BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY

Department of Electrical and Electronic Engineering

Course No. : EEE 414
Course Title : Electrical Services Design Laboratory

Electrical Services Design Project

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Group : 08

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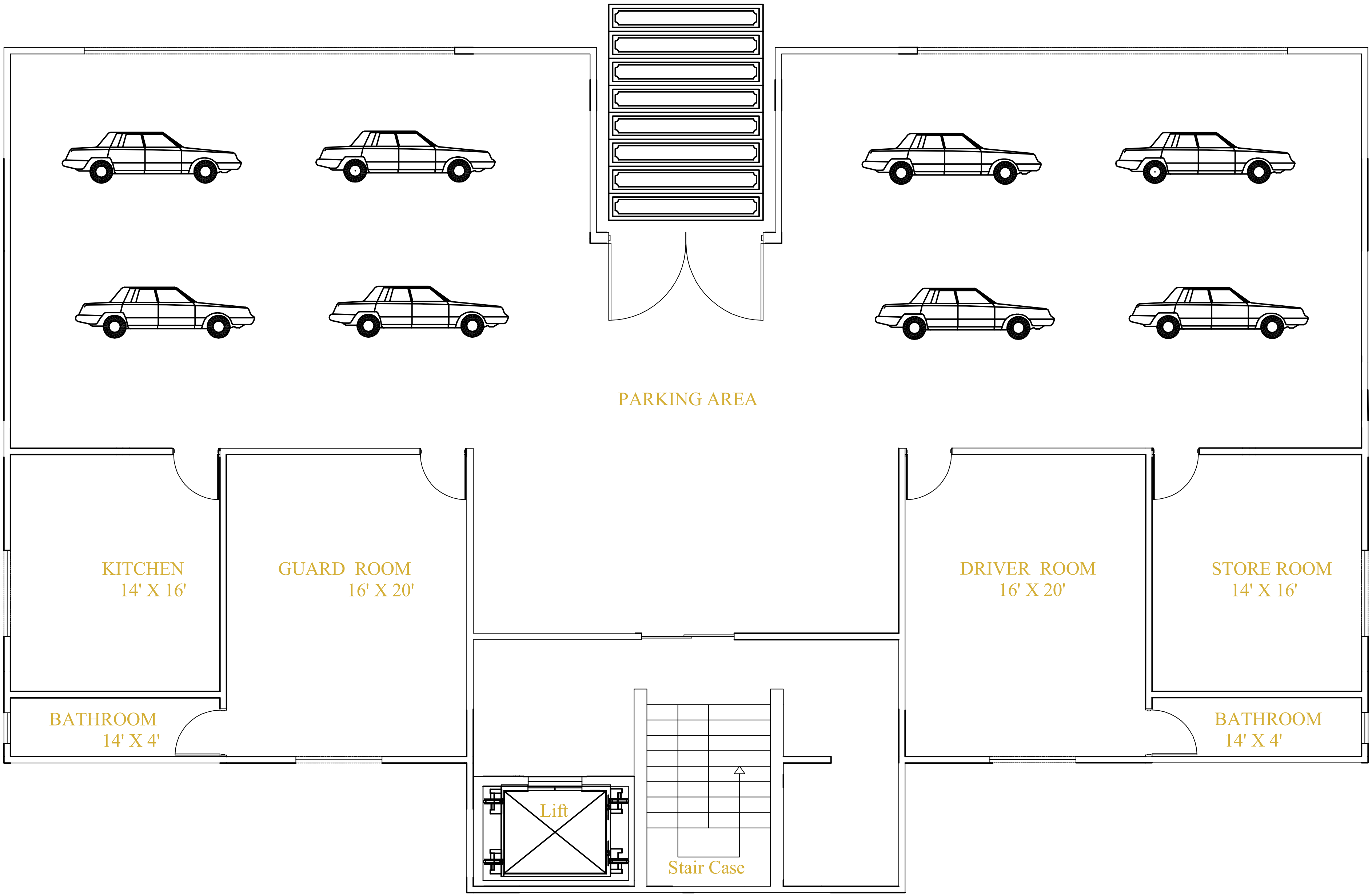
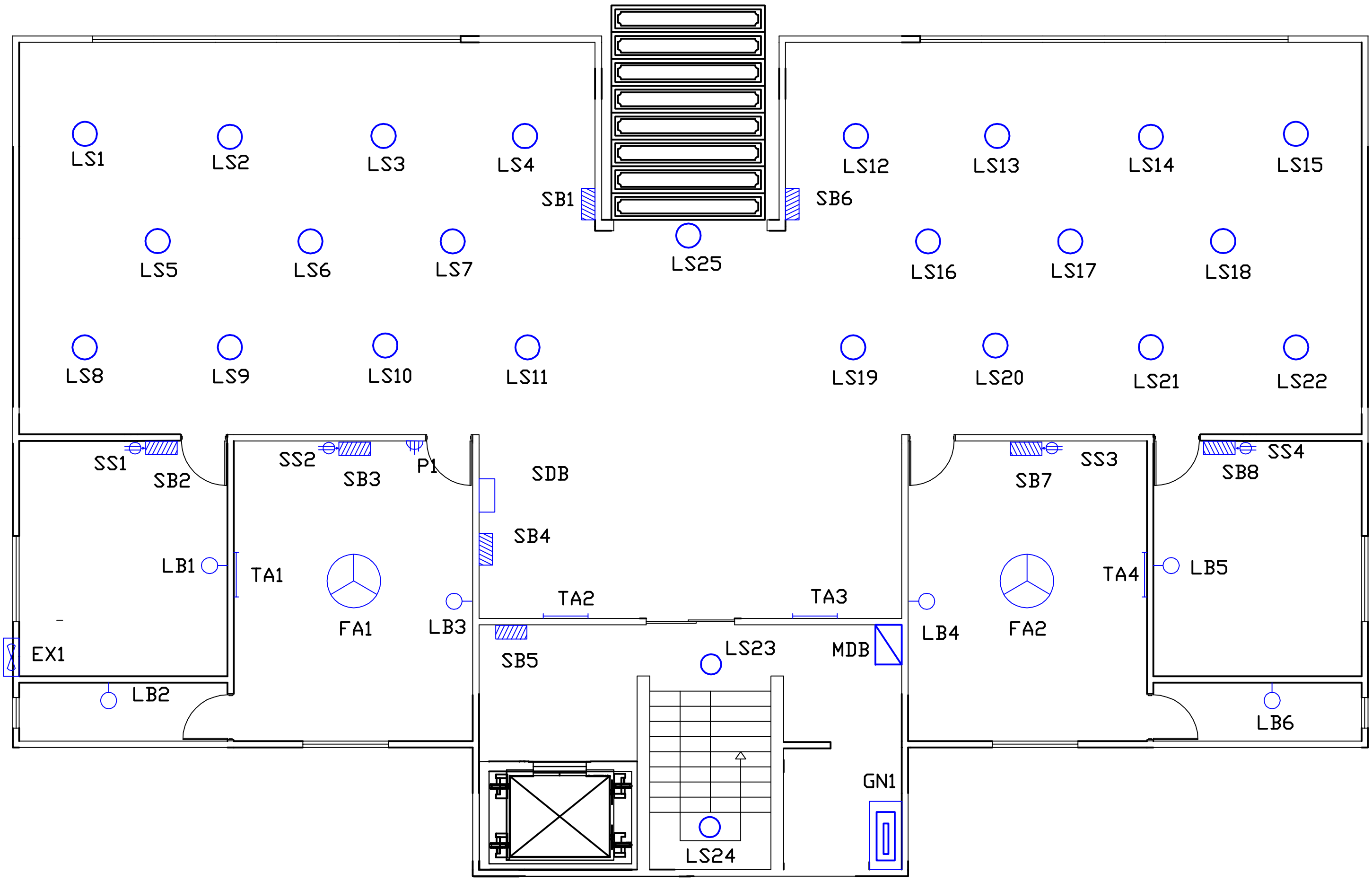
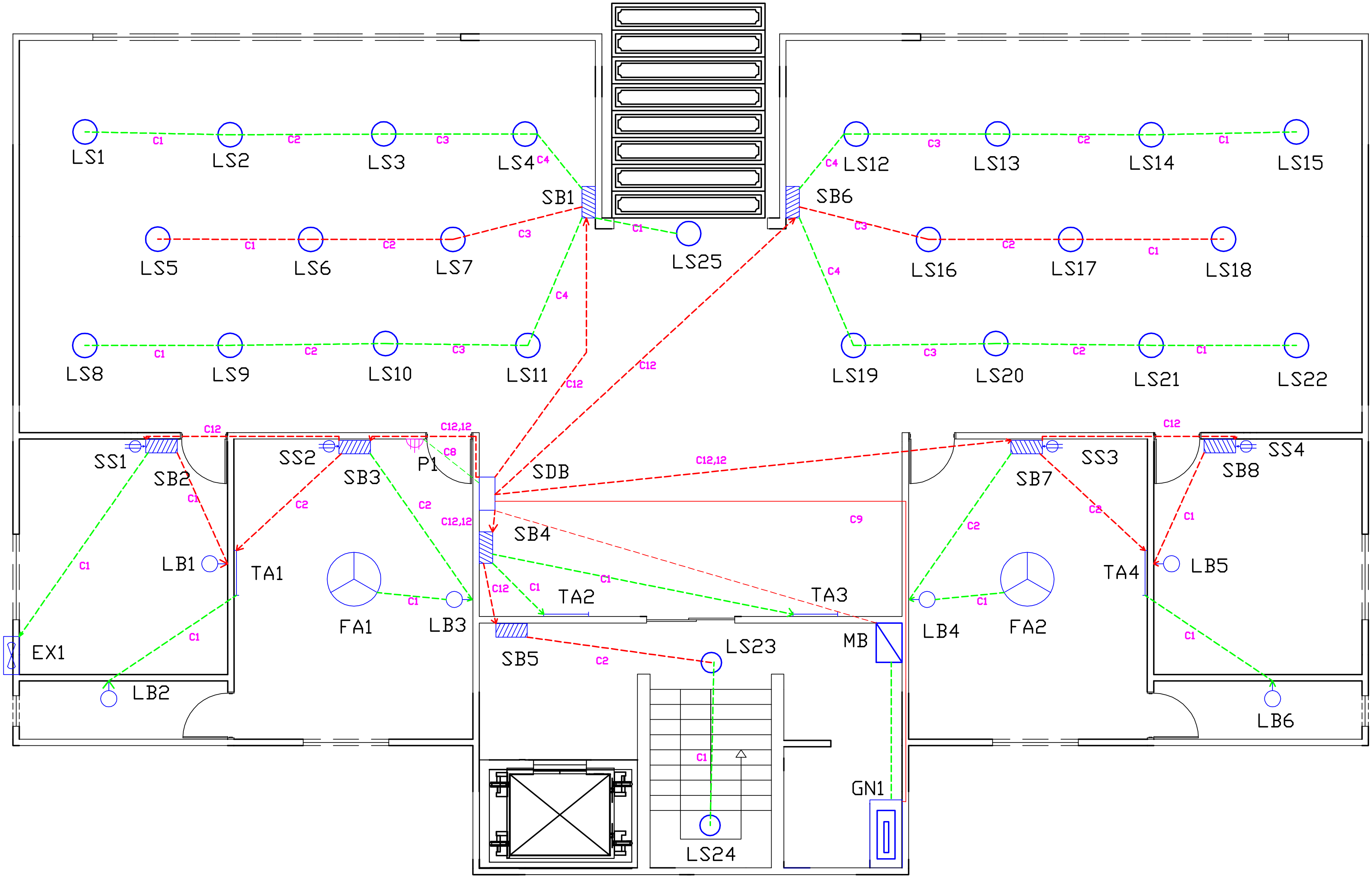


(Ground Floor)

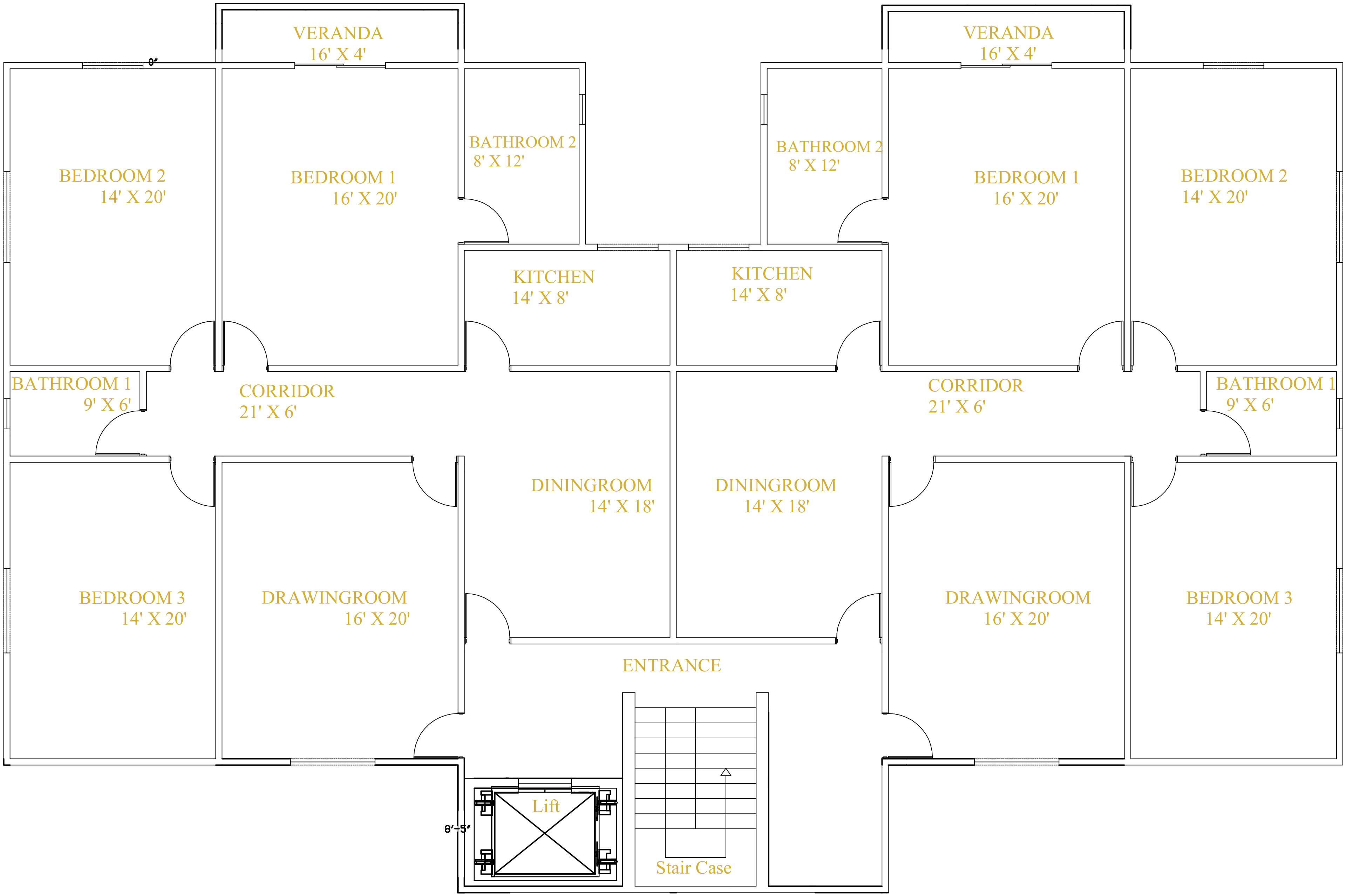


(Ground Floor)
Fittings and Fixtures

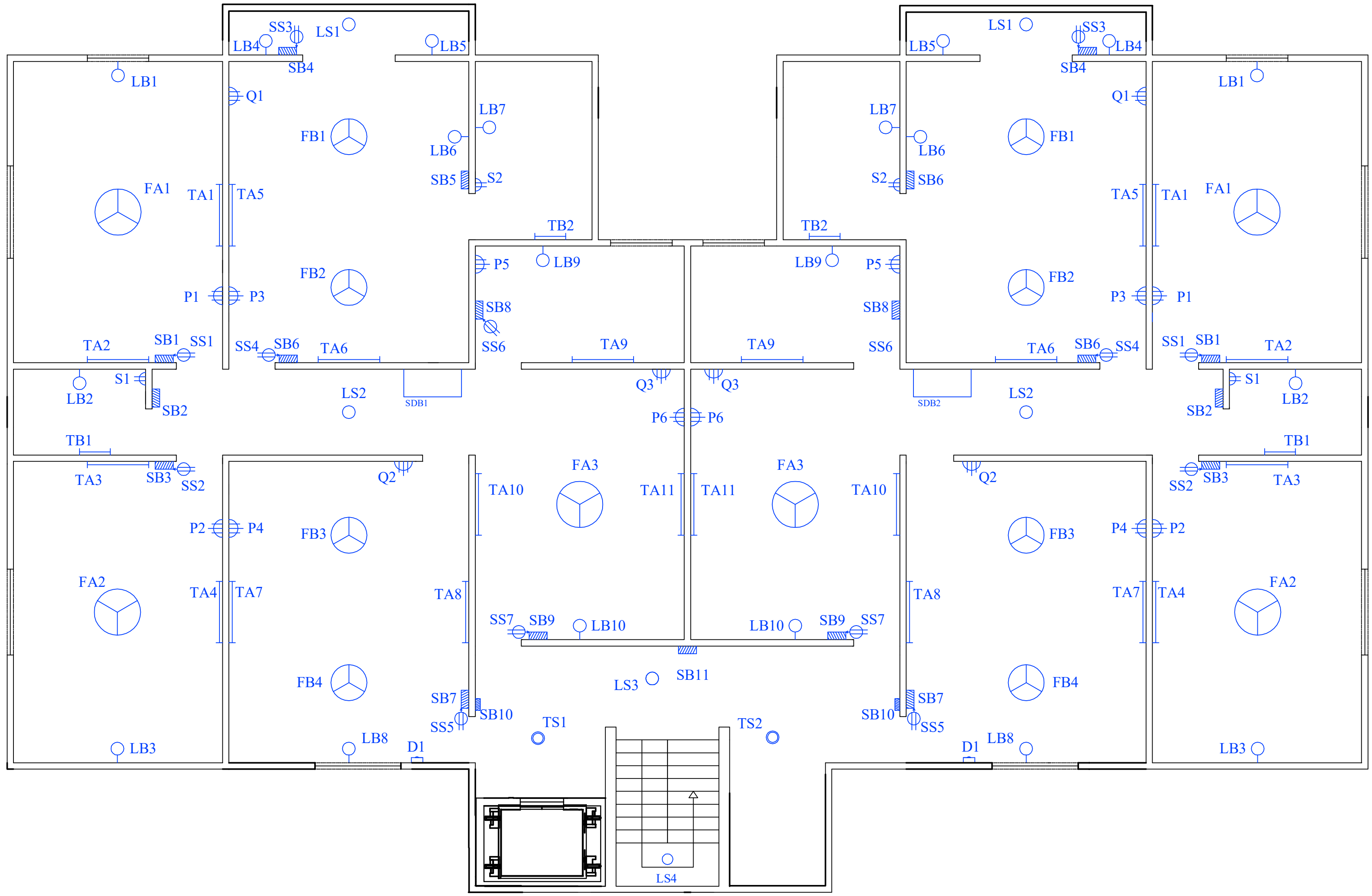


(Ground Floor)

Conduits

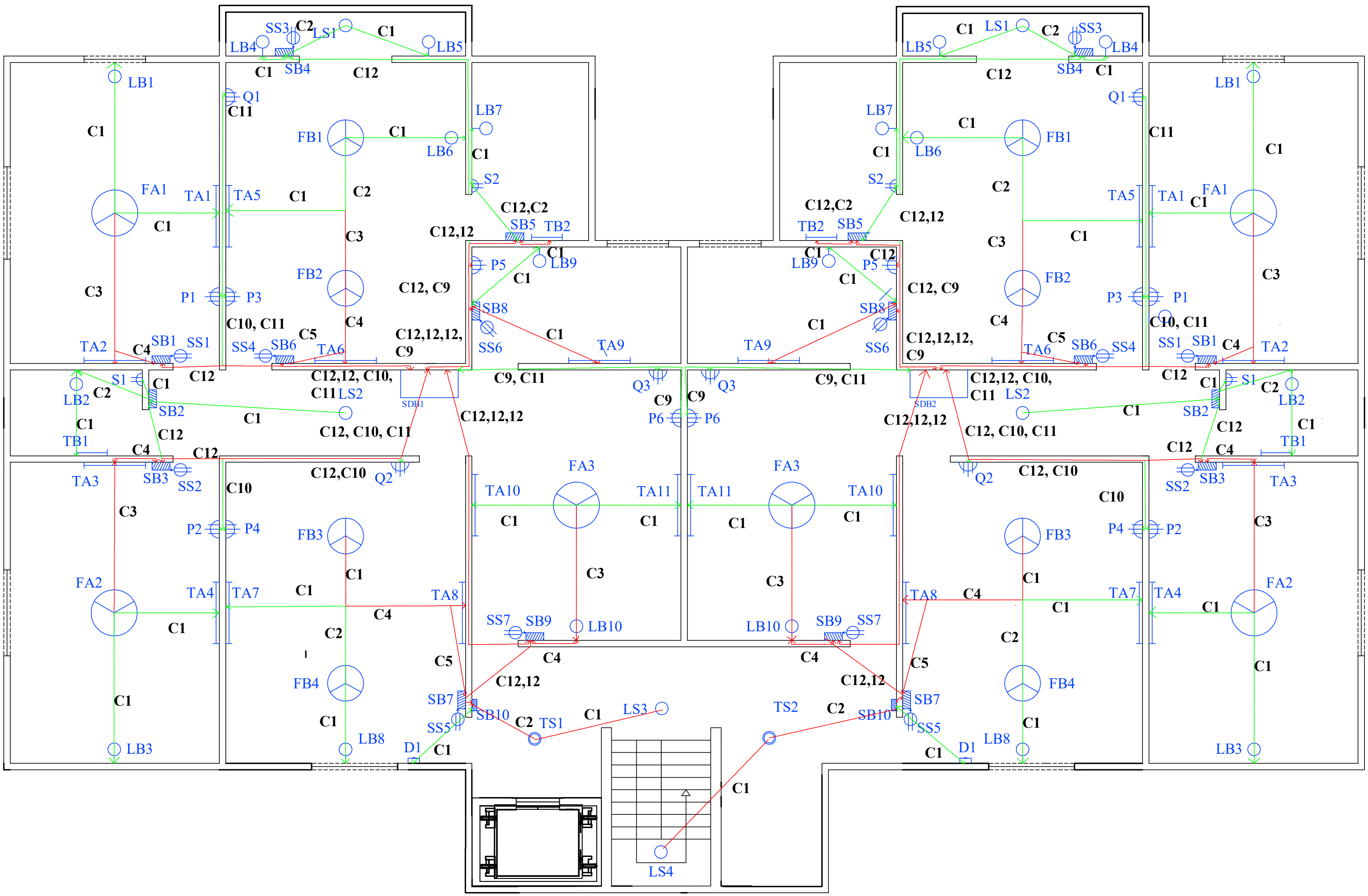


(1st-5th Floor)



(1st to 5th Floor)

Fittings and Fixtures

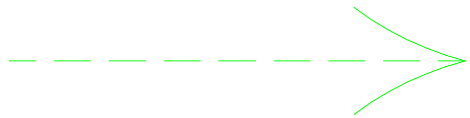
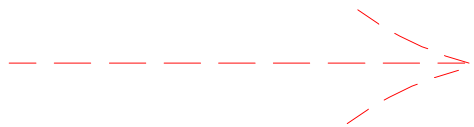


1ST-5th FLOOR
CONDUIT

Legends

Description	Height	Caption	Symbol	
			Fitting & Fixtures	Conduit Layout
4'-40W Wall Mounted Fluroscent Tube Light	Lintel	TA		
2'-20W Wall Mounted Fluroscent Tube Light	Lintel	TB		
60 W Incandescent Light Bracket	Lintel	LB		
23W Energy Bulb	Ceiling	LS		
60W Staircase Light	Ceiling	TS		
36"-56" Sweep Fan	Ceiling	FA		
28"-36" Sweep Fan	Ceiling	FB		
Generator	Floor	GN		
Main Distribution Board	Switchboard	MDB		
12" Exhaust Fan	Lintel	EX		
5A-2 Pin Socket in Switchboard	Switchboard	SS		
5A-2 Pin Socket	Skirting	S		
15A-3 Pin Socket	Skirting	P		
20A-3 Pin Socket	Skirting	Q		
Doorbell	Switchboard	D		
Switcboard (integrated with Emergency Switchboard)	Switchboard	SB		
Sub Distribution Board	Switchboard	SDB		

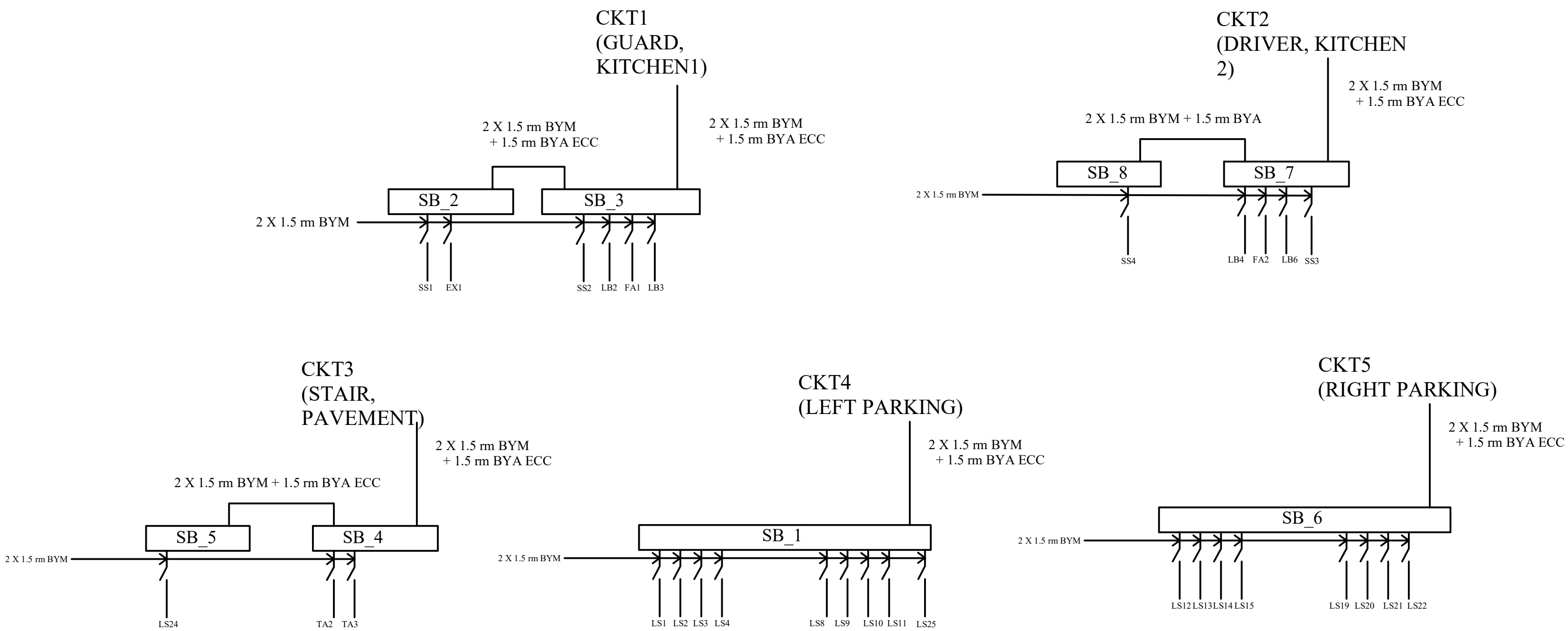
Conduit symbols

Conduit Type	Symbol
Normal Concealed Conduit	
Normal Concealed Conduit Going Up	
Normal Concealed Conduit Going Down	
Normal+Emergency Concealed Conduit	
Normal+Emergency Concealed Conduit Going Up	
Normal+Emergency Concealed ConduitGoing Down	

Conduit Schedules

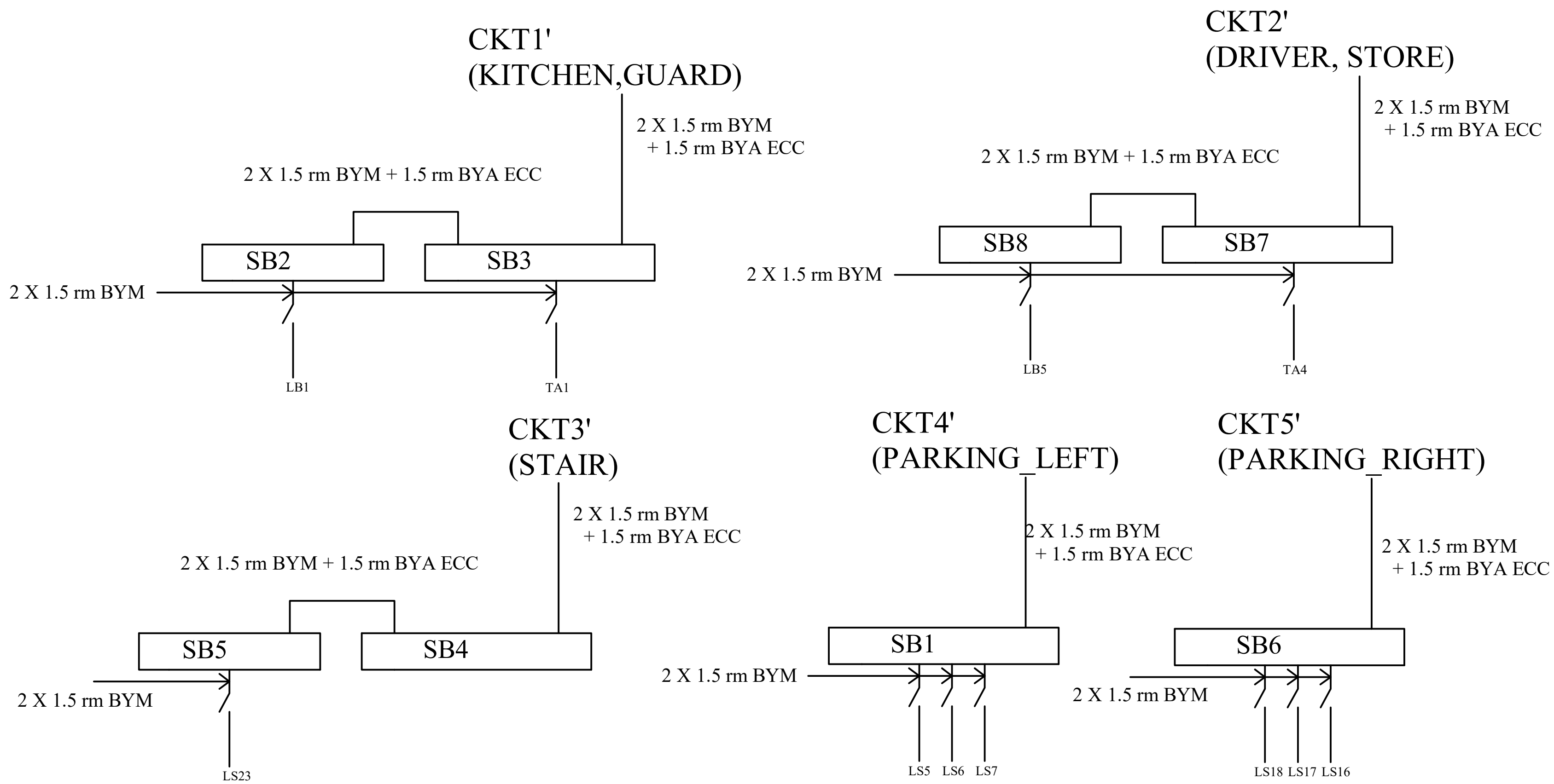
Name	Cable Size	Conduit Size
C1	2 x 1.5 rm BYM	3/4"
C2	4 x 1.5 rm BYM	3/4"
C3	6 x 1.5 rm BYM	3/4"
C4	8 x 1.5 rm BYM	1"
C5	10 x 1.5 rm BYM	1"
C6	2 x 2.5 rm BYM+ 2.5 rm BYAECC	1"
C7	4 x 2.5 rm BYM +2.5 rm BYAECC	1"
C8	6 x 2.5 rm BYM + 2.5 rm BYAECC	1"
C9	2 x 4 rm BYM + 4 rm BYAECC	1"
C10	4 x 4 rm BYM + 4 rm BYAECC	1"
C11	2 x 6 rm BYM + 6 rm BYAECC	1"
C12	2 x 1.5 rm BYM+ 1.5 rm BYAECC	3/4"

SWITCHBOARD DIAGRAM
(Ground Floor)

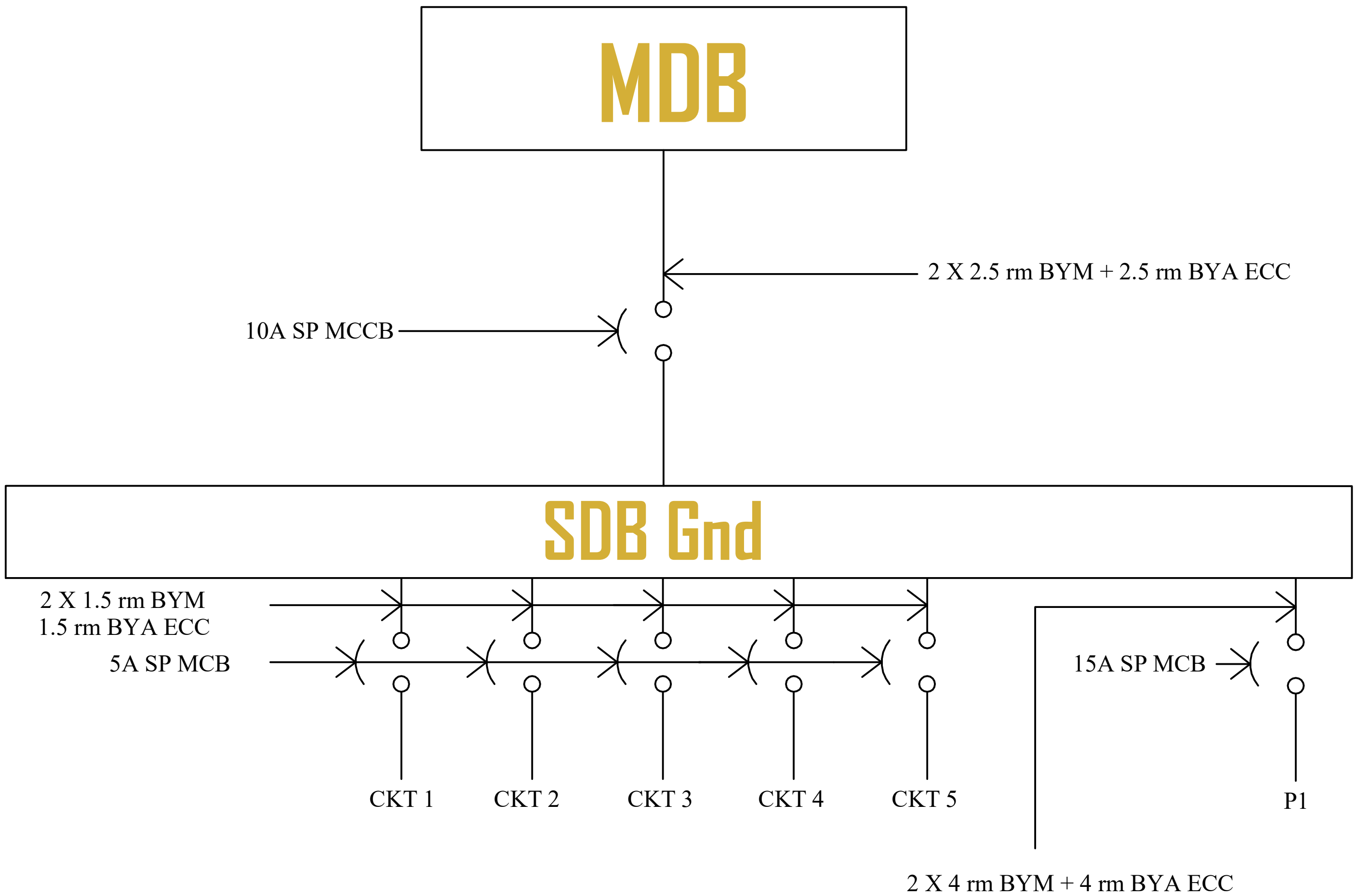


EMERGENCY SWITCHBOARD DIAGRAM

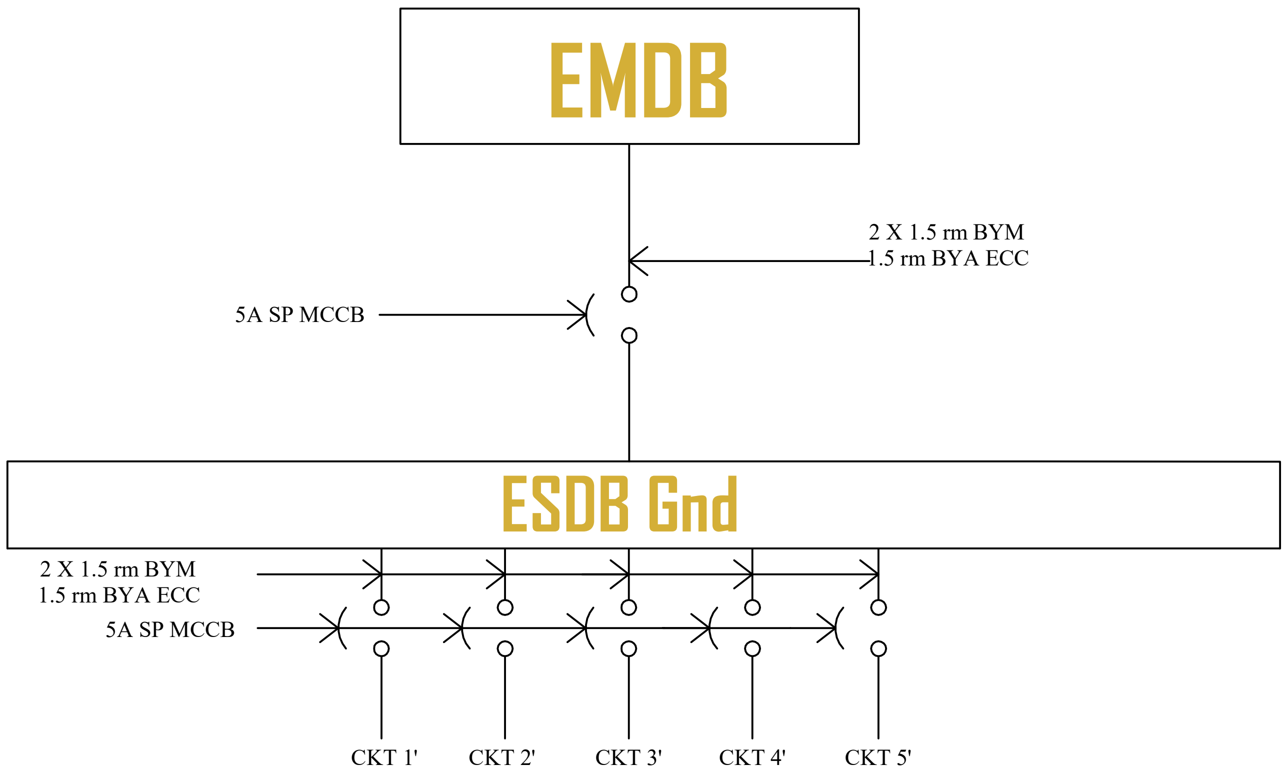
(Ground Floor)



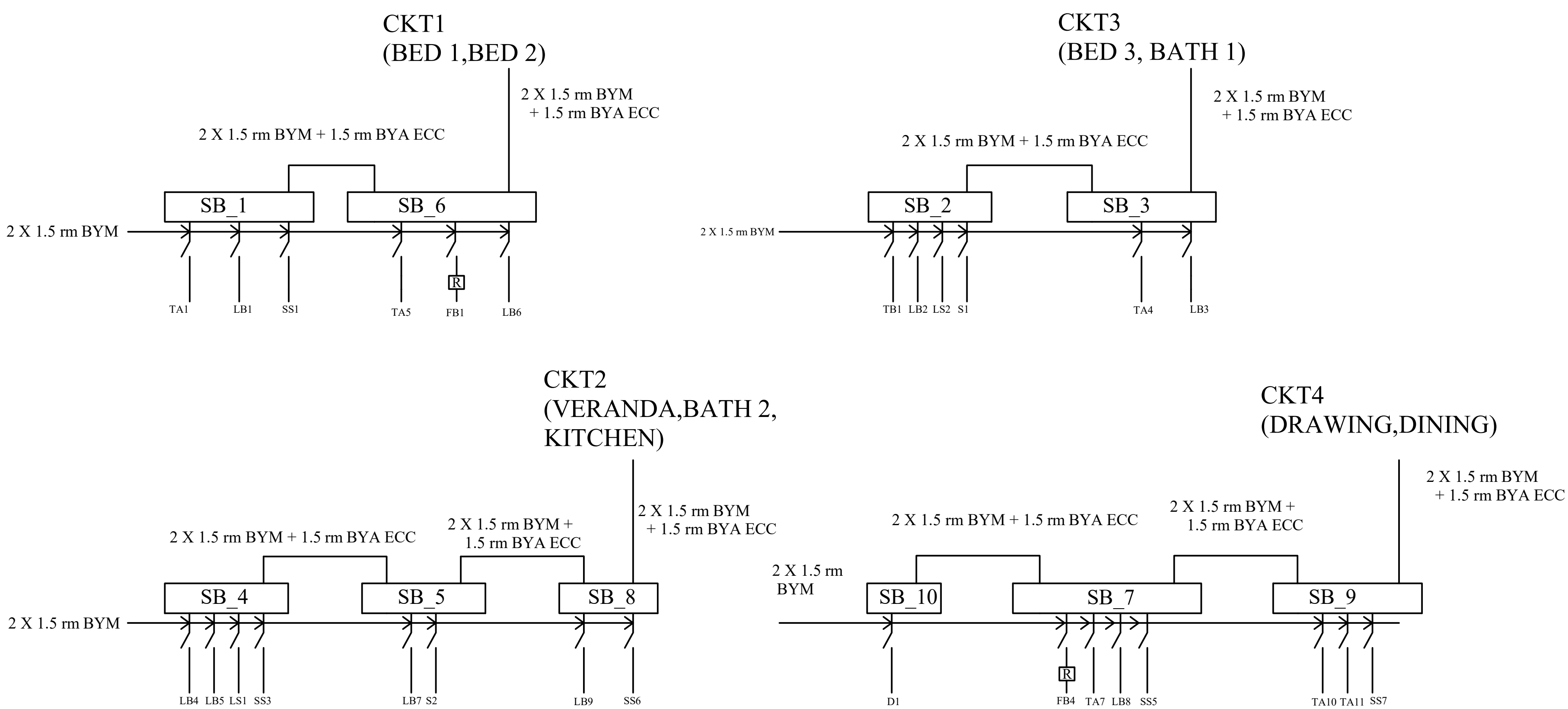
SUB-DISTRIBUTION BOARD DIAGRAM
Ground Floor



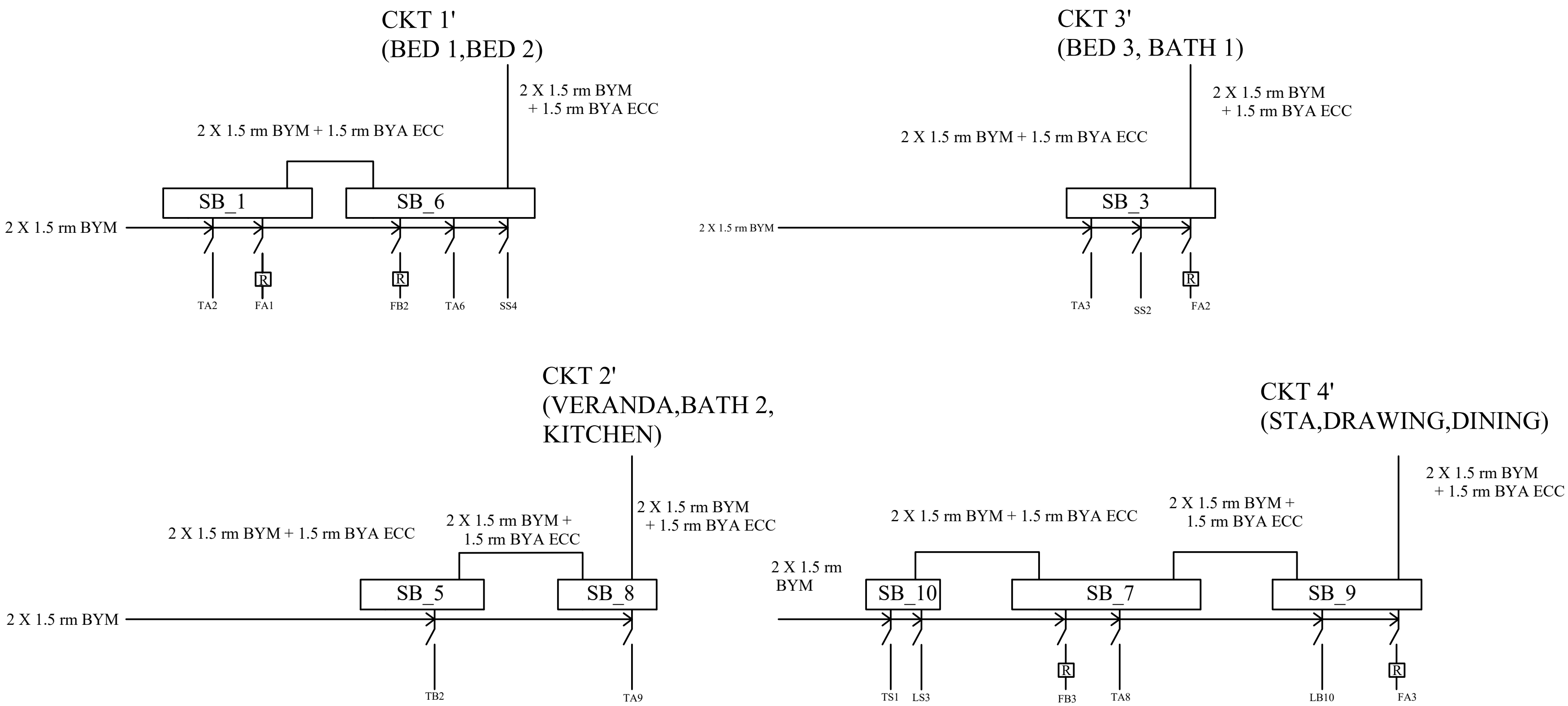
Emergency
SUB-DISTRIBUTION BOARD DIAGRAM
Ground Floor



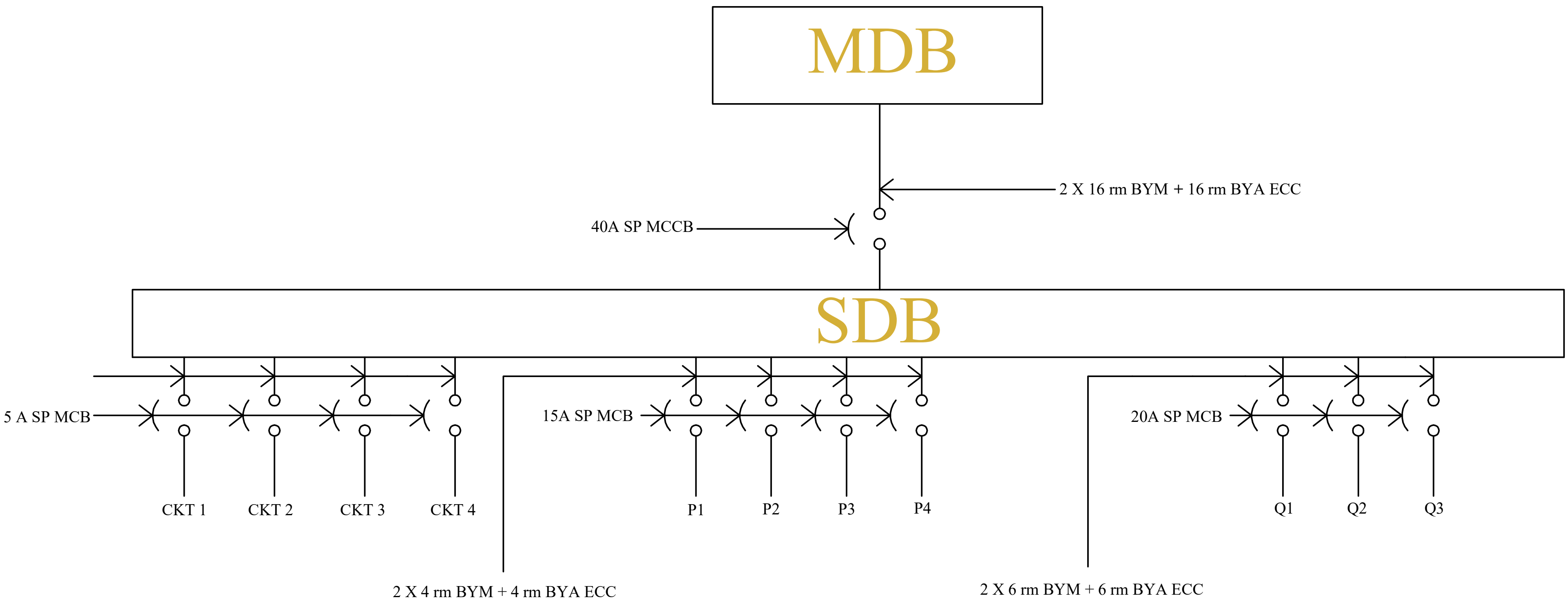
SWITCHBOARD DIAGRAM
(1st to 5th floor)



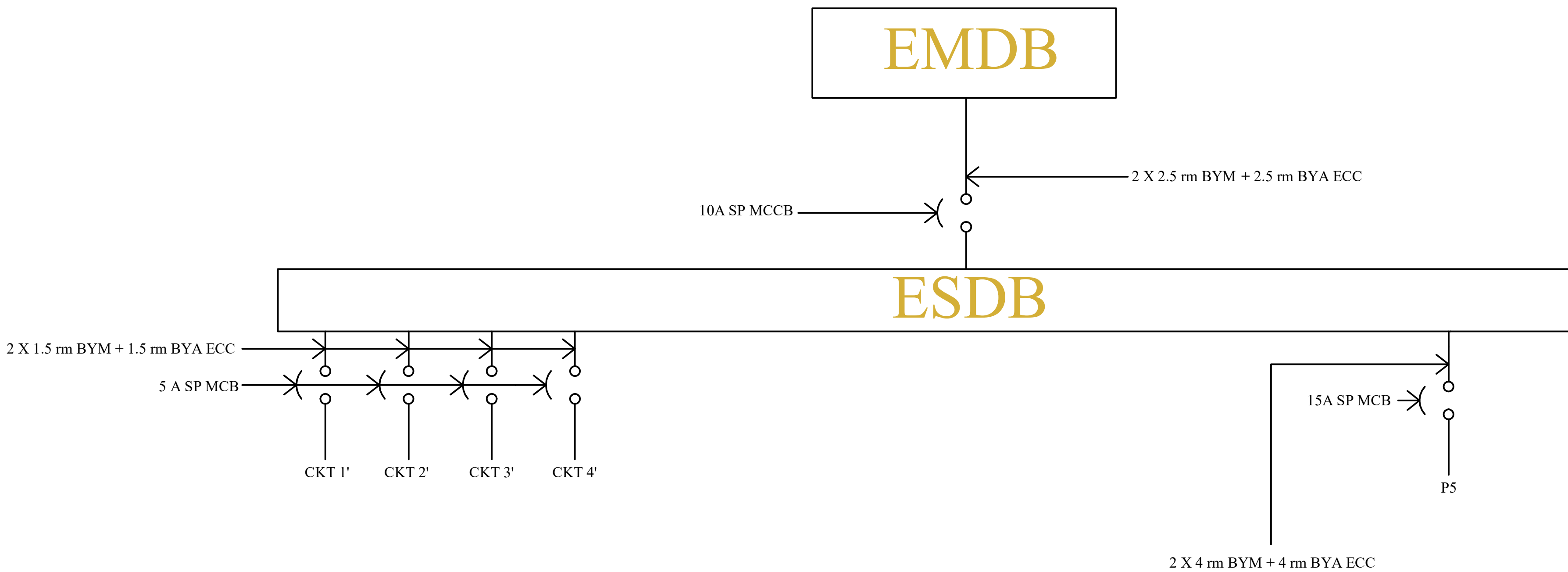
EMERGENCY SWITCHBOARD DIAGRAM
(1st to 5th floor)



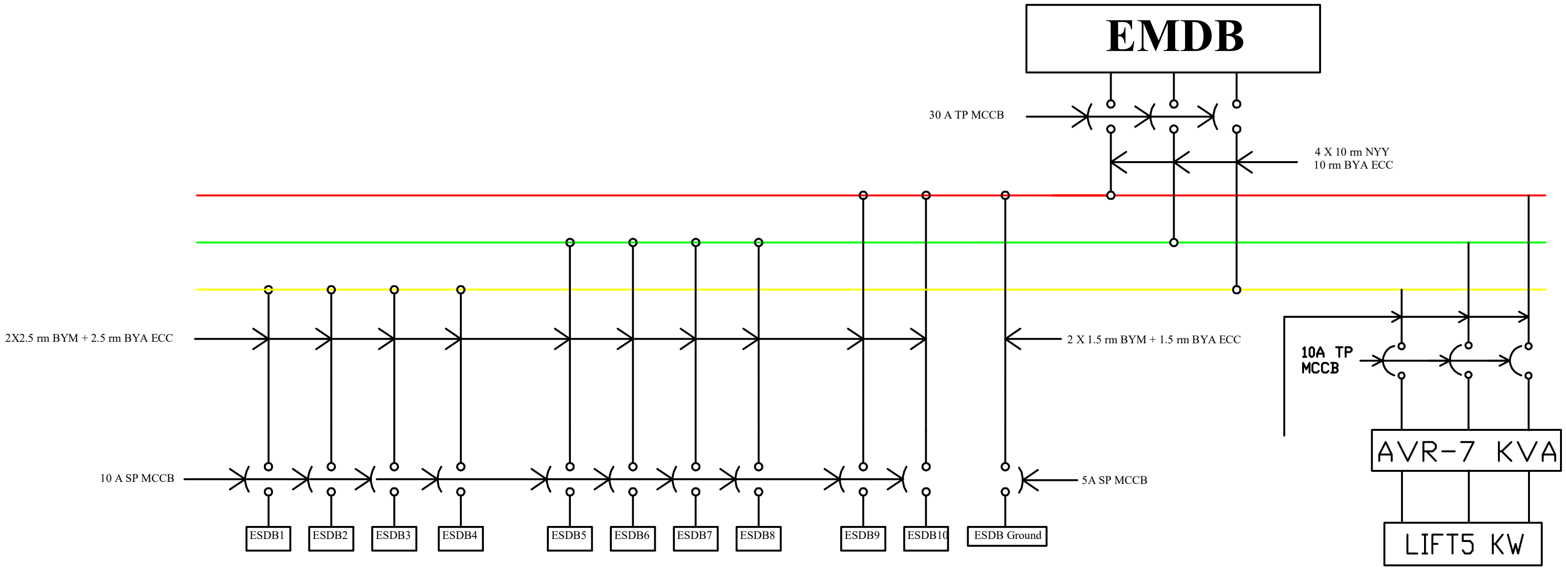
SUB-DISTRIBUTION BOARD DIAGRAM
1st to 5th floor



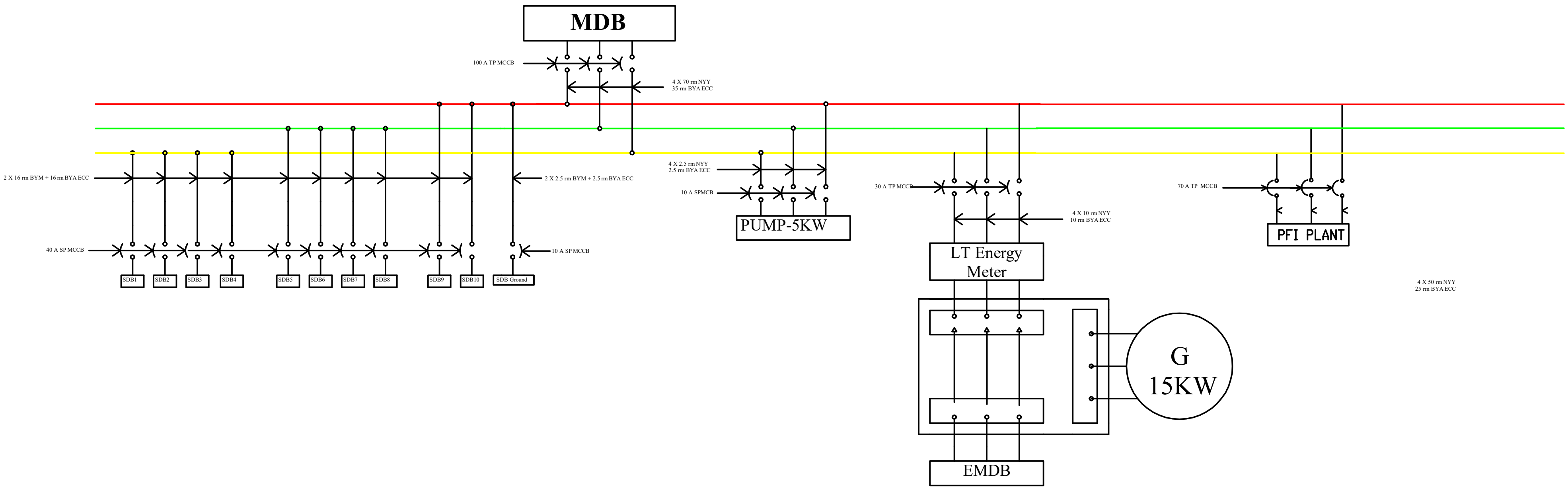
Emergency
SUB-DISTRIBUTION BOARD DIAGRAM
1st to 5th floor



CONNECTION DIAGRAM FOR EMDB



CONNECTION DIAGRAM FOR MDB



Switchboard diagram (1^{st}-5^{th} floor) circuits:

Utility	Load
TA	40 W
TB	20 W
LB	60 W
LS	23 W
TS	60 W
SS	100 W
FA	100 W
FB	75 W
S	100 W
D	50 W

CKT 1:

CKT1 load = 375 W

$I = \frac{40+60+100+40+75+60}{220*0.8} = 2.13$ A

CKT 2:

CKT2 load = 563 W

$I = \frac{100+23+60+60+60+100+60+100}{220*0.8} = 3.199$ A

CKT 3:

CKT3 load = 303 W

$I = \frac{60+100+20+23+60+40}{220*0.8} = 1.7216$ A

CKT 4:

CKT4 load = 505 W

$I = \frac{50+100+40+75+60+100+40+40}{220*0.8} = 2.869$ A

All of the circuits above have current less than 5 A. So, 2 x 1.5rm BYM + 1.5 BYA ECC are used in all of them.

Emergency switchboard diagram (1^{st}-5^{th} floor) circuits:

CKT 1':

CKT 1' load = 355 W

$I = \frac{40+100+100+40+75}{220*0.8} = 2.017$ A

CKT 2':

CKT 2' load = 60 W

$I = \frac{20+40}{220*0.8} = 0.341$ A

CKT 3':

CKT 3' load = 240 W

$I = \frac{40+100+100}{220*0.8} = 1.364$ A

CKT 4':

CKT 4' load = 358 W

$I = \frac{23+60+75+40+60+100}{220*0.8} = 2.034$ A

All of the circuits above have current less than 5 A. So, 2 x 1.5rm BYM + 1.5 BYA ECC are used in all of them.

Calculation for SDB (1^{st}-5^{th} floor)

Total load = CKT 1 load+ CK2 load + CKT 3 load + CKT 4 load
= (375 +563 +303 +505) W
= 1746 W

P load = 3000 W

Q load = 4000 W

There is 5 P load in the circuit and 3 Q load.

So, total load at the SDB for first floor = (1746 * .7 + 4 * 3000 * .2 + 3* 4000 * .2) W
= 6022.2 W

SDB current = $\frac{6022.2}{220*0.8}$ = 34.217 A

So, 40A SP MCCB is needed from SDB to MDB. 2 x 16rm BYM + 16rm BYA ECC cable is needed.

Calculation for ESDB (1^{st}-5^{th} floor)

Total load = CKT 1' load+ CK2' load + CKT 3' load + CKT 4' load
= (355 +60 + 240 +358) W
= 1013 W

P load = 3000 W

Q load = 4000 W

There is one P load in the emergency circuit and no Q load.

So, total load at the ESDB for first floor = (1013 * .7 + 1 * 3000 * .2) W = 1309.1 W

ESDB current = $\frac{1309.1}{220*0.8}$ = 7.438 A

So, 10A SP MCCB is needed from ESDB to EMDB.

2 x 2.5rm BYM + 2.5rm BYA ECC cable is needed.

Calculation of Lightings:

Bedroom 1 and Drawing room:

Area = 16 * 20 sqft = 29.74 m^2

E = 100 lumen/ m^2

LLF x UF = .8

n = 1

Flux = 1300 lumen

From calculation, N = 2.86

So, we used 2 TA and 1 LB

Bedroom 2 and Bedroom 3:

Area = 14 *20 sqft = 26.026 m^2

E = 100 lumen/ m^2

LLF x UF = .8

n = 1

Flux = 1300 lumen

From calculation, N = 2.5

So, we used 2 TA and 1 LB

Dining room:

Area = 14 * 18 sqft = 23.42 m^2

E = 100 lumen/ m^2

LLF x UF = .8

n = 1

Flux = 1300 lumen

From calculation, N = 2.25

So, we used 2 TA and 1 LB

Corridor:

Area = 6* 21.5 sqft = 12.9 m^2

E = 100 lumen/ m^2

LLF x UF = .8

n = 1

Flux = 1300 lumen

From calculation, N = 1.15

We used 1 LS considering the cost.

Kitchen:

Area = 8*14 sqft = 10.41 m^2

E = 100 lumen/ m^2

LLF x UF = .8

n = 1

Flux = 1300 lumen

From calculation, N = 1.00

We used 1 TA and 1 LB, where the extra one is kept for alternative uses and to bring variation.

Toilet 1:

Area = 6*9 sqft = 5.019 m^2

E = 100 lumen/ m^2

LLF x UF = .8

n = 1

Flux = 1300 lumen

From calculation, N = 0.4824

We used 1 TB and 1 LB, where the extra one is kept for alternative uses.

Toilet 2:

Area = 8*12 sqft = 8.923 m^2

E = 100 lumen/ m^2

LLF x UF = .8

n = 1

Flux = 1300 lumen

From calculation, N = 0.858

We used 1 TB and 1 LB, where the extra one is kept for alternative uses.

Veranda:

Area = 16*4 sqft = 5.948 m^2

E = 100 lumen/ m^2

LLF x UF = .8

n = 1

Flux = 1300 lumen

From calculation, N = 0.572

Here, though only 1 light is needed, we used 1 LS and 2 LB for decoration purposes.

To Sub Distribution Board (SDB_GND)

CKT 1:

CKT 1 load = 465 W

$$I = \frac{45+100+60+60+100+100}{220*0.8} = 2.641 \text{ A}$$

So, 2 x 1.5 rm BYM + 1.5 rm BYA ECC are used

CKT 2:

CKT 2 load = 420 W

I = $\frac{100+60+60+100+100}{220*0.8}$ = 2.38 A

So, 2 x 1.5 rm BYM + 1.5 rm BYA ECC are used

CKT 3:

CKT 3 load = 140 W

I = $\frac{23+40+40}{220*0.8}$ = 0.795 A

So, 2 x 1.5 rm BYM + 1.5 rm BYA ECC are used

CKT 4:

CKT 4 load = 180 W

I = $\frac{9*23}{220*0.8}$ = 1.023 A

So, 2 x 1.5 rm BYM + 1.5 rm BYA ECC are used

CKT 5:

CKT 5 load = 160 W

I = $\frac{8*23}{220*0.8}$ = 0.909 A

So, 2 x 1.5 rm BYM + 1.5 rm BYA ECC are used

Calculations for SDB_GND

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

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

SDB Current = $\frac{SDB\ load}{Voltage * pf}$ (A)

P load = 3000 W

Voltage = 220 V

Power Factor, pf = 0.8

CKT1 load = $45 + 100 + 60 + 60 + 100 + 100$ = 465 W

CKT1 load = $100 + 60 + 60 + 100 + 100$ = 420 W

CKT1 load = $23 + 40 + 40$ = 103 W

CKT1 load = 9*23 = 207 W

CKT1 load = 8*23 = 184 W

Total load = 465 + 420 + 103 + 207 + 184 = 1379 W

SDB load = 1379*0.7 + 3000*0.2 = 1565.3 W

SDB current = $\frac{1565.3}{220*0.8}$ = 8.89 A

So, 10A SP MCCB is needed from SDB to MDB.

Guard-room:

Area = 16'X20' = 320 sqft = 29.729 m^2

Luminance, E= 80 Lumen/m^2

Light Loss Factor and Utilization Factor, LLF x UF = 0.8

Number of lights per illuminaire, n=1;

Flux = 1300 Lumen

Number of Lights, N =?

Calculating from the above formula, N= 2.287

So, 2 Light Bulbs and 1 Tube Light are needed.

But, to preserve power consumption, 1 light bulb and 1 tube light are set.

Number of Fans = 2

So, 2 fans are needed, but to preserve power consumption, 1 ceiling fan is set.

Driver-room:

Area = 16'X20' = 320 sqft = 29.729 m^2

Luminance, E= 80 Lumen/m^2

Light Loss Factor and Utilization Factor, LLF x UF = 0.8

Number of lights per illuminaire, n=1;

Flux = 1300 Lumen

Number of Lights, N =?

Calculating from the above formula, N= 2.284

So, 2 Light Bulbs and 1 Tube Light are needed.

But, to preserve power consumption, 1 light bulb and 1 tube light are set.

Number of Fans = 2

So, 2 fans are needed, but to preserve power consumption, 1 ceiling fan is set.

Kitchen:

Area = 14'X18' = 252 sqft = 23.4116 m^2

Luminance, E = 80 Lumen/m^2

Light Loss Factor and Utilization Factor, LLF x UF = 0.8

Number of lights per illuminaire, n=1;

Flux = 1300 Lumen

Number of Lights, N =?

Calculating from the above formula, N= 1.8

So, 2 Light Bulbs are needed.

But, to preserve power consumption, 1 light bulb is set.

Storeroom:

Area = 14’X18’ = 252 sqft = 23.4116 m^2

Luminance, E = 80 Lumen/m^2

Light Loss Factor and Utilization Factor, LLF x UF = 0.8

Number of lights per illuminaire, n=1;

Flux = 1300 Lumen

Number of Lights, N =?

Calculating from the above formula, N= 1.8

So, 2 Light Bulbs are needed.

But, to preserve power consumption, 1 light bulb is set.

Bathroom-1:

Area = 14’X5’ = 70 sqft = 6.50321m^2

Luminance, E = 80 Lumen/m^2

Light Loss Factor and Utilization Factor, LLF x UF = 0.8

Number of lights per illuminaire, n=1;

Flux = 1300 Lumen

Number of Lights, N =?

Calculating from the above formula, N= 0.5002

So, 1 Light Bulb is needed.

Bathroom-2

Area = 14’X5’ = 70 sqft = 6.50321m^2

Luminance, E = 80 Lumen/m^2

Light Loss Factor and Utilization Factor, LLF x UF = 0.8

Number of lights per illuminaire, n=1;

Flux = 1300 Lumen

Number of Lights, N =?

Calculating from the above formula, N= 0.5002

So, 1 Light Bulb is needed.

To Emergency Sub-Distribution Board of Ground Floor (ESDB Gnd):

CKT 1’:

CKT 1’ load = 100 W

I = $\frac{40+60}{220*0.8}$ = 0.57 A

So, 2 x 1.5rm BYM + 1.5 BYA ECC are used

CKT 2’:

CKT 2’ load = 100 W

I = $\frac{40+60}{220*0.8}$ = 0.57 A

So, 2 x 1.5rm BYM + 1.5 BYA ECC are used.

CKT 3’:

CKT 3’ load = 23 W

I = $\frac{23}{220*0.8}$ = 0.13 A

So, 2 x 1.5rm BYM + 1.5 BYA ECC are used.

CKT 4’:

CKT 4’ load = 69 W

I = $\frac{23+23+23}{220*0.8}$ = 0.39 A

So, 2 x 1.5rm BYM + 1.5 BYA ECC are used.

CKT 5’:

CKT 5’ load = 69 W

I = $\frac{23+23+23}{220*0.8}$ = 0.39 A

So, 2 x 1.5rm BYM + 1.5 BYA ECC are used.

ESDB GND Calculation:

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

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

ESDB Current = $\frac{ESDB\ load}{Voltage * pf}$ (A)

Voltage = 220 V

Power Factor, pf = 0.8

CKT1’ Load = 40 + 60 = $100W$

CKT2’ Load = 40 + 60 = $100W$

CKT3’ Load = $23W$

CKT4’ Load = 23 + 23 + 23 = $69W$

CKT5’ Load = 23 + 23 + 23 = $69W$

Total load = 100 + 100 + 23 + 69 + 69 = $361W$

ESDB Load = 361 $*$ 0.7 = 252.7W

ESDB Current = 1.44A

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

Calculations for EMDB:

EMDB load = (Total ESDB load) × 0.7 + Lift Load × 0.7

Total ESDB load = (10 × ESDB load) + ESDB ground load

EMDB current = $\frac{EMDB\ Load}{3*phase\ voltage*pf}$ (A)

Phase voltage = 220 V

pf = 0.8

Lift Load = 5000 W

ESDB load (1st to 5th floor) =1309.1 W

ESDB ground load = 252.7 W

Total ESDB load = (10 × 1309.1) + 252.7 = 13343.7 W

∴ EMDB load = (13343.7) × 0.7 + 5000 × 0.7 = 12840.59 W

EMDB current = $\frac{12840.59}{3*220*0.8}$ = 24.32 A

So, 30 A TP MCCB is required from EMDB to MDB.

A 15kW generator is used to supply the EMDB load.

Calculations for MDB:

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

Total SDB load = (10 × SDB load) + SDB ground load

MDB current = $\frac{MDB\ Load}{3*phase\ voltage*pf}$ (A)

Phase voltage = 220 V

pf = 0.95 (due to PFI plant)

SDB load (1st to 5th floor) = 6022.2 W

SDB ground load = 1565.3 W

Total SDB load = (10×6022.2) + 1565.3 = 61,787 W

EMDB load = 12840.59 W

Pump Load = 5000 W

∴ MDB load = (61787 +12840.59 + 5000) × 0.7 = 55,738.9 W

MDB current = $\frac{55{,}738.9}{3*220*0.95}$ = 88.89 A

So, 100 A TP MCCB is needed from MDB to Main Line

Calculations for PFI Plant:

$cos\theta$ = 0.8,

$sin\theta$ = √{1-($cos\theta$)^2} = 0.6

Q = 3$VIsin\theta$

= $Ptan\theta$

= 41.804 $KVAR$

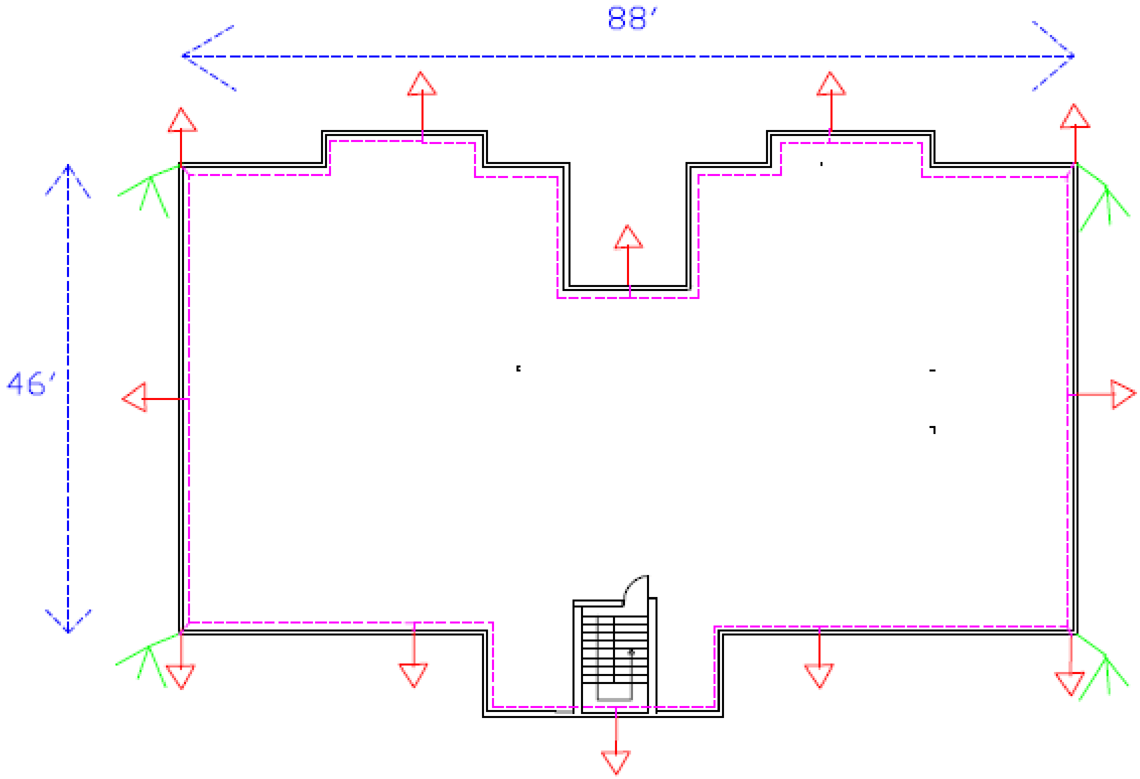
After pf improvement, sinθ = 1

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

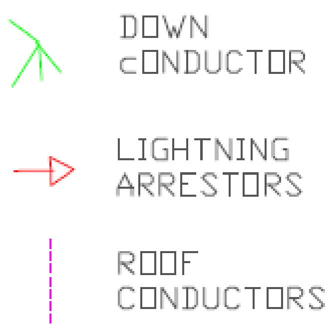
= 63.34 A

So, 70 A TP MCCB is needed from PFI to MDB

ROOFTOP LAYOUT OF LIGHTNING PROTECTION SYSTEM :



Lightning Protection System
(ROOFTOP)



Calculations :

Index Calculation :

A. Use of Structure : index = 4
B. Type of Construction : Index = 4
C. Contents or Consequential effects: index = 2
D. Degree of Isolation : Index = 5
E. Type of Terrain : index = 2
F. Height of structure : 60ft(10*6) = 18.288 meter. So index = 8
G. Lightning Prevalence : index = 11

Total = 36 < 40

So actually, for the building the lightning protection system is not necessary. We will design it anyway.

Lightning Protection System Design Parameters:

Number of Air Terminal Calculation:

We will use Rod height of 2.2 meter.

Roof dimensions:

Linear Length = 88 ft.

Linear Width = 46 ft.

We have used one air terminal at each of the four corners of the roof.

Length of the roof is 88 ft. The air terminals at the side can be 25' apart at maximum. So we need 3 air terminals (in total 6) in between for each side of the length.

Width of the roof is 46 ft. So one air terminal(2 total 2) in between of the edges can match the requirements for both width sides.

So total number of Air Terminal = (3*2+1*2+1*4) = 12 [3*2 for length side, 1*2 for width side, 1*4 for 4 corners].

Down Conductors:

Total Area = 88*46 sq ft = 4048 sq-ft = 376.1 sq-m

Number of down conductors = (376.1/100) = 3.76

So we have used 4 down conductors at the 4 corners of the roof.

Roof Conductors:

We have placed roof conductors 8" away from the roof railing connecting all the Air Terminals and Down Conductors.