The fact that the operating device of the switch is in the toggle up position doesn't mean that the switch is off in all cases.

6. SWITCHING CHARTS

The internal connections of components often need to be determined. The importance of this is that many components have numerous applications in which different terminals are used. With an appropriate testing procedure, the following can be revealed:

- Closed contacts
- Open contacts
- Load or consuming device (e.g. lamp filament)
- Looping terminals.

The following are examples of suitable test equipment, that can be use to test for continuity:

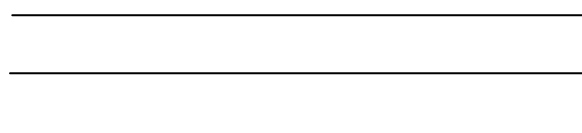


Fig. 1 shows a single-pole, single throw, manually operated, normally open switch and the resulting Switching chart. As well as, a single-pole, single throw, manually operated, normally closed switch and the resulting Switching chart.



Fig. 1

Table 1

Terminals	Normally open		Normally closed	
	Resistance		Resistance	
	Toggle Up (OFF or NORMALLY)	Toggle Down (ON or ACTIVATED)	Toggle Up (OFF or NORMALLY)	Toggle Down (ON or ACTIVATED)
1-2		X	X	

From this operation, (which is simply measuring the resistance between each set of contacts with the toggle in both positions), it can show which terminals are appropriate for a given application. Table 1 is an example method of tabulating results. This table may seem unnecessary, given the simple nature of the switch; however it is very useful when the devices being tested are more complex.

It is not always necessary to enter an actual resistance value in the table, usually it is sufficient to indicate with an 'X' only those positions where a circuit is present.

Student Exercise 3:

The following diagram of figure 2 is that of a circuit containing a single-pole double-throw switch (such as a HPM type 770) controlling a lamp. Using the diagram and your electrically reasoning, fill in the switching table.

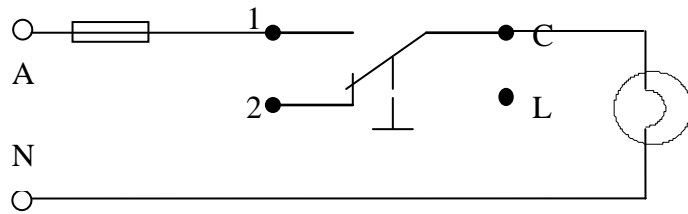


Fig. 2

Table 2

Terminals	Toggle Up	Toggle Down
C - 1		
C - 2		
C - L		
1 - 2		
1 - L		
2 - L		

This procedure can be used for all unfamiliar accessories and devices. Only experience with a given accessory eliminates the need to determine terminal connections. This procedure may also be used for accessories other than switches, as it provides a useful means of identifying terminal allocation.

Single-way switching - single lighting point

Single-way switching provides simple ON/OFF control of one or more lighting points from a single switch.

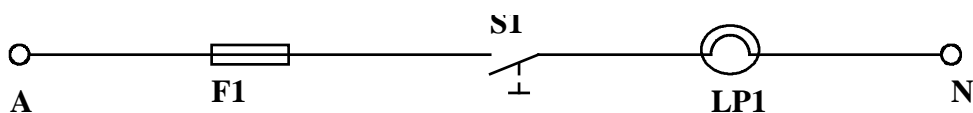


Fig. 3: Single way switching - one lighting point

While a single-pole, single-throw (SPST) switch is suitable, single-pole, double-throw (SPDT) switches are normally used in these circuits, because they can be used in multi-way switching.

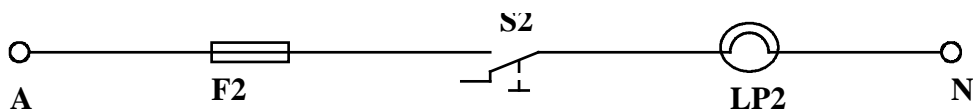


Fig. 4: Single way switching - one lighting point

Two-way switching - single lighting point

It is often necessary to control a lighting point from either of two positions e.g. for lighting in a or . In these situations the lighting point must be capable of being switched ON or OFF from either of the two control positions. Switches S1 and S2 in figure 5 are SPDT type switches. The switching chart for a SPDT switch is shown on the previous page (table 2).

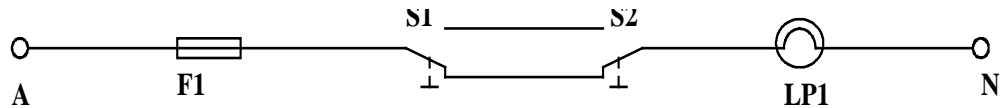


Fig.5: Two-way switching single lighting point

NOTE: with a two-way switching circuit, it is possible that the light can be turned on by moving the toggle up, depending on the position of the other switch. That is, neither switch has a true OFF position. A typical light switch such as a Clipsal 39 series or a HPM 770 series may be used as either a single or two-way switch.

Student Exercise 4:

Refer to figure 5 and complete table 3.

Switch configuration	LP1 condition	
	On	Off
Switches S1 and S2 both toggled down (as drawn)		
Switch S1 toggled up only		
Switch S2 toggled up only		
Switches S1 and S2 both toggled up		

Intermediate Switching

Intermediate switching is an extension of the principle of two-way switching. The block diagram of Fig. 6 explains.

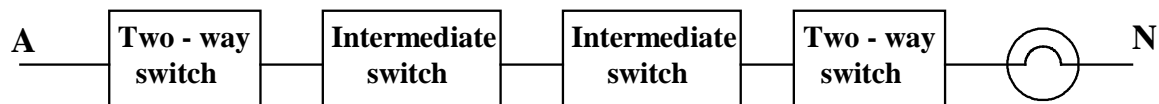


Fig. 6: Block diagram - two-way and intermediate switching

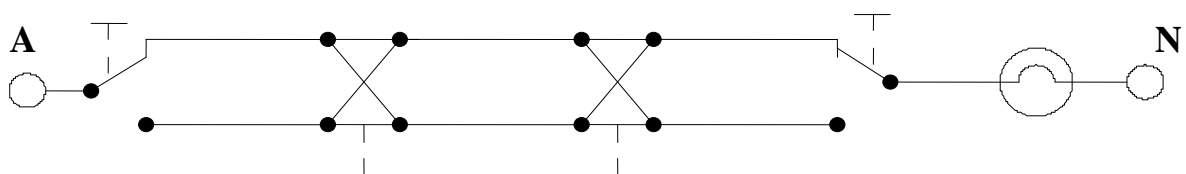


Fig.7: Circuit diagram - two-way and intermediate switching

Intermediate switching allows ON/OFF control from any of three or more switching positions. This switching system is normally used in rooms or areas with multiple exits, e.g. hallways, school gyms etc.

While two-way switches are normally single pole double throw (SPDT) switches, the intermediate switches have special switches constructed, so they have only limited use. Due to the manufacturer's design, there are two types. They operation in the same way, but have a different allocation for terminals.



Fig. 8

The switching chart for each type of these switches are shown in Table 4 & 5

Table 4 - Clipsal 30MI switch

Terminals	Switch position	
	toggle up	toggle down
1 – 2		
1 – 3		X
1 – 4	X	
2 – 3	X	
2 – 4		X
3 – 4		

Table 5 - HPM 770/I switch

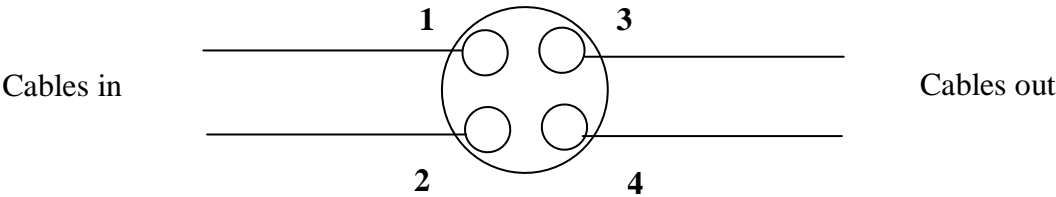
Terminals	Switch position	
	toggle up	toggle down
1 - 2	X	
1 - 3		
1 - 4		X
2 - 3		X
2 - 4		
3 - 4	X	

Student Exercise 5:

Using switching [table 4](#) as a guide, draw the connecting contacts for the intermediate switch mechanism of figure 9 below.

NOTE: Use a solid line to represent contacts when the switch is toggle down. —————

Use a broken line to represent contacts when the switch is toggle up. -----



Circuit Diagrams

PURPOSE:

In this topic you will develop your skills in creating switching charts and connecting circuits from a circuit diagram

TO ACHIEVE THE PURPOSE OF THIS SECTION:

At the end of this practical assignment the student will be able to:

- Use a continuity testing device to construct a switching chart to identify the terminals of a switch
- Connect equipment according to a circuit diagram and confirm the operation of the circuit

EQUIPMENT:


The equipment needed for this exercise will be determined by you as part of the exercise.

REFERENCES:

- HAMPSON, J. *ELECTRICAL TRADE PRINCIPLES (2ND EDITION)*, PEARSON EDUCATION, FRENCHS FOREST NSW.
- HAMPSON, J. *ELECTROTECHNOLOGY PRACTICE*, PEARSON EDUCATION, FRENCHS FOREST NSW.
- AS/NZS 3000:2007 WIRING RULES.

NOTE:

This practical segment is to be completed by students on an individual basis.

<u>UEENEEE107A</u> WPS - Practical Section		
1		
2		
3		

1. SWITCHING CHARTS

The task is to test switching devices to determine the terminal configuration of the switches.

Switch 1 – Panel 1

1. Using a suitable testing device, check for continuity between each terminal combination for each position of the switch toggle.
2. Number the switch terminals on the diagram according to your results.
3. Draw, in the table below, the switching chart for the switch on the panel stated. Remember to take into account the:
 - a. Number of terminals
 - b. Number of switch positions
4. Indicate the closed terminal connections with a cross in the appropriate box.
5. Draw the Australian standard symbol for the switch next to the table.

Terminals	Toggle Up	Toggle Down

Switch 1 – Panel 2

1. Using a suitable testing device, check for continuity between each terminal combination for each position of the switch toggle.
2. Number the switch terminals on the diagram according to your results.
3. Draw, in the table below, the switching chart for the switch on the panel stated. Remember to take into account the:
 - a. Number of terminals
 - b. Number of switch positions
4. Indicate the closed terminal connections with a cross in the appropriate box.
5. Draw the Australian standard symbol for the switch next to the table.

Terminals	P/B In	P/B Out

Switch 1 – Panel 3

1. Using a suitable testing device, check for continuity between each terminal combination for each position of the switch toggle.
2. Number the switch terminals on the diagram according to your results.
3. Draw, in the table below, the switching chart for the switch on the panel stated. Remember to take into account the:
 - c. Number of terminals
 - d. Number of switch positions
4. Indicate the closed terminal connections with a cross in the appropriate box.
5. Draw the Australian standard symbol for the switch next to the table.

[illegible]

Switch 3 – Panel 3

1. Using a suitable testing device, check for continuity between each terminal combination for each position of the switch toggle.
2. Number the switch terminals on the diagram according to your results.
3. Draw, in the table below, the switching chart for the switch on the panel stated. Remember to take into account the:
 - e. Number of terminals
 - f. Number of switch positions
4. Indicate the closed terminal connections with a cross in the appropriate box.
5. Draw the Australian standard symbol for the switch next to the table.

[illegible]

Switch 1 – Panel 4

1. Using a suitable testing device, check for continuity between each terminal combination for each position of the switch toggle.
2. Number the switch terminals on the diagram according to your results.
3. Draw, in the table below, the switching chart for the switch on the panel stated. Remember to take into account the:
 - g. Number of terminals
 - h. Number of switch positions
4. Indicate the closed terminal connections with a cross in the appropriate box.
5. Draw the Australian standard symbol for the switch next to the table.

[illegible]

Switch 2 – Panel 4

1. Using a suitable testing device, check for continuity between each terminal combination for each position of the switch toggle.
2. Number the switch terminals on the diagram according to your results.
3. Draw, in the table below, the switching chart for the switch on the panel stated. Remember to take into account the:
 - i. Number of terminals
 - j. Number of switch positions
4. Indicate the closed terminal connections with a cross in the appropriate box.
5. Draw the Australian standard symbol for the switch next to the table.

[illegible]

Switch 3 – Panel 4

1. Using a suitable testing device, check for continuity between each terminal combination for each position of the switch toggle.
2. Number the switch terminals on the diagram according to your results.
3. Draw, in the table below, the switching chart for the switch on the panel stated. Remember to take into account the:
 - k. Number of terminals
 - l. Number of switch positions
4. Indicate the closed terminal connections with a cross in the appropriate box.
5. Draw the Australian standard symbol for the switch next to the table.

Terminals	Button Out	Button In

Switch 4 – Panel 4

1. Using a suitable testing device, check for continuity between each terminal combination for each position of the switch toggle.
2. Number the switch terminals on the diagram according to your results.
3. Draw, in the table below, the switching chart for the switch on the panel stated. Remember to take into account the:
 - m. Number of terminals
 - n. Number of switch positions
4. Indicate the closed terminal connections with a cross in the appropriate box.
5. Draw the Australian standard symbol for the switch next to the table.

Terminals	Pos 1	Pos 2	Pos 3

2. CIRCUIT DIAGRAMS

The task is to connect equipment according to a circuit diagram and confirm the operation of the circuit

Single lamp controlled by a single switch

1. Connect the circuit according to the circuit diagram.



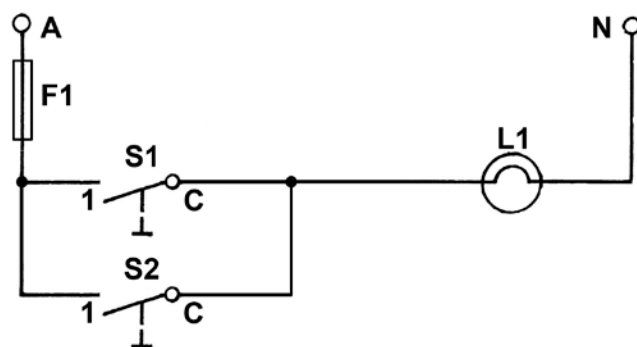
Circuit diagram 1

Have your teacher check your circuit connections

2. Apply power to the circuit and check that it operates correctly.

3. With the power turned off disconnect the circuit.

Single lamp controlled by parallel connected switches



Circuit diagram 2

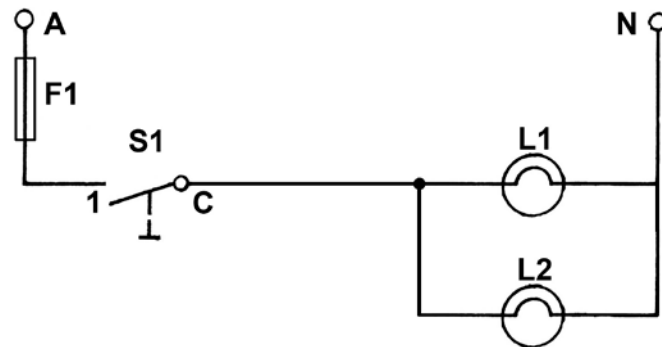
1. Connect the circuit according to the circuit diagram

Have your teacher check your circuit connections

2. Apply power to the circuit and check that it operates correctly.

3. With the power turned off disconnect the circuit.

Two parallel connected lamps controlled by a single switch



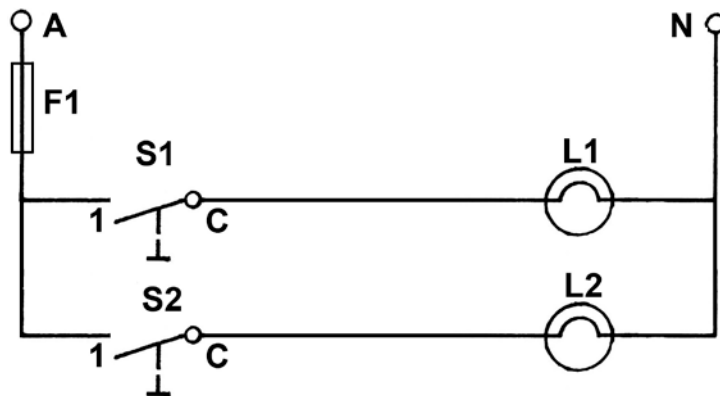
Circuit diagram 3

1. Connect the circuit according to the circuit diagram.

Have your teacher check your circuit connections

2. Apply power to the circuit and check that it operates correctly.
3. With the power turned off disconnect the circuit.

Two parallel connected lamps individually controlled



Circuit diagram 4

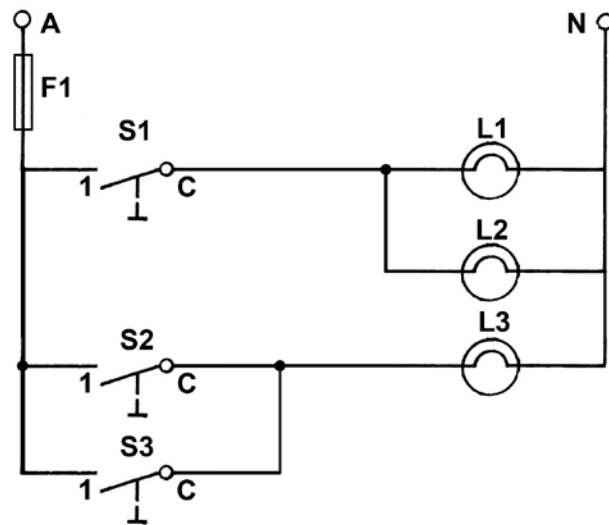
Wiring diagram 4

1. Connect the circuit according to the circuit diagram.

Have your teacher check your circuit connections

2. Apply power to the circuit and check that it operates correctly.
3. With the power turned off disconnect the circuit.

Multiple lamp circuit



Circuit diagram 5

1. Connect the circuit according to the circuit diagram.

Have your teacher check your circuit connections

2. Apply power to the circuit and check that it operates correctly.
3. With the power turned off disconnect the circuit.

Electrical Drawings.

These questions will help you revise what you have learnt in Section. In the following statements, circle the letter that best answers the question.

1. Circuit diagrams are intended to describe:
 - (a) The operation of some components in a circuit
 - (b) The operation of switch contacts in a circuit
 - (c) The operation of all components in a circuit
 - (d) The physical layout of components in a circuit
2. Circuit diagrams are sometimes referred to as:
 - (a) schematic diagrams
 - (b) block diagrams
 - (c) wiring diagrams
 - (d) component diagrams
3. Circuit diagrams are always drawn in the electrically:
 - (a) cold condition
 - (b) shutdown condition.
 - (c) reset condition
 - (d) all of the above
4. SPST is an abbreviation for:
 - (a) single plate/single throw
 - (b) switch plate/single throw
 - (c) single pole/switch toggle
 - (d) single pole/single throw
5. An instrument suitable for testing circuit continuity would be a:
 - (a) voltmeter
 - (b) ohmmeter
 - (c) wattmeter
 - (d) none of the above
6. What is the minimum number of switches to be wired for an intermediate switch setup:
 - (a) 1
 - (b) 2
 - (c) 3
 - (d) 4
7. A triple pole switch is a switch which:
 - (a) opens or closes three contacts simultaneously with one toggle action
 - (b) opens or closes one single contact with three toggle actions
 - (c) has three switch mechanisms mounted on one plate
 - (d) opens or closes three contacts with a triple action

Section B - Blank spaces in the following statements represent omissions. Write the appropriate information.

1. All circuit diagrams contain _____ that represent components or items of equipment.
2. The most common arrangement for circuit diagrams is _____ representation.
3. Circuit diagrams are commonly drawn as _____
_____ where component parts of an item are drawn remote from each other.
4. When freehand sketching, it is important to maintain the same _____ for all symbols for the same type of device.
5. Switching charts provide a useful means of identifying _____ allocation.
6. Intermediate switching allows on/off control from any of _____ or more switching positions.

Section C – In the space provided, draw the Australian Standard symbols for the following:

a) Lamp - illuminating	
b) SPST switch (open)	
c) SPST switch (closed)	
d) Circuit breaker – single pole	
e) Circuit breaker – double pole	

Building Construction Drawings & Diagrams.

PURPOSE:

In this section you will develop your knowledge of building terms and structures and the materials used in the construction of different building types, and the constructional sequence of building structures

TO ACHIEVE THE PURPOSE OF THIS SECTION:

At the end of this section the student should be able to:

- Describe the building types: timber frame, brick veneer, double brick and metal frame
- Identify and describe the different types of
 - Footings
 - Floors
 - External walls
 - Roofs
 - Interior walls
- List the sequence of each constructional stage for brick, brick veneer and timber cottages
- Identify the stages at which the electrical first and second fixing occurs in the constructional sequence
- List areas of cooperation between electrical and other building trades
- State the purpose of environmental and heritage regulation effecting electrotechnology services and systems

REFERENCES:

- HAMPSON, J. *ELECTRICAL TRADE PRINCIPLES* (2ND EDITION), PEARSON EDUCATION, FRENCHS FOREST NSW.
- HAMPSON, J. *ELECTROTECHNOLOGY PRACTICE*, PEARSON EDUCATION, FRENCHS FOREST NSW.
- AS/NZS 3000:2007 WIRING RULES.

1. INTRODUCTION

Having an understanding of the construction methods, materials and sequence in which a building is constructed, enables electricians to select the correct wiring method(s), cables and accessories to be used, and the timing in which the electrical services can be installed. In addition, it is important to understand the relevant changes in SAA Wiring rules and Building regulations associated with structures of different types.

2. BUILDING CONSTRUCTION METHODS

The factors that can influence house construction methods are:

- climatic conditions
- soil conditions
- local, state and other building regulations
- environmental & heritage awareness
- cost, and
- government services (sewerage pipes)

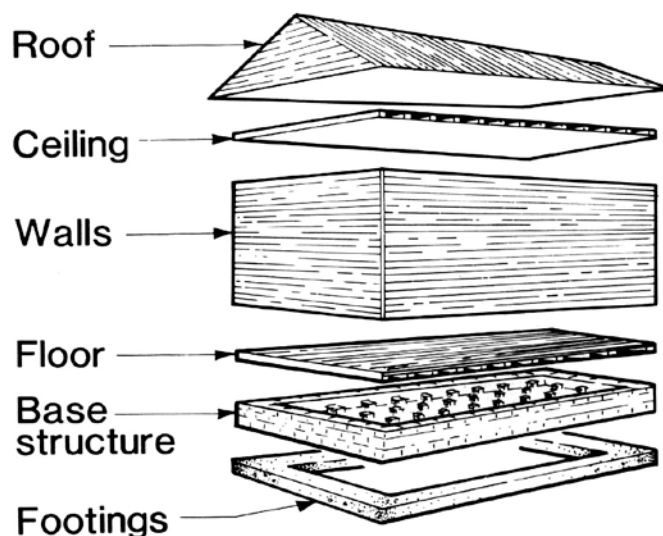
3. BUILDING TYPES

The domestic house construction can be divided into four main types:

- timber framed construction
- veneer construction
- cavity brick construction (or concrete block)
- metal frame

4. BASIC CONSTRUCTION OF A HOUSE

Regardless of the structure, there are six main areas associated with house construction:



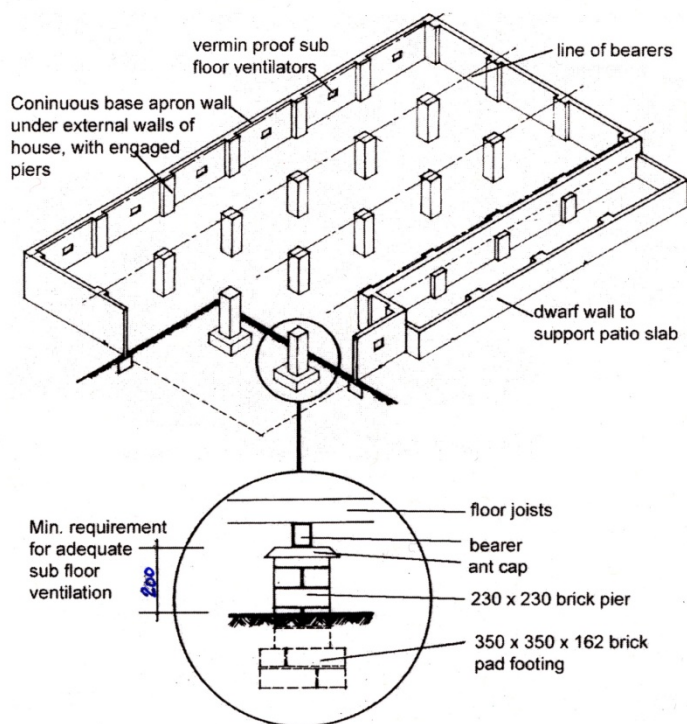
FOUNDATIONS

The foundations are the actual ground on which the building is constructed. Depending on the type of footings and ground it is prepared by levelling, trenching, backfilling etc.

Footings

This is the part of the construction that supports the load of the house in the soil. The three most common types are:

- i. Pad footings – under isolated piers
- ii. Strip footings – usually a continuous reinforced concrete pour around the building as a base for the external walls.
- iii. Concrete slab footings – act as the support for the structure as well as being the floor. Some services need to be installed before the concrete pour.



Base brick wall with engaged and isolated piers for a basic timber framed, brick veneer cottage

Detailed view of an isolated pier

Base or Sub Floor Structure

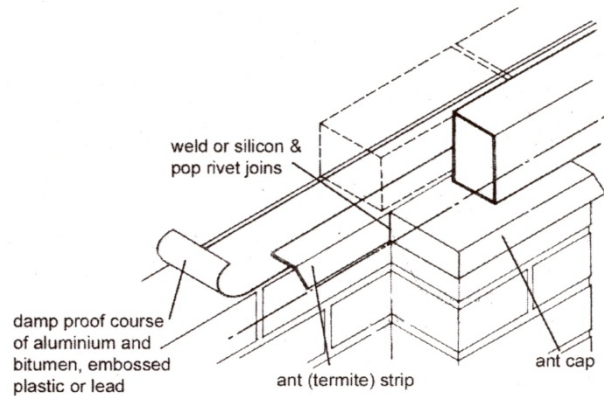
This is the construction between the floor frame and the footings. Three common types are used, sometimes in combination:

- i. Continuous masonry walls
- ii. Brick piers
- iii. Concrete stumps (some states allow timber stumps)

To help prevent dampness and white ants entering the floor structure, a

_____ course and _____ caps are placed between the base and the floor timbers.

Ant capping to piers and ant stripping to the base wall is an essential measure required in all areas, particularly where there is termite activity. The capping must be thoroughly bonded and must be kept intact.



The damp course prevents moisture rising up the wall. ("*rising damp*")

NOTE: Ant caps or strips and damp course should never be cut, damaged or removed to gain cable access.

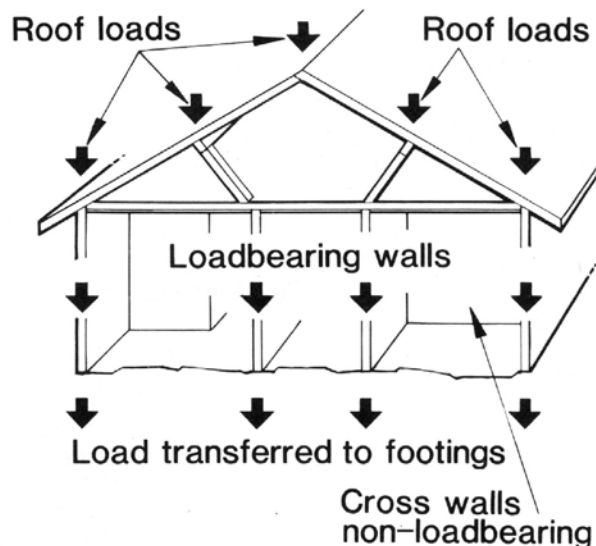
Floors

- i. Timber floor boards or compressed sheets (tongue and groove) are the most common type of flooring. The floor is constructed so that the external and internal piers support bearers. Floor joists are nailed to the bearers and the flooring is nailed to the joists.
- ii. Concrete (Raft) slab – screeded for a smooth surface.

Walls

The two main types of walls are:

- i. Load-bearing walls
 - Load-bearing walls, transfer loads to the foundations. That is they support the weight of the roof etc.
 - External wall framing and some internal walls are load-bearing.
- ii. Non load-bearing walls
 - Non load-bearing walls are usually called partition walls and do not carry any of the roof loads.
 - They divide the space into living areas – i.e. rooms.

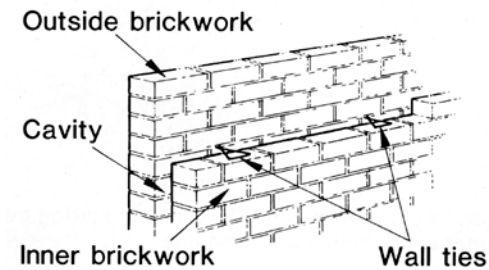


Both types of walls, load or non load-bearing, could be constructed from timber, masonry or steel.

Cavity Brick Wall Construction

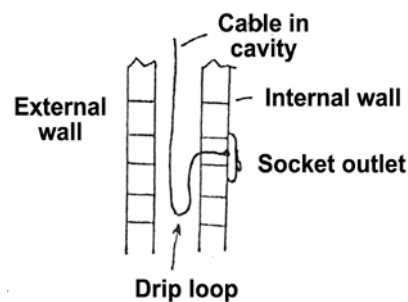
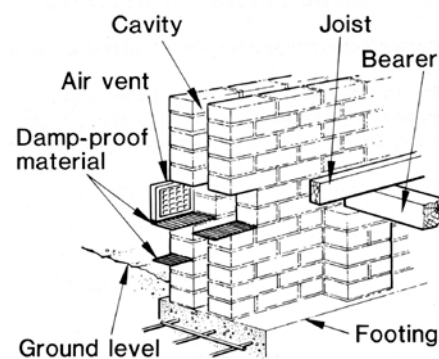
Cavity or double brick construction has two brick walls separated by a cavity of approximately 50 mm and the two walls are held together with wall ties of either steel strip or wire embedded in the _____ joints.

The inner skin of the brickwork is structural i.e. the load-bearing part, while the outer skin provides protection from the weather as well as being designed for visual effect.



The function of the wall cavity is to:

- i Provide a moisture barrier from the outside wall to the inside wall (most masonry is porous)
- ii Provide air circulation to assist in drying out any moisture that has penetrated the external wall
- iii Provide thermal and acoustic insulation



The cavity can be used as a route for electrical wiring, but the electrician should be careful not to provide a moisture path from the external wall to the internal wall with his/her cable. The cable should not touch both walls. When terminating, an excess of cable should be pushed back into the cavity so that a loop of cable is formed which is lower than the point of termination.

This is known as a *drip loop*

Student exercise 1: - Complete the following:

What is the purpose of a 'drip loop'?

List 2 possible consequences of not properly forming a 'drip loop'

Brick Veneer Wall Construction

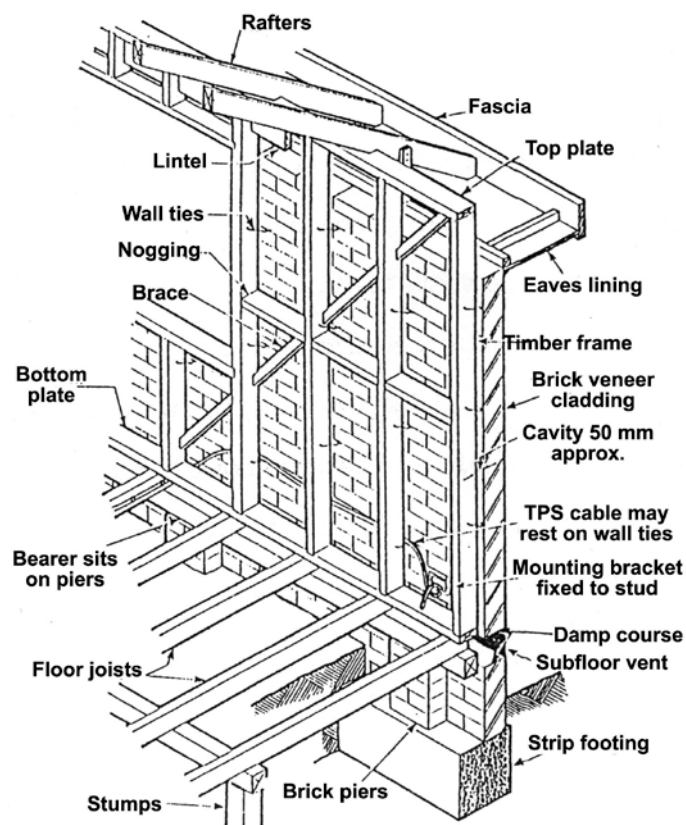
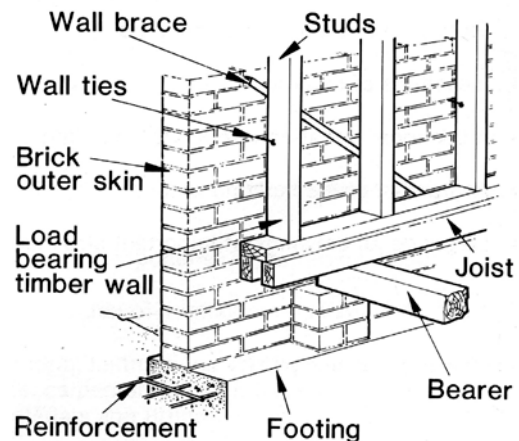
Veneer construction has a non load-bearing outer brick "skin" and a load-bearing timber or steel frame, separated by a cavity.

The cavity between the outer brick skin and the frame is approximately 50 mm and serves two purposes:

- i. To prevent the transfer of moisture from the outer wall to the inner wall
- ii. To allow for movement between the timber frame and the brickwork

The outer brick wall is stabilised by tying it to the inner wall as in double brick construction, with _____ embedded in the mortar.

The cavity can be used as a route for electrical wiring and similar precautions to double brick construction need to be taken.



Brick veneer construction

Timber or Metal Frame Construction

Timber frame construction employs a single timber frame, which forms the internal and external walls.

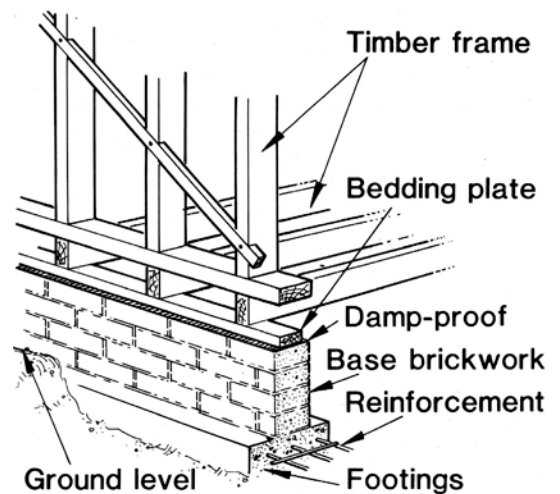
That is there is no cavity.

The internal wall is clad with normal internal cladding (Gyprock etc)

The outside of the frame must be covered with one of various types of waterproof cladding.

Some types of cladding include:

- ❑ Weatherboards (timber)
- ❑ Brick tile sheets
- ❑ Treated metal (aluminium or steel)
- ❑ Fibre cement (sheets or planks)
- ❑ Plywood
- ❑ Hardboard
- ❑ PVC (sheeting or planks)

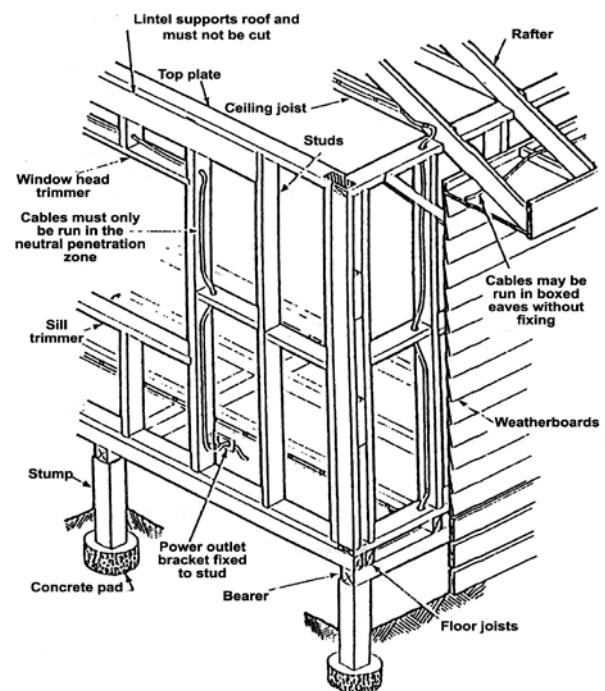


Electrical cabling is run through the timber frame by means of drilled holes.

The holes should be drilled to the _____ possible dimension to avoid weakening the timber structure.

The cable hole must be drilled in the centre of the studs to avoid cable damage from fixing devices, nails and screws etc.

Metal frame walls have integral holes in them which allow the passage of cable. The holes must be fitted with a flexible grommet to protect the cable from damage.



Student exercise 2:

Refer to AS/NZS 3000:2007 *Clause 3.9.4*, and answer the following:

- (a) TPS cable requires further mechanical protection if installed within _____ mm of an external or internal surface.
- (b) List 1 protection method (including the clause number) that could be used if a cable were to be installed in a location deemed to 'require additional protection'.

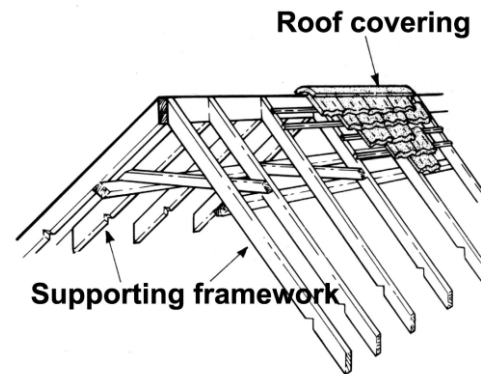
_____ Clause: _____

Roof

The roof may vary from steeply sloping to almost flat. It will consist of:

- i. Roof covering – Tiles or sheet metal material
- ii. Supporting timber framework

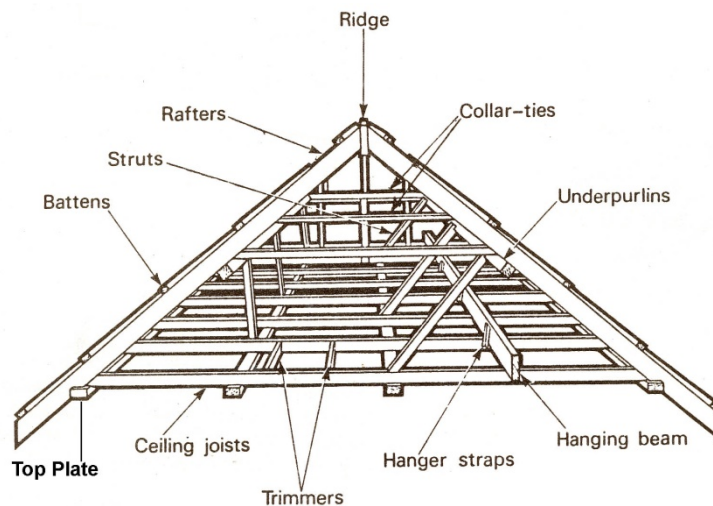
The type of roof structure determines the ease of access for wiring etc.



Conventional roof frame

A conventional roof frame is made up of rafters, battens, under purlins, struts, ridge(s) and collar ties to support the roof cladding.

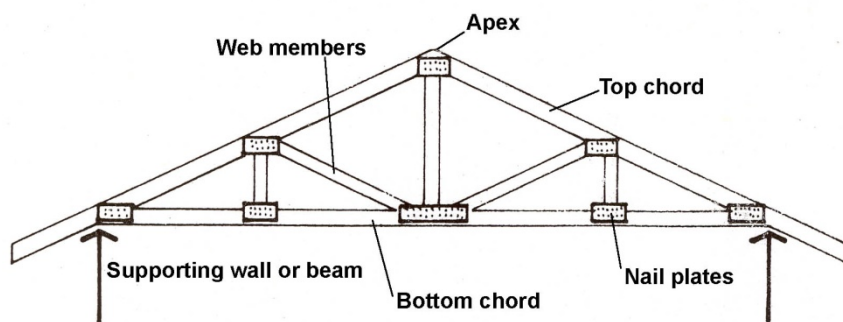
The ceiling is supported by ceiling joists, trimmers and hanging beams.



Trussed roofs

This is a pre-fabricated form of roofing frame.

A trussed roof is a structural load bearing frame comprising a number of equally spaced trusses which span across the building and are supported on the outside _____ walls. When fixed in position the trusses are designed to support the roof and ceiling loads.

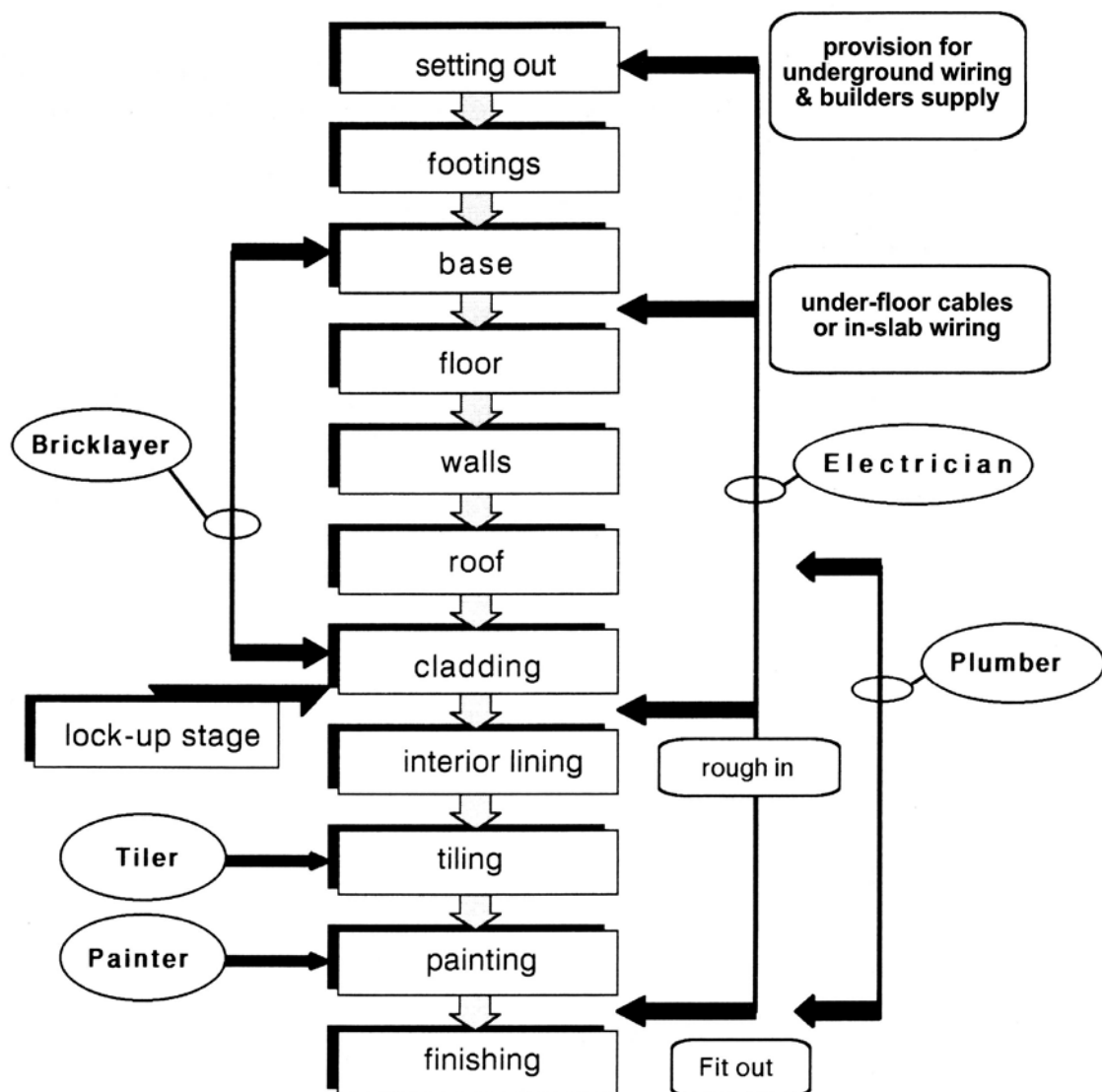


Inter-trade Relationships in the Building Sequence

The electrician must be familiar with the construction sequence and the structural details so that the wiring can be hidden as much as possible.

Also, an appreciation of the role and timing of other tradespersons on the job can improve communication and co-operation. This is important to be able to determine when it is appropriate to install _____, fit _____ and _____.

The following diagram shows the sequence of construction for a domestic residence and the points in the sequence where an electrician may need to become involved. The diagram also shows which trades are involved in the various areas of construction, and so gives an indication of how the builder must arrange the work schedule so that the various trades interact smoothly.



Building/Construction Terminology

Beam – A horizontal load-bearing structural member.

Bearer – A sub floor timber supporting the floor joists.

Brick veneer construction – In housing, a system in which a structural timber frame is tied to a single brick external wall.

Ceiling – The overhead internal lining of a room.

Concrete, reinforced – Concrete reinforced or strengthened by the inclusion of steel mesh, bars and rods.

Cladding – The outer covering of the external walls of a framed building.

Dampcourse – A waterproof membrane laid between courses of brickwork or masonry.

Eaves – The lower part of the roof that overhangs the wall.

Footing – The construction whereby the weight of the structure is transferred from the base structure to the foundation.

Gable – The triangular end of a house formed at the end of a pitched roof, from the eaves line to the apex.

Hip roof – A roof which is roughly pyramidal in shape with surfaces sloping upwards from all the eaves.

Joists, ceiling – Timber members spanning between walls or other supports, to which the ceiling is attached.

Joists, floor – Timber members to which the flooring is fixed.

Lintel – A horizontal load-bearing member spanning an opening.

Nogging – A horizontal piece of timber providing a stiffener between studs in wall frames.

Pier caps (Ant caps) – A membrane (usually galvanised steel) to prevent dampness and deter insect attack of sub-floor timber.

Purlins – Longitudinal roof timber giving intermediate support for rafters.

Rafter – In roof construction, a timber framing member providing the principle support for the roofing material.

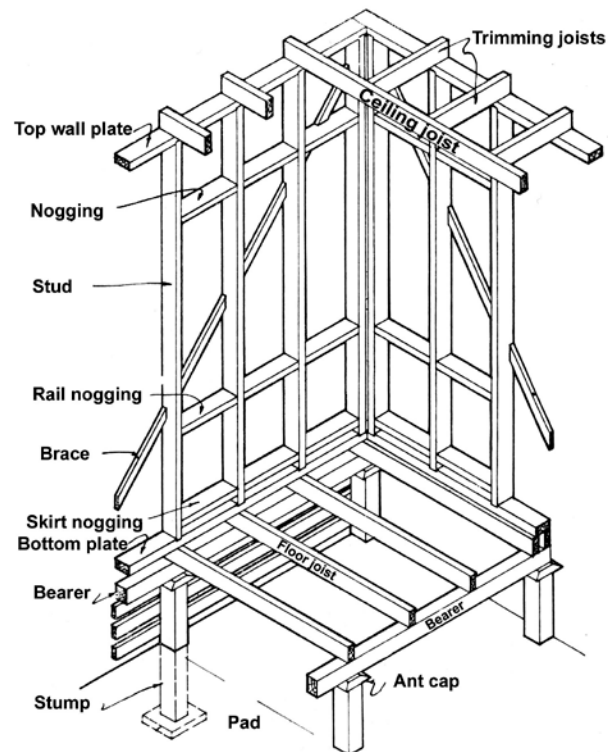
Sarking – A covering of waterproof building paper or boarding fixed on the top of the rafters beneath the external roof covering.

Skillion or lean-to roof – A roof sloping in one direction only with the rafters pitching or leaning against a wall.

Stud – A vertical timber forming part of a load-bearing external wall frame or of an internal wall partition.

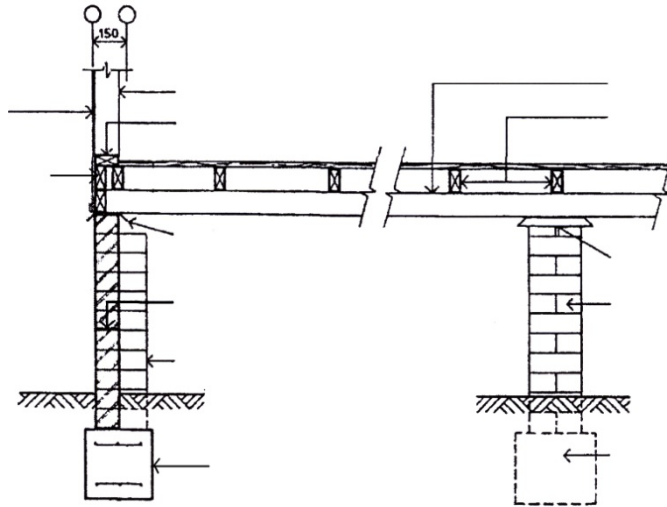
Truss – A structural load-bearing frame. E.g. roof truss.

Wall brace – Provides lateral support for the wall frame.



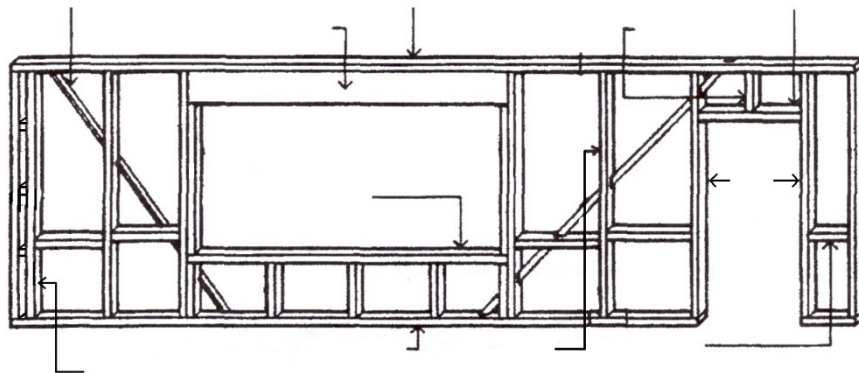
Student exercise 3:

Name the parts indicated by the arrows on the diagram



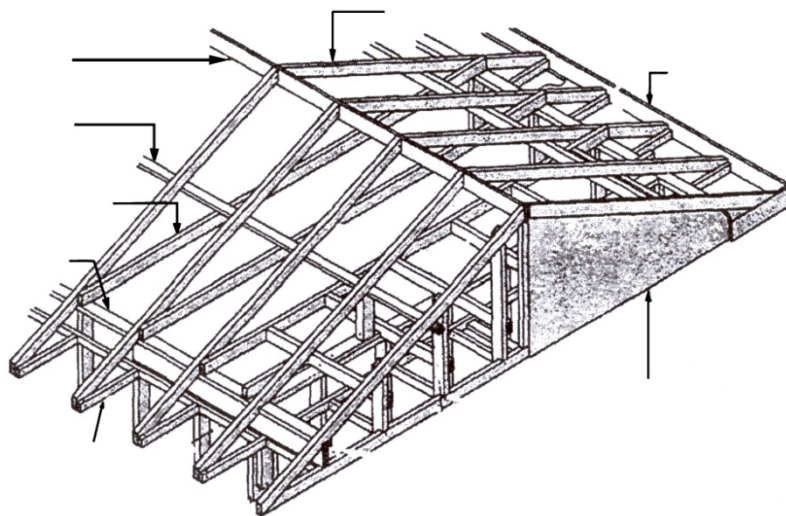
Student exercise 4:

Name the parts indicated by the arrows on the diagram



Student exercise 5:

Name the parts indicated by the arrows on the diagram



***** Notes *****

Building Construction

PURPOSE:

In this topic you will develop your skills in the preparation and termination of various cables that are required to be installed into a building structure.

TO ACHIEVE THE PURPOSE OF THIS SECTION:

At the end of this practical assignment the student will be able to:

- Strip and prepare various size single core solid and stranded cables
- Strip and prepare various size multi-core solid and stranded cables
- Strip, prepare and join various size single core solid and stranded cables
- Strip, prepare and join various size multi-core solid and stranded cables
- Connect various electrical accessories to prepares cables

EQUIPMENT:


The equipment needed for this exercise will be determined by you as part of the exercise. Refer to the job specifications.

REFERENCES:

- HAMPSON, J. *ELECTRICAL TRADE PRINCIPLES (2ND EDITION)*, PEARSON EDUCATION, FRENCHS FOREST NSW.
- HAMPSON, J. *ELECTROTECHNOLOGY PRACTICE*, PEARSON EDUCATION, FRENCHS FOREST NSW.
- AS/NZS 3000:2007 WIRING RULES.

NOTE:

This practical segment is to be completed by students on an individual basis.

<u>UEENEEE107A</u> WPS - Practical Section		
1		
2		
3		

1. JOB SPECIFICATION – Stripping and preparing cable ends.

1. TERMINATING SINGLE DOUBLE INSULATED CABLE

Cut 300 mm of each conductor

Strip the end of the cable and fold the conductor over



1 sq mm

2.5 sq mm

4 sq mm

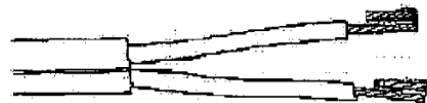
6 sq mm Have the cables checked by the Teacher

Checked	
---------	--

2. TERMINATING TWIN DOUBLE INSULATED CABLE

Cut 300 mm of each conductor

Strip the end of the cable and fold the conductor over



1 sq mm

2.5 sq mm

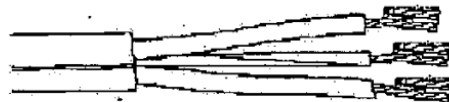
4 sq mm Have the cables checked by the Teacher

Checked	
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3. TERMINATING TWIN AND EARTH DOUBLE INSULATED CABLE

Cut 300 mm of each conductor

Strip the end of the cable and fold the conductor over



1 sq mm

2.5 sq mm Have the cables checked by the Teacher

Checked	
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4. JOIN SINGLE DOUBLE INSULATED CABLE

Cut 300 mm of each conductor

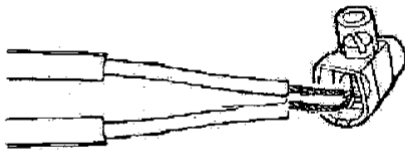
Strip the each end of the cable and join in a single connector

1 sq mm

2.5 sq mm

Have the cables checked by the Teacher

Checked	
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5. JOIN TWIN DOUBLE INSULATED CABLE

Cut 300 mm of each conductor

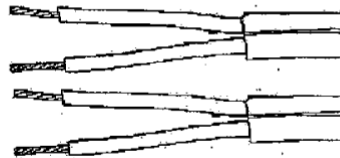
Strip the each end of the cable and join in a single connector

1 sq mm

2.5 sq mm

Have your Teacher check your exercise

Checked	
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6. JOIN TWIN AND EARTH DOUBLE INSULATED

Cut 300 mm of each conductor

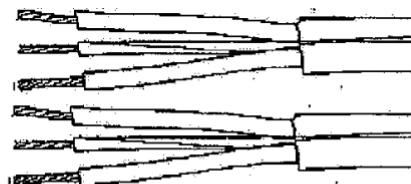
Strip the each end of the cable and join in a single connector

1 sq mm

2.5 sq mm

Have your Teacher check your exercise

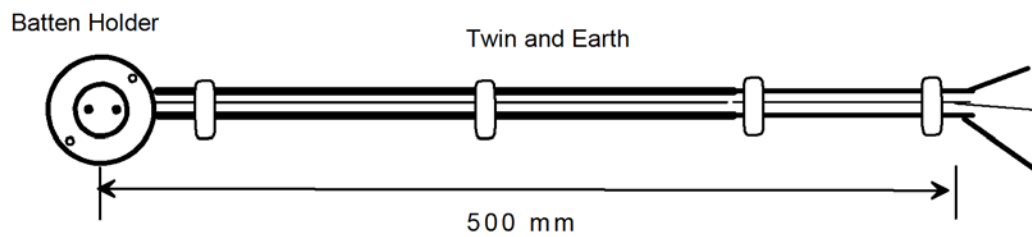
Checked	
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2. JOB SPECIFICATION – installing accessories onto prepared cable ends.

1. 1.5 SQ MM TWIN AND EARTH CABLE

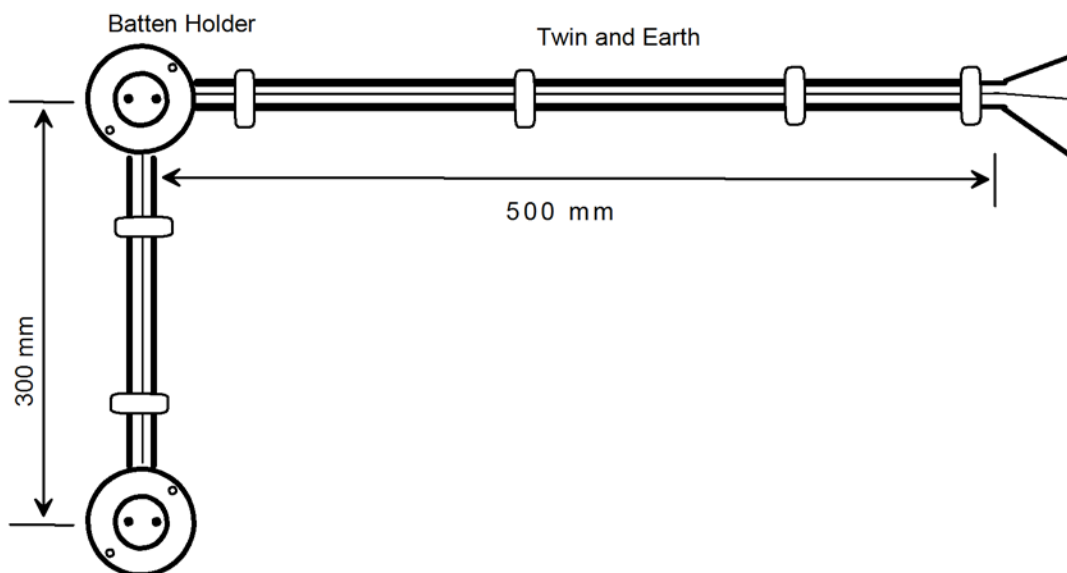
1. Cut cable to size and pin clip or cable clip the cables to the board
2. Fix junction box to the board and connect the junction box
3. Connect the lighting point
4. Strip the end of the supply cable – 75mm single insulated, 15mm exposed, twisted copper.



Have your teacher check your work

<i>Checked</i>	
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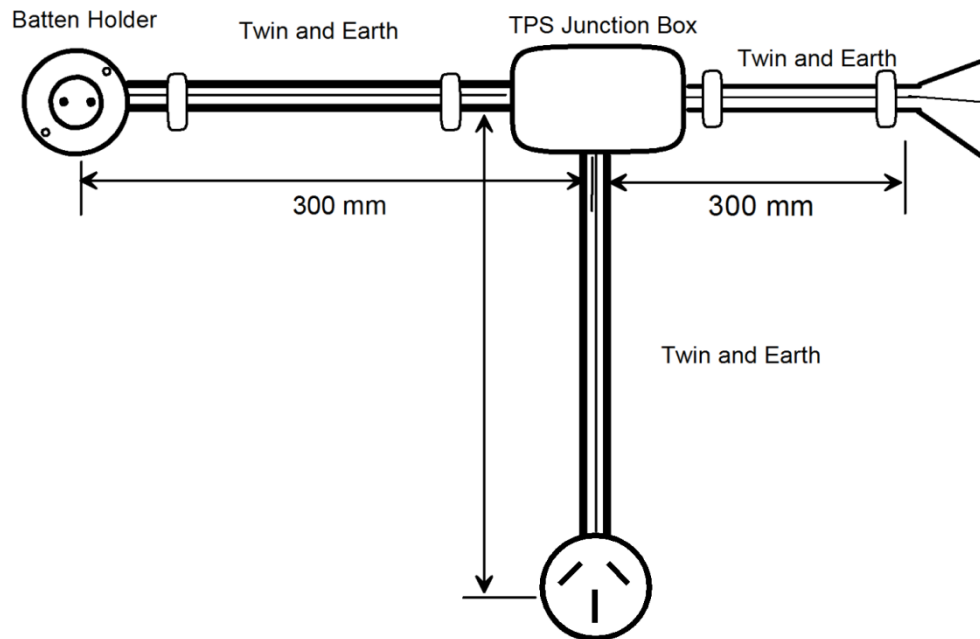
5. Add another light point to the existing point.



Have your teacher check your work

<i>Checked</i>	
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6. Re-arrange the circuit and add a junction box and 3 pin socket base.



Have your teacher check your work

<i>Checked</i>	
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Building Construction.

These questions will help you revise what you have learnt in Section. In the following statements, circle the letter that best answers the question.

1) Name the six main parts of a structure.

- a) _____ b) _____ c) _____
b) _____ e) _____ f) _____

2) State two reasons why a concrete slab footing is sometimes used in preference to piers.

- a) _____
b) _____

3) Define the following terms used in timber floor construction:

a) Floor joists:

b) Bearers:

c) Pier:

d) Floorboard:

4) Define the following terms used in framed wall construction:

a) Studs:

b) Top plate:

c) Bottom plate:

d) Noggings:

e) Braces:

5) Define the following terms used in brick wall construction:

a) Single brick wall:

b) Course:

c) Feature wall:

d) Rendered wall:

6) What is the average width of the cavity between the brick wall and the framed wall in brick veneer construction?

7) What purpose does the cavity serve in a double brick wall?

8) Name three common types of roof covering.

a) _____ b) _____ c) _____

9) In what circumstances are trussed roofs used?

10) List four materials used to clad the external walls of a house built using timber frame construction.

a) _____ b) _____

c) _____ d) _____

11) In relation to the installation of wiring, describe the meaning of the following terms:

c) First fixing or rough in:

d) Second fixing or fit out:

12) When installing wiring in the cavity of a cavity wall, explain why it is important that the cables don't touch both the internal and external walls.

13) The following is a list of constructional stages of a timber framed cottage. Write these in the correct sequence.

Base
floor
footings
setting out

cladding
roof
interior lining
tiling

finishing
walls
painting

a) _____ b) _____ c) _____

d) _____ e) _____ f) _____

g) _____ h) _____ i) _____

j) _____ k) _____