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Electrical and Electronic Engineering
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TASK 1

A new sheltered accommodation extension block is to be constructed consisting of a communal dining room, kitchen and utility rooms, 6x 1 bedroom accommodation and 1 x2 bedroom accommodation over two storeys. Within the complex there are numerous cookers, a lift, washing machine and tumble dryer as indicated in the following diagrams. Your task is to produce an electrical design for the extension block.

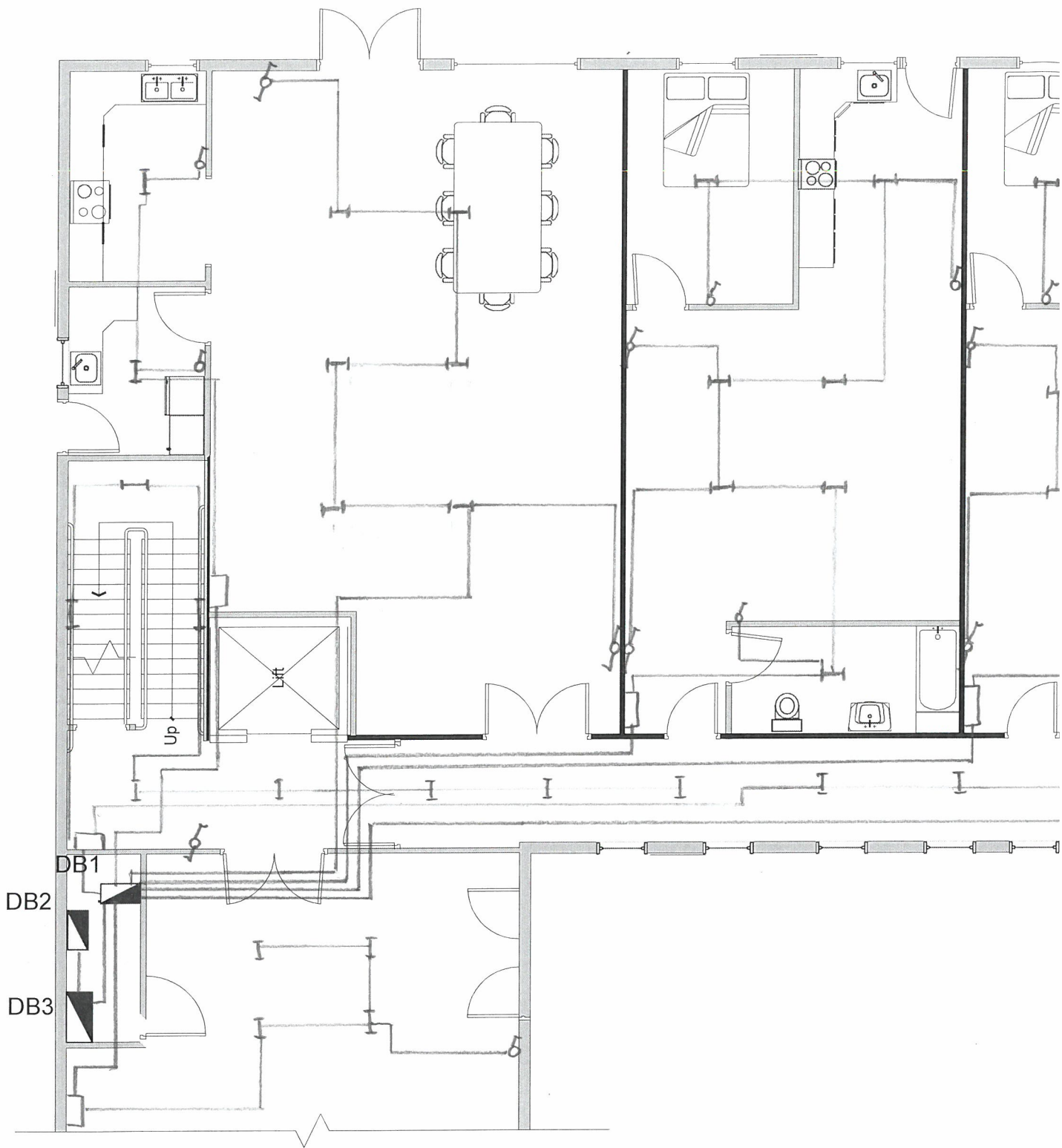
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- 1) Appropriate lighting systems for all areas including wiring diagrams.
- 2) Appropriate power distribution design including wiring diagrams.
- 3) Cable size calculations.
- 4) Circuit Protection Designs
- 5) Emergency lighting design
- 6) An outline of suitable cable support systems used throughout the installation
- 7) Lift Motor

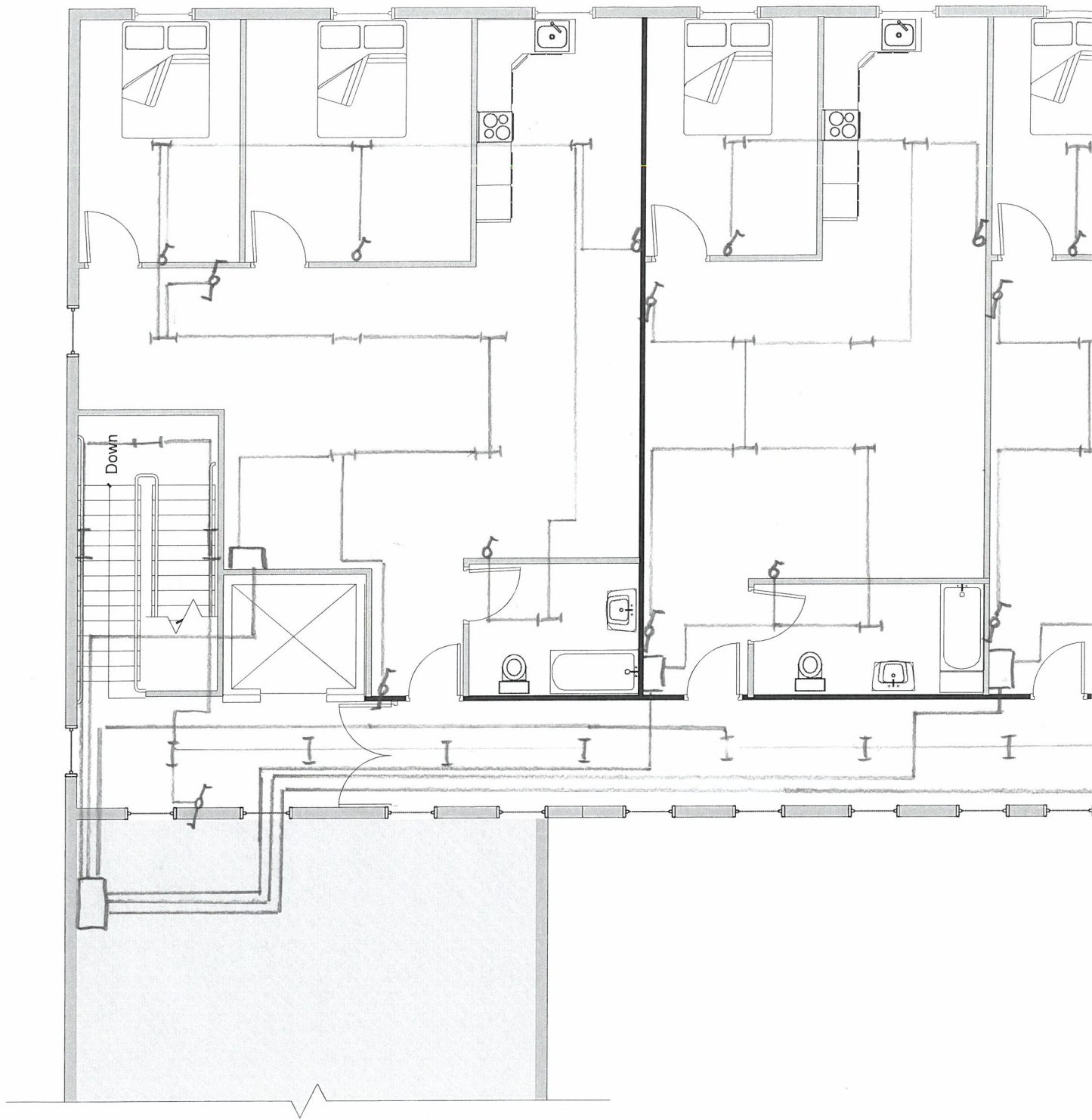
Assumptions

I have assumed that the lighting in the lift is already been wired, therefore I have not included this in my wiring diagram.

I have also assumed that the ambient temperature of the rooms is no more than 24°C. The ambient temperature for the communal room will reach a maximum of 28°C whilst the ambient temperature of the kitchen could reach a maximum temperature of 30°C.



Sheltered accommodation Ground Floor
Scale 1:125



Sheltered accommodation First Floor
Scale 1:125

Lighting Systems

Lighting circuits are usually radial circuits because they begin at the consumer unit and terminate at the final light. I have chosen for my lights to be radial because it is illegal in the UK for the lights to be on a ring circuit, this is because ?

I have chosen for DB1 to be the consumer unit for my circuits downstairs, DB2 to be the consumer unit for my circuits upstairs and for DB3 to be the consumer unit for DB1 and DB2. I have also decided to put a junction box in each room however I have not put one in the communal living area because I have gone straight from the consumer unit for this. I have also shared a junction box between the stairs and the hallway. The reason I have decided to share a junction box for these two is because it reduces the cost and I do not think it is necessary to have one for each separate room because they are very close together which means if one trips the junction box is still not too far away. Another reason for doing this is because these are the only two areas in the building where the lighting will be motion sensed.

I have decided for the lights on the stairs and the hallway to be motion sensed because this is also a very good way to reduce cost and help reduce negative impacts on the environment. The way that this reduces costs for running the residential home is because if there is nobody in these areas the lights will not be on, and no electricity will be used, however if there is a need for these lights to be on then they will come on automatically when motion is detected. They also reduce the cost during the installation process as they are very easy to install. This way this helps reduce the negative effects on the environment is because this way there will be less power used.

There are different types of motion sensed lighting including passive infrared sensors, ultrasonic sensors and microwave sensors which all have their benefits and drawbacks. The advantage of using a microwave sensor is they are very good at detecting motion with high sensitivity however they consume a lot of energy which means they will be more expensive to run, for this reason, most microwave sensors come with an on/off cycle. With ultrasonic sensors, they can be passive or active, these work by emitting sound wave pulses and will detect movement based on how they reach different surfaces. The disadvantage of using ultrasonic sensors is that they can be heard by pets such as dogs which can be disturbing for them. I have chosen to use passive infrared sensors, which are small electronic eyes that detect infrared waves, when people move they radiate heat waves which are infrared waves, if these waves are detected by the sensor it will cause the light to switch on. The reason I have decided to install these sensors is because they last for a very long time and consume very little energy therefore they will not need to be replaced often and will keep costs low.

Following my research into different types of bulbs, I have found out that many manufacturers are disbanding the classic 100W bulb and instead opting for a more efficient energy saving bulb which is a lower wattage. However these energy saving bulbs have many disadvantages as well as advantages to consider.

The main advantage to consider when thinking about this bulb is that it reduces the amount of energy used. Wattages can vary between manufacturers however typically, a standard 100W bulb would be 70W as a halogen bulb and only about 25W as an LED. Another advantage to using the energy saving bulb is that they have an increased lifespan. This is another way they can help consumers save money because they will most likely need replacing less frequently. The lifespan of a bulb will always depend on the usage and the environment of the bulb however an LED bulb can be expected to outlast a normal 100W bulb by up to 50x.

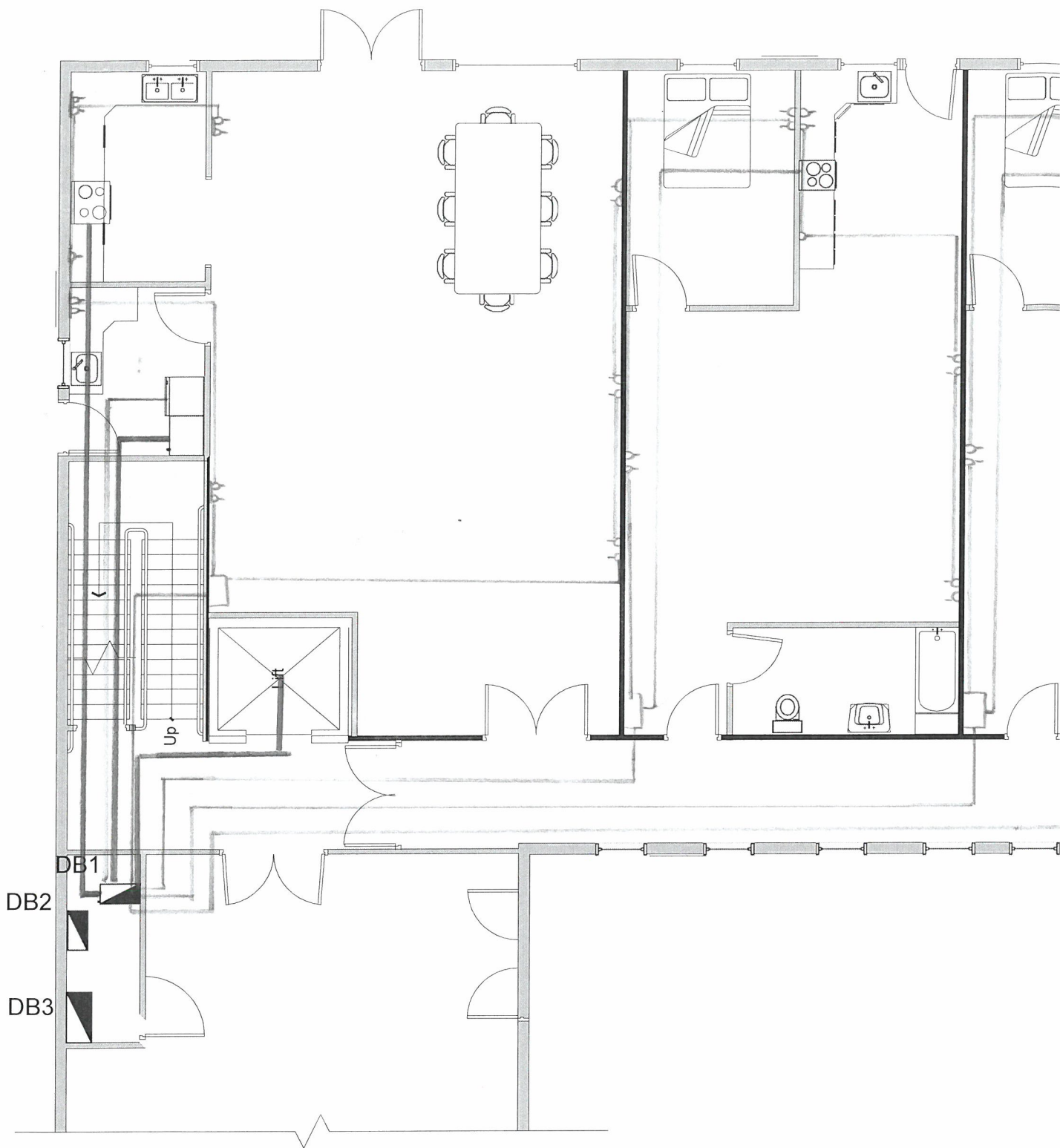
The disadvantages of using these is that they have a very high initial cost which makes the installation process more expensive. Replacing standard 100W bulbs with the energy efficient bulbs

could cost between £2- £15 each depending on manufacturer.

Another major disadvantage is that there are safety concerns with the energy efficient bulbs. The reason they present safety concerns is that they contain a small amount of mercury which is poisonous and could potentially be harmful if the bulb were to break. Once one of these bulbs reaches the end of its lifespan it automatically self destructs. This is as a safety precaution and is caused by the electronics of the bulb. Some poorly designed bulbs have been known to cause fires once their lifespan has come to an end.

After weighing up the advantages and disadvantages of the energy saving bulbs I have decided for each of my lights to be 100W incandescent bulbs, I believe that this is the best option because they are cheaper to install and are typically a lot safer especially in the event of an accident where a bulb may break.

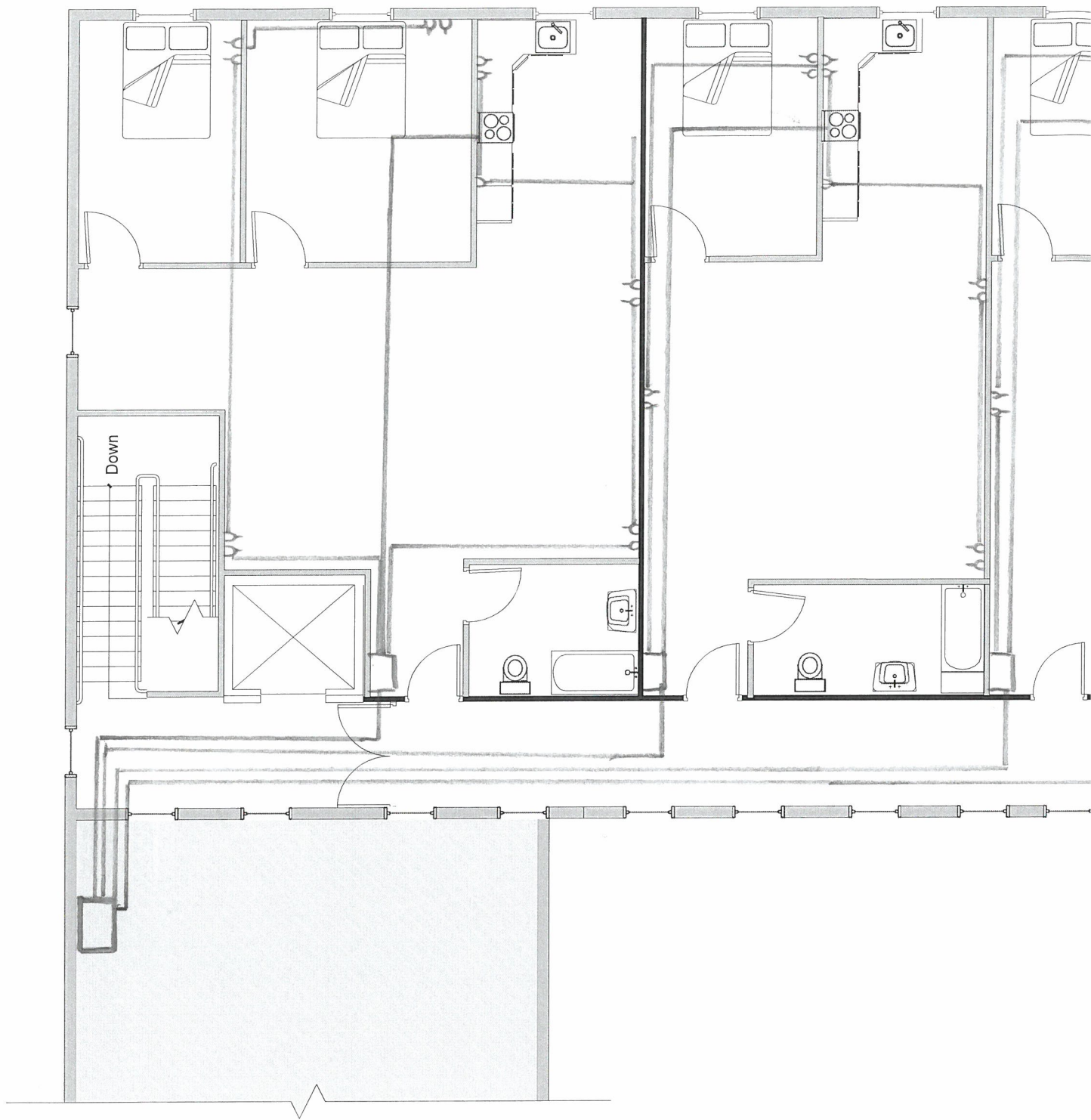
I have also placed switches with the lights in places I think will be appropriate, I have decided where would be the most beneficial for residents living in the building and tried to cater to their needs. I have placed light switches close to the doors so that users can switch the lights on as soon as they walk in to avoid any safety concerns over walking to the switch in the dark. I have also placed a light switch in each bedroom and each kitchen so not all of the lights have to be on at the same time. This will save energy and will be beneficial for the environment. In the residents living area I have installed two way single pole switches so that they can be operated at two different locations, I have placed one outside the bedroom so the light can be turned on or off when entering or leaving the bedroom and one at the main entrance door. I have also placed the switches for the bathroom outside the bathroom because if I installed them in the bathroom then they would have to be pull chord switches, I have decided to keep all my switches the same and just keep the switch outside. This is to follow regulations because it is a potential safety hazard to have an electric switch in the bathroom where there is lots of condensation and water. In the utility room I have also fitted a normal switch for the light in there, in the communal living area I have installed two way switches single pole at both entrances to the room so the lights can be operated from whichever entrance is used.



| = 3 Phase

| = 1 Phase

Sheltered accommodation Ground Floor
Scale 1:125



Sheltered accommodation First Floor
Scale 1:125

Power Distribution

I have decided to wire my sockets using a radial circuit as I think that this would be the most appropriate. I have made this decision after analysing the advantages and disadvantages of multiple circuit types, particularly ring and radial.

A ring circuit is a ring of cables carrying electricity around your home, the reason it is called a ring circuit is because it forms a 'ring' as the cables return back to the consumer unit. The way the ring circuit works is because the current can flow in both directions, this is possible because both ends of the ring are connected to the same terminals in the consumer unit. The benefit of this is that it means there is less of a load on the cables. The reason it is beneficial to supply power from both ends is because if we put too much load on a cable that is not designed for the amount it is potentially very dangerous, also power is lost over long lengths of cable, so by using a ring circuit the length from the source is reduced. In buildings each floor usually has a separate ring main so that things don't get complicated, however sometimes we need to put sockets upstairs to feed lights or sockets downstairs.

A radial circuit is a circuit where the power is transmitted from point to point and starts at the junction box and terminates at the last device which is connected to the series of devices. With this type of circuitry there is never a loop wiring structure and there may be need for more junction boxes connecting individual or multiple sockets.

The advantage of using radial circuits is that it makes fault finding extremely easy because each device is powered by the previous device therefore all that is needed to do is identify which device has stopped working and the fault should lie between this device and the previous and if none of the devices are working the fault is almost guaranteed to lie in the consumer unit.

Another advantage of using radial circuits is that if the circuit is within an area of 50 square metres and has its own MCB of the correct rating you can have as many sockets or lights as you want. This is good for this particular project because it is within the limited area and I will fit an appropriate MCB in the circuit.

I have positioned my sockets where I think will be appropriate and installed a suitable number of sockets in each room. In the communal living area I have installed seven double sockets because there may be need for them in certain situations as this room may become very busy at certain times of the day causing a higher demand for sockets. This amount of sockets will be enough so that each person can use one at any given time which means there should never be a shortage. This may be for electric chairs or charger cables or extractors and fans. In the communal kitchen I will have four double sockets which I think is necessary because in the kitchen there is a lot of electrical appliances that will need to be powered at one time including the dishwasher, the oven, the kettle, the microwave, the toaster, and the fridge. I will have the same number and positioning of sockets in each personal room as they are all the same standard size and will all be used nearly identically depending on the resident. I will have two double sockets in each bedroom, four double sockets in each personal kitchen area and three double sockets in each personal living room. Electrical sockets are potentially a safety hazard in bathrooms as there is typically a lot of water in bathrooms, this is dangerous because water has a lot of impurities and these impurities can conduct electricity potentially leading to injury or death. However electrical sockets are allowed in bathrooms they must be greater than 3m away from the edge of a bath, there are also specially designed units which allow this distance to be reduced however it cannot be reduced to closer than 600mm away from the bath. The bathroom is 3.625 m long which means I will be able to safely install a socket in the bathroom as I can install it without infringing any laws however I do not feel that this is necessary to have sockets in the bathroom in this residential building because it creates an unnecessary safety hazard.

Cable Calculations

Three phase power

$$\text{Design current, } I_b = \frac{W}{V} = \frac{7000}{\sqrt{3} \times 400} = 10.1 \text{ A}$$

Size of BS EN 60898 Fuse required = 32 amps (I_n)

$$\text{Tabulated current, } I_t \geq \frac{I_n}{\text{correction factors}}$$

From table 4C1, (1 circuit, method 3)

$$C_g = 1.0$$

From table 4B1, (1 circuit, method 1)

$$C_a = 1.0$$

$$\begin{aligned} I_t &\geq \frac{I_n}{C_a \times C_g} \\ &\geq \frac{32}{1 \times 1} \\ &\geq 32 \text{ A} \end{aligned}$$

I have reached my value for mV/A/m by using the table 4D2B in the on site guide. I have decided to use 4mm conductor cross sectional area and by following the table I have got 9.5 because this is the value for two-core cable three phase.

From table 4D2B

$$\begin{aligned} \text{volts drop} &= \frac{\text{mV/A/m} \times I_b \times L}{1000} \\ &= \frac{9.5 \times 10.1 \times 15}{1000} \\ &= 1.44 \text{ V (satisfactory)} \end{aligned}$$

230V

4.161V is satisfactory because for the voltage drop to be satisfactory it must be less than 5% of the total supply voltage. In this case the supply voltage is 240V, this means that the voltage drop must be less than 12V. 4.161V is clearly less than 12 and it is significantly less which means there should not be a problem with the voltage drop in this cable.

11.5V

Single Phase Power - Communal room

Design Current, $I_b = 32A$

Size of MCB required = 13 A for each socket (I_n)

Tabulated Current, $I_t \geq \frac{I_n}{\text{correction factors}}$

From table 4C1, Ambient temperature = 30°

(4 circuits, method 3)

$$C_g = 0.77$$

From table 4B1, (4 circuits, method 1)

$$C_a = 1$$

$$I_t \geq \frac{I_n}{1 \times 0.77}$$

$$\geq 16.9A$$

From table 4D2A (method A single phase) select 2.5mm^2 cable which takes 18.5 A

Check volts drop

$$\text{volts drop} = \frac{\text{mV/A.m} \times I_b \times L}{1000}$$

$$= \frac{18 \times 32 \times 17.5}{1000}$$

$$= 10.08V \quad (\text{satisfactory})$$

Lighting - Communal Room

$$\text{Design current, } I_b = \frac{W}{V} = \frac{600}{240} = 2.5 \text{ amps}$$

Size of BSEN 60898 Fuse required = 5 amps (I_n)

$$\text{tabulated current, } I_t \geq \frac{I_n}{\text{correction factors}}$$

From table 4C1, (2 circuits, method 3)

$$C_g = 0.88$$

From table 4B1, (2 circuits, method 1)

$$C_a = 1.0$$

$$\begin{aligned} I_t &\geq \frac{I_n}{C_a \times C_g} \\ &\geq \frac{5}{1 \times 0.88} \\ &\geq 5.7 \text{ A} \end{aligned}$$

From table 4D2B (using 2.5 mm^2)

$$\begin{aligned} \text{volts drop} &= \frac{\text{mv/A.m} \times I_b \times L}{1000} \\ &= \frac{18 \times 2.5 \times 30.625}{1000} \\ &= 1.38 \text{ V (satisfactory)} \end{aligned}$$

Lighting - Bedrooms

$$\text{Design Current, } I_b = \frac{W}{V} = \frac{700}{240} = 2.92 \text{ A}$$

size of BSEN 60898 Fuse required = 5 A (I_n)

$$\text{Tabulated current, } I_t \geq \frac{I_n}{\text{correction factors}}$$

From table 4C1, (2 circuit, method 3)

$$C_g = 0.88$$

table 4B1, (2 circuits, method 1)

$$C_a = 1.0$$

$$\begin{aligned} I_t &\geq \frac{I_n}{C_a \times C_g} \\ &\geq \frac{5}{0.88 \times 1} \\ &\geq 5.7 \text{ A} \end{aligned}$$

402B (using 2.5 mm^2)

$$\text{volts drop} = \frac{\text{mV/A.m} \times I_b \times L}{1000}$$

$$= \frac{18 \times 2.5 \times 25}{1000}$$

$$= 1.125 \text{ V (satisfactory)}$$

Lighting - Stairs and Hallway

$$\text{Design Current, } I_b = \frac{W}{V} = \frac{800}{240} = 3.3 \text{ A}$$

size of BSEN 60898 fuse required = 5 A (I_n)

$$\text{Tabulated Current, } I_t \geq \frac{I_n}{\text{correction factors}}$$

From table 4C1, (1 circuit, method 1)

$$C_g = 1.0$$

table 4B1, (1 circuit, method 3) Amb. temp = 30°

$$C_a = 1.0$$

$$I_t \geq \frac{I_n}{C_a \times C_g}$$

$$\geq \frac{5}{1 \times 1}$$

$$\geq 5 \text{ A}$$

402B (using 2.5mm²)

$$\text{volts drop} = \frac{mV/Am \times I_b \times L}{1000}$$

$$= \frac{18 \times 3.3 \times 28.75}{1000}$$

$$= 1.7 \text{ V (satisfactory)}$$

Lights - Hallway

$$\text{Design Current, } I_b = \frac{W}{V} = \frac{600}{240} = 2.5 A$$

Size of BSEN 60898 fuse required = 5 A

$$\text{Tabulated Current, } I_t \geq \frac{I_n}{\text{correction factors}}$$

From table 4C1, (1 circuit, method 3)

$$C_g = 1.0$$

table 4B1, (1 circuit, method 1) Amb. temp. 30°

$$C_a = 1.0$$

$$I_t \geq \frac{I_n}{C_a \times C_g}$$

$$\geq \frac{5}{1 \times 1}$$

$$\geq 5 A$$

4D2B (using 2.5 mm²)

$$\text{volts drop} = \frac{\text{mV/A} \times I_b \times L}{1000}$$

$$= \frac{18 \times 2.5 \times 33.75}{1000}$$

$$= 1.52 V \quad (\text{satisfactory})$$

Lights - Utility room and Communal Kitchen

$$\text{Design Current, } I_b = \frac{W}{V} = \frac{200}{240} = 0.8 \text{ A}$$

Size of BSEN 60898 fuse required = 5 A (I_n)

$$\text{Tabulated current, } I_t \geq \frac{I_n}{\text{Correction factors}}$$

From table 4C1, (2 circuits, method 3)

$$C_g = 0.88$$

table 4B1, (2 circuits, method 1)

$$C_a = 1.0$$

$$I_t \geq \frac{I_n}{C_a \times C_g}$$

$$\geq \frac{5}{0.88 \times 1}$$

$$\geq 5.7 \text{ A}$$

4D2B (using 2.5 mm^2)

$$\text{volts drop} = \frac{\text{mV/A.m} \times I_b \times L}{1000}$$

$$= \frac{18 \times 0.8 \times 10}{1000}$$

$$= 0.144 \text{ V (satisfactory)}$$

Lights - Reception

$$\text{Design Current, } I_b = \frac{W}{V} = \frac{400}{240} = 1.6 \text{ A}$$

size of BSEN 60898 fuse required = 5 A (I_n)

$$\text{Tabulated current, } I_t \geq \frac{I_n}{\text{Correction factors}}$$

From table 4C1, (1 circuit, method 3)

$$C_g = 1.0$$

table 4B1, (1 circuit, method 1)

$$C_a = 1.0$$

$$I_t \geq \frac{I_n}{C_a \times C_g}$$

$$\geq \frac{5}{1 \times 1}$$

$$\geq 5 \text{ A}$$

4D2B (using 2.5 mm^2)

$$\text{volts drop} = \frac{\text{mV/A.m} \times I_b \times L}{1000}$$

$$= \frac{18 \times 1.6 \times 11.25}{1000}$$

$$= 0.324 \text{ V (satisfactory)}$$

Single Phase Power

Design Current, $I_b = 32A$

Size of MCB required = 13 A for each socket (I_n)

Tabulated Current, $I_t \geq \frac{I_n}{\text{correction factors}}$

From table 4C1, Ambient temperature = 30°
(4 circuits, method 3)

$$C_g = 0.77$$

From table 4B1, (4 circuits, method 1)

$$C_a = 1$$

$$I_t \geq \frac{I_n}{1 \times 0.77}$$

$$\geq 16.9A$$

From table 4D2A (method A single phase) select 2.5mm^2 cable which takes 18.5A

Check volts drop

$$\text{volts drop} = \frac{\text{mV/A} \times I_b \times L}{1000}$$

$$= \frac{18 \times 32 \times 17.5}{1000}$$

$$= 10.08V \quad (\text{satisfactory})$$

Lighting - Upstairs double bedroom

$$\text{Design Current, } I_b = \frac{W}{V} = \frac{900}{240} = 3.75A$$

size of BSEN 60898 fuse required = 5A (I_n)

$$\text{Tabulated current, } I_t \geq \frac{I_n}{\text{Correction factors}}$$

From table 4C1, (2 circuits, method 3)

$$C_g = 0.88$$

table 4B1, (2 circuits, method 1)

$$C_a = 1.0$$

$$I_t \geq \frac{I_n}{C_a \times C_g}$$

$$\geq \frac{5}{0.88 \times 1}$$

$$\geq 5.7A$$

4D2B (using 2.5mm^2)

$$\text{volts drop} = \frac{\text{mV/Amm} \times I_b \times L}{1000}$$

$$= \frac{18 \times 3.75 \times 31.9}{1000}$$

$$= 2.2 \text{ V (satisfactory)}$$

Lighting - Stairs and Hallway

$$\text{Design Current, } I_b = \frac{W}{V} = \frac{700}{240} = 2.9 \text{ A}$$

size of BSEN 60898 fuse required = 5 A (I_n)

$$\text{Tabulated current, } I_t \geq \frac{I_n}{\text{Correction factors}}$$

From table 4C1, (1 circuits, method S)

$$C_g = 1.0$$

table 4B1, (1 circuits, method 1)

$$C_a = 1.0$$

$$I_t \geq \frac{I_n}{C_a \times C_g}$$

$$\geq \frac{5}{1 \times 1}$$

$$\geq 5 \text{ A}$$

4D2B (using 2.5 mm^2)

$$\text{volts drop} = \frac{\text{mV/A.m} \times I_b \times L}{1000}$$

$$= \frac{18 \times 2.9 \times 27.5}{1000}$$

$$= 1.4 \text{ V} \quad (\text{satisfactory})$$

Lighting - Hallway

$$\text{Design Current, } I_b = \frac{W}{V} = \frac{700}{240} = 2.9 \text{ A}$$

size of BSEN 60898 fuse required = 5 A (I_n)

$$\text{Tabulated current, } I_t \geq \frac{I_n}{\text{Correction factors}}$$

From table 4C1, (1 circuits, method 3)

$$C_g = 0.88$$

table 4B1, (1 circuits, method 1)

$$C_a = 1.0$$

$$\begin{aligned} I_t &\geq \frac{I_n}{C_a \times C_g} \\ &\geq \frac{5}{1 \times 1} \\ &\geq 5 \text{ A} \end{aligned}$$

4D2B (using 2.5 mm^2)

$$\begin{aligned} \text{volts drop} &= \frac{\text{mV/A} \times I_b \times L}{1000} \\ &= \frac{18 \times 2.9 \times 32.5}{1000} \\ &= 1.7 \text{ V (satisfactory)} \end{aligned}$$

Single Phase - Bedrooms

Design Current, $I_b = 32 \text{ A}$

$$I_n = 32 \text{ A}$$

Tabulated current, $I_t \geq \frac{I_n}{\text{Correction factors}}$

From table 4C1, (3 circuits, method S)

$$C_g = 0.82$$

table 4B1, (3 circuits, method 1)

$$C_a = 1.0$$

$$I_t \geq \frac{I_n}{C_a \times C_g}$$

$$\geq \frac{32}{0.82 \times 1}$$

$$\geq 39 \text{ A}$$

4D2B (using 4 mm^2)

$$\text{volts drop} = \frac{\text{mV/A} \times I_b \times L}{1000}$$

$$= \frac{11 \times 32 \times 30}{1000}$$

$$= 10.5 \text{ V (satisfactory)}$$

Single Phase - Utility and kitchen

Design Current, $I_b = 32A$

size of BSEN 60898 fuse required = 5A (I_n)

Tabulated current, $I_t \geq \frac{I_n}{\text{Correction factors}}$

From table 4C1, (2 circuits, method 3)

$$C_g = 0.88$$

table 4B1, (2 circuits, method 1)

$$C_a = 1.0$$

$$I_t \geq \frac{I_n}{C_a \times C_g}$$

$$\geq \frac{32}{0.88 \times 1}$$

$$\geq 36A$$

4D2B (using 2.5mm^2)

$$\text{volts drop} = \frac{\text{mV/A.m} \times I_b \times L}{1000}$$

$$= \frac{18 \times 32 \times 16.9}{1000}$$

$$= 9.7 \text{ V (satisfactory)}$$

Single Phase - Upstairs double bedroom

Design Current, $I_b = 32A$

$$I_n = 32A$$

$$\text{Tabulated current, } I_t \geq \frac{I_n}{\text{Correction factors}}$$

From table 4C1, (4 circuits, method 3)

$$C_g = 0.77$$

table 4B1, (4 circuits, method 1)

$$C_a = 1.0$$

$$I_t \geq \frac{I_n}{C_a \times C_g}$$

$$\geq \frac{32}{0.77 \times 1}$$

$$\geq 41.6A$$

4D2B (using 2.5mm^2)

$$\text{volts drop} = \frac{\text{mV/A} \times I_b \times L}{1000}$$

$$= \frac{18 \times 32 \times 18.75}{1000}$$

$$= 10.8 \text{ V (satisfactory)}$$

Single Phase - upstairs double bedroom

Design Current, $I_b = 32A$

$$I_n = 32A$$

Tabulated current, $I_t \geq \frac{I_n}{\text{Correction factors}}$

From table 4C1, (4 circuits, method 3)

$$C_g = 0.77$$

table 4B1, (4 circuits, method 1)

$$C_a = 1.0$$

$$I_t \geq \frac{I_n}{C_a \times C_g}$$

$$\geq \frac{32}{0.77 \times 1}$$

$$\geq 41.6A$$

4D2B (using 4 mm^2)

$$\text{volts drop} = \frac{\text{mV/Amm} \times I_b \times L}{1000}$$

$$= \frac{11 \times 32 \times 20}{1000}$$

$$= 7.04V \text{ (satisfactory)}$$

Three phase - Tumble dryer

$$\text{Design Current, } I_b = \frac{6400}{\sqrt{3} \times 400} = 9.2 \text{ A}$$

$$I_n = 32 \text{ A}$$

$$\text{Tabulated current, } I_t \geq \frac{I_n}{\text{Correction factors}}$$

From table 4C1, (3 circuits, method 3)

$$C_g = 0.82$$

table 4B1, (3 circuits, method 1)

$$C_a = 1.0$$

$$I_t \geq \frac{I_n}{C_a \times C_g}$$

$$\geq \frac{32}{0.82 \times 1}$$

$$\geq 39 \text{ A}$$

4D2B (using 2.5 mm^2)

$$\text{volts drop} = \frac{\text{mV/A} \times I_b \times L}{1000}$$

$$= \frac{18 \times 9.2 \times 11.25}{1000}$$

$$= 1.9 \text{ V (satisfactory)}$$

Three phase - lift motor

$$\text{Design Current, } I_b = \frac{7500}{\sqrt{3} \times 400 \times 0.89 \times 0.98} = 13.8 \text{ A}$$

$$I_n = 32 \text{ A}$$

$$\text{Tabulated current, } I_t \geq \frac{I_n}{\text{Correction factors}}$$

From table 4C1, (3 circuits, method 3)

$$C_g = 0.82$$

table 4B1, (3 circuits, method 1)

$$C_a = 1.0$$

$$I_t \geq \frac{I_n}{C_a \times C_g}$$

$$\geq \frac{32}{0.82 \times 1}$$

$$\geq 39 \text{ A}$$

4D2B (using 2.5 mm^2)

$$\text{volts drop} = \frac{\text{mV/A} \times I_b \times L}{1000}$$

$$= \frac{18 \times 13.8 \times 7.5}{1000}$$

$$= 1.863 \text{ V (satisfactory)}$$

Single Phase - Washing Machine

$$\text{Design Current, } I_b = \frac{3600}{240} = 15A$$

$$I_n = 32A$$

$$\text{Tabulated current, } I_t \geq \frac{I_n}{\text{Correction factors}}$$

From table 4C1, (3 circuits, method 3)

$$C_g = 0.82$$

table 4B1, (3 circuits, method 1)

$$C_a = 1.0$$

$$I_t \geq \frac{I_n}{C_a \times C_g}$$

$$\geq \frac{32}{0.82 \times 1}$$

$$\geq 39A$$

4D2B (using 2.5mm^2)

$$\text{volts drop} = \frac{\text{mV/A} \times I_b \times L}{1000}$$

$$= \frac{18 \times 15 \times 12}{1000}$$

$$= 3.24V \text{ (satisfactory)}$$

Single Phase - Cookers

$$\text{Design Current, } I_b = \frac{4000}{240} = 16.7 \text{ A}$$

$$I_n = 32 \text{ A}$$

$$\text{Tabulated current, } I_t \geq \frac{I_n}{\text{Correction factors}}$$

From table 4C1, (3 circuits, method 3)

$$C_g = 0.82$$

table 4B1, (3 circuits, method 1)

$$C_a = 1.0$$

$$\begin{aligned} I_t &\geq \frac{I_n}{C_a \times C_g} \\ &\geq \frac{32}{0.82 \times 1} \\ &\geq 39 \text{ A} \end{aligned}$$

4D2B (using 2.5 mm^2)

$$\text{volts drop} = \frac{mV/A \times I_b \times L}{1000}$$

$$= \frac{18 \times 16.7 \times 14}{1000}$$

$$= 4.2 \text{ V (satisfactory)}$$

Single Phase - upstairs cooker double bedroom

$$\text{Design Current, } I_b = \frac{4000}{240} = 16.7 \text{ A}$$

$$I_n = 32 \text{ A}$$

$$\text{Tabulated current, } I_t \geq \frac{I_n}{\text{Correction factors}}$$

From table 4C1, (4 circuits, method 3)

$$C_g = 0.77$$

table 4B1, (4 circuits, method 1)

$$C_a = 1.0$$

$$I_t \geq \frac{I_n}{C_a \times C_g}$$

$$\geq \frac{32}{0.77 \times 1}$$

$$\geq 41.6 \text{ A}$$

4D2B (using 2.5 mm^2)

$$\text{volts drop} = \frac{\text{mV/A} \times I_b \times L}{1000}$$

$$= \frac{18 \times 16.7 \times 14}{1000}$$

$$= 4.2 \text{ V (satisfactory)}$$

Circuit Protection Designs

There are many different circuit protection designs I can install and I have researched multiple different types to understand which would be the most appropriate for the design I am doing. Throughout the wiring of the retirement home I will install various types of circuit protection to reduce risk of danger and to allow each circuit to work smoothly. The first circuit protection design that I will consider are fuses, this is perhaps the most basic circuit protection as these act as a 'cap' which are used to stop too much current flowing through the circuit. If the current becomes too high the fuse will blow. This works because a fuse is a very low resistance resistor so if too much current is running through this then it breaks. This is not too much of an issue though because they will hopefully not have to be utilised often and also they are very cheap, therefore if they are utilised and needs to be replaced it will not cost a lot to do this. Another benefit of a fuse is that they come in different sizes and can be different current ratings therefore you can install a fuse which is suitable for our circuit. The limitation of fuses is that they can only be used once, once a fuse has been used it cannot be used again and must then be replaced.

To overcome this problem we can use resettable fuses which are also known as poly switches. These are basically fuses that can be reset because instead of breaking once utilised they break the circuit through a mechanical disconnection, these are common in computers or power supplies where fuses aren't easy to get to and thus not easy to be replaced.

Another device which can be used for circuit protection is an MCB (miniature circuit breaker), this device is also to stop the circuit from overcurrent. If there is continuous over current flowing through the MCB it will cause it to heat up fairly quickly, inside the MCB there is a bimetallic strip which when heated bends. Once this bends it releases a latch and the MCB trips. An MCB is very common in electrical circuits and is now used more frequently as a replacement for fuses. The reason a lot of electricians prefer MCBs to fuses is because they are much more electrically safer than a fuse and can easily be reset once they have been utilised. MCBs are installed in millions of residential buildings already and they will remain stable during a minor short term overload however if the overload remains the MCB will open the circuit. An MCB will also open the circuit during a short circuit and it will do this immediately in order to minimise the damage caused by the short circuit because when there is a short circuit there is infinite current. As well as the thermal trigger for overload of current they also have a magnetic trigger for short circuits. There are many different types of MCBs which vary based on this magnetic trigger, there are D, C or B. B is the most common type. A B1 rating will trip currents instantly if they are $3-5 \times I_{nom}$, when the nominal current being 1A. MCBs are also very good because the higher the current the faster the MCB will trip, this is because if the current is higher there is more risk of danger to the circuit and people using the circuit. The benefit of an MCB rather than a fuse is that it can be operated either automatically or manually to restart regular operation. Also, like a fuse, a circuit breaker can come in all different sizes and ratings so that it is always applicable to your circuit, this allows circuit breakers to be used in low voltage circuits and in high voltage circuits.

Another circuit protection method is inrush current limiter, the purpose of these is to stop regular damage to devices within the circuit and stopping tripping circuit breakers and blowing fuses. The way the work is by having a massive resistance initially therefore any huge amounts of current flowing from turn on.

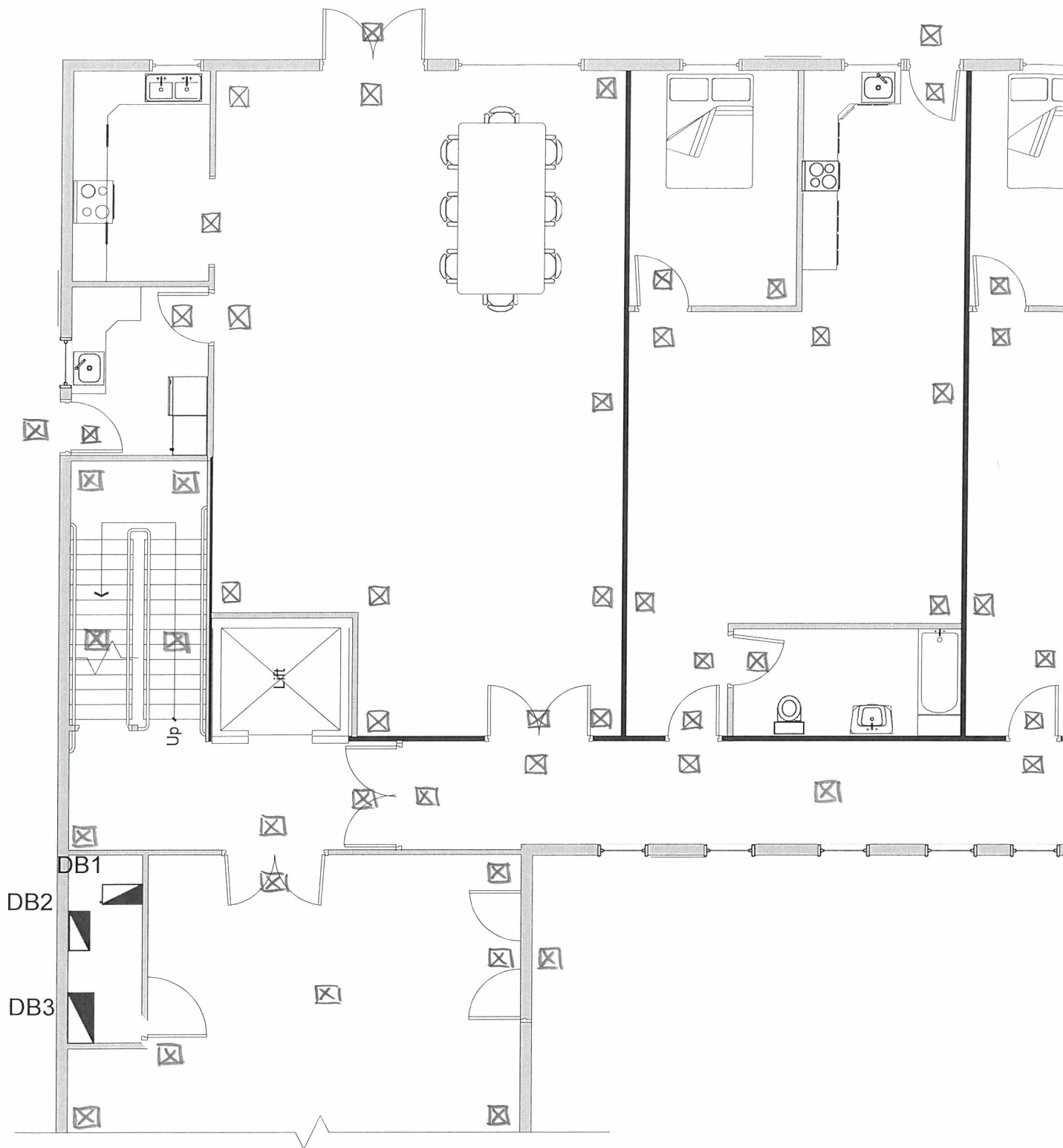
A device which is very commonly used for protection from over voltage is the surge protection device. This is usually allied in parallel in the power supply and can be placed at any stage of the power supply.

I have decided to install a 13A MCB in each resident's living area. On the ground floor, I will run a cable from DB1 to each of the MCBs and then my lighting and power circuits will come through the MCBs. I have chosen to do this because if there is a current which is too large the MCB will trip and will ensure the safety of the circuit. This means that the power to the circuit will almost immediately stop and there will be no current flowing. After the circuit breaker has tripped a maintenance engineer can then analyse the circuit to find why there was a large increase in current and how the fault can be fixed and determine whether it is safe to turn the power to the circuit back on. The reason I have chosen to put an MCB in each room is because this way if there is a fault and the circuit trips the circuit will only be powerless to the point of the MCB, this means that if there is a fault in one residents kitchen for example, the power to their room will cut but the power for the rest of the building will remain unchanged. I think that this would be more appropriate because it would be very inconvenient for other residents if their power was cut without any fault within their personal rooms.

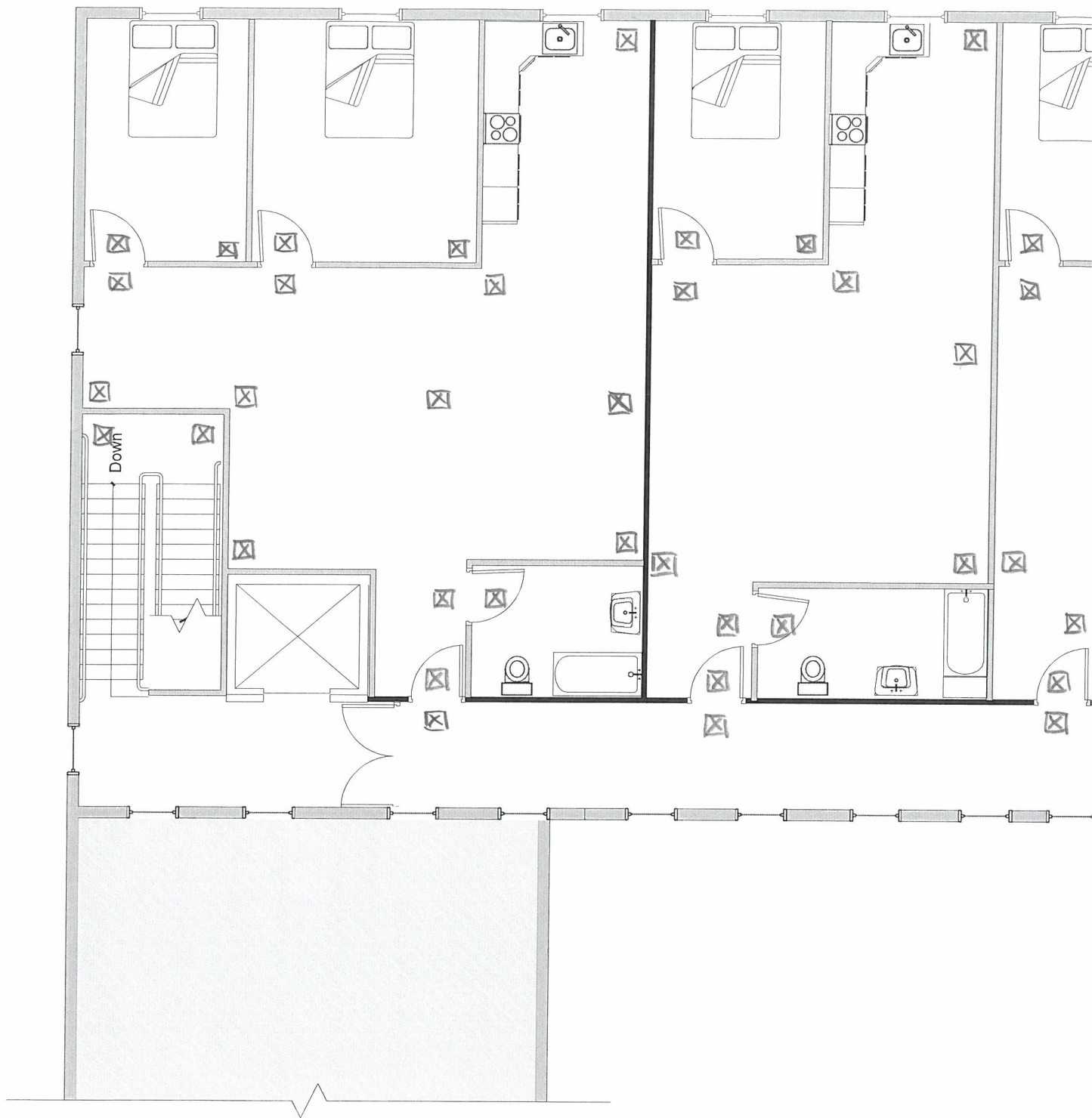
I will use BS 3036 fuse for the kitchen cooker, I have chosen to use this because it is suitable as a protection device for my three phase supply. This is a semi enclosed fused, which is also known as a rewire-able fuse.



Product Details	Delivery	Reviews	Downloads
Circuit Breakers Description Product	Circuit Breaker		
Circuit Breakers Description Type (Cable Baskets)	MCB		
Circuit Breakers Features Pole Configuration	SP		
Circuit Breakers Features Ingress Protection	IP20		
Circuit Breakers Features Trip Type	Type C		
Circuit Breakers Features Short Circuit Rating	10/15 kA		
Circuit Breakers Dimensions Cable Capacity	1 to 25 Sq mm		
Circuit Breakers Dimensions Height	60 mm		
Circuit Breakers Dimensions Width	18 mm		
Circuit Breakers Technical Data Current Rating	13 A		
Circuit Breakers Technical Data Voltage	230/240 V 48 V		
Circuit Breakers General Standards	IEC EN 60898/60947-2		
Dimension	13A 10/15kA		
Manufacturer	Eaton		
Brand	Memshield 3		



Sheltered accommodation Ground Floor
Scale 1:125



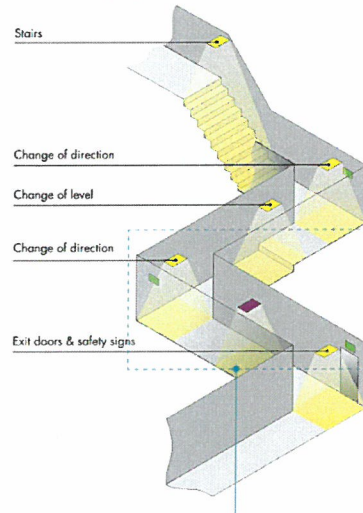
Sheltered accommodation First Floor
Scale 1:125

Emergency Lighting Design

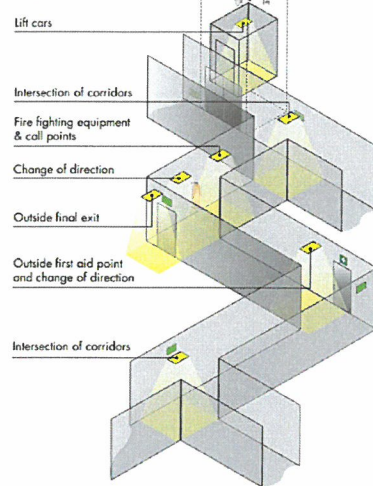
There are many things to consider when installing emergency lighting, one of which is where I will place the emergency lights.

These images show exactly where there must be emergency lights and signs. As it says, I must have emergency lighting on all staircases, any changes of direction or changes of level and all exit doors and safety signs. There must also be lighting at all the intersections of corridors and outside all first aid points. There must also be lighting above all fire fighting equipment and call points.

Step 1 – Exit Signage



Step 2 – Mandatory Points



There are three steps, exit signage, mandatory points and infill lighting. Exit signage is vital because in the event of an emergency all residents must be able to easily identify the nearest and safest exit to them so they can leave the building effectively and efficiently. There are mandatory points to provide essential lighting in important areas which I have outlined above, there may also be a need to infill luminaires to achieve the perfect lighting in the event of an emergency, this is to avoid places being too dark within the building which could hinder the easiness of somebodies exit.

It is important to consider the brightness of the emergency lights because they can't be too bright as they may hinder the vision of people attempting to leave the building, another reason why they can't be overly bright is because they may cause signs to be difficult to read. On the other hand the lights must be bright enough to ensure everything is clear and easy to identify so each person can exit the building as safely as possible.

This is the permitted glares set out by the current standards. As the table displays, the higher the light is mounted the greater the intensity of the light can be, this is because it is further away from signs and people and pathways and therefore needs

Mounting height h (m)	Escape route & open area Maximum Luminous Intensity I _{max} (cd)	High Risk Maximum Luminous Intensity I _{max} (cd)
$h < 2.5$	500	100
$2.5 < h < 3$	900	1800
$3 < h < 3.5$	1600	3200
$3.5 < h < 4$	2500	5000
$4 < h < 4.5$	3500	7000
$4.5 < h$	5000	10000

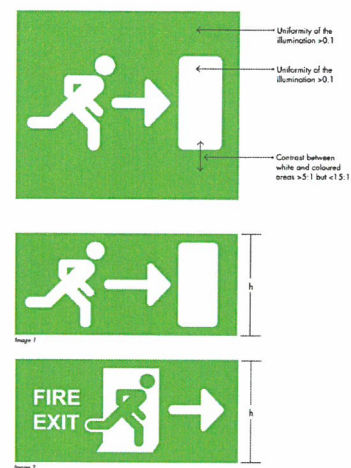
to be more intense to have the same effect. It will also not create too much of a dazzle because it is further away and won't block or impair vision to important signs and information.

I have decided to position my emergency lights where I have because I have followed the regulations of where they must be. This is why I have it one on every corner, I have put them on the inside and outside of doors and entrances and they are also on stairs and they will be fitted so they point down the stairs to illuminate the whole staircase to prevent any impairment in vision so the building can be exited safely during the event of an emergency. I have also put emergency lights in the large distances between emergency lights because I do not want them to be spaced out too much because this could cause there to be not enough illumination.

In the open spaces such as the communal living area and the personal living areas, I must ensure that all of the fire exits signs and fire exit emergency lighting is visible from everywhere. In some cases the exits are hidden around the corner which are not in sight of certain areas in the room, to overcome this problem I have put fire exit signs in places which are visible to all areas with arrows pointing to the fire exit.

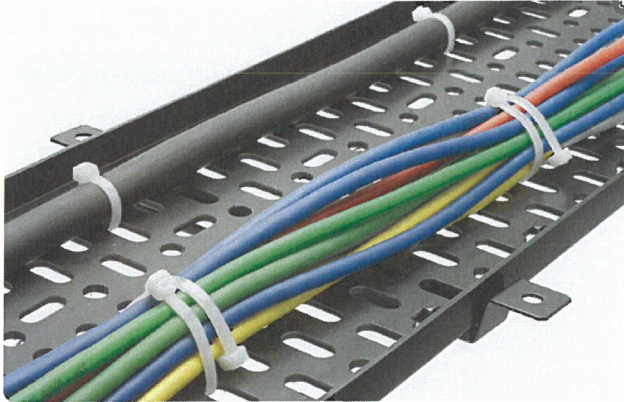
Some of the fire exit signs I will install have arrows on, this is so, in the event of an emergency, everybody will clearly understand which direction they need to go in order to exit the building as quickly as possible.

All of my emergency lighting will be battery operated. I have decided not to put the on a circuit from a junction box because if there was an emergency where the power to the lights was cut it would mean there would be no power to the emergency lights either and there would be no illumination, this would make the exiting the building extremely difficult and dangerous.



Support systems

For my cable support systems I have chosen to use cable trays because after analysing different options I think that these would be most suitable. I can only put a maximum of 4 cables in each cable tray so I will arrange my cables accordingly so that I do not infringe this rule.



The reason I have chosen to use cable trays is because an open cable is very dangerous and presents numerous safety hazards, with the use of a cable tray all the cables can be safely kept out of the way. Cable trays are the most reliable solution and are designed for all sizes of cables including heavy duty cables.

Cable trays allow us to take multiple cables and wires to the same places and different places through different routes. They are a very effective way of managing cables so everything is neat, this allows any work in the future to be done easier because problems are

easier to identify and fix. Cable trays are also very durable and do not require replacing often.

Cable trays can be made in many different materials depending on what their use will be and what environment they will be in. They also come with significant cost benefits as compared to conduits and raceways, cable trays are cheaper with design, installation and maintenance.

Lift Motor

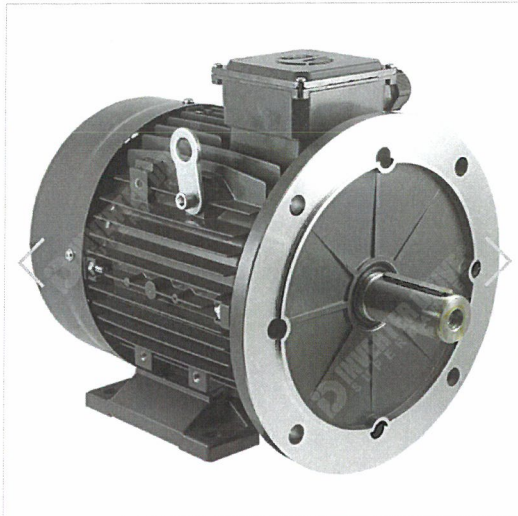


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0 items : £0.00



AC Inverter Drives | DC Motor Drives | Servo Drives | Soft Starters | DOL Starters | Motors | Gearboxes | Control Gear | HMIs | Feedback Devices | Shop by Brand



TEC IE2 7.5kW Aluminium Three Phase Motor 400V 2 Pole 132S Frame B35

7.523TECAB35-IE2 (TECA2-132S2-2-B35)

Order Code: 22416

List Price: ~~£292.00~~

£292.00

£265.72

1+

10+

1 in Stock - order by 3pm for next working day delivery*
2+ normally 3-5 days

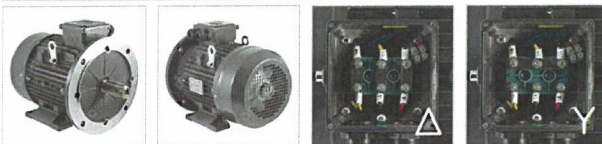
1

Add to cart

Condition: New from Manufacturer with Warranty

Brand: TEC Electric Motors

Range: TECA Three Phase IE2 Aluminium



Details

TEC Electric - 7.5kW 3ph 2 Pole High Efficiency Foot and Flange Mounting (B35) 132S Frame AC Motor for 400V 3 phase supply. Inverter Rated for use with a Variable Frequency Inverter Drive or a fixed frequency mains supply at 50Hz.

Fixed mains supply output: 7.5kW (10HP) x 2910RPM at 400V x 50Hz 3ph.

Inverter Supply Output: 14:1 Speed Control range from 291RPM to 4074RPM for 5Hz to 70Hz control, with suitable de-rating at the lower speeds.

Full Load Current - 13.8A at 400V.

Power Factor is 0.89 when mains connected at 50Hz.

Efficiency is 88.1%

252mm Wide x 437mm Long x 318mm high overall in its IP55 enclosure.

Foot mount on 12mm holes at 216mm wide x 140mm centres 89mm back from the shaft shoulder and Flange mount on 15mm holes at 265mm PCD with 230mm diameter spigot in the 300mm diameter flange.

Shaft is 38mm dia x 80mm with 10mm wide key.

Weight is 46.2kg.

Rated at 40C Ambient.

Ventilation space required at rear cooling air intake.

Thermistor for over-temperature protection.

Manufacturer Part Number is 7.23TECAB35-IE2. Previous Part Number was - TECA2-132S2-2-B35

For Variable Speed use:-

Part Time Output when Inverter powered is...

17.58Nm - 7.5kW (10.05HP) x 4074 RPM at 70 Hz

24.61Nm - 7.5kW (10.05HP) x 2910 RPM at 50 Hz

24.61Nm - 3.75kW (5.03HP) x 1455 RPM at 25 Hz

24.61Nm - 0.75kW (1.01HP) x 291 RPM at 5 Hz

I have decided to use this motor because it is three phase, this is needed because it will be the motor for the lift which will require a lot of power and will be three phase. It is not too big so that it will be easy to install and has a full load current of 13.8A at 400V. The power factor is 0.89 when mains connected at 50Hz and the efficiency is 88.1%.

References

<https://medium.com/@brilltechengineers/main-purpose-of-installing-the-cable-trays-9aa806c7eed5>

This source is quite small and doesn't go into lots of detail, this means that the formation I have received of this website has been quite basic however it contains very relevant information which I have used within my project. It is dated February 25th 2017 which means it is still very reliable and the information is valid.

<https://www.familyhandyman.com/electrical/outdoor-lighting/how-to-choose-and-install-motion-detector-lighting/>

This website has helped me learn more about sensor lighting, I believe that this is a reliable source with lots of valid information, it has been extremely helpful because it is easy to use and uses clear photos and sentences which are appropriate for somebody with only a small understanding.

<https://sciencing.com/energysaving-light-bulbs-pros-cons-5118.html>

This source has been extremely useful to me when weighing up the pros and cons of energy saving light bulbs, it helped me reach a decision which allowed me then to use specific figures in my cable calculations. It makes extremely valid points and I believe this is a reliable source.

<https://www.lightscoop.com/how-do-motion-sensor-lights-work>

I have used this as a reference for understanding motion sensor lighting better, I have used this source because it is very current and is clear and easy to read to give a very basic understanding of what I need.

https://www.tlc-direct.co.uk/Technical/DataSheets/EmergencyLighting/Em_Lighting_Design_Guide.pdf

I have used this website to help me gain a better understanding of emergency lighting, it has also given me a better insight into what the regulations of emergency lighting are. This source of information is quite old which may reduce its validity slightly however I still think that this is a very good website to use as it still contains information which is relevant and specific to my task.

<https://www.edn.com/design/components-and-packaging/4368820/Circuit-protection-basics--Part-1-Issues-and-design-solutions>

https://www.youtube.com/watch?v=T3NoJ_x8oiA

I have chosen to use this YouTube video because it is a different way of learning. It has contained lots of important, key information which I have used when talking about MCBs, this is the YouTube video I have decided to use because it is very clear and is very relevant as the video was only posted last year.

<https://www.elprocus.com/what-is-a-protection-device-different-types-of-protection-devices/>

This website has been useful for when I was looking at different types of protection devices, it has allowed me to analyse each type to choose which one I think is the most appropriate for my design.

<https://www.diydoctor.org.uk/projects/radialcircuit.htm>

This website has been particularly helpful because it has explained what a radial circuit is and where it should be used, it has also given values of MCBs, this information is from a trustworthy

source because it is from a website that specialises in this.

I have used a variety of different websites which I believe are all trustworthy and contain valid, relevant information. These websites have helped me make important decisions throughout this project and have allowed me to weigh up the pros and cons of different choices I could have made to make the best circuit designs I possibly could. I have also avoided using websites such as Wikipedia and I haven't used any forums, the reason I haven't used these is because some of the information presented on these websites may be false or incorrect, the reason I believe that this information isn't reliable is because anybody can share information through them therefore you do not know who the information you are receiving is from and how experienced they are.

I have also used the On-Site Guide BS 7671:2018 which has been extremely helpful especially when working out my cable calculations. It has also been very helpful when making sure that I have followed all of the regulations so that my project complies with the law.