***Project 1***

***Project Name:***

*Course title: Electrical Services Design of a studio apartment of 480-520 square feet*

*Course code: EEE300*

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*ID: 2018-1-80-032*

*Section: 1*

***Submitted to:***

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***East West University***

**Abstract:**

The aim of this project is to present a suitable approach to design electrical wiring complete layout including fitting fixture, switchboard and distribution board subject to specifications and constraints considering applicable standards and codes. Analyze electrical power demand in a building based on customer needs and all the approaches and design based on the requirements for a 300 square feet studio apartment set by the latest version of the Bangladesh National Building Code (BNBC 2015: Vol. 3, Part 8, Chapter 1).

**Objective:**

Main goal of this project is to understand design of the electrical services, which includes designing fitting and fixture layout , conduit diagram, power fitting diagram, switchboard and distribution board layout, estimating total power demand of the apartment and choose proper circuit breakers for safety.

**Outcomes:**

The assignment will address the following Course Outcomes of EEE 300

**CO1:** Analyze electrical power demand in a building based on customer needs.

**CO2:** Design electrical wiring complete layout including fitting, fixture, switchboard and distribution board subject to specifications and constraints considering applicable standards and codes.

**CO4:** Prepare and present basic technical documentation of a building services system.

**Design specifications:**

**Lighting and illuminations:**

Visual comfort through adequate illumination of the working surface, prevention of gayer, avoidance of shadow and ease of maintenance. Exhaust fans must be provided in kitchen and bathroom. Air conditioner or sweep fan shall be provided for cooling.

**Conductor and Breaker:**

- For 5A circuit 1.5mm$^2$ conductor shall be used, 5A breaker shall be used to protect the conductor.
- For 10A circuit 2.5mm$^2$ conductor shall be used, 10A breaker shall be used to protect the conductor.
- For 15A circuit 4mm$^2$ conductor shall be used, 15A breaker shall be used to protect the conductor.
- For 20A circuit 6mm$^2$ conductor shall be used, 20A breaker shall be used to protect the conductor.

**Conduits and conduit fittings:**

Cables of an electrical distribution installation are drawn through electrical conduits. For the installation of conduits various types of fittings are needed.

**Distribution board:**

Distribution Board is the junction point of the incoming line and the outgoing lines for the distribution of electricity throughout the building. The incoming as well as the outgoing lines must have Circuit Breaker Protection or Fuse protection.

**Electrical wiring for Living and bed area:**

15A 3pin socket outlets shall be provided at skirting level for different appliance.
20A 3pin round socket outlet shall be provided for air conditioner and heater at lintel level.

**Electrical wiring for kitchen:**

15A 3pic socket outlet shall be provided at table height for easy use of kitchen appliance.
Exhaust fan must be provided for ventilation.

**Electrical wiring for bathroom:**

Switchboard must be outside the bathroom near the entrance. Switchboard must not be inside the bathroom. Exhaust fan shall be provided for ventilation.

**Electrical Services Design:**

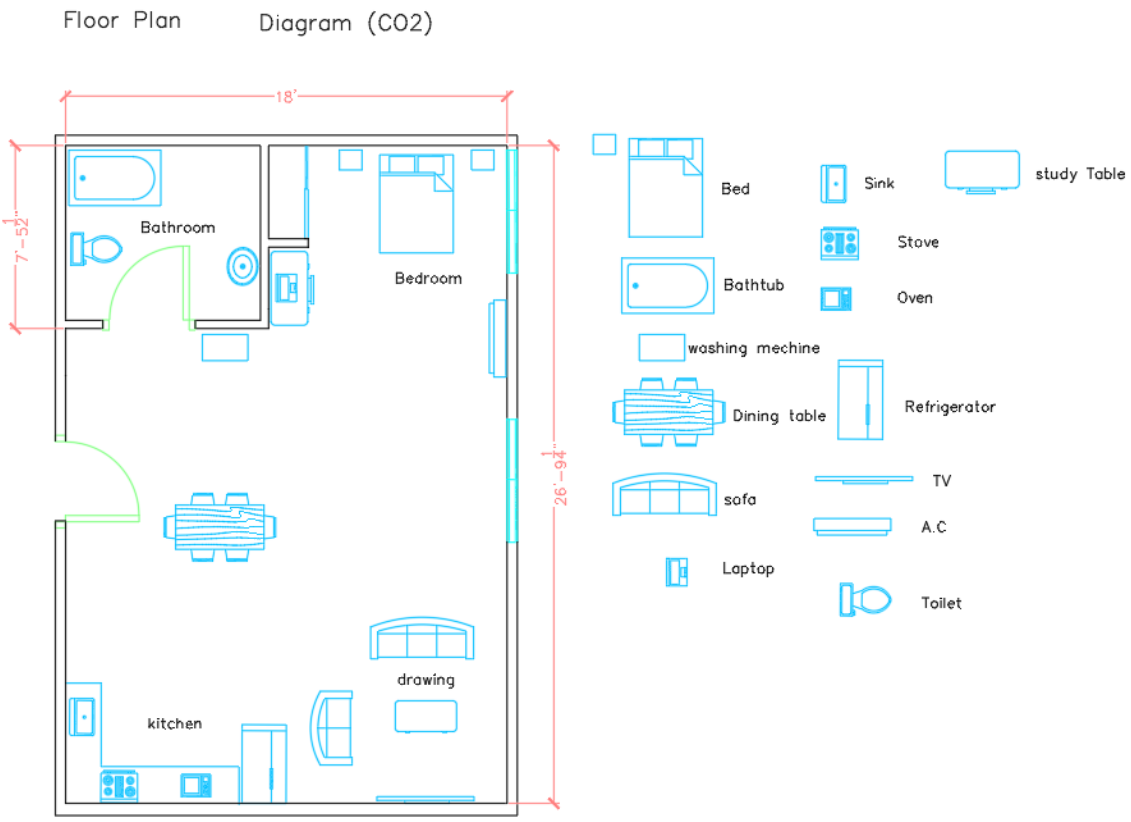
These services are consisting of,

- Floor plan
- Fittings & fixture layout
- Conduit diagram layout
- Power fitting layout
- Switch board connection diagram
- Distribution board connection diagram
- Calculation of power ratings of each type of circuits breaker

**Floor Plan (CO4):**

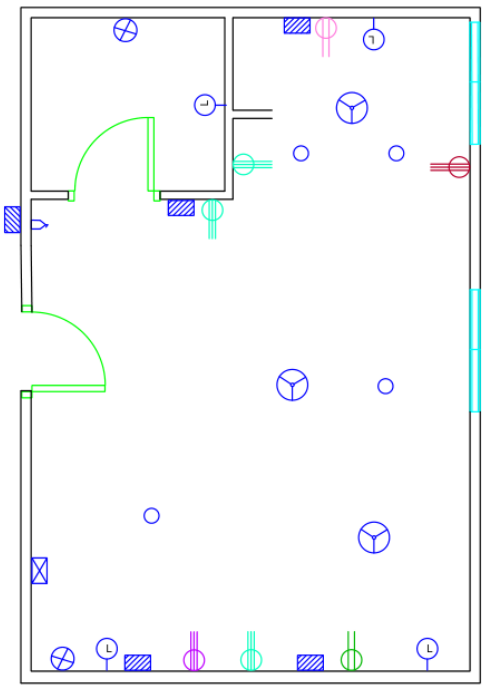
Floor plan of a single storied studio apartment of around 400 square feet which is 20’X20’ and the thickness of the wall is 5”. There are two doors, three windows . There is no inner wall in single storied studio apartment except bathroom. The areas are living area 11’-5”x12’-5”, sleeping space 12’x6’, kitchen 10’x4’-2” and bathroom 6’x4’8”. There are so many appliances. There is computer, Tv, Refrigerator, Table lamp, light, fan, washing machine, oven, exhaust fan, deash washer and Ac.

# Floor Plan


Floor Plan Diagram (CO2)
18'
7'-5½"
26'-9¼"
Bathroom
Bedroom
drawing
kitchen
Bed
Sink
study Table
Stove
Bathtub
Oven
washing mechine
Dining table
Refrigerator
sofa
TV
A.C
Laptop
Toilet

# Fittings and fixer layout [CO2]

Fitting and fixture diagram (CO2)
Fitting and fixture layout



Legends:

- ST 2-Pin 5A Socket at Table Height
- SL 3-Pin 15A Socket at Lintel Level
- SK 3-Pin 5/15A Socket at Skirting Level
- TS 2-Pin 5A Socket at Skirting Level for TV
- ST 3-Pin 15A Socket at Table Level
- SB 3-Pin 15A Socket at SB Level
- Exhaust Fan
- Distribution Board
- Switch Board Concealed
- Fan
- Wall Bracket Light
- Calling Bell or Buzzer
- K celling light

## Conduit Layout (CO4)

In Conduit layout there are 3 multiple conduit layouts attached. The main target of the conduit layout is to use the least length of conduit not the least number of them. I think layout 1 is most appropriate and using a smaller number of conduit and minimum conduit length to complete the wire. The main target of the conduit layout is to use the least length of conduit not the least number of them.

The following rules are given below:

There are different sizes of cables (p 8-34; Vol3)- 1.For

5A circuit 1.5mm2 conductor shall be used.

2.For 10A circuit 2.5mm2 conductor shall be used.

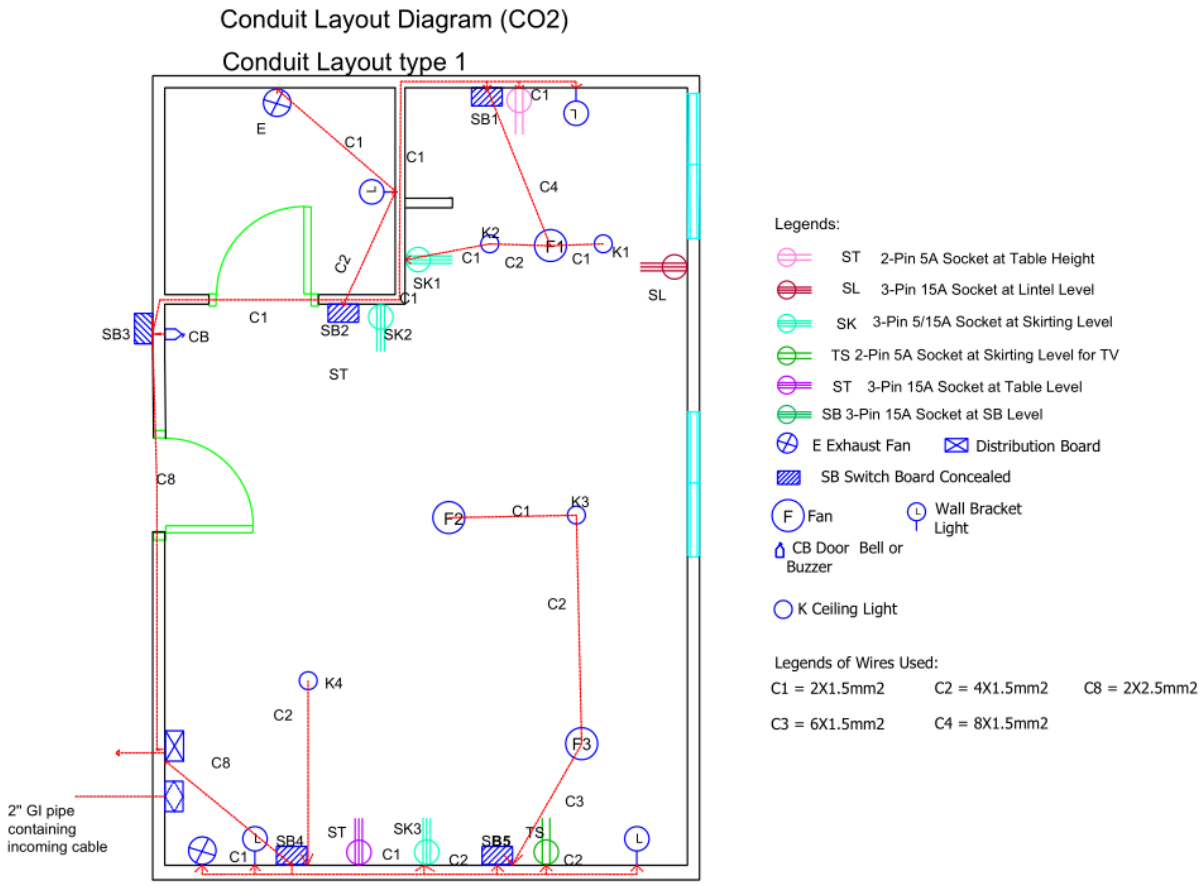
3.For 15A circuit 4mm2 conductor shall be used.

4.For 20A circuit 6mm2 conductor shall be used.

5. For the final circuit/sub-circuit and Light/fan point wiring the cable nominal cross-section of the cable shall not be less than 1.5 mm2 for copper conductors. (P 8-37, Vol 3) 6.A Light/Fan Circuits must be used for all Domestic and Residential buildings. The corresponding circuit wire in the BDB/ SDB/ DB then shall be not less than 1.5 mm2. (P8-37, Vol 3)

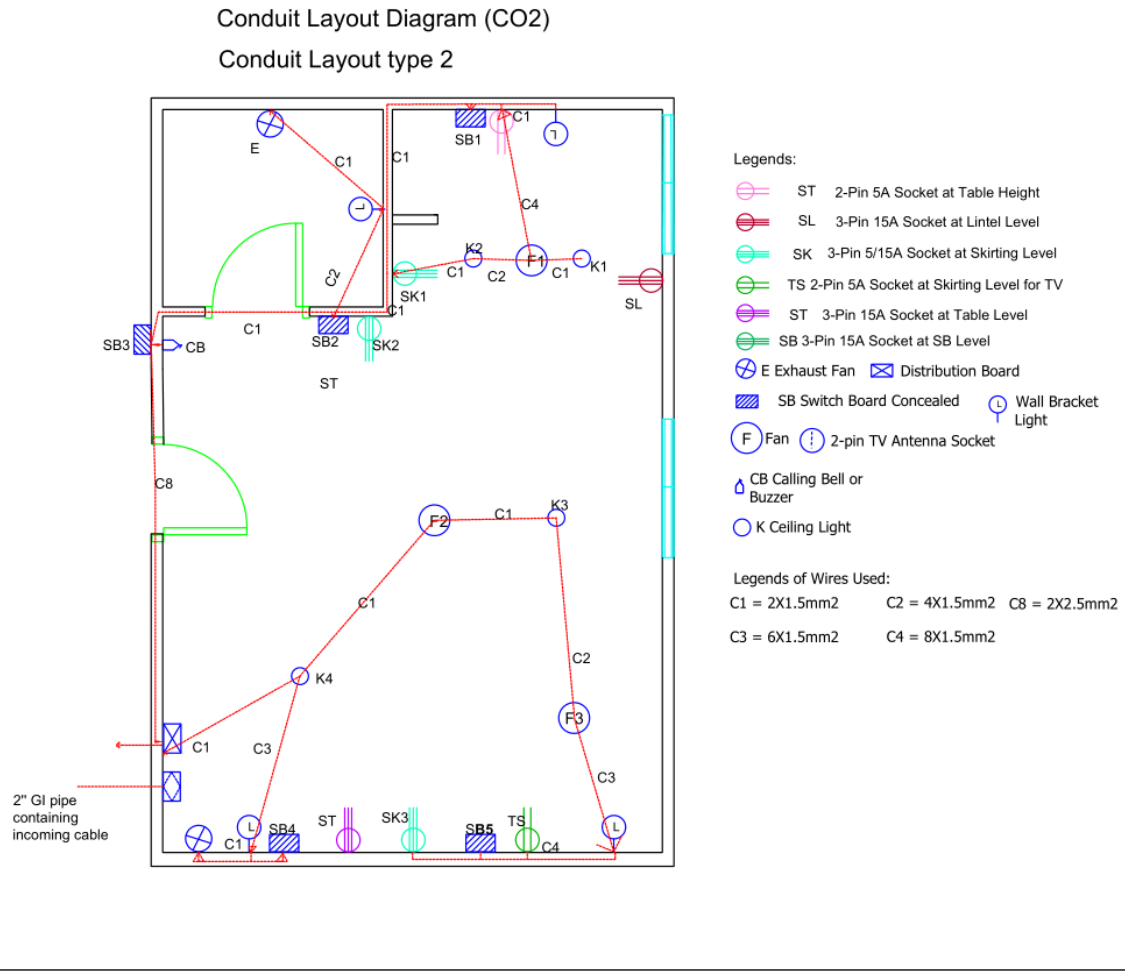
# Conduit Diagram layout [CO2]

## Conduit Type 1:



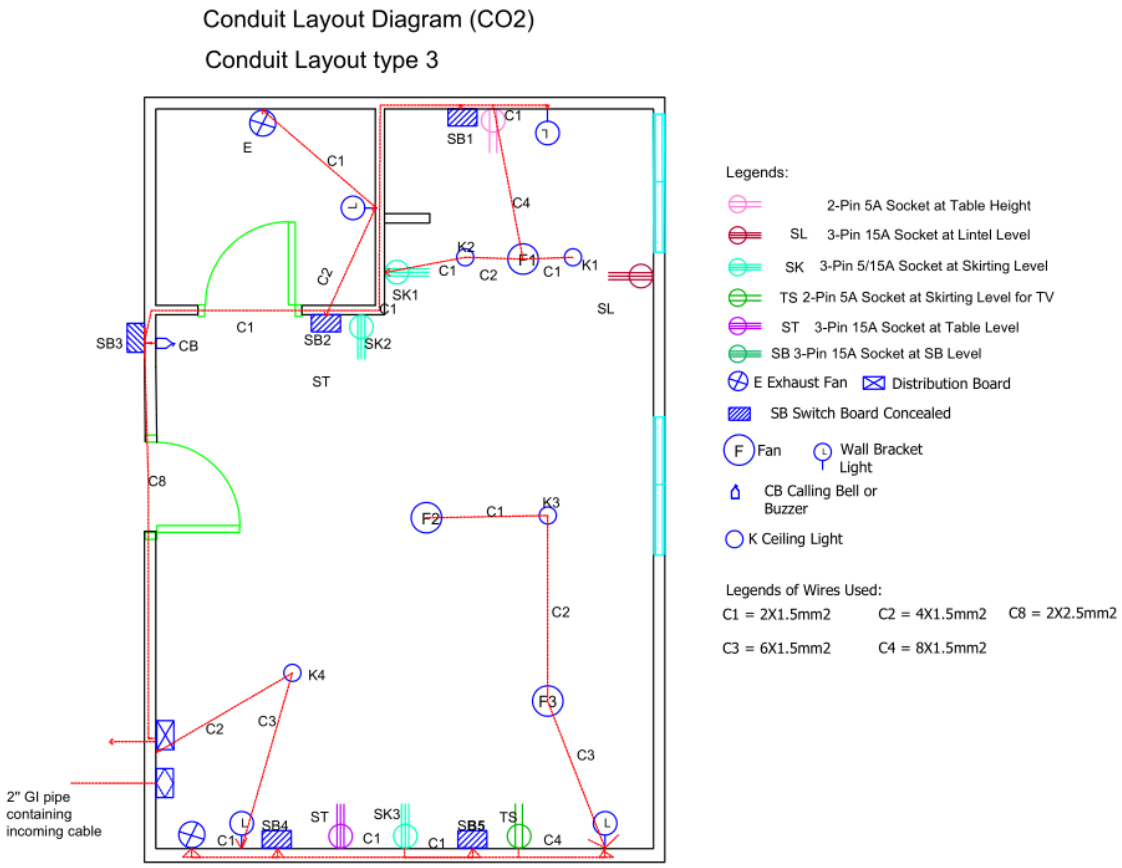
# Conduit Diagram layout [CO2]

## Conduit Type 2:



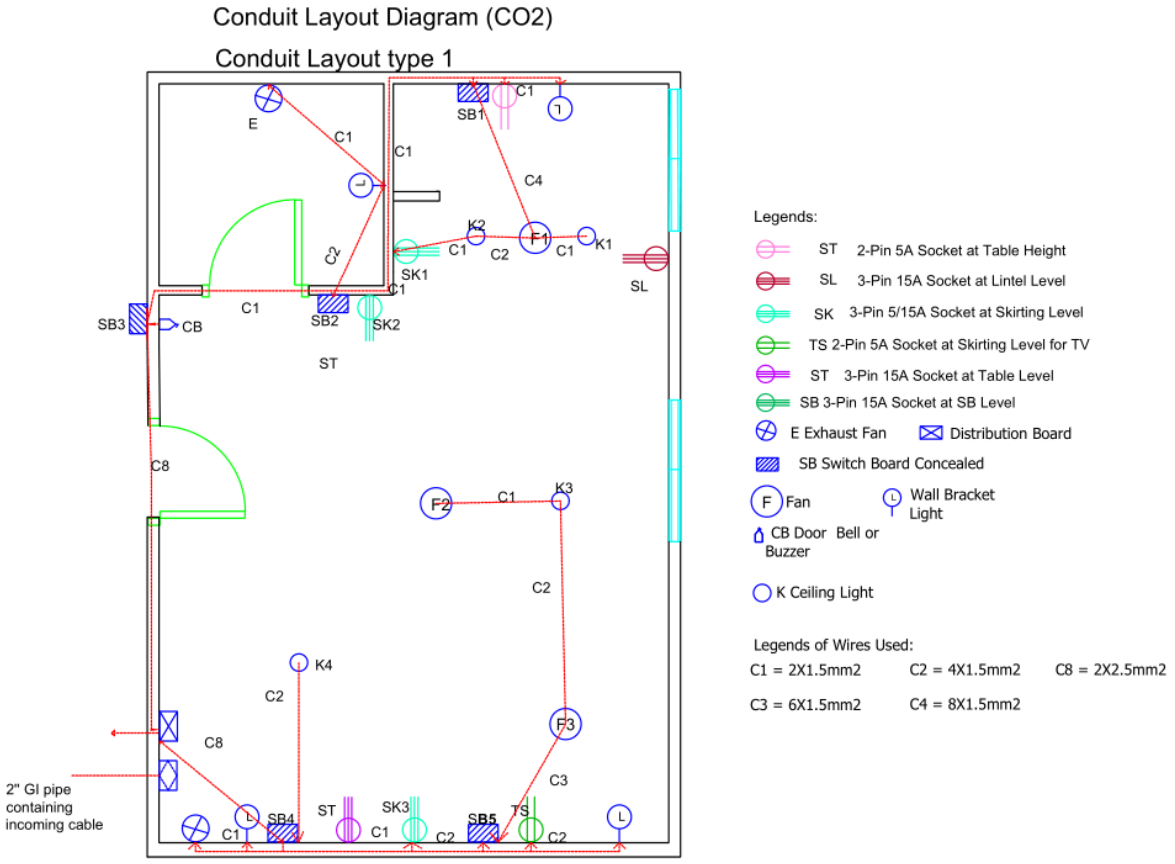
# Conduit Diagram layout [CO2]

## Conduit Type 3:



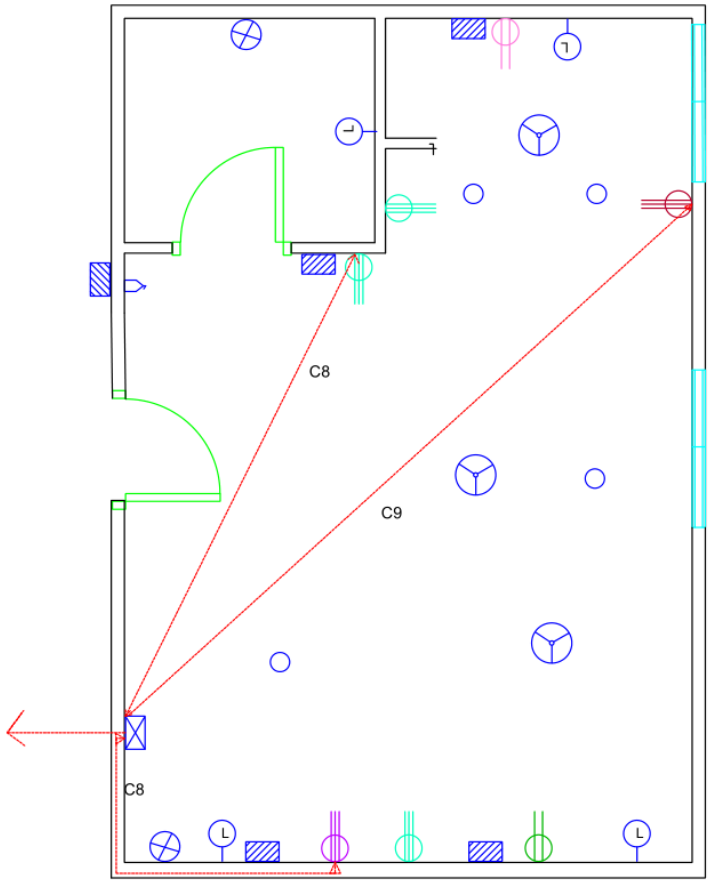
# Final Conduit diagram layout [CO2]

**Note:** I prefer "conduit layout type 1" from these 3 type of conduit layouts because in "conduit layout 1" I need less conduit length. And "conduit layout 1" is more simple. So, this conduit layout is perfect than other two type of layout so I use this layout design for my 484.2square feet floor plan.



# Power fitting layout [CO2]

Power Fitting Diagram (CO2)
Power Fitting layout




Legends:

- ST 2-Pin 5A Socket at Table Height
- SL 3-Pin 15A Socket at Lintel Level
- SK 3-Pin 5/15A Socket at Skirting Level
- TS 2-Pin 5A Socket at Skirting Level for TV
- ST 3-Pin 15A Socket at Table Level
- SB 3-Pin 15A Socket at SB Level
- E Exhaust Fan
- Distribution Board
- SB Switch Board Concealed
- F Fan
- Wall Bracket Light
- CB Door Bell or Buzzer
- K Ceiling Light

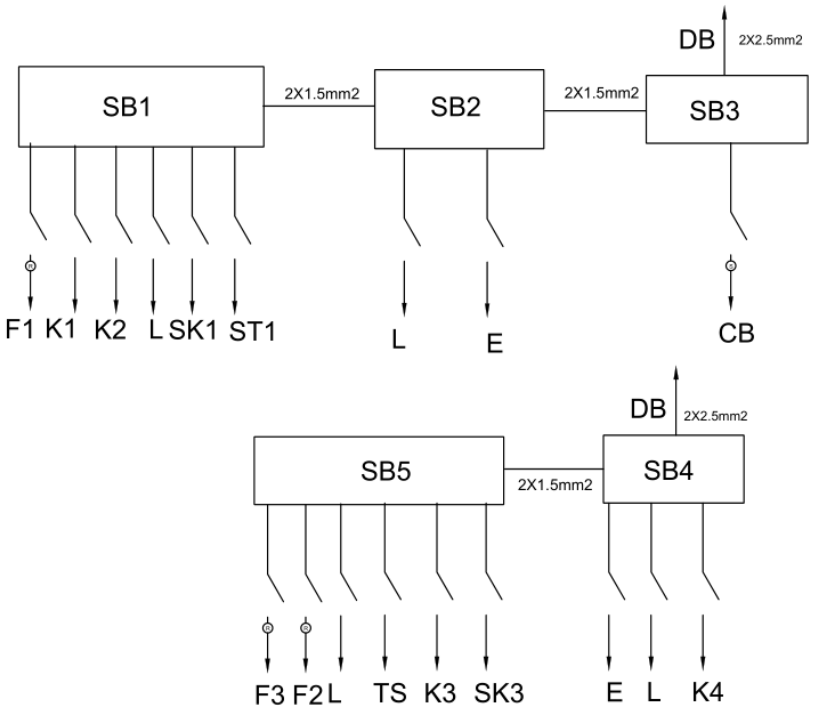
Legends of Wires Used:

C8 = 2X2.5mm2

C9 = 2X4mm2

# Switch board connection Diagram[CO2]

Switch Board Connection Diagram (CO2)




Legends:

CB=Calling Bell

K1,K2,K3,K4= Ceiling Light

F1,F2,F3=Fan

CL=Chandelier Light

ST1= TV

SK3= PC

E= Exhaust Fan

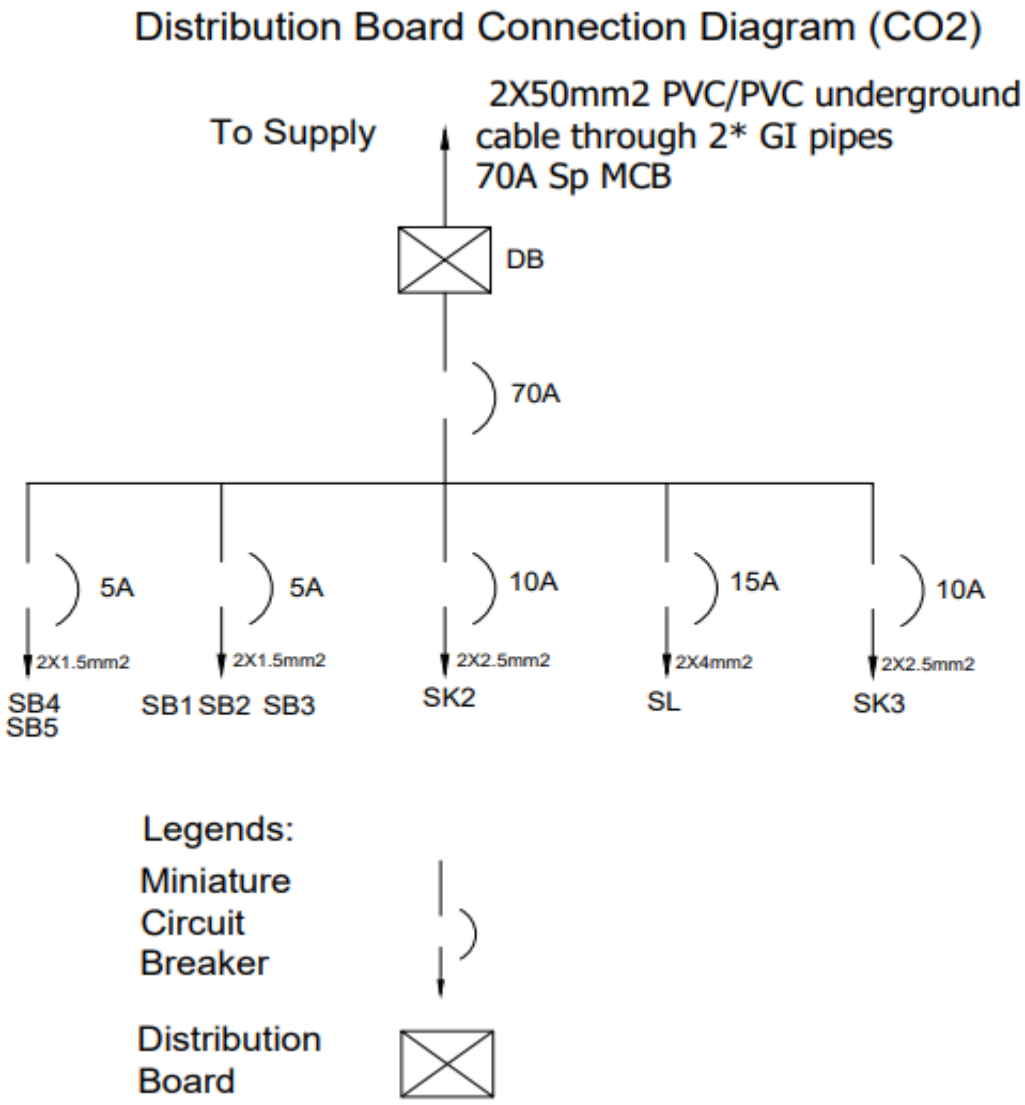
SK1=Refrigerator

ST2,ST3=Table Lamp

L=Wall Bracket Light

DB=Distribution Board

## Distribution Board Diagram [CO2]



**Current and power rating of each appliance [C04]:**

| No. | Appliance | Legend | Power | Current rating(A) |
|---|---|---|---|---|
| 1 | PC | SK1 | 200W | $\frac{200*1.65}{220}$=1.5A |
| 2 | Table Lamp | ST (1) | 100W | $\frac{100 * 1.65}{220} = .75$ |
| 3 | TV | TS | 93W | $\frac{93 * 1.65}{220} = .70A$ |
| 4 | AC | SL | 2050W | $\frac{2050}{.8 * 220} = 11.65A$ |
| 5 | Ceiling Light | K | 24W | $\frac{24 * 1.65}{220} = .18A$ |
| 6 | Washing Machine | SB | 850W | $\frac{850 * 1.65}{220} = 6.37A$ |
| 7 | Refrigerator | SK3 | 150W | $\frac{150 * 1.65}{220} = 1.125A$ |
| 8 | Oven | ST | 1500W | $\frac{1500}{.8 * 220} = 8.53A$ |
| 9 | Exhaust Fan | E | 40W | $\frac{40 * 1.65}{220} = .3A$ |
| 10 | Door Bell | CB | 10W | $\frac{10 * 1.65}{220} = .075A$ |
| 11 | Wall Bracket Light at | L | 65W | $\frac{65 * 1.65}{220} = .48A$ |
| 12 | Ceiling Fan | F | 100W | $\frac{100 * 1.65}{220} = .75A$ |

**Note:** 5.Calculation of current (1.3.2.4): For the calculation of current (for the selection of cables and breakers) of the ceiling fans, table fans, pedestal fans, exhaust fans the ratings are to be multiplied by a factor of 1.65 to take care of the power factor and the starting current situation.

For the calculation of current (for the selection of cables and breakers) of the small inductive loads (up to 1.0 kW) the ratings are to be multiplied by a factor of 1.65 to take care of the power factor and the starting current situation. The factor shall be higher for higher rated motor. BNBC has not specified any power factor for 1KW rating appliance. So, for calculating current rating 0.8 power factor is considered (BNBC2020 )

**Calculation of current ratings for each MCB [CO1]:**

Current Rating =100% for non- continuous load &

Current Rating =125% for continuous load.

**For SB1:**

Fan (F1)=0.75A (continuous)

Celling light (K1+K2) =.18+.18(continuous)

Table lamp (TS)=.75A(continuous)

Wall bracket light (L) =.48A(continuous)

Computer=1.5A (non-continuous)

Current = (.75+.18+.18+.75+.48) *125%+(1.5*100%)

= 2.825+1.5

= 4.325A

For SB1 5A MCB is required

**For SB2:**

Exhaust fan =.3A(continuous)

Wall bracket light (L) =.48A(continuous)

Current =(.3+.48)*1.25

=.975A

For SB2 5A MCB is required .

**For SB3:**

Doorbell (CB) = .075A (non-continuous)

Current = 0.075*100%

=0.075A

For SB3 5A MCB is required.

**For SB4:**

Celling light (K4) =0.18A (continuous)

Wall bracket light (L) = .48A(continuous)

Exhust fan (E) =.3A (continuous)

Current = (.18+.48+.3)*125%

=1.2A

For SB4 5A MCB is required.

For Sb 5

**For SB5:**

Fan (F2,F3) =.75A (continuous)

Celling light(K3)=.18A(continuous)

wall bracket light(L)=.48A(continuous)

T.V=.69A(non-continuous)

Refrigerator =1.125A (continuous)

Current = (.75+.75+.18+.48+1.125)* 125%+(.69*100%)

=4.79A

For SB5 5A MCB is required.

**For Socket SL:**

AC(SL)= 11.14A(non -continuous)

∴Current= (1*11.14) A

=11.14A

For AC 15A MCB is required.

**For Socket SK2:**

Washing Machine (SB)= 6.37(non -continuous)

∴Current= (1*6.37) A

=6.37A

For washing machine 10A MCB is required.

**For Socket ST:**

Oven (ST)=8.53A (non -continuous)

∴Current= (1*8.53) A

=8.53A

For Oven 10A MCB is required

Now,

**Total supply current**

=SB1+SB2+SB3+SB4+SB5+SL+ST+SK3

= (5+5+5+5+5+15+10+10)

=60A

Total supply current 60A.So 70A MCB is suitable for the apartment .

For the small inductive loads (up to 1.0 kW) the ratings are to be multiplied by a factor of 1.65 to take care of the power factor and the starting current situation. The factor shall be higher for higher rated motor. BNBC has not specified any power factor for 1KW rating appliance. So, for calculating current rating 0.8 power factor is considered. (BNBC 2020).

**Minimizing of total electrical power demand [CO1]:**

**Total Electrical Power Demand Calculation**

| No | Appliance | Quantity | Power(W) |
|---|---|---|---|
| 1. | PC | 1 | 200W |
| 2. | Table Lamp | 1 | 100W |
| 3. | TV | 1 | 93W |
| 4. | AC | 1 | 2050W |
| 5. | Ceiling Light | 4 | 24*4=96W |
| 6. | Washing Machine | 1 | 850W |
| 7. | Refrigerator | 1 | 150W |
| 8. | Oven | 1 | 1500W |
| 9. | Exhaust Fan | 1 | 40*2=80W |
| 10. | Door Bell | 1 | 10W |
| 11. | Wall Bracket Light | 4 | 260W |
| 12. | Ceiling Fan | 3 | 100*3=300 |
| | | | Total=5689W<br>= 5.689KW |

**Total =12 type of appliances =5689W**

**Note:**

In this floor plan I used the basic and most needed appliences for our day to day life to ensure maximum comfort without any lacking .In this design I use minimum number of lights, fan, ac, computer, fridge, oven etc. Here for 484.2 square feet apartment I have installed AC which will cover the whole apartment and alos washing machine and oven . this floor plan mostly like a luxury floor plan.

But if I don't use high loaded but not that much needed compound like , oven, washing machine then our electrical power demand will be minimized without affecting the comfort of people . But this time this floor plan look less luxurious. But my design will be ensuring comfort for any type of people.

**Minimizing of total electrical demand,**

| No | Appliance | Quantity | Power(W) |
|---|---|---|---|
| 1. | PC | 1 | 200W |
| 2. | Table Lamp | 1 | 100W |
| 3. | TV | 1 | 93W |
| 4. | AC | 1 | 2050W |
| 5. | Ceiling Light | 4 | 24*4=96W |
| 6. | Refrigerator | 1 | 150W |
| 7. | Exhaust Fan | 1 | 40*2=80W |
| 8. | Door Bell | 1 | 10W |
| 9. | Wall Bracket Light | 4 | 260W |
| 10. | Ceiling Fan | 3 | 100*3=300 |
| | | | Total=3339W<br>= 3.339KW |

Here I design this diagram without oven and washing machine which is more luxuries compound with high loaded rating. But I use fan lights and other things as usual for room and also, I used TV, fridge and sufficient number of fan for ensuring

maximum comfort . So in this way I can minimize the total electrical power demand for ensuring maximum comfort .

**Conclusion:**

From this project I learned how to prepare and present building services design for studio apartment or any apartment . I will be able to design a floor plan of any size and also will be able to implement this knowledge understand about its fittings and fixture, conduit layout, power fitting layout, switch board and distribution board diagram. I also will be able to do calculation and minimize the total electrical power demand ensuring maximum comfort. Besides, I hold the knowledge about which wire size I should use, less conduit length and conduit size benefits, difference between conduit layout and power fitting layout and its condition for wire connection.

**Reference:**

Book: BNBC 2020: Volume 1, Part 8, Chapter

- Different size of cables at BNBC p (8-34; volume 3)
- Small number of cross point of conduits as possible at at BNBC p (8-37; volume 3)
- Circuit wire in DB/SDB can't less than 1.5mm$^2$ at BNBC p (8-37; volume 3)

For domestic or residential buildings, we must use light or fan circuit at BNBC p (8-37;

1. https://www.daftlogic.com/information-appliance-power-consumption.htm
2. https://letsavelectricity.com/wattage-power-consumption-of-household-appliances/
3. https://paylesspower.com/blog/how-much-electricity-does-a-tv-use/
4. www.google.com