BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY

LAB PROJECT REPORT

On Design of a Two-unit Multistoried Building

Group: 4 (C1)

Course No: EEE 414
Course Title: Electrical Services Design
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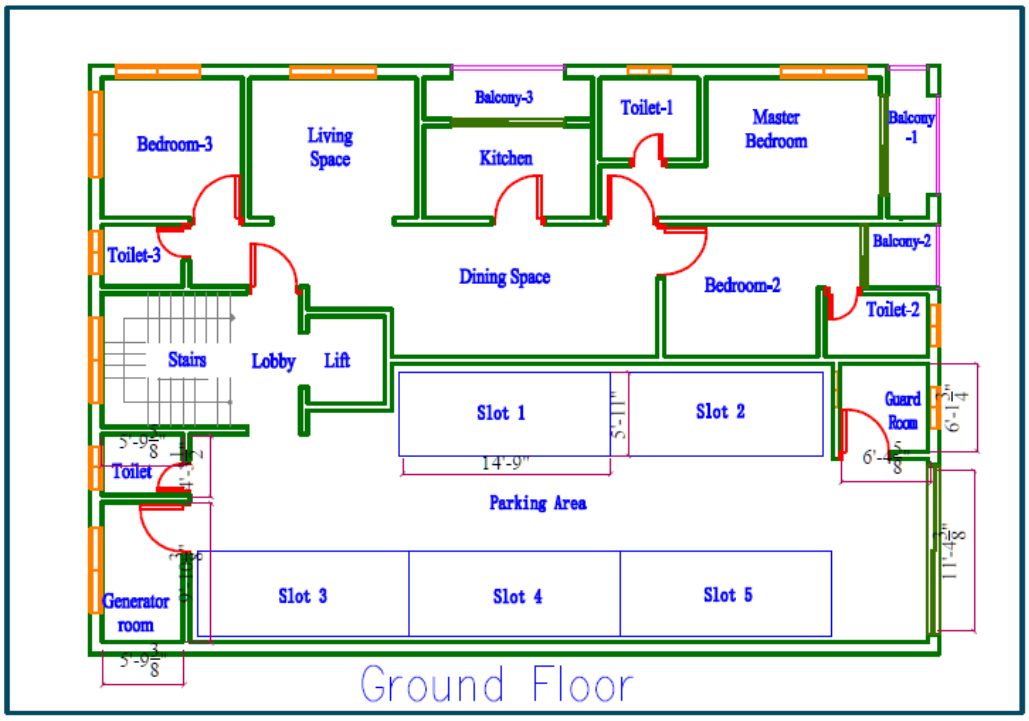
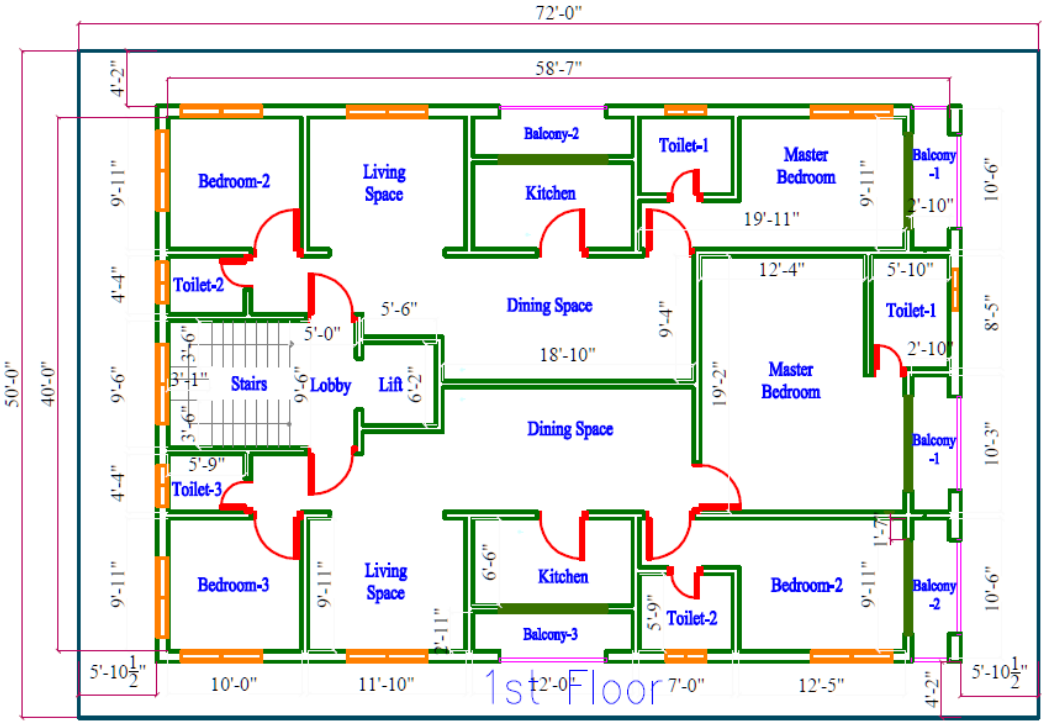
Floor plan

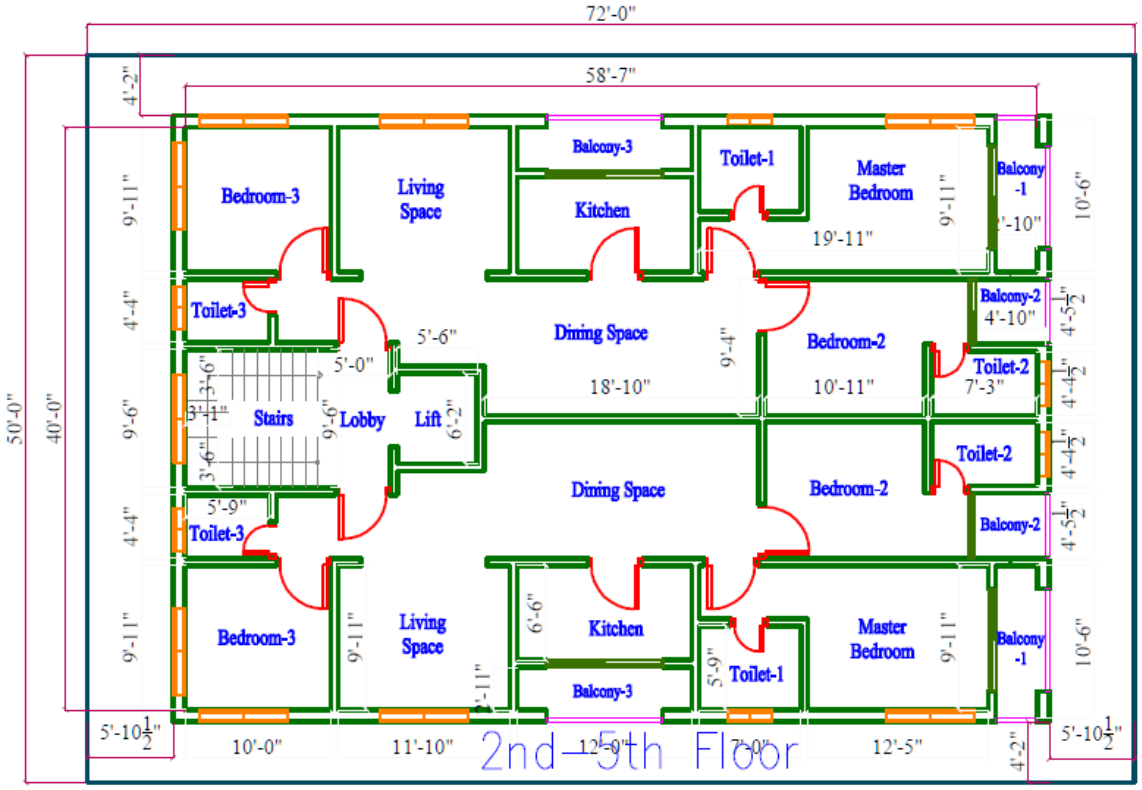
Ground floor



1st floor

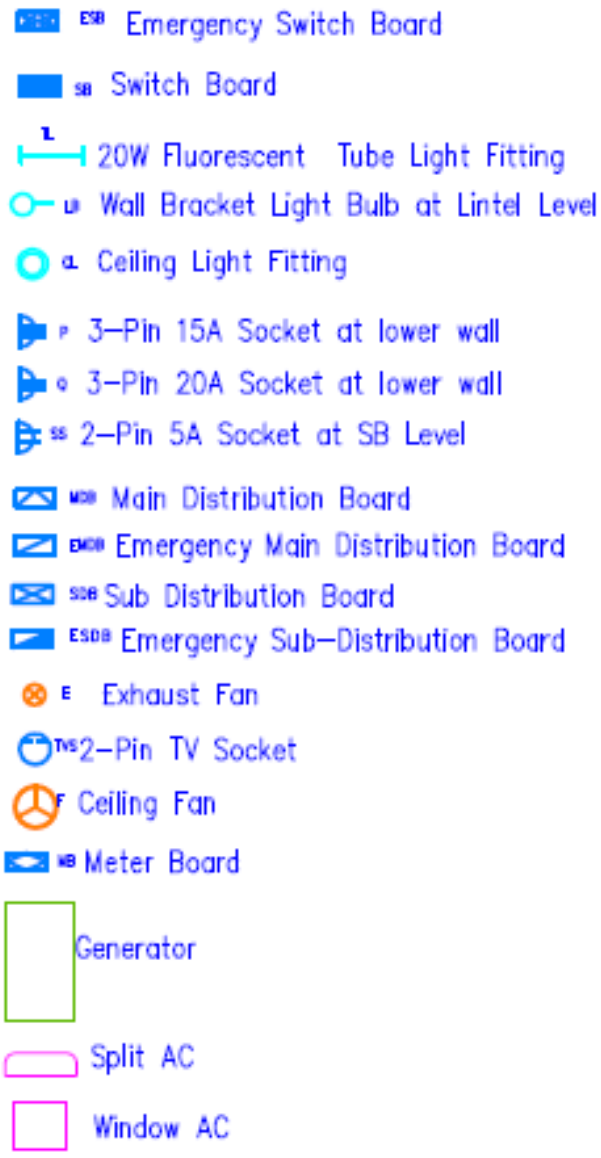


2nd -5th floor

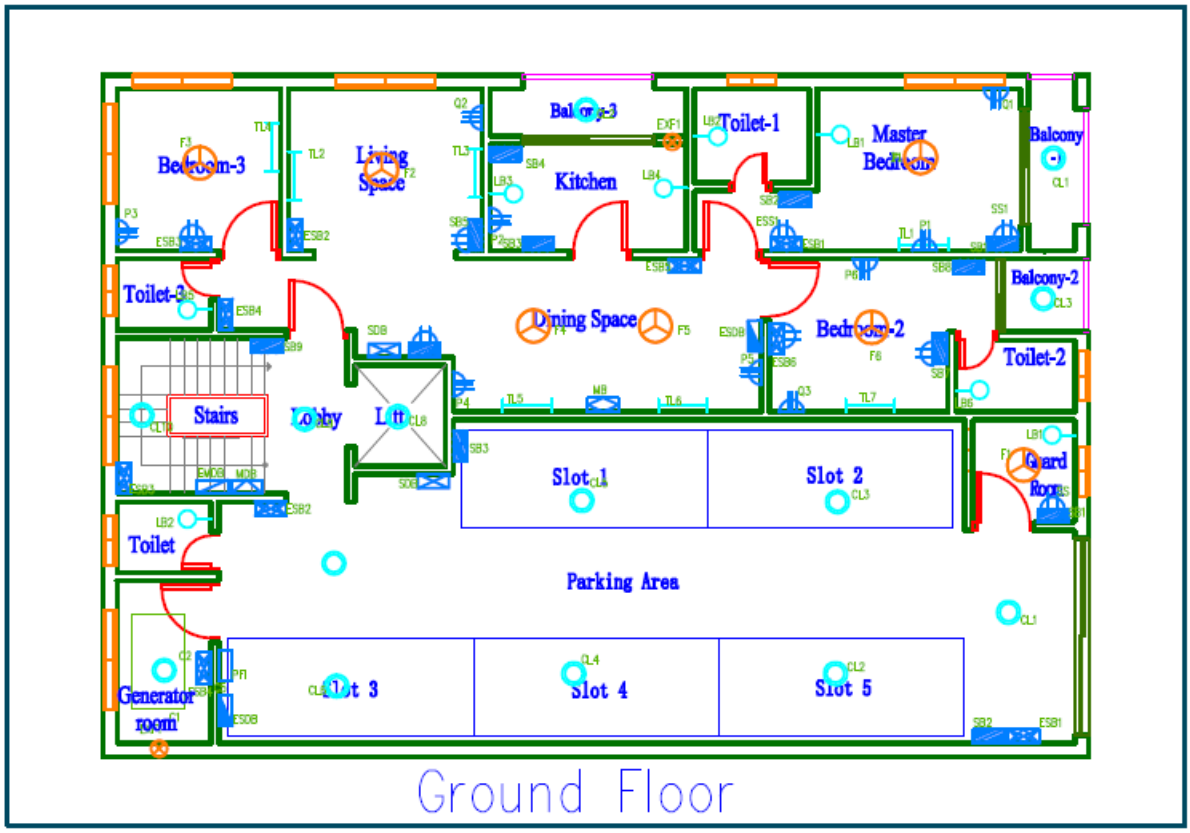


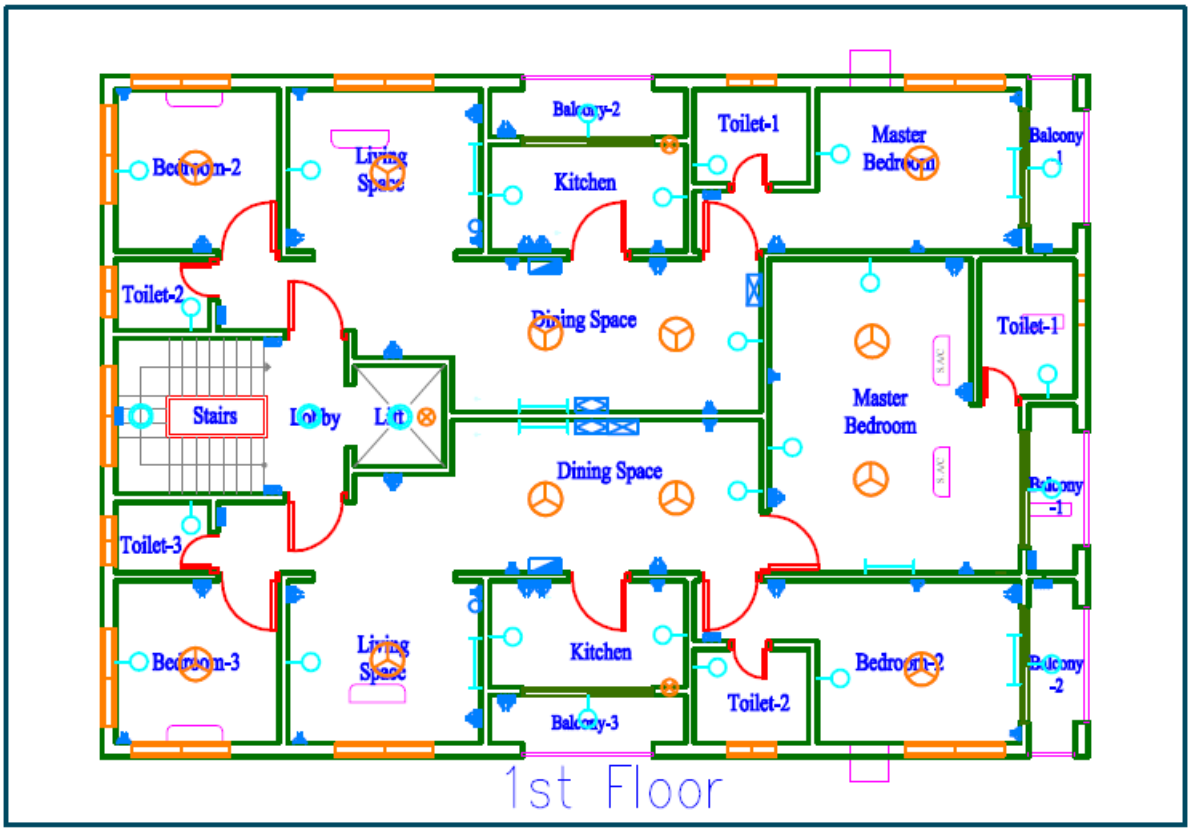
Fixtures and Fittings

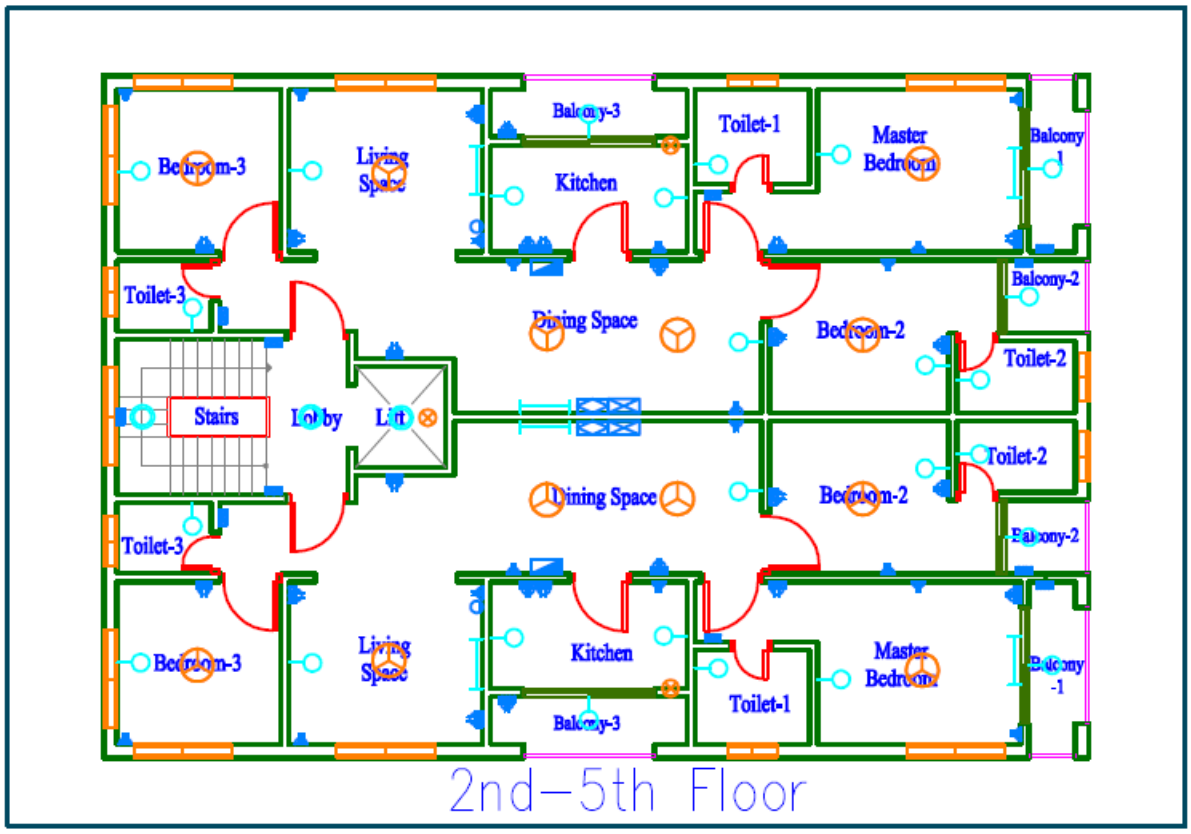
Legends



In layouts


Bedroom-3
Living Space
Kitchen
Toilet-1
Master Bedroom
Balcony
Toilet-3
Dining Space
Bedroom-2
Balcony-2
Toilet-2
Stairs
Lobby
Lift
Slot 1
Slot 2
Guard Room
Toilet
Parking Area
Generator room
Slot 3
Slot 4
Slot 5
Ground Floor


Bedroom-2
Living Space
Balcony-2
Kitchen
Toilet-1
Master Bedroom
Balcony -1
Toilet-2
Dining Space
Toilet-1
Stairs
Lobby
Lift
Master Bedroom
Dining Space
Balcony -1
Toilet-3
Bedroom-3
Living Space
Kitchen
Toilet-2
Bedroom-2
Balcony -2
Balcony-3
1st Floor



Calculation of fittings:

$$Number\ of\ Lights, N = \frac{E \times A(m^2)}{n \times F \times UF \times LLF}$$

Assumptions:

Number of lights per illuminaire, n = 1

Flux, F = 1800 Lumen (20W energy saving bulb and fluorescent tube light)

Utilization factor and light loss factor, UF = found from table using room index

Light loss factor, LLF = 0.9

Reflectance:

Ceiling = 0.3

Walls = 0.5

Floor = 0.2

$$\text{Room Index} = \frac{Length * Width}{Mounting\ Height * (Length + Height)}$$

$$Number\ of\ Fans, N = \frac{A(sqft)}{100}$$

Diameter of fan = 56”

Second Floor:

Room	E (Lumen/ m^2)	Length	Width	Room index	Utilization factor	Number of Lights	Number of lights rounded	Number of Fans
Master Bedroom	100	12’5”	9’11”	0.840237687	0.35	1.220195409	2	1
Bedroom-2	100	10’11”	9’4”	0.76680823	0.31	1.009684002	1	1
Bedroom-3	100	10’	9’11”	0.758811715	0.305	0.982707712	1	1
Living Space	150	11’10”	9’11”	0.822239847	0.34	1.744306189	2	1
Dining Space	100	18’10”	9’4”	0.951072189	0.36	1.741897591	2	2
Kitchen	160	12’	6’6”	0.642551351	0.2	1.236725268	2	1
Toilet-1	100	7’	5’9”	0.481105882	0.15	0.398863718	1	0
Toilet-2	100	7’3”	4’4.5”	0.415822581	0.12	0.314321952	1	0
Toilet-3	100	5’9”	4’4”	0.376591736	0.11	0.246915635	1	0
Balcony-1	70	10’6”	2’10”	0.3400425	0.1	0.20636862	1	0
Balcony-2	70	4’10”	4’5.5”	0.353435874	0.15	0.157686	1	0
Balcony-3	70	12’	2’11”	0.357586592	0.17	0.2477987	1	0

First Floor (Owner's Bigger Unit):

Room	E (Lumen/ m^2)	Length	Width	Room index	Utilization factor	Number of Lights	Number of lights rounded	Number of Fans
Master Bedroom	100	19'2"	12'4"	1.143672	0.39	3.475981	3	2.363889
Toilet-1	100	8'5"	5'10"	0.525082	0.175	1.608918	1	
Balcony-1	70	10'3"	2'10"	0.338289	0.1	1.165828	1	

Ground Floor:

Room	E (Lumen/ m^2)	Length	Width	Room index	Utilization factor	Number of Lights	Number of lights rounded	Number of Fans
Guard Room	100	6'3"	6'3"	0.47625	0.15	1.493426	1	1
Toilet	100	5'9"	4'4"	0.376592	0.11	1.299009	1	
Generator Room	70	9'11"	5'9"	0.554679	0.19	1.204739	1	1
Parking Area	70	52'4"	19'9"	2.185222	0.54	7.683599	7	
Common space								
Stairs	80	9'6"	9'1"	0.707669	0.28	0.684097	1	
Lobby	80	9'6"	5'	0.499241	0.17	0.376567	1	
Lift	80	6'2"	5'6"	0.443049	0.13	0.268882	1	1

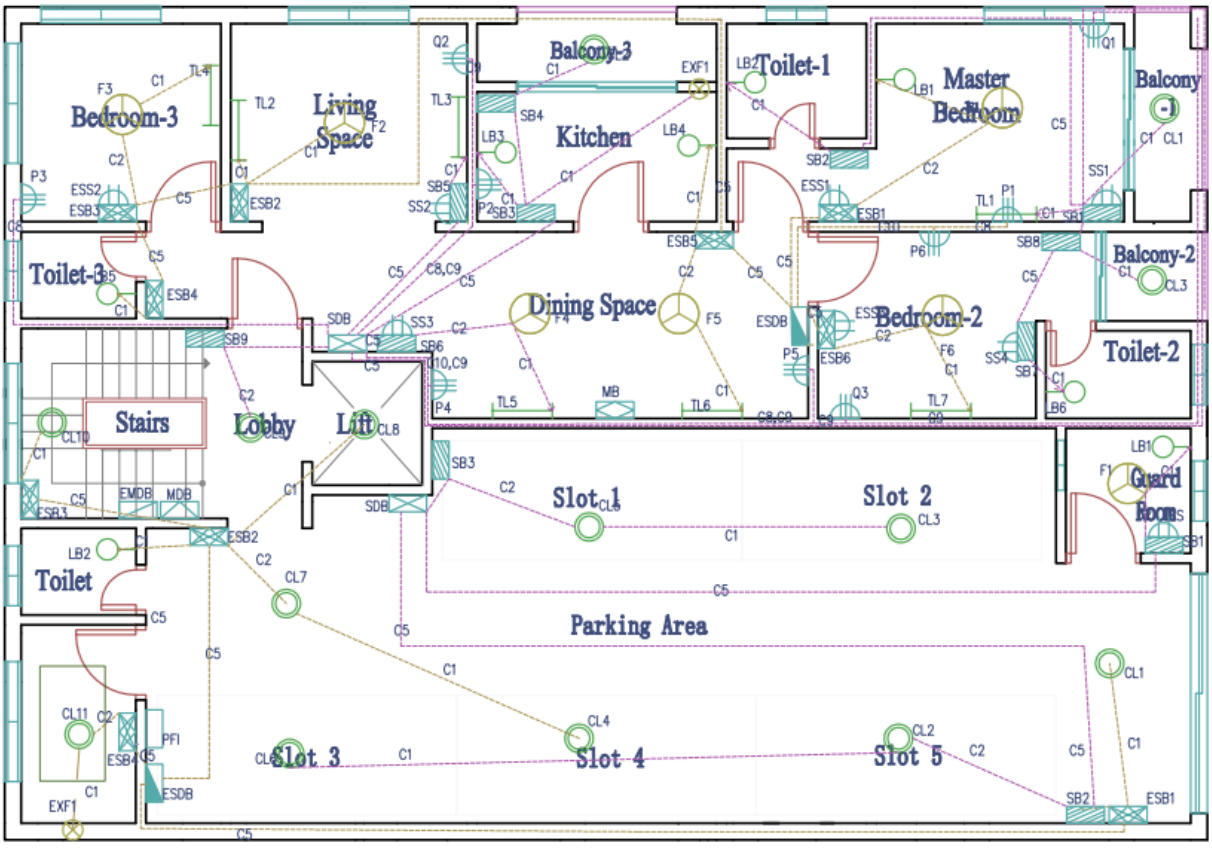
Conduit

Legend for conduits

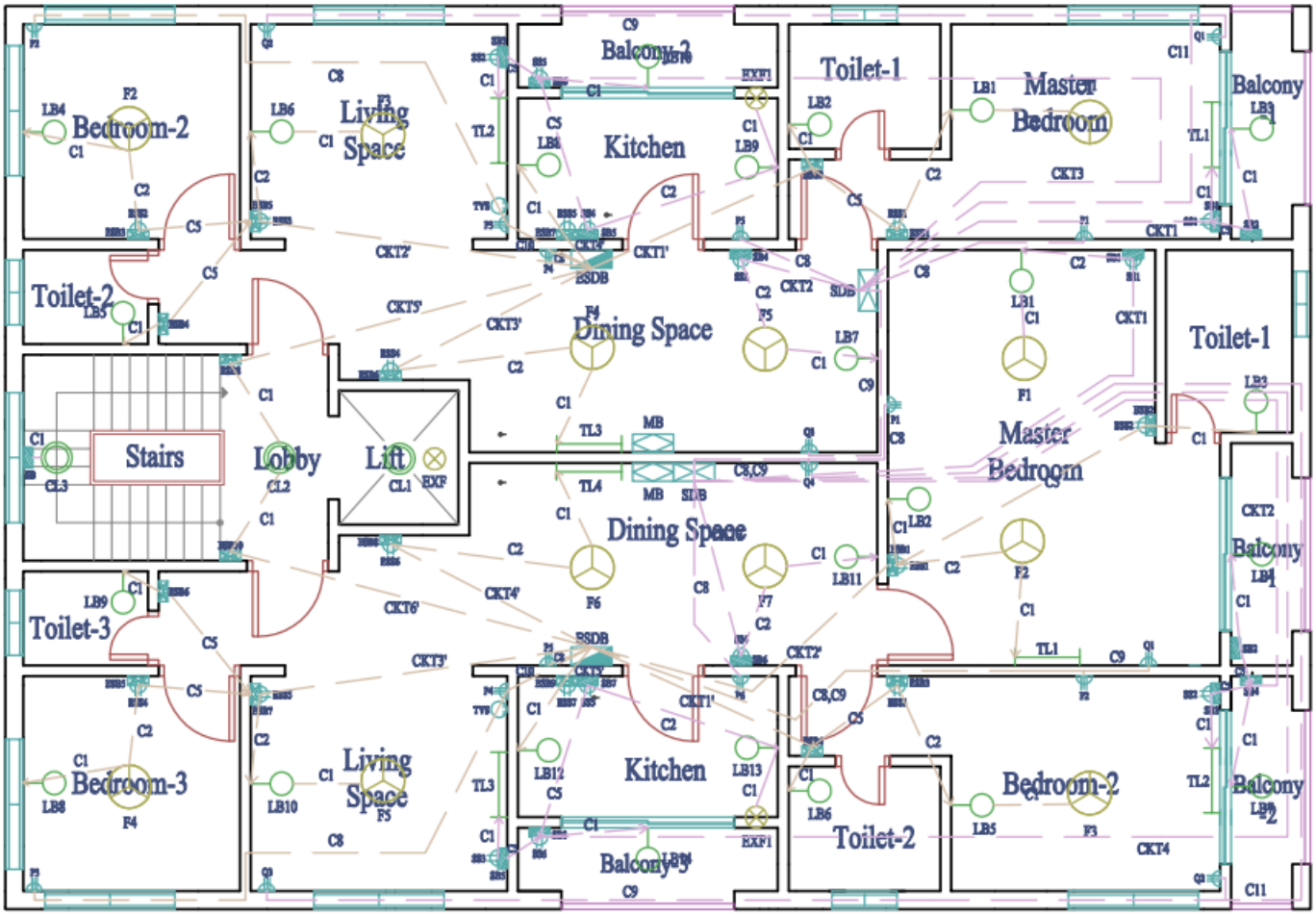
Symbol	Containing Power Cable
C1	2x1.5 rm BYM
C2	4x1.5 rm BYM
C3	6x1.5 rm BYM
C4	8x1.5 rm BYM
C5	2x1.5 rm BYM+1.5 rm BYAECC
C8	2x4 rm BYM + 4 rm BYAECC
C9	2x6 rm BYM + 6 rm BYAECC
C10	4x4 rm BYM + 2x4 rm BYAECC

C11	4x6 rm BYM + 2x6 rm BYAECC
C12	2x 16 rm BYM + 16 rm BYA ECC

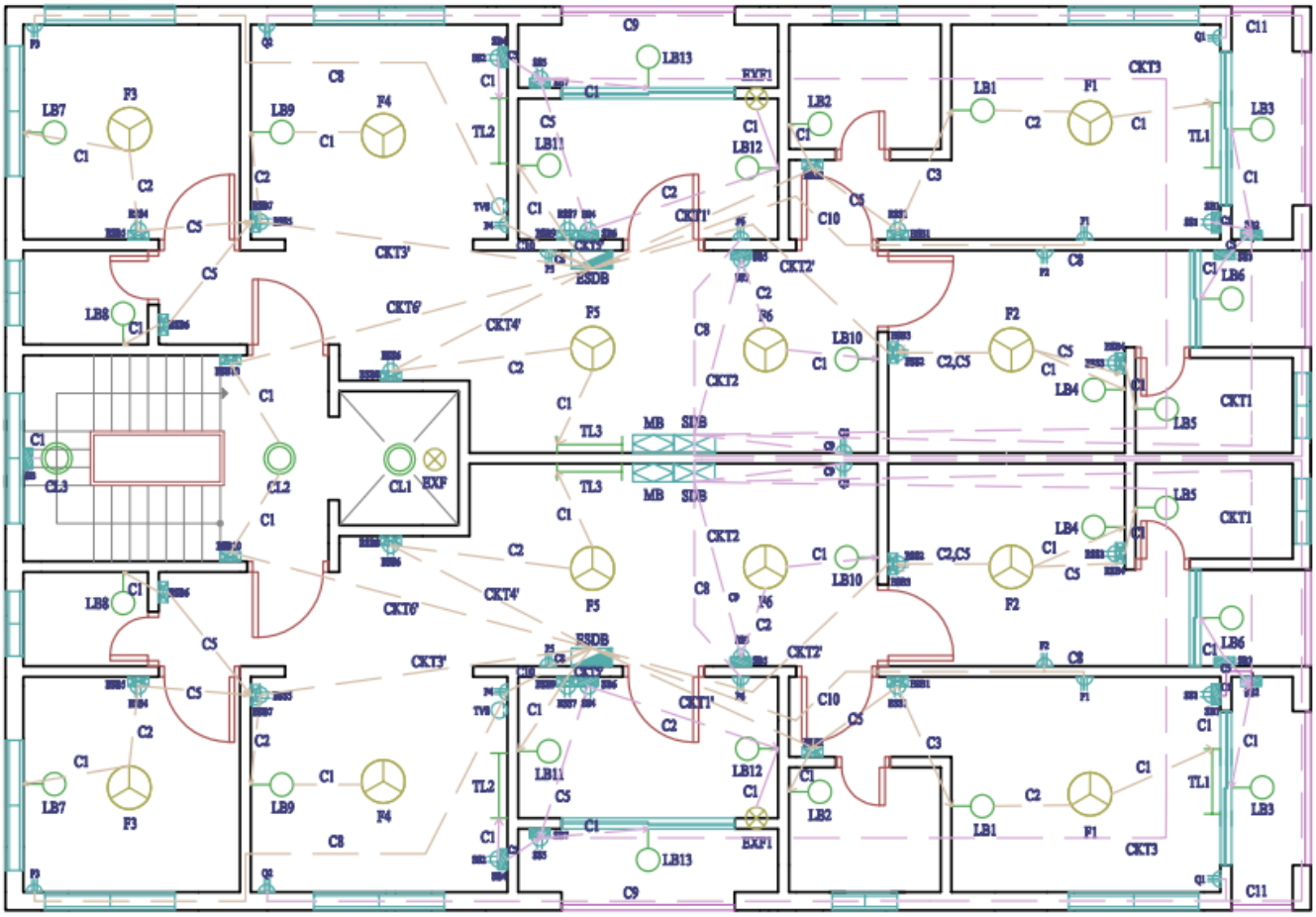
Conduit Layout of Ground Floor



Conduit Layout of First Floor



Conduit Layout of Second to Fifth Floor



Calculations for Conduits:

Formula:

$$Ampere\ Rating, I = \frac{P}{V \times pf}\ A$$

Assumptions:

Voltage, V = 220 V

Power factor, pf = 0.7

Light Bulb (LB) = 20 W

Tube Light (TL) = 20 W

Ceiling Light (CL) = 20 W

Ceiling Fan (F) = 100 W

Exhaust Fan (EXF) = 60 W

Switchboard Socket (SS) = 100 W

Emergency Switchboard Socket (ESS) = 100 W

It is seen that , all Internal wires are below 5 A rating so 2x1.5 rm BYM is used in all internal wiring.

- **Ground Floor (Single Unit):**

To Sub-Distribution Board (SDB):

SB1: P = SS1 + TL1 + CL1 + SB2 + SB8 = 100 + 20 + 20 +20 + 140 = 300 W

SB2: P = LB2 = 20 W

SB3: P = LB3+ EXF1 + SB4 = 20+ 60 + 20 = 100 W

SB4: P = CL2 = 20 = 20 W

SB5: P = SS2 + TL3 = 100 + 20 = 120 W

SB6: P = F4 + TL5 + SS3 = 100 + 20 +100 = 220 W

SB7: P = SS4 + LB6 = 100 + 20 = 120 W

SB8: P = CL3 + SB7 = 20 + 120 = 140 W

SB9: P = CL9 = 20 = 20 W

CKT1 Rating:

$$I = \frac{P(SB1)}{V \times pf} = \frac{300}{220 \times 0.7} = 1.95\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

CKT2 Rating:

$$I = \frac{P(SB3)}{V \times pf} = \frac{100}{220 \times 0.7} = 0.65\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

CKT3 Rating:

$$I = \frac{P(SB5)}{V \times pf} = \frac{120}{220 \times 0.7} = 0.78\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

CKT4 Rating:

$$I = \frac{P(SB6)}{V \times pf} = \frac{220}{220 \times 0.7} = 1.43\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

CKT5 Rating:

$$I = \frac{P(SB9)}{V \times pf} = \frac{20}{220 \times 0.7} = 0.13\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

To Emergency Sub-Distribution Board (ESDB):

ESB1: P = ESS1 + F1 + LB1 = 100 + 100 + 20 = 220 W

ESB2: P = F2 + TL2 + ESB3 = 100 + 20 + 240 = 360 W

ESB3: P = F3 + TL4 + ESS2 + ESB4 = 100 + 20 + 100 +20 = 240 W

ESB4: P = LB5 = 20 = 20 W

ESB5: P = F5 + TL6 + LB4 + ESB2 = 100 + 20 + 20 + 360 = 500 W

ESB6: P = F6 + TL7 + ESS3 = 100 + 20 + 100 W = 220 W

CKT1' Rating:

$$I = \frac{P(ESB1)}{V \times pf} = \frac{220}{220 \times 0.7} = 1.43\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

CKT2' Rating:

$$I = \frac{P(ESB5)}{V \times pf} = \frac{500}{220 \times 0.7} = 3.25\ A < 5\ A$$

CKT3' Rating:

$$I = \frac{P(ESB6)}{V \times pf} = \frac{220}{220 \times 0.7} = 1.43\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

➢ Ground Floor (Parking Area):

To Sub-Distribution Board (SDB):

SB1: P = SS + F1 + LB1 = 100 + 100 + 20 = 220 W

SB2: P = CL2 + CL6 = 20 + 20 = 40 W

SB3: P = CL3 + CL5 = 20 + 20 = 40 W

SB4: P = CL12 = 20 = 20 W

SB5: P = CL13 = 20 = 20 W

SB6: P = CL14 = 20W

SB7: P = CL15 = 20W

SB8: P = CL16 = 20W

CKT1 Rating:

$$I = \frac{P(SB1)}{V \times pf} = \frac{220}{220 \times 0.7} = 1.43\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

CKT2 Rating:

$$I = \frac{P(SB2)}{V \times pf} = \frac{40}{220 \times 0.7} = 0.26\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

CKT3 Rating:

$$I = \frac{P(SB3)}{V \times pf} = \frac{40}{220 \times 0.7} = 0.26\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

CKT4 Rating:

$$I = \frac{P(SB4)}{V \times pf} = \frac{20}{220 \times 0.7} = 0.13\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

CKT5 Rating:

$$I = \frac{P(SB5)}{V \times pf} = \frac{20}{220 \times 0.7} = 0.13\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

CKT6 Rating:

$$I = \frac{P(SB6)}{V \times pf} = \frac{20}{220 \times 0.7} = 0.13\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

CKT7 Rating:

$$I = \frac{P(SB7)}{V \times pf} = \frac{20}{220 \times 0.7} = 0.13\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

CKT8 Rating:

$$I = \frac{P(SB8)}{V \times pf} = \frac{20}{220 \times 0.7} = 0.13\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

To Emergency Sub-Distribution Board (ESDB):

ESB1: P = CL1 = 20 W

ESB2: P = ESB3 + CL4 + CL7 + CL8 + LB2 = 20 + 20 + 20 + 20 + 20 = 100 W

ESB3: P = CL10 = 20 W

ESB4: P = CL11 + EXF1 = 20W + 60W = 80W

CKT1' Rating:

$$I = \frac{P(ESB1)}{V \times pf} = \frac{20}{220 \times 0.7} = 0.13\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

CKT2' Rating:

$$I = \frac{P(ESB2)}{V \times pf} = \frac{100}{220 \times 0.7} = 0.649\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

CKT3' Rating:

$$I = \frac{P(ESB4)}{V \times pf} = \frac{80}{220 \times 0.7} = 0.519\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

- **First Floor (Bigger Unit):**

To Sub-Distribution Board (SDB):

SB1: P = SS1 + F1 + LB1 = 100 + 100 + 20 = 220 W

SB2: P = LB4 = 20 W

SB3: P = SS2 + TL2 = 100 + 20 = 120 W

SB4: P = SB2 + SB3 + LB7 = 20 + 120 + 20 = 160 W

SB5: P = SS3 + TB3 = 100 + 20 = 120 W

SB6: P = SS4 + F7 + LB11 = 100 + 100 + 20 = 220 W

SB7: P = SS5 + EXF1 + LB13 = 100 + 60 + 20 = 180 W

SB8: P = SB5 + SB7 + SS6 + LB14 = 120 + 180 + 100 + 20 = 420 W

CKT1 Rating:

$$I = \frac{P(SB1)}{V \times pf} = \frac{220}{220 \times 0.7} = 1.43\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

CKT2 Rating:

$$I = \frac{P(SB4)}{V \times pf} = \frac{160}{220 \times 0.7} = 1.04\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

CKT3 Rating:

$$I = \frac{P(SB6)}{V \times pf} = \frac{220}{220 \times 0.7} = 1.43\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

CKT4 Rating:

$$I = \frac{P(SB8)}{V \times pf} = \frac{420}{220 \times 0.7} = 2.73\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

To Emergency Sub-Distribution Board (ESDB):

ESB1: P = ESB2 + ESS1 + F2 + LB2 + TL1 = 120 + 100 + 100 + 20 + 20 = 360 W

ESB2: P = ESS2 + LB3 = 100 + 20 = 120 W

ESB3: P = ESS3 + F3 + LB5 = 100 + 100 + 20 = 220 W

ESB4: P = ESB3 + LB6 = 220 + 20 = 240 W

ESB5: P = ESS4 + F4 + LB8 = 100 + 100 + 20 = 220 W

ESB6: P = LB9 = 20 W

ESB7: P = ESB5 + ESB6 + ESS5 + F5 + LB10 = 220 + 20 + 100 + 100 + 20 = 460 W

ESB8: P = ESS6 + F6 + TL4 = 100 + 100 + 20 = 220 W

ESB9: P = ESS7 + LB12 = 100 + 20 = 120 W

ESB10: P = CL2 = 20 W

CKT1' Rating:

$$I = \frac{P(ESB4)}{V \times pf} = \frac{240}{220 \times 0.7} = 1.56\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

CKT2' Rating:

$$I = \frac{P(ESB1)}{V \times pf} = \frac{360}{220 \times 0.7} = 2.34\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

CKT3' Rating:

$$I = \frac{P(ESB7)}{V \times pf} = \frac{460}{220 \times 0.7} = 2.99\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

CKT4' Rating:

$$I = \frac{P(ESB8)}{V \times pf} = \frac{220}{220 \times 0.7} = 1.43\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

CKT5' Rating:

$$I = \frac{P(ESB9)}{V \times pf} = \frac{120}{220 \times 0.7} = 0.78\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

CKT6' Rating:

$$I = \frac{P(ESB10)}{V \times pf} = \frac{20}{220 \times 0.7} = 0.13\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

- **First Floor (Smaller Unit):**

To Sub-Distribution Board (SDB):

SB1: P = SB2 + SS1 + TL1 = 20 + 100 + 20 = 140 W

SB2: P = LB3 = 20 W

SB3: P = SS2 + TL2 = 100 + 20 = 120 W

SB4: P = SS3 + F5 + LB7 = 100 + 100 + 20 = 220 W

SB5: P = SS4 + EXF1 + LB9 = 100 + 60 + 20 = 180 W

SB6: P = SB3 + SB5 + SS5 + LB10 = 120 + 180 + 100 + 20 = 420 W

CKT1 Rating:

$$I = \frac{P(SB1)}{V \times pf} = \frac{140}{220 \times 0.7} = 0.91\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

CKT2 Rating:

$$I = \frac{P(SB4)}{V \times pf} = \frac{220}{220 \times 0.7} = 1.43\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

CKT3 Rating:

$$I = \frac{P(SB6)}{V \times pf} = \frac{420}{220 \times 0.7} = 2.73\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

To Emergency Sub-Distribution Board (ESDB):

ESB1: P = ESS1 + F1 + LB1 = 100 + 100 + 20 = 220 W

ESB2: P = ESB1 + LB2 = 220 + 20 = 240 W

ESB3: P = ESS2 + F2 + LB4 = 100 + 100 + 20 = 220 W

ESB4: P = LB5 = 20 W

ESB5: P = ESB3 + ESB4 + ESS3 + F3 + LB6 = 220 + 20 + 100 + 100 + 20 = 460 W

ESB6: P = ESS4 + F4 + TL3 = 100 + 100 + 20 = 220 W

ESB7: P = ESS5 + LB8 = 100 + 20 = 120 W

ESB8: P = CL2 = 20 W

CKT1' Rating:

$$I = \frac{P(ESB2)}{V \times pf} = \frac{240}{220 \times 0.7} = 1.56\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

CKT2' Rating:

$$I = \frac{P(ESB5)}{V \times pf} = \frac{460}{220 \times 0.7} = 2.99\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

CKT3' Rating:

$$I = \frac{P(ESB6)}{V \times pf} = \frac{220}{220 \times 0.7} = 1.43\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

CKT4' Rating:

$$I = \frac{P(ESB7)}{V \times pf} = \frac{120}{220 \times 0.7} = 0.78\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

CKT5' Rating:

$$I = \frac{P(ESB8)}{V \times pf} = \frac{20}{220 \times 0.7} = 0.13\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

- **Second Floor to Fifth Floor (Both Units):**

To Sub-Distribution Board (SDB):

SB1: P = SS1 + TL1 = 100 + 20 = 100 W

SB2: P = SB1 + SB3 + LB3 = 100 + 20 + 20 = 140 W

SB3: P = LB6 = 20 W

SB4: P = SS2 + TL2 = 100 + 20 = 120 W

SB5: P = SS3 + F6 + LB10 = 100 + 100 + 20 = 220 W

SB6: P = SS4 + EXF1 + LB12 = 100 + 60 + 20 = 180 W

SB7: P = SB4 + SB6 + SS5 + LB13 = 120 + 180 + 100 + 20 = 420 W

CKT1 Rating:

$$I = \frac{P(SB2)}{V \times pf} = \frac{140}{220 \times 0.7} = .91\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

CKT2 Rating:

$$I = \frac{P(SB5)}{V \times pf} = \frac{220}{220 \times 0.7} = 1.43\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

CKT3 Rating:

$$I = \frac{P(SB7)}{V \times pf} = \frac{420}{220 \times 0.7} = 2.73\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

To Emergency Sub-Distribution Board (ESDB):

ESB1: P = ESS1 + F1 + LB1 = 100 + 100 + 20 = 220 W

ESB2: P = ESB1 + LB2 = 220 + 20 = 240 W

ESB3: P = ESB4 + ESS2 + F2 + LB4 = 120 + 100 + 100 + 20 = 340 W

ESB4: P = ESS3 + LB5 = 100 + 20 = 120 W

ESB5: P = ESS4 + F3 + LB7 = 100 + 100 + 20 = 220 W

ESB6: P = LB8 = 20 W

ESB7: P = ESB5 + ESB6 + ESS5 + F4 + LB9 = 220 + 20 + 100 + 100 + 20 = 460 W

ESB8: P = ESS6 + F5 + TL3 = 100 + 100 + 20 = 220 W

ESB9: P = ESS7 + LB11 = 100 + 20 = 120 W

ESB10: P = CL2 = 20 W

CKT1' Rating:

$$I = \frac{P(ESB2)}{V \times pf} = \frac{240}{220 \times 0.7} = 1.56\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

CKT2' Rating:

$$I = \frac{P(ESB3)}{V \times pf} = \frac{340}{220 \times 0.7} = 2.21\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

CKT3' Rating:

$$I = \frac{P(ESB7)}{V \times pf} = \frac{460}{220 \times 0.7} = 2.99\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

CKT4' Rating:

$$I = \frac{P(ESB8)}{V \times pf} = \frac{220}{220 \times 0.7} = 1.43\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

CKT5' Rating:

$$I = \frac{P(ESB9)}{V \times pf} = \frac{120}{220 \times 0.7} = 0.78\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used.

CKT6' Rating:

$$I = \frac{P(ESB10)}{V \times pf} = \frac{20}{220 \times 0.7} = 0.13\ A < 5\ A$$

So, 2x1.5 rm BYM + 1.5 rm BYAECC are used

❖ Calculations for SDB and ESDB:

Formula:

SDB load = Total load x 0.7 + Total P socket load x 0.2 + Total Q socket load x 0.2

ESDB load = Total load x 0.7 + Total P socket load x 0.2 + Total Q socket load x 0.2

$$SDB\ current = \frac{SDB\ load}{Voltage \times pf}$$

$$ESDB\ current = \frac{ESDB\ load}{Voltage \times pf}$$

Assumptions:

P load = 3000 W

Q load = 4000 W

Voltage = 220 V

Power factor, pf = 0.7

➢ Ground Floor (Single Unit):

Sub-Distribution Board (SDB):

Total load = CKT1 load + CKT2 load + CKT3 load + CKT4 load + CKT5 load

CKT1 load = 100 + 20 + 20 + 20 + 140 = 300 W

CKT2 load = 20 + 60 + 20 = 100 W

CKT3 load = 100 + 20 = 120 W

CKT4 load = 100 + 20 + 100 = 220 W

CKT5 load = 20 W

Total load = 760 W

SDB load = 760 x 0.7 + 4 x 3000 x 0.2 + 3 x 4000 x 0.2 = 5332 W

$$SDB\ current = \frac{5332}{220\ \times 0.7} = 34.62\ A$$

So, 40 A SP MCCB is needed from SDB to MDB

Emergency Sub-Distribution Board (ESDB):

Total load = CKT1' load + CKT2' load + CKT3' load

CKT1' load = 100 + 100 + 20 = 220 W

CKT2' load = 100 + 20 + 20 + 300 + 60 = 500 W

CKT3' load = 100 + 20 + 100 = 220 W

Total load = 940 W

ESDB load = 940 x 0.7 + 2 x 3000 x 0.2 = 1858 W

$$ESDB\ current = \frac{1858}{220\ \times 0.7} = 12.06\ A$$

So, 15 A SP MCCB is needed from ESDB to EMDB

- ## Ground Floor (Parking Area):

Sub-Distribution Board (SDB):

Total load = CKT1 load + CKT2 load + CKT3 load + CKT4 load + CKT5 + CKT6 + CKT7 + CKT8 load

CKT1 load = 100 + 100 + 20 = 220 W

CKT2 load = 20 + 20 = 40 W

CKT3 load = 20 + 20 = 40 W

CKT4 load = 20 = 20 W

CKT5 load = 20 = 20 W

CKT6 load = 20 = 20 W

CKT7 load = 20 = 20 W

CKT8 load = 20 = 20 W

Total load = 400 W

SDB load = 400 x 0.7 = 280W

$$SDB\ current = \frac{280}{220\ \times 0.7} = 1.82\ A$$

So, 5 A SP MCCB is needed from SDB to MDB

Emergency Sub-Distribution Board (ESDB):

Total load = CKT1' load + CKT2' load + CKT3' load

CKT1' load = 20 W

CKT2' load = 20 + 20 + 20 + 20 + 20 = 100 W

CKT3' load = 20 W + 60W = 80W

Total load = 200 W

ESDB load = 200 x 0.7 = 140 W

$$ESDB\ current = \frac{140}{220\ \times 0.7} = .90\ A$$

So, 5 A SP MCCB is needed from ESDB to EMDB

- **First Floor (Bigger Unit):**

Sub-Distribution Board (SDB):

Total load = CKT1 load + CKT2 load + CKT3 load + CKT4 load

CKT1 load = 100 + 100 + 20 = 220 W

CKT2 load = 20 + 120 + 20 = 160 W

CKT3 load = 100 + 100 + 20 = 220 W

CKT4 load = 120 + 180 + 100 + 20 = 420 W

Total load = 1020 W

SDB load = 1020 x 0.7 + 2 x 3000 x 0.2 + 3 x 4000 x 0.2 = 4314 W

$$SDB\ current = \frac{4314}{220\ \times 0.7} = 28.013\ A$$

So, 30 A SP MCCB is needed from SDB to MDB

Emergency Sub-Distribution Board (ESDB):

Total load = CKT1' load + CKT2' load + CKT3' load + CKT4' load + CKT5' load + CKT6' load

CKT1' load = 220 + 20 = 240 W

CKT2' load = 120 + 100 + 100 + 20 + 20 = 360 W

CKT3' load = 220 + 20 + 100 + 100 + 20 = 460 W

CKT4' load = 100 + 100 + 20 = 220 W

CKT5' load = 100 + 20 = 120 W

CKT6' load = 20 W

Total load = 1420 W

ESDB load = 1420 x 0.7 + 4 x 3000 x 0.2 + 1 x 4000 x 0.2 = 4194 W

$$ESDB\ current = \frac{4194}{220\ \times 0.7} = 27.234\ A$$

So, 30 A SP MCCB is needed from ESDB to EMDB

- **First Floor (Smaller Unit):**

Sub-Distribution Board (SDB):

Total load = CKT1 load + CKT2 load + CKT3 load

CKT1 load = 100 + 20 + 20 = 140 W

CKT2 load = 100 + 100 + 20 = 220 W

CKT3 load = 120 + 180 + 100 + 20 = 420 W

Total load = 780 W

SDB load = 780 x 0.7 + 2 x 3000 x 0.2 + 3 x 4000 x 0.2 = 4146 W

$$SDB\ current = \frac{4146}{220\ \times 0.7} = 26.922\ A$$

So, 30 A SP MCCB is needed from SDB to MDB

Emergency Sub-Distribution Board (ESDB):

Total load = CKT1' load + CKT2' load + CKT3' load + CKT4' load + CKT5' load

CKT1' load = 220 + 20 = 240 W

CKT2' load = 220 + 20 + 100 + 100 + 20 = 460 W

CKT3' load = 100 + 100 + 20 = 220 W

CKT4' load = 100 + 20 = 120 W

CKT5' load = 20 W

Total load = 1060 W

ESDB load = 1060 x 0.7 + 3 x 3000 x 0.2 + 0 x 4000 x 0.2 = 2542 W

$$ESDB\ current = \frac{2542}{220\ \times 0.7} = 16.506\ A$$

So, 20 A SP MCCB is needed from ESDB to EMDB

- ## Second Floor to Fifth Floor (Both Units):

Sub-Distribution Board (SDB):

Total load = CKT1 load + CKT2 load + CKT3 load

CKT1 load = 120 + 20 = 140 W

CKT2 load = 100 + 100 + 20 = 220 W

CKT3 load = 120 + 180 + 100 + 20 = 420 W

Total load = 780 W

SDB load = 780 x 0.7 + 1 x 3000 x 0.2 + 3 x 4000 x 0.2 = 3546 W

$$SDB\ current = \frac{3546}{220\ \times 0.7} = 23.026\ A$$

So, 30 A SP MCCB is needed from SDB to MDB

Emergency Sub-Distribution Board (ESDB):

Total load = CKT1' load + CKT2' load + CKT3' load + CKT4' load + CKT5' load + CKT6' load

CKT1' load = 220 + 20 = 240 W

CKT2' load = 120 + 100 + 100 + 20 = 340 W

CKT3' load = 220 + 20 + 100 + 100 + 20 = 460 W

CKT4' load = 100 + 100 + 20 = 220 W

CKT5' load = 100 + 20 = 120 W

CKT6' load = 20 W

Total load = 1400 W

ESDB load = 1400 x 0.7 + 5 x 3000 x 0.2 + 0 x 4000 x 0.2 = 3980 W

$$ESDB\ current = \frac{3980}{220\ \times 0.7} = 25.844\ A$$

So, 30 A SP MCCB is needed from ESDB to EMDB

❖ Calculations for EMDB:

EMDB Load = Total ESDB Load x 0.7 + Lift Load x 0.7

Total ESDB Load = ESDB_Gnd_unit + ESDB_Parking + ESDB_FF_unit1 + ESDB_FF_unit2 + ESDB_SF x 8

= 1858 + 140 + 4194 + 2542 + 3980 x 8

= 40574 W

EMDB Current = $\frac{EMDB\ Load}{\sqrt{3} * Line\ Voltage * pf}$

Phase Voltage = 220 V

Line Voltage = $\sqrt{3}$ * 220 V = 381.05 V

Power Factor, pf = 0.7

Lift Load = 5000 W

EMDB Load = 40574 x 0.7 + 5000 x 0.7= 31901.8 W

$$EMDB\ current = \frac{31901.8}{\sqrt{3} \times 381.05 \times 0.7} = 69.05\ A$$

So, 70 A TP MCCB 2x50 rm NYY + 25 rm BYAECC is needed from EMDB to MDB

A 40 KW Generator is used to supply the EMDB Load through an ATS.

Calculations for MDB

MDB load = Total SDB load x 0.7 + (EMDB load + Pump load) x 0.7

Total SDB load = SDB_Gnd_unit + SDB_Parking + SDB_FF_unit1 + SDB_FF_unit2

+ SDB_SF_unit x 2

= 5332 + 280 + 4314 + 4146 +3546 x 8

= 42440 W

$$MDB\ current = \frac{MDB\ Load}{\sqrt{3} * Line\ Voltage * pf}$$

Phase Voltage = 220 V

Line Voltage = $\sqrt{3}$ x 220 V = 381.05 V

Power Factor, pf = 0.95 (Due to PFI plant)

Total SDB load = 42440 W

EMDB load = 31901.8 W

Pump load = 5000 W

MDB load = 42440 x 0.7 + (31901.8 + 5000) x 0.7 = 55539.26 W

$$MDB\ current = \frac{55539.26}{\sqrt{3} \times 381.05 \times 0.95} = 88.58\ A$$

So, 100 A TP MCCB 4x70 rm NYY + 35 rm BYAECC is needed from MDB to Main Line

❖ Calculations for PFI Plant:

$cos\theta = 0.7, sin\theta = \sqrt{1 - (cos\theta)^2} = 0.714$

$Q = 3VIsin\theta = Ptan\theta = 56.66\ KVAR$

After pf improvement sinθ = 1

$$I = \frac{Q}{3 \times V \times sin\theta} = 85.85\ A$$

So, 100A TP MCCB 4x70 rm NYY + 35 rm is needed from PFI to MDB

❖ Calculations for Minimum Load Density:

➢ Ground Floor (Single Unit):

$$Load\ density = \frac{Total\ load}{Apartment\ size\ in\ meter^2} = \frac{5332+1858}{1255 \times 0.3048^2} = 61.667\ W/m^2$$

➢ Ground Floor (Parking area):

$$Load\ density = \frac{Total\ load}{Apartment\ size\ in\ meter^2} = \frac{280+140}{1255 \times 0.3048^2} = 3.6\ W/m^2$$

➢ First Floor (Bigger Unit):

$$Load\ density = \frac{Total\ load}{Apartment\ size\ in\ meter^2} = \frac{4314 + 4194}{1452\ \times\ 0.3048^2} = 63.071\ W/m^2$$

➢ First Floor (Smaller Unit):

$$Load\ density = \frac{Total\ load}{Apartment\ size\ in\ meter^2} = \frac{4146 + 2542}{1059\ \times\ 0.3048^2} = 67.978\ W/m^2$$

➢ Second Floor to Fifth Floor (Both Units):

$$Load\ density = \frac{Total\ load}{Apartment\ size\ in\ meter^2} = \frac{3546 + 3980}{1255\ \times\ 0.3048^2} = 64.549\ W/m^2$$

Lightning Protection:

Index	Index Figure	Description	Index Value
A	Use of Structure	Houses and similar buildings	2
B	Type of Construction	Reinforced concrete with non-metal roof	2
C	Consequential effects	Ordinary domestic(not containing valuable materials)	2
D	Degree of Isolation	Structure located in an area with a few other structures of similar height	5
E	Type of Terrain	Flat terrain at any level	2
F	Height of Structure	(6(floor)+1)×10′(floor height)3.281(convert to meter)=21.34(6floor+1)×10′floor height3.281convert to meter=21.34	8

G	No. of thunderstorm days per year	Over 21	21
Total			42

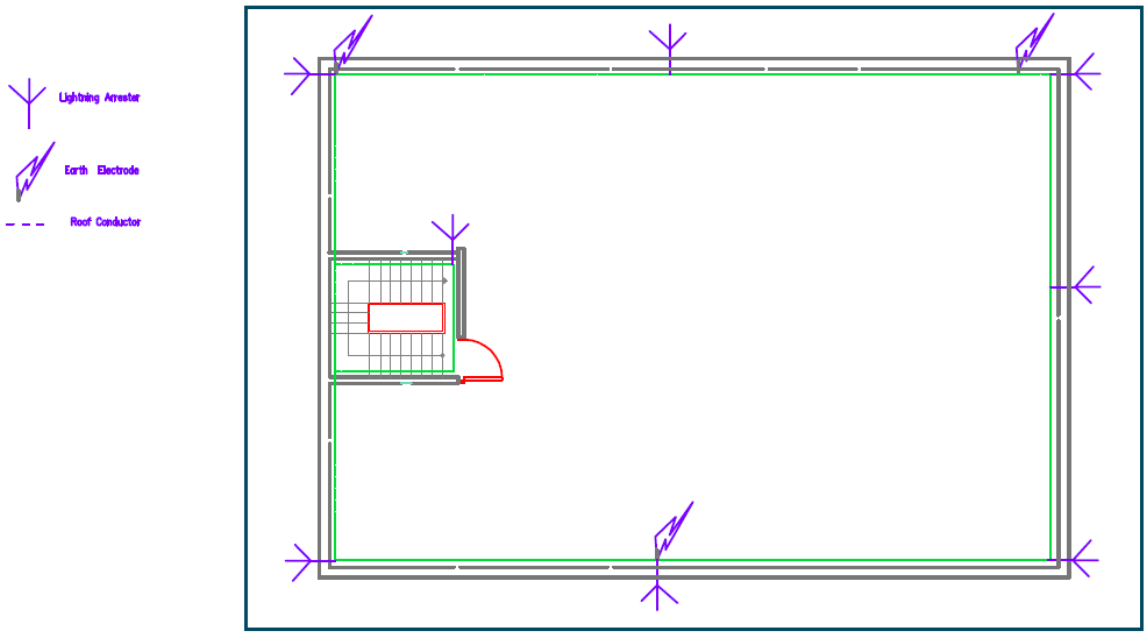
Total index number is 42 which is higher than 40. So lightning protection is essential.

LPS Design Parameters

Lightning Arrester
Rod Height = 2 m
Roof Perimeter = 2 x (41.67’ + 61.83’) = 207 ft
Here, 8 lightning arresters have been placed, 25ft distance apart.

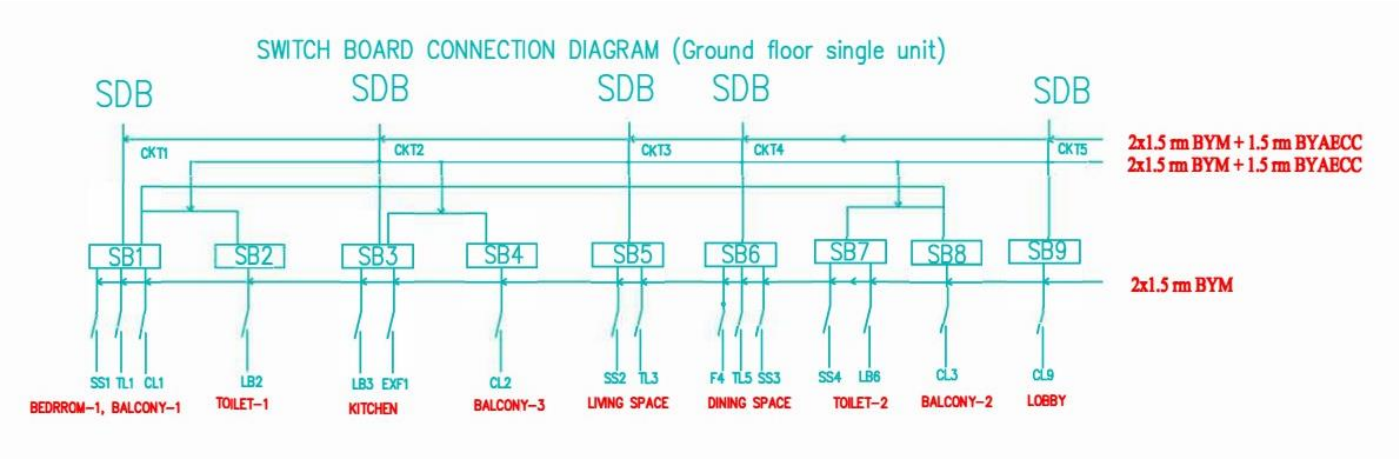
Down Conductor:
Total Area = 41.67’ x 61.83’ = 2576.45 sq. ft. = 239.36 sq. m
Number of down conductors – 1 conductor for first 180 sq. M
(239.36 - 80) /100 = 1.59 ≈ 2 extra conductors
We have used total 3 down conductors with ground electrodes.
Earth termination resistance of ground electrodes – less than 10 ohms

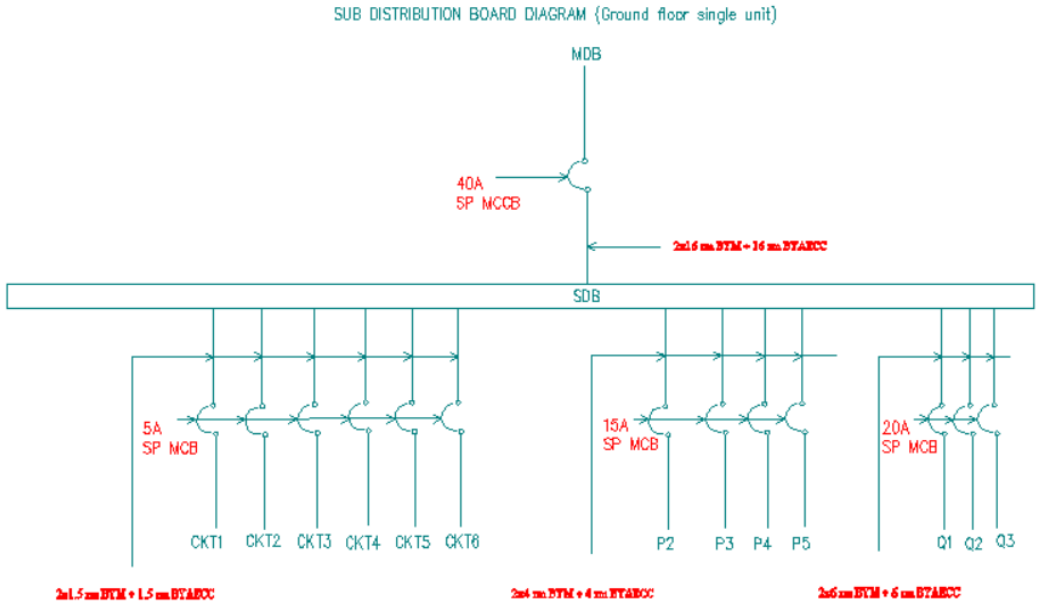
Roof Conductors:
Roof conductors are placed 6” away from the roof railing connecting all the lightning arrestors to the down conductors.



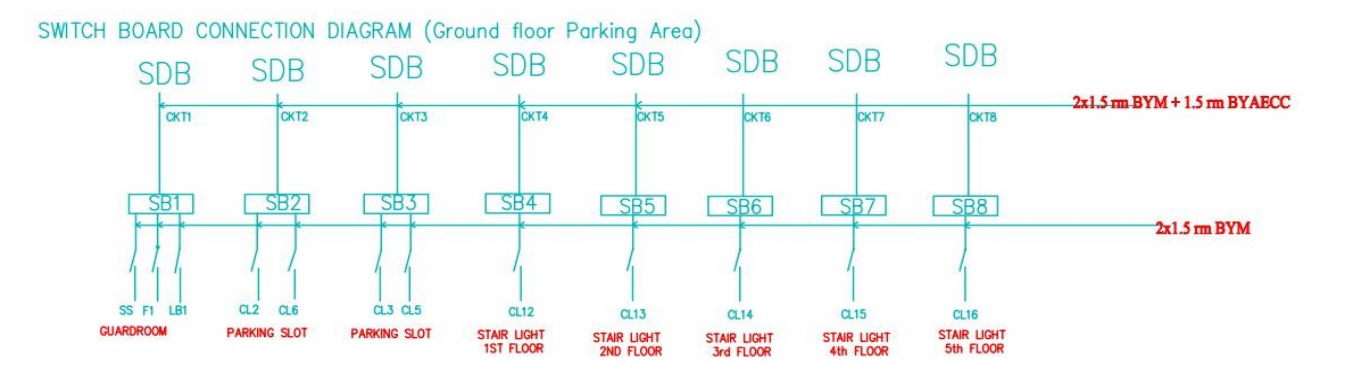
Switchboard Connection Diagrams

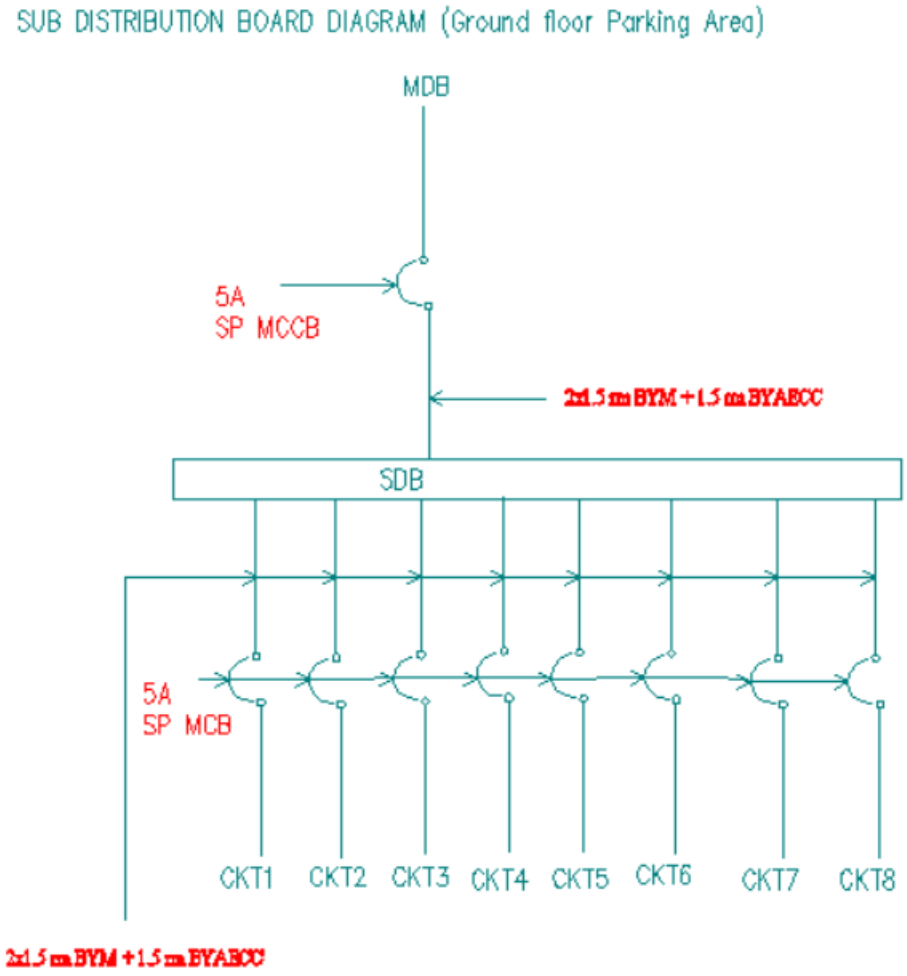
Switchboard of Ground Floor single unit



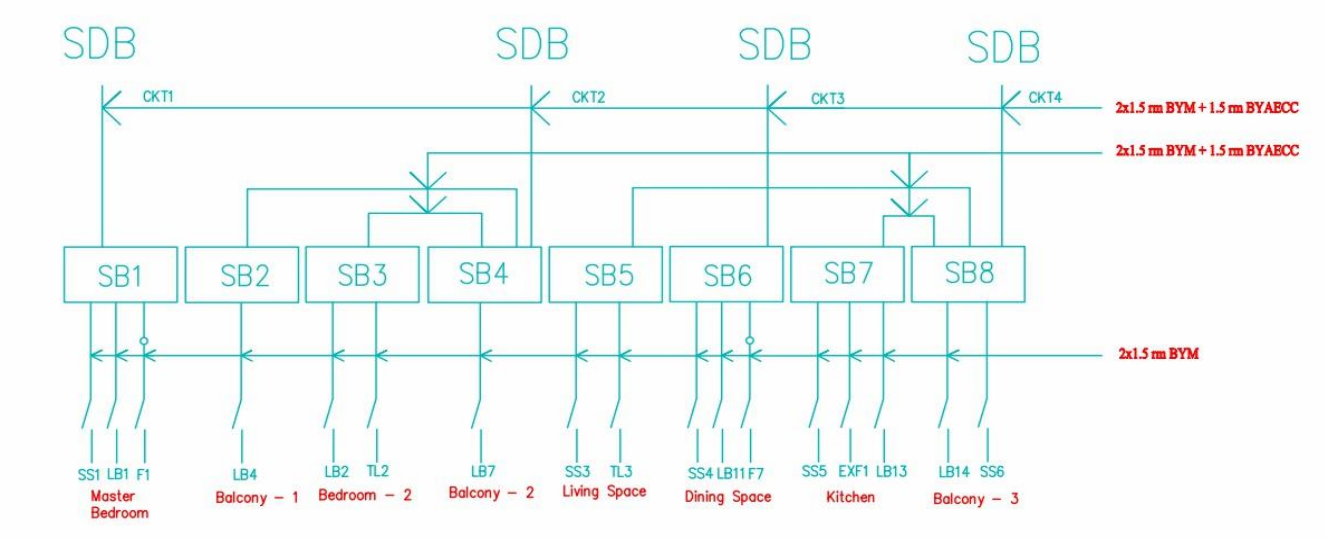


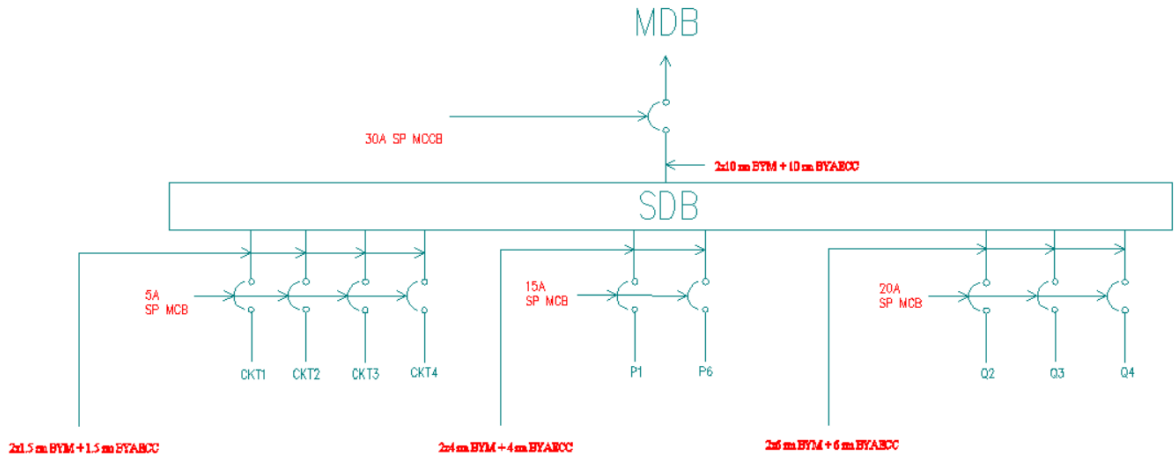
Switchboard of Ground Floor Parking Area



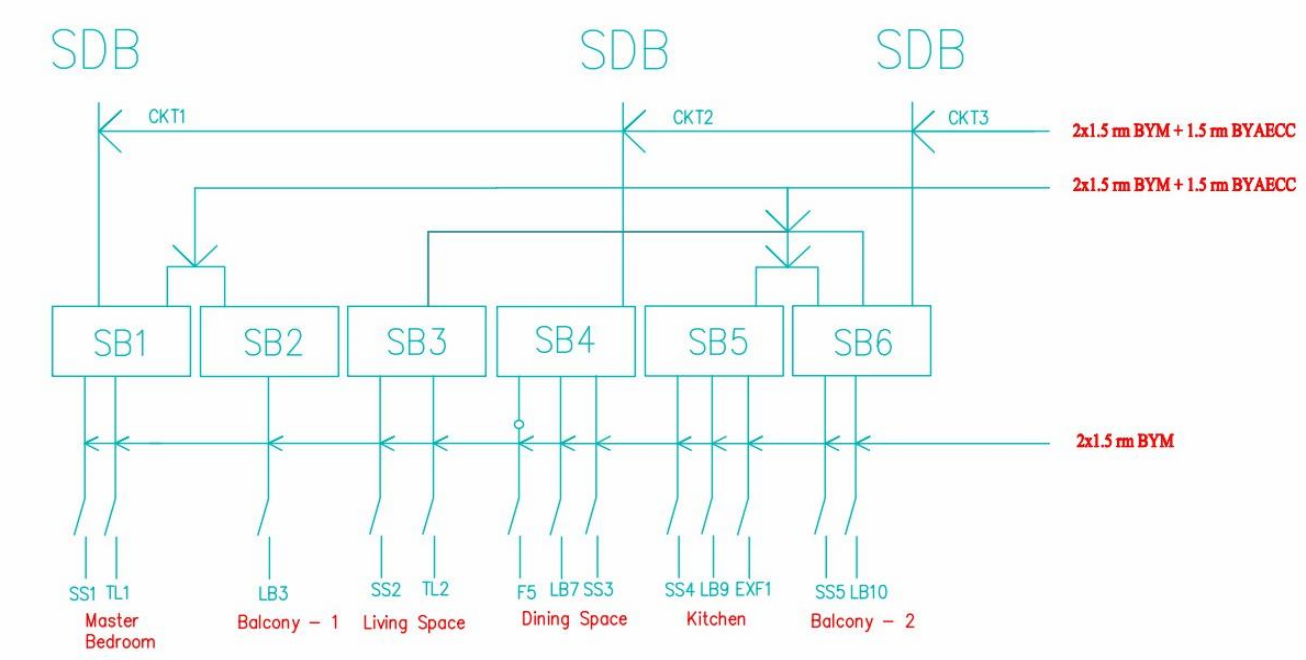


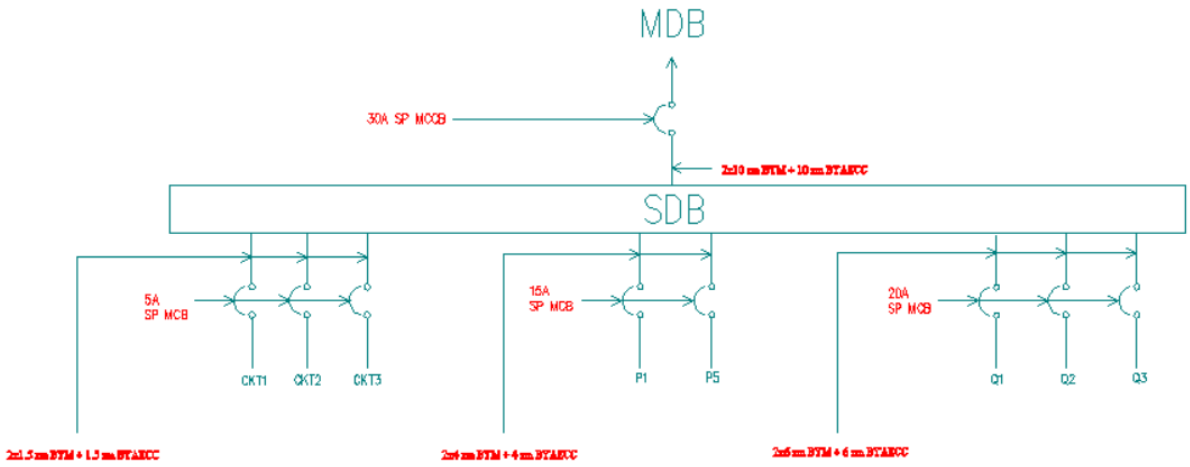
Switchboard of 1st floor (Owner's Bigger Unit)



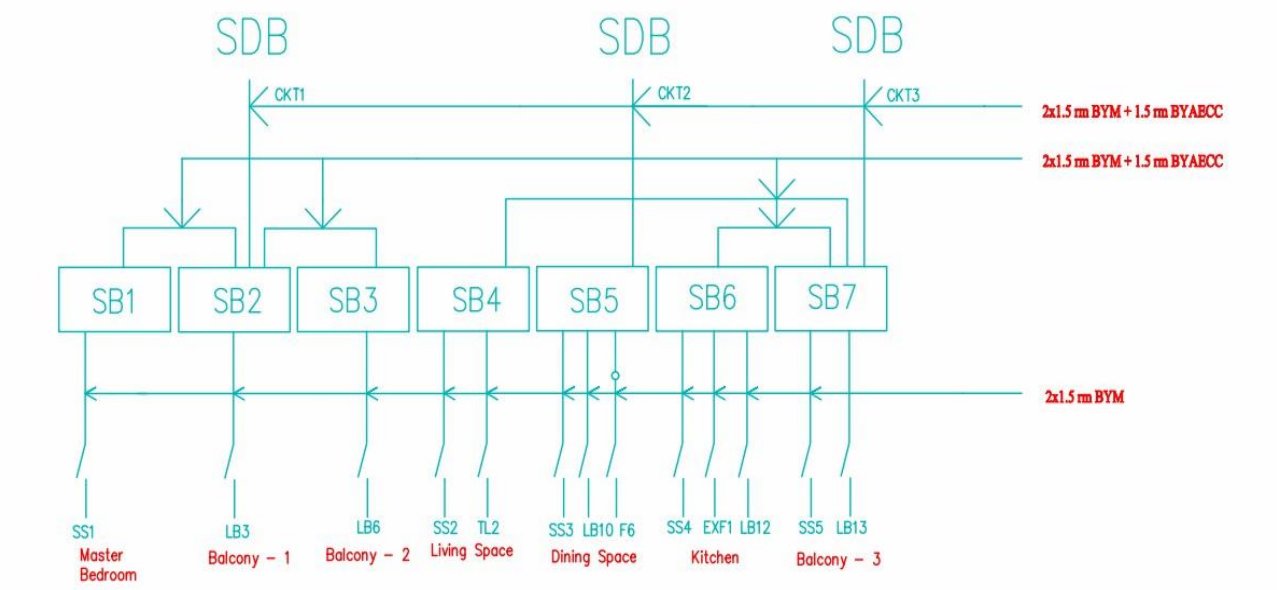


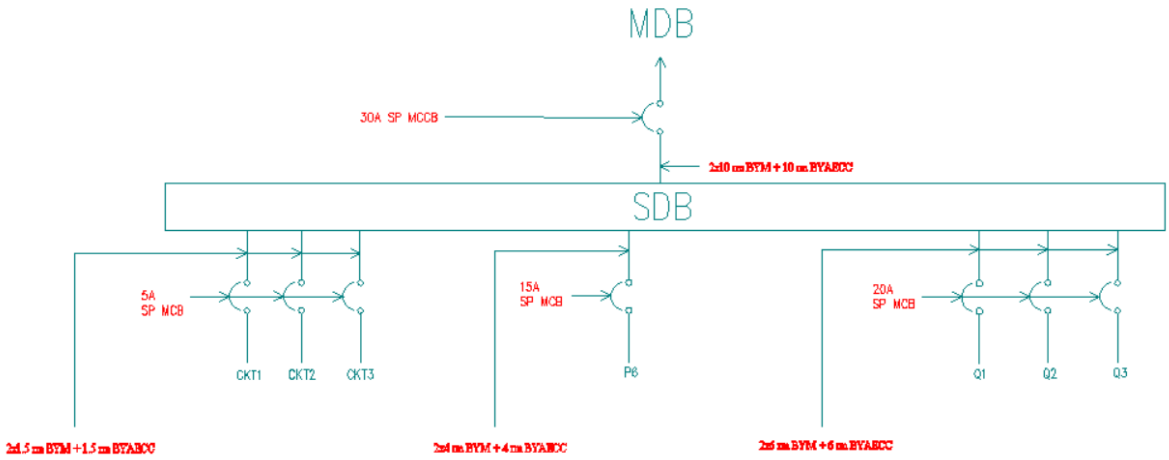
Switchboard of 1st floor (Smaller Unit)



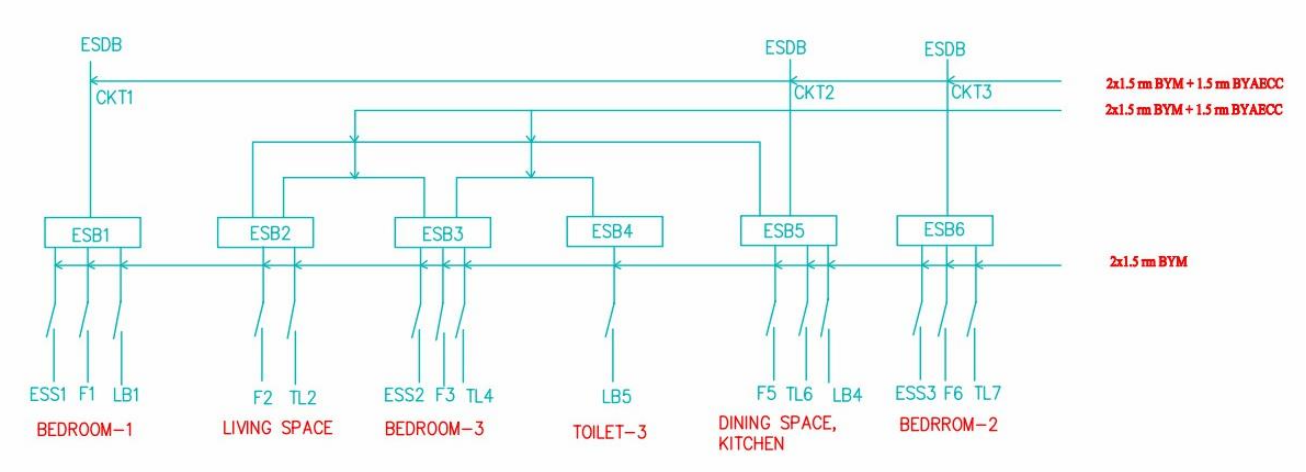


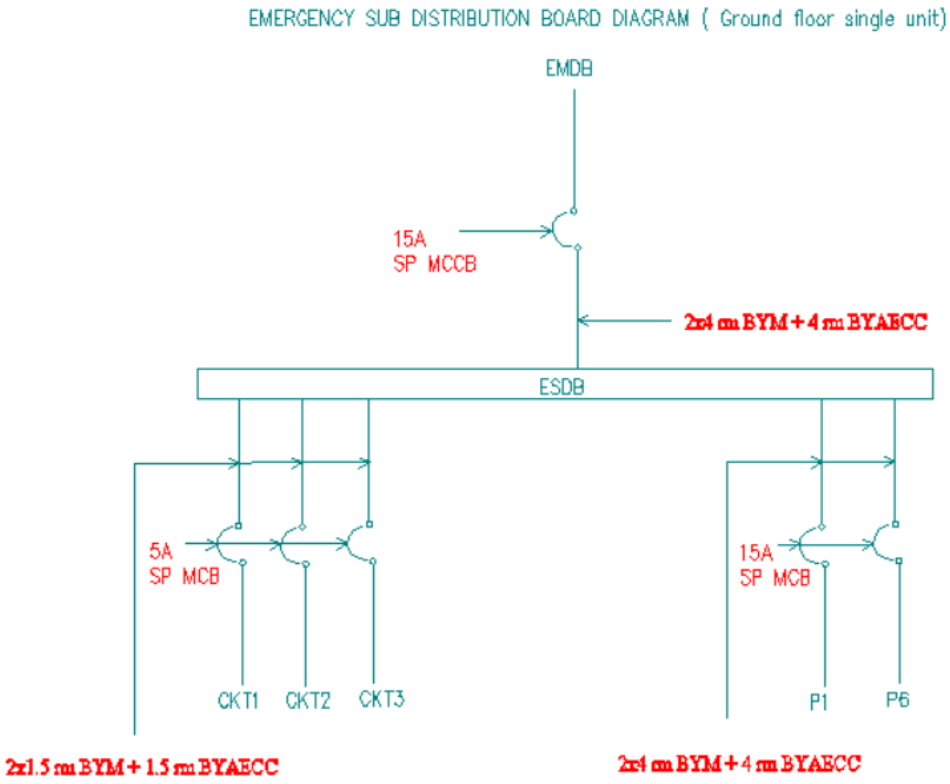
Switchboard of 2nd to 5th floor typical unit



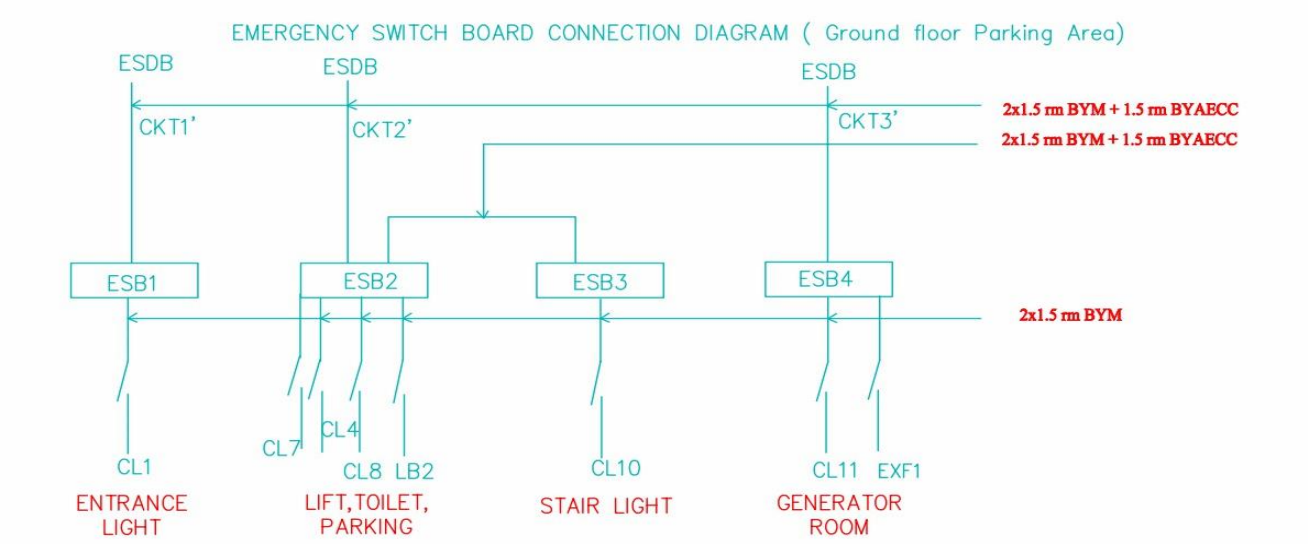


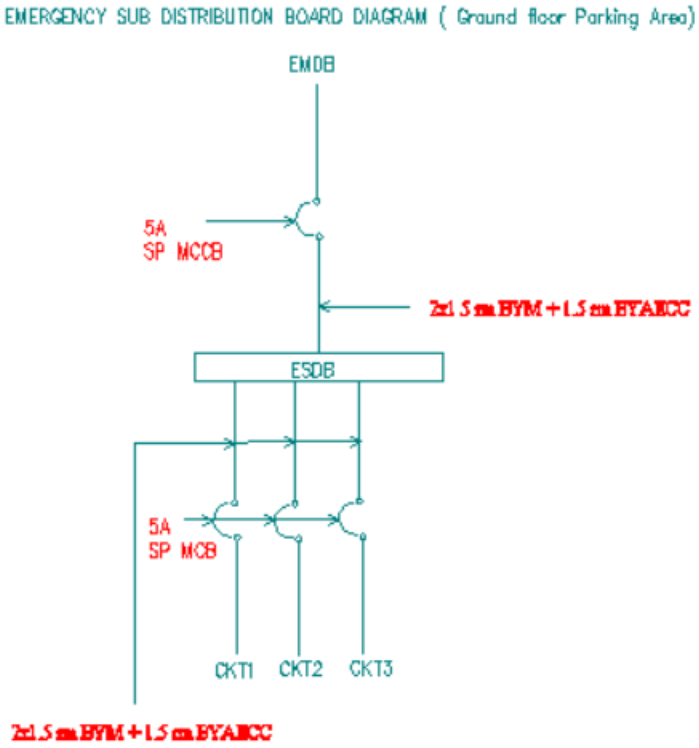
Emergency Switchboard of Ground Floor Single unit



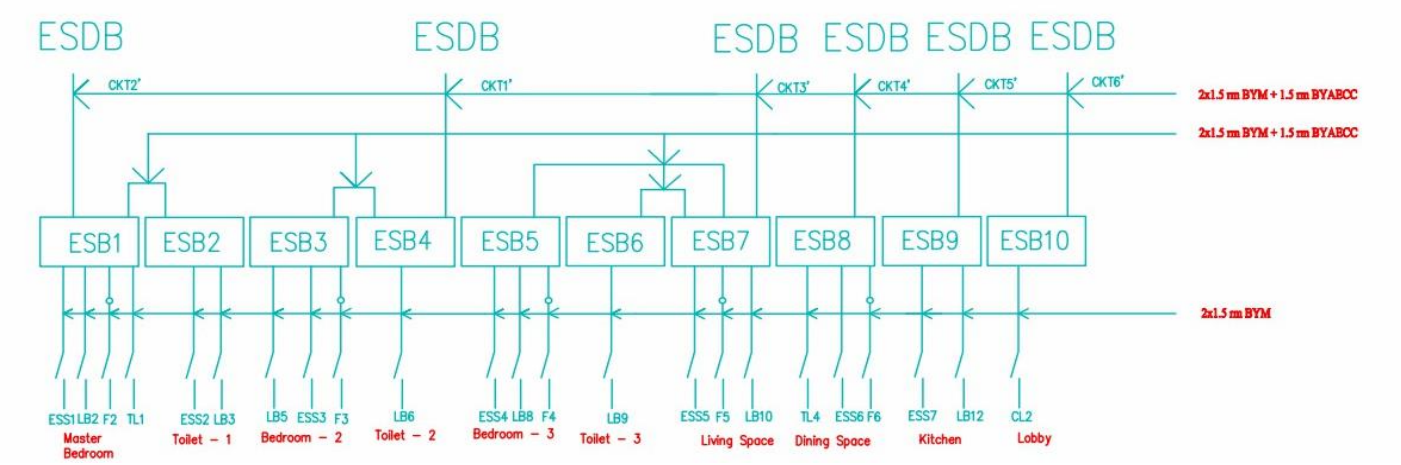


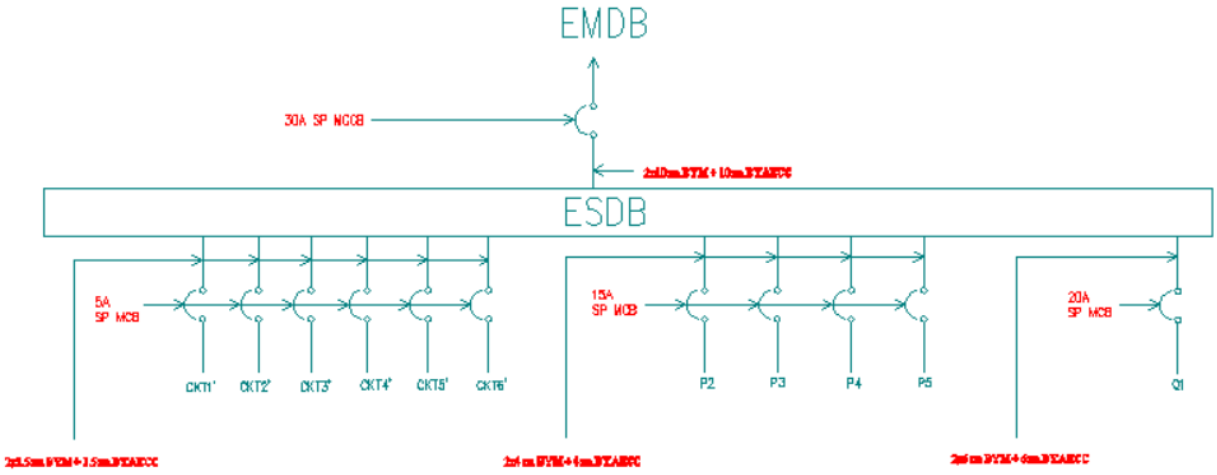
Emergency Switchboard of Ground Floor Parking Area



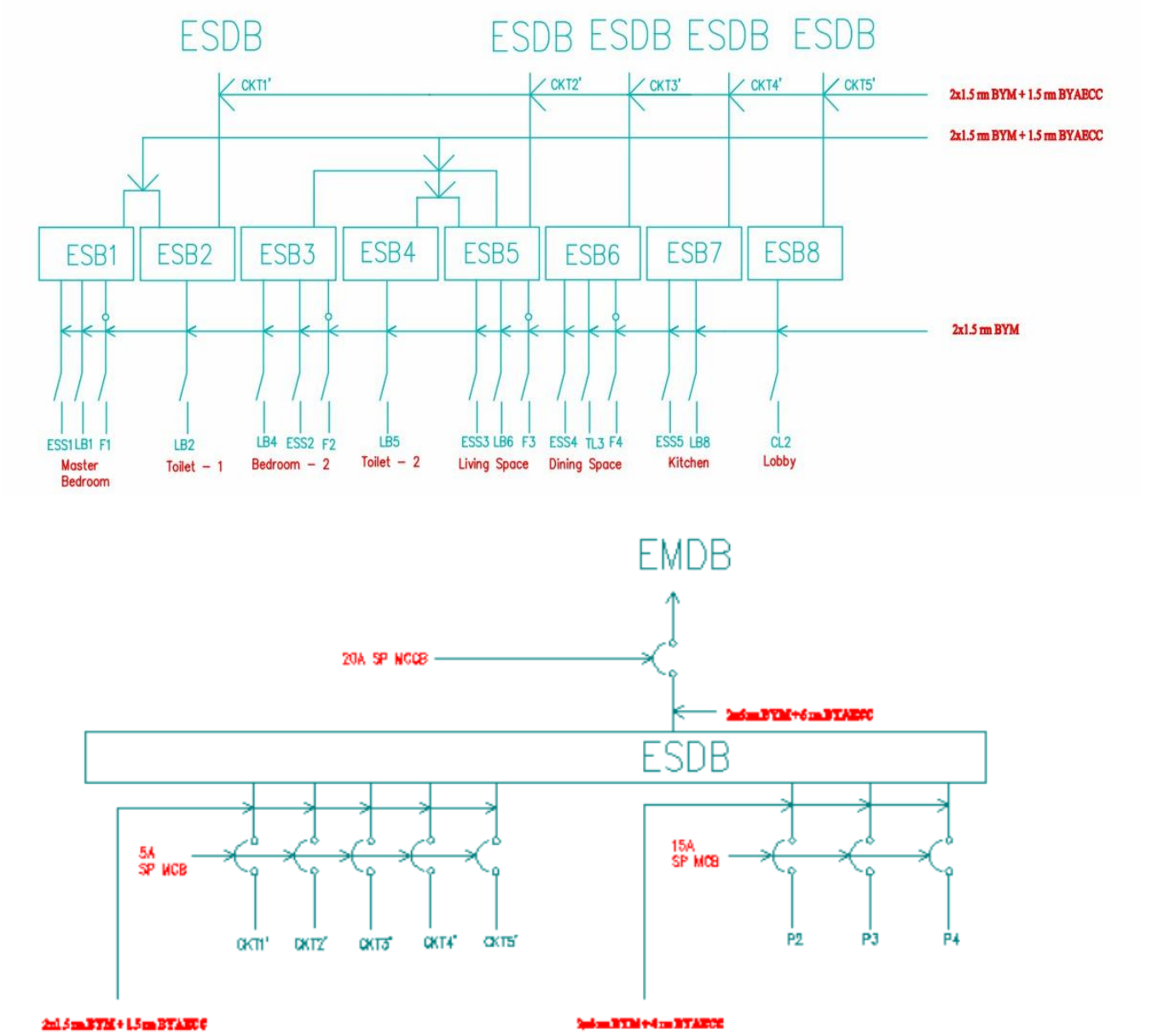


Emergency Switchboard of 1st floor (Owner's Bigger Unit)

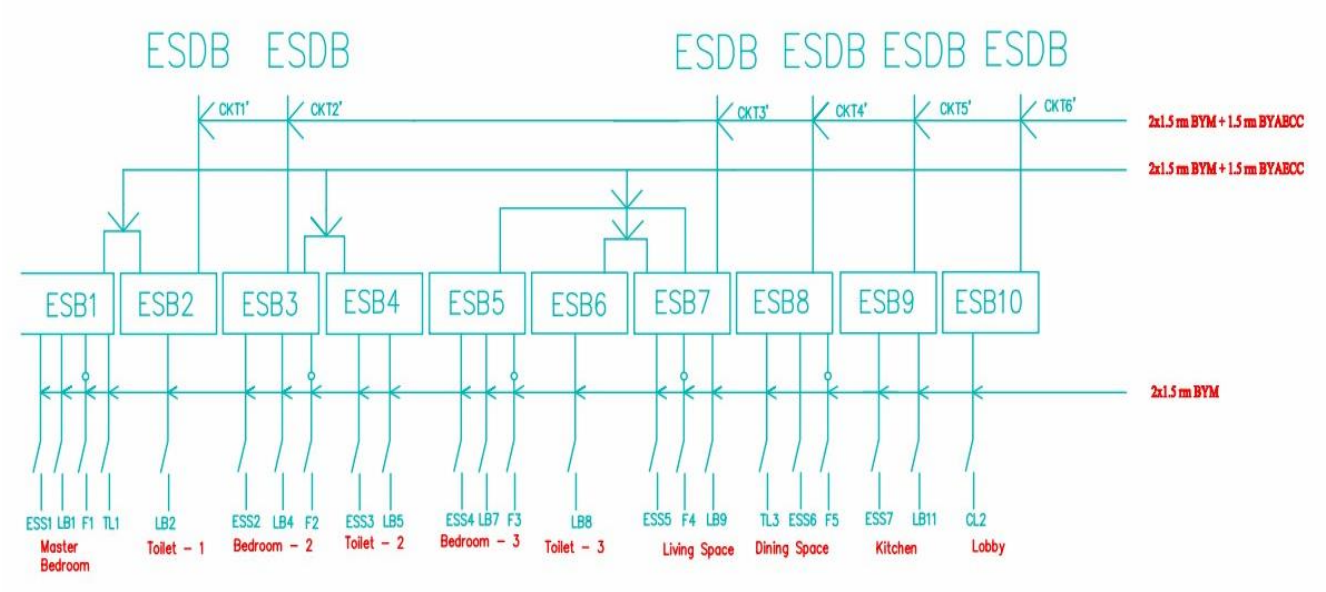


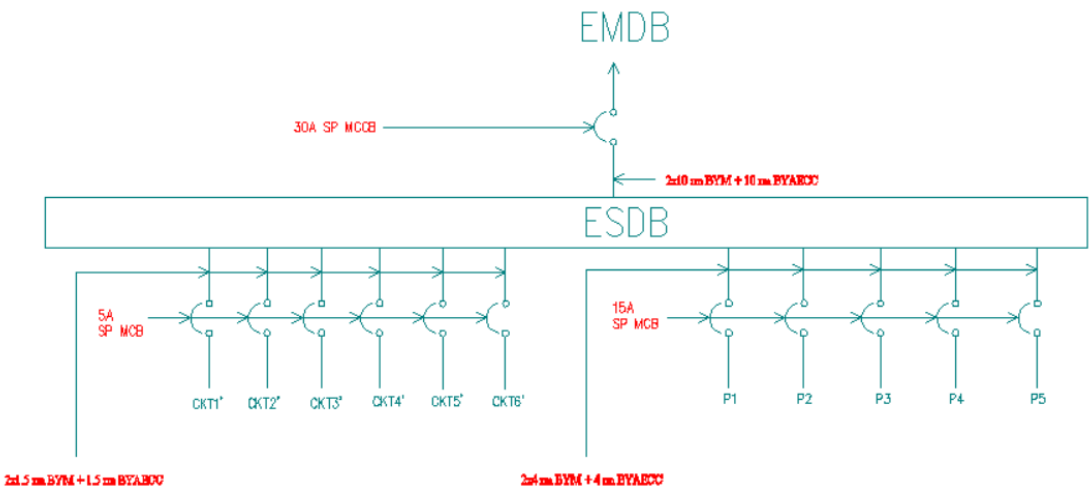


Emergency Switchboard of 1st floor (Smaller Unit)

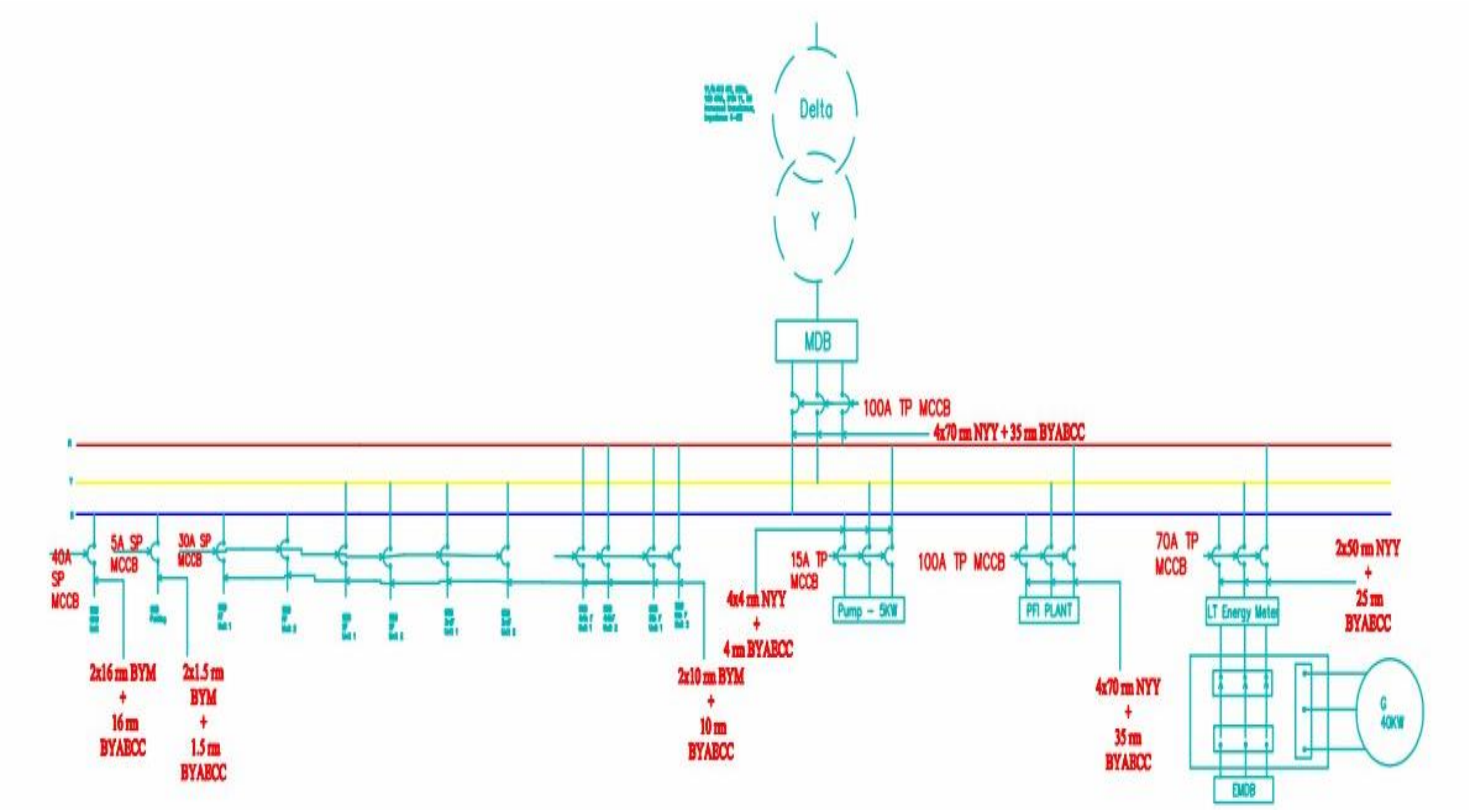


Emergency Switchboard of 2nd floor typical unit





Main Distribution Board



Emergency Main Distribution Board