ELECTRICAL INSTALLATION LABORATARY

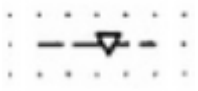
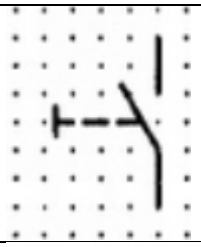
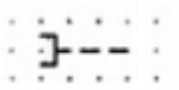
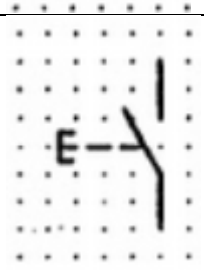
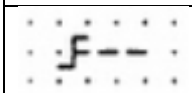
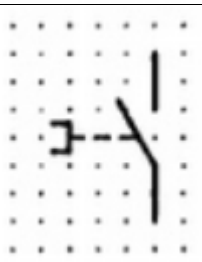
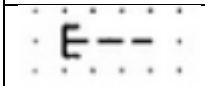
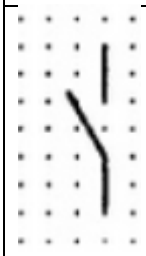
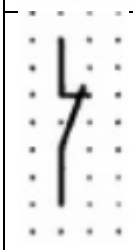
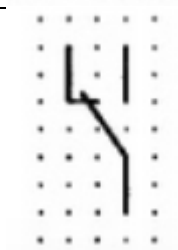
LABORATORY MANUAL

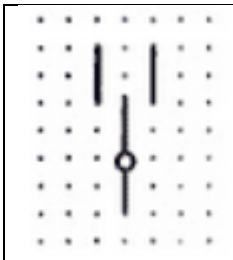
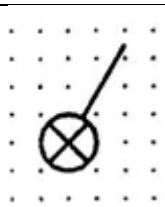
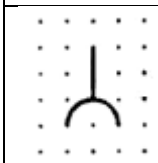
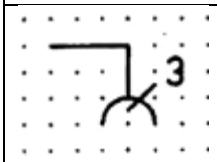
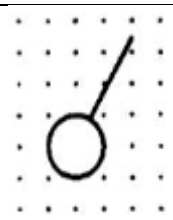
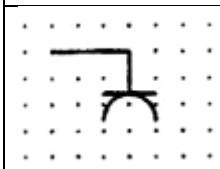
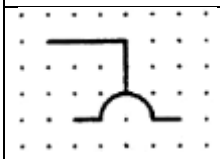
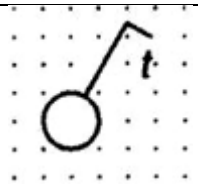
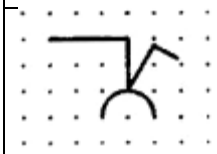
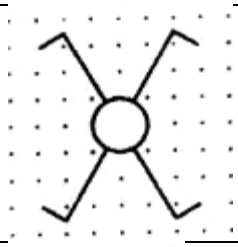
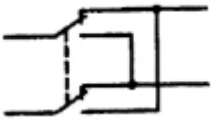
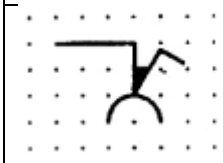
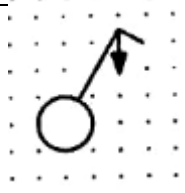
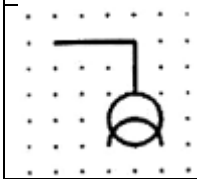
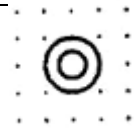
TEACHER/STUDENT handbook

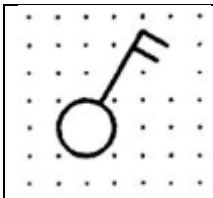
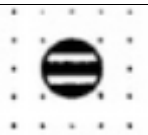
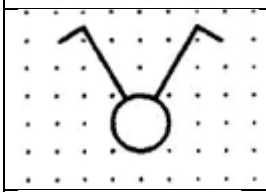
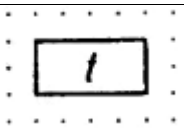
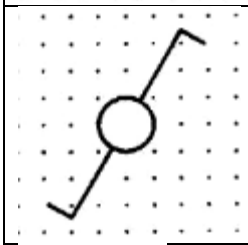
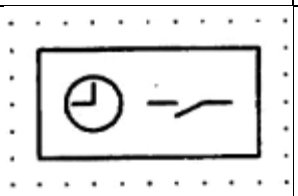
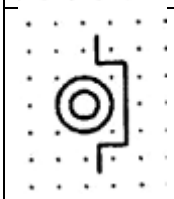
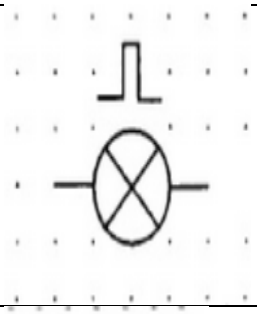
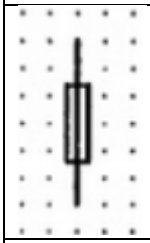
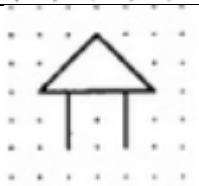
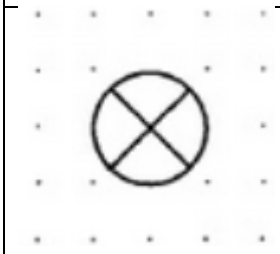
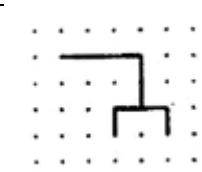
Prepared by:

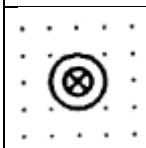
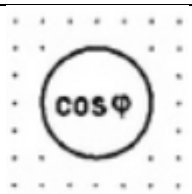
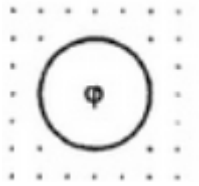
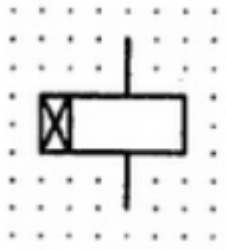
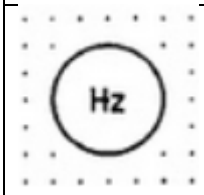
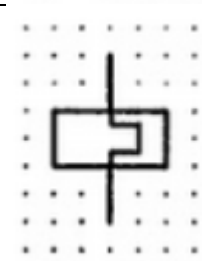
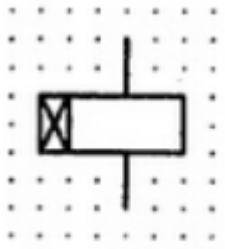
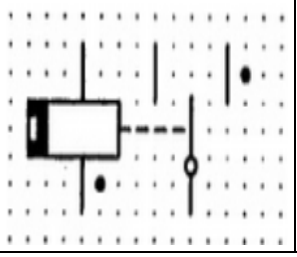
Eng:Asma' shara'b

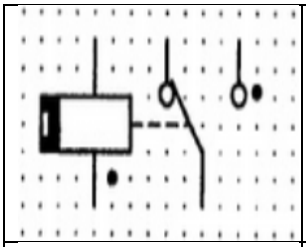
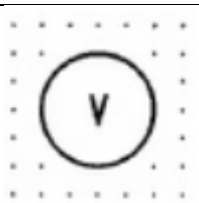
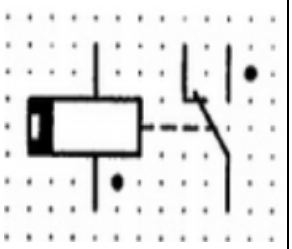
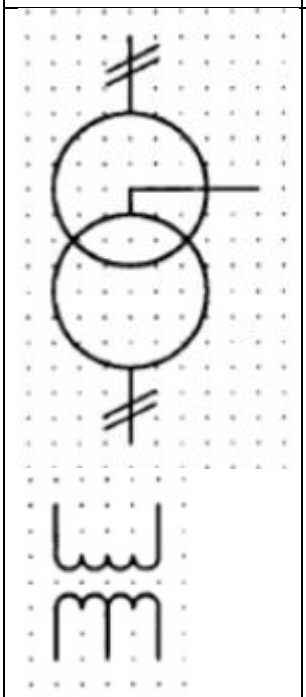
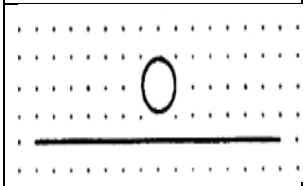
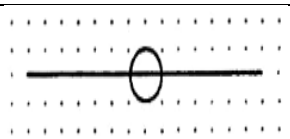
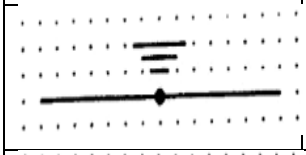
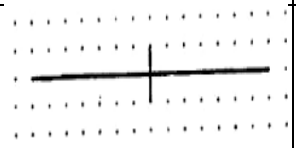
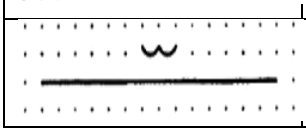
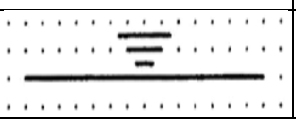
NO	Topics	NO of Lecture
1.	Lighting installation works include: **Exercise1……Exercise10**	2
2.	Plugs and sockets installation works include: **Exercise11……Exercise17**	2
3.	Signaling installation works include : **Exercise18……Exercise27**	2
4.	Interphone installation works include: **Exercise28……Exercise30**	1
5.	Distribution system include: **Exercise31……Exercise38**	2
6.	Automatic Transfer Switch(ATS) **Exercise39**	1
7.	Electrical testing of an apartment building include: **Exercise40……Exercise46**	2
8.	Devices for safety and continuity of power supply include **Exercise47……Exercise52**	2
9.	Fire detection and alarm system installation chart with its element and control panel. **Exercise53**	1
10.	Burglar alarm system installation chart with its elements and control panel. **Exercise54**	1
11.	Industrial electrical installation include: **Exercise55……Exercise58**	2
11.	Electrical installation electronically controlled industrial system include: **Exercise59……Exercise61**	2
13.	Drawing Electrical Layout by AutoCAD	5

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
	Mechanical interlock between two devices.		Manually operated switch, general symbol.
	Operated by pulling.		Push button switch make contact and automatic return.
	Operated by turning.		Pull -switch with make contact and automatic return.
	Operated by pushing.		Turn -switch with make contact without automatic return.
	Make contact and may also be used as the general symbol for a switch.		Emergency stop switch “mushroom – head " activated with positive opening operation of the break contact and maintain position.
	Break contact.		Change over break before make contact.

	Change over contact with off position in the center.		Switch with pilot light.
	Socket outlet (power), general symbol		Dimmer
	Multiple outlet socket (power), the symbol is shown with three outlets		Switch ,general symbol
	Socket outlet (power) with protective contact		Switch with pilot light.
	Socket outlet (power) with shutter		Period limiting switch ,single pole.
	Socket outlet (power) with single pole switch		Intermediate switch Equivalent circuit diagram. 
	Socket outlet (power) with interlock switch		Pull-cord single pole switch
	Socket outlet (power) with isolating transformer for example: shaver outlet.		Push - button

	Two pole switch		Indicator, electromechanical annunciator element.
	Multi-position single pole switch.		Timer period limiting equipment
	Two way single pole switch		Time switch
	Push- button protected against unintentional operation for instance by means of break -glass cover		Signal lamp, flashing type.
	Fuse, general symbol.		Siren
Socket outlet (power)	Buzzer		Bell
	Lamp, general symbol. Signal lamp, general symbol. if it desired to indicate the color , a notation according to following code is placed adjacent to the symbol: RD = red YE =yellow GN =green BU =blue		Socket outlet telecommunication outlet, general symbol. May be used to distinguish different types of outlets TP= telephone FX= telefax M=microphone TV= television TX=telex

	WH =white If it is desired to indicate the of lamp , a notation according the following code is placed adjacent to the symbol: Ne =neon Xe =xenon Na =sodium vapor Hg =mercury I =iodine IN =incandescent EL =electroluminescent ARC = arc FL =fluorescent IR =infra-red UV = ultra-violet LED =light emitting diode		FM=frequency module
	Push -button with indicator lamp		Power factor meter
	Phase meter		Relay coil of a slow – operating relay
	Frequency meter		Operating device of thermal relay
	Relay coil of a slow – operating relay		Polarized relay with neutral position, self-restoring, operating for either direction of current in the winding

	Polarized relay with two stable positions		voltmeter
	Polarized relay, self-restoring, operating for only one direction of current in the winding.		Reactive current ammeter
	Transformer with center tapping on one winding		Single –phase transformer with two winding.
	Line within a duct Line within a pipe		Overhead line
	Line with buried joint		Line with gas or oil block
	Submarine line		Underground line

Exercise 1- Controlling a lamp with a single switch.

Realization of typical domestic lighting circuit. This first exercise is not difficult to perform, but introduces the student to the fundamental principles of practical electric circuits.

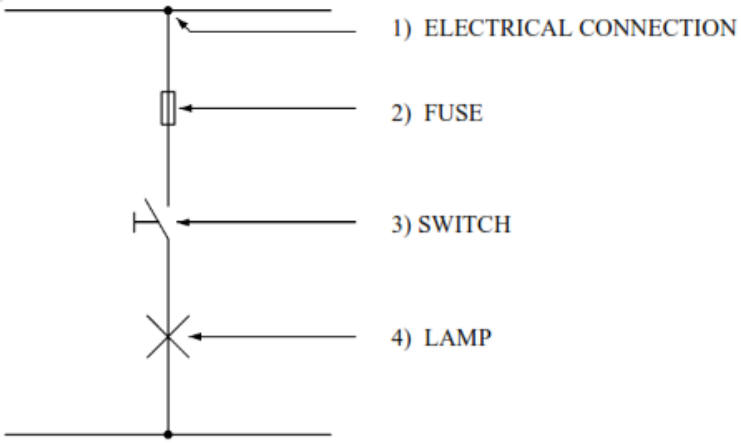


Fig. 1.1

To practically implement the circuit of this exercise, it is necessary –to fix one of each of the following modules to the panel (Fig. 1.2).

AZ10 (fuse holder)
AZ8 (lamp holder)
AZ1 (single pole switch).

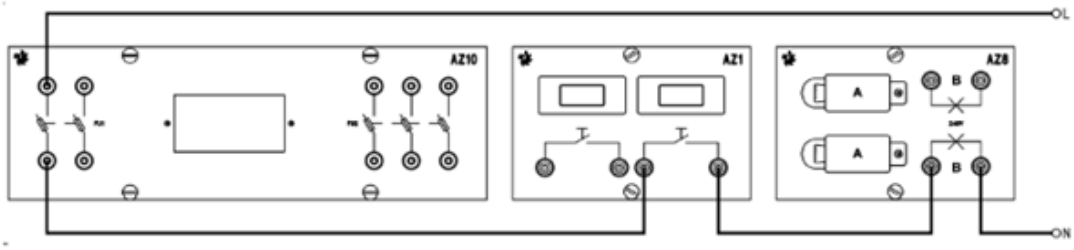


Fig. 1.2

TESTING

On operating the switch the lamp should light and on successively reopening, the lamp should extinguish. To assist the practical realization of the circuit, the functional schematic in transformed into a wiring schematic as shown in (Fig .1.3). We can now identify the position of the supply, the lamp holder, the switch and the fuse.

Following the functional schematic: from the phase though the fuse to the switch and finally complete the circuit through the lamp to the neutral terminal.

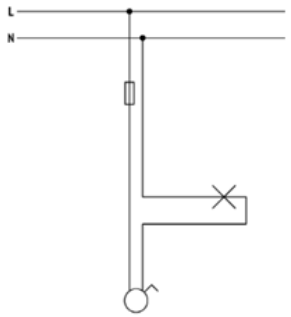


Fig .1.3

Exercise 2-Several lamps controlled by 2 single-pole switches.

Realization of an electric construction as used to illuminate a hall where the lighting consists of two groups of lights (A and B), controlled from a single point.
a) The lamps, consisting of two groups, must be OFF.
b) The lamps of group A must be on and the lamps from group b out.
c) The lamps of the two groups must be lit.
d) The lamps of group A must be out the lamp of group B must be lit.
In practice, this is a repeat of the previous exercise with more modular elements to simulate the groups of lamps and two switches.
The functional schematic as shown (Fig. 2.1) doesn't introduce any new symbols but reinforces those which were learnt in the previous exercise.

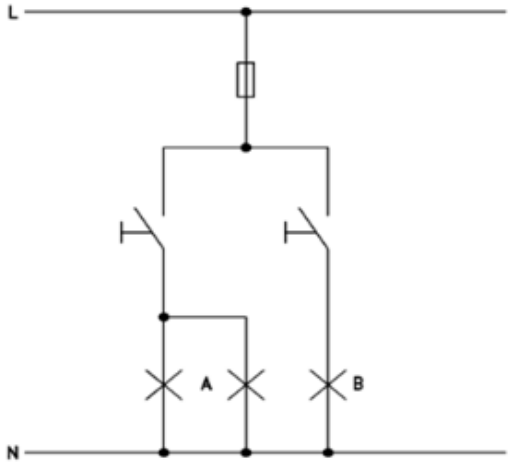


Fig .2.1

The same effect however can be obtained using a two circuit switch, the symbol for which is shown in (Fig. 2.2).

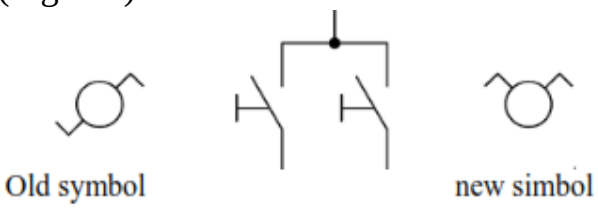


Fig.2.2

The functional schematic, of the two circuit switch in analogous to the previous are as shown in (Fig. 2.3.)

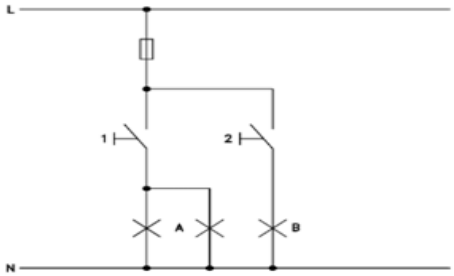


Fig.2.3

Note that it is not possible to feed group B without first supplying group A.
For the practical realization of this switch circuit, the following modules are required (refer Fig. 2.4)
AZ1 (on/off switches)
AZ8 (two lamp sockets)
AZ10 (fuse holders).

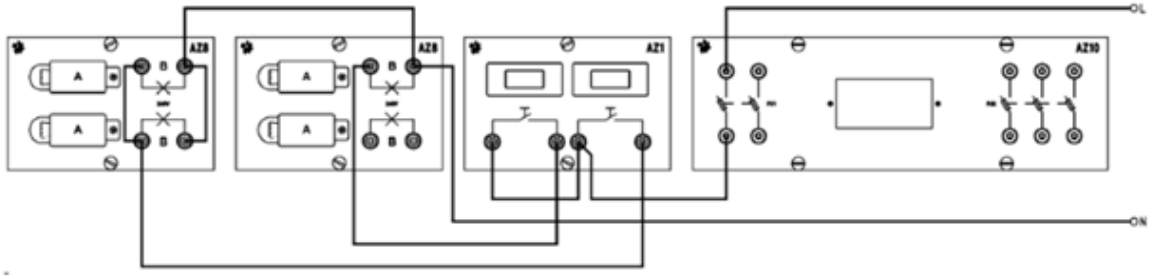


Fig.2.4

Exercise 3- Several lamps controlled by a two circuit switch.

In this case, to use the double pole switch we will have (refer to Fig.3.1).
AZ10 (fuse holder)

AZ8 (two lamp sockets)
AZ2 (switch).

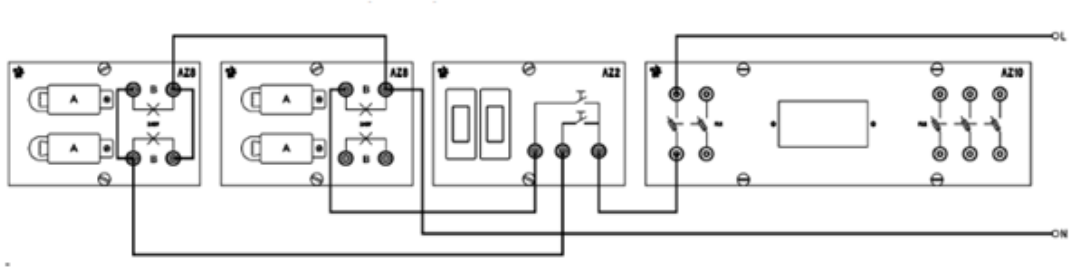


Fig.3.1

The transformation of the functional schematic to a wiring diagram is shown in two possible ways (Figs. 3.2, 3.3).

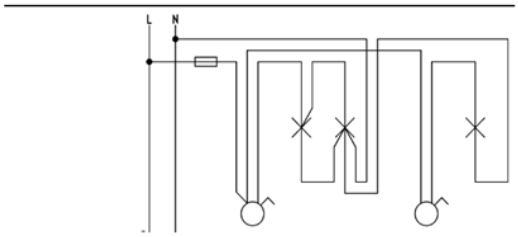


Fig.3.2

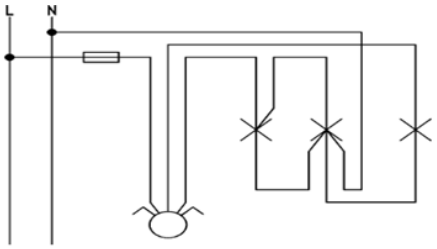


Fig.3.3

Exercise 4- Several lamps controlled using a 2 way switch.

A short corridor is illuminated by a single light source, consisting of two lamps.
The electrical mechanism which allows control of the light from two points is realized. Inserting first, an on/off switch for the domestic electrical supply.
For the realization of this circuit, a new type of switch must be introduced: the TWO WAY switch, whose symbol is shown in Fig. 4.1.

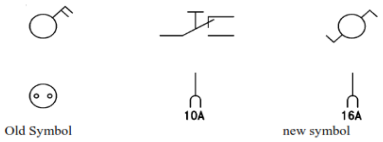


Fig.4.1

The functional schematic relevant to this exercise is shown in Fig 4.2. In the condition shown, the lamps are off. Note that if contact 1 is closed on switch A, contact 2 will open and a continuous metal path will be established through contact 3 of two way switch B and the lamps will light up. Then if contact 3 in opened, contact 4 will close and the lights will go

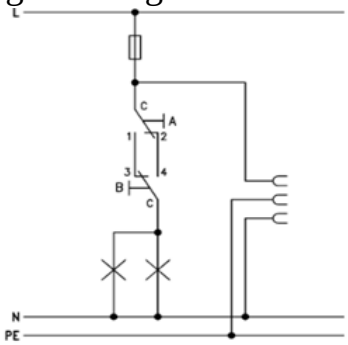


Fig.4.2

At each successive opening or closing of switches A and B, the lamps will alternately go on and off. The socket must be inserted before the switches, since it must always be supplied; but after the protective device, for obvious reasons.
In the practical realization, the central terminal of two way switch A must be connected to the phase conductor (via the fuse) and the center terminal of two way switch B to the lamps; in each case the functioning of the system will only be correct if the switches are correctly wired (refer Fig. 4.3).

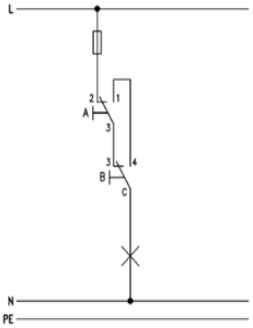


Fig.4.3

In the condition shown, the lamp is out whenever the circuit is opened at two ways switch A. Subsequent operation of switch B cannot light the lamp until the circuit is closed at A.
For the practical implementation of this circuit, the module elements AZ10, AZ8, AZ3, AZ9a are used and may be arranged and wired as in Fig .4.4.

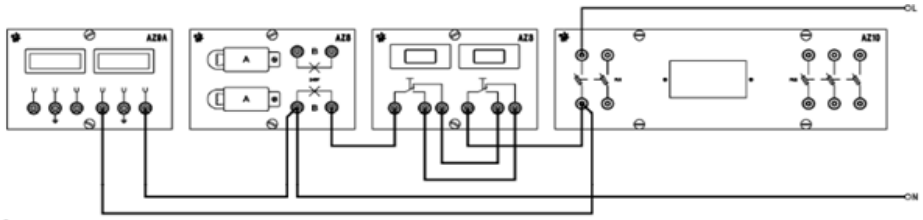


Fig.4.4

Exercise 5-Controlling several lamps with a 2 pole 2 way switch + 3 wall sockets.

A bedroom is illuminated by three lights, all on a central mounting. An electric circuit is implemented which allows control of the lights at the entrance to the room, and also from the two bedsides. The installation must be completed by the insertion of two wall sockets to supply the two table lamps and to supply a domestic appliance (television). In the preceding exercise, to control lights from two points, the two way switch was introduced. When there are more than 2 control points required, it is once again necessary to introduce a new device: the INTERMEDIATE SWITCH as shown in Fig .5.1.

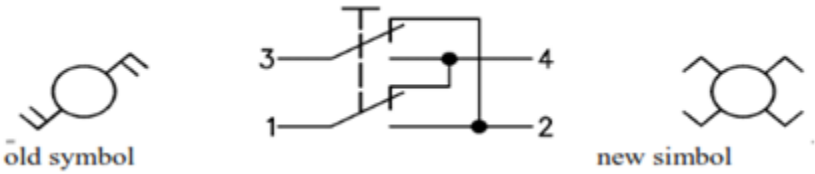


Fig .5.1

This switch allows metallic contact between terminals 1-4 and 3-2 in one position and between terminals 1-2 and 3-4 in the other. In practice the pair of terminals 1-3 and 2-4 are distinguishable by their colors (blue or brown). In this modular element, the pair of terminals 1-3 is distinguishable by the color RED and the pair 2-4 by the color GREEN. Observe firstly in the description of the system that the number of intermediate switches required is given by the expression:

U = N - 2

Where u: represents the number of intermediate switches

N: is the total number of control points

2: is the number of two way switches which must be inserted.

In the case of 10 points of control we have:

u = 10 - 2 = 8 intermediate switches.

In the case of this exercise we require

u = 3 - 2 = 1 intermediate switch

The schematic to implement the system refereed to the text is shown in Fig .5.2.

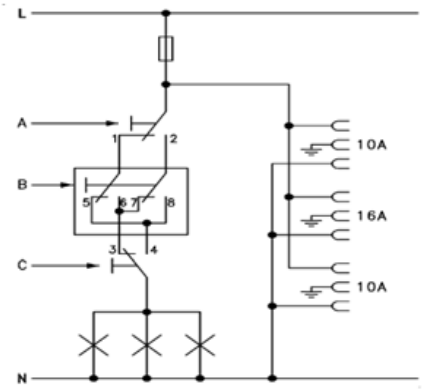


Fig .5.2

The schematic, in Fig.5.3, confirms this. With the situation as indicated in the figure, the lamps are out owing to an interruption of metallic continuity at point 5.

On operating the inverter switch, the lamp lights but the circuit remains open at point 4.

To realize this system, the following modules are necessary:

AZ (two way switches)

AZ9 (two 10A sockets)

AZ (15A socket)

AZ4 (intermediate switch)

AZ10 (fuse holder)

AZ (two lamp sockets)

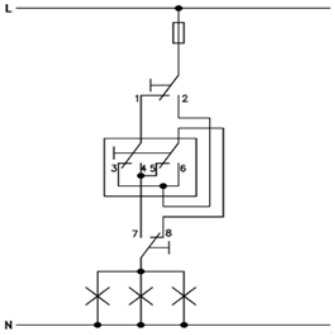


Fig .5.3

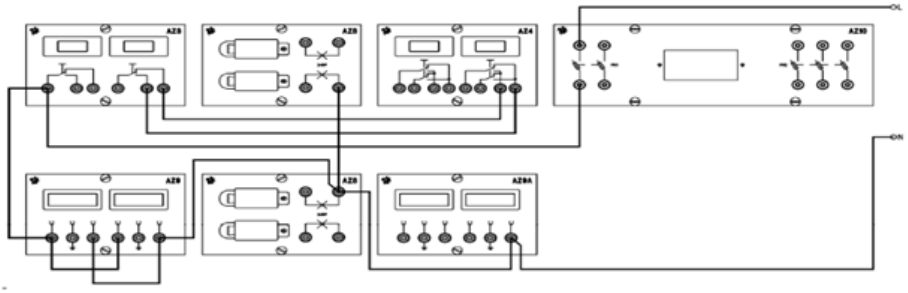


Fig .5.4

Exercise 6- Controlling several lamps from 3 points with a single pole relay.

The next step in to implement an excitation circuit which allows the control of lighting in a corridor from four different points. An electrical implementation is required which allows an excitation from each of the points, using 220 Volt coils. Consider Fig .6.1.

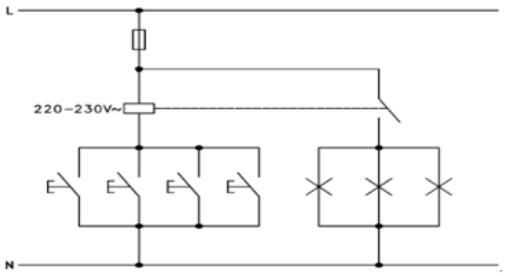


Fig .6.1

As a result of a press at one of the push buttons connected in parallel with each other, the relay coil is excited, which energizes the relay and closes the contact in series with the lamps. At a successive command the relay steps to interrupt the metallic continuity in the supply circuit to the lamp. To implement this system, the following modules are required:

AZ6 Relay

AZ5 four push buttons, as are partially connected in Fig. 6.2.

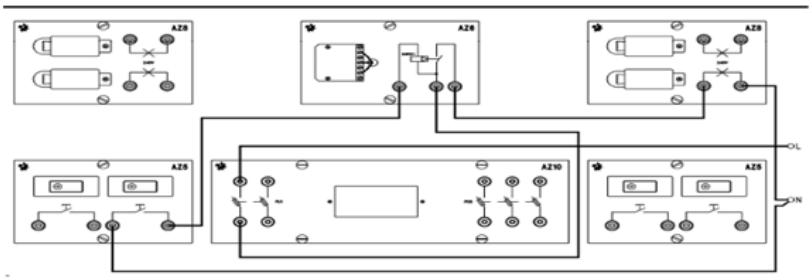


Fig .6.2

Exercise 7- Controlling groups of lamps from 3 points.

We can control each group of lamps with two way switches and an intermediate switch as shown in Fig. 7.1.

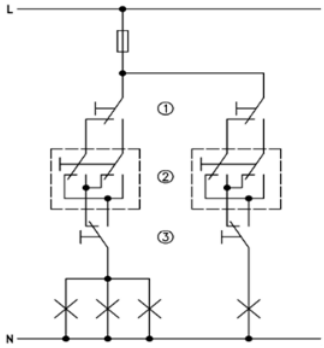


Fig .7.1

Exercise 8 -Controlling a group of lamps from 3 points using a two pole relay

The two pole relay required for this exercise is substantially the same as the single pole relay used previously, but distinguishable by the two contacts which allow the same switching mechanism thanks to the particular construction of a cam which rotates through 90° at each excitation pulse applied to the coil.
The symbol for the two pole relay is shown in Fig .8.1

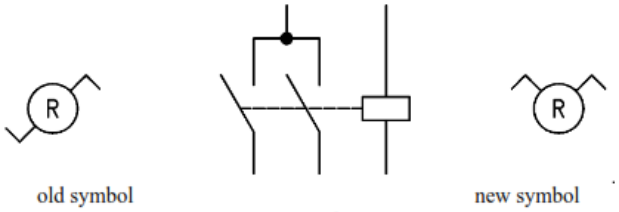


Fig .8.1

The schematic for this circuit also includes two sockets and is shown in Fig. 8.2.

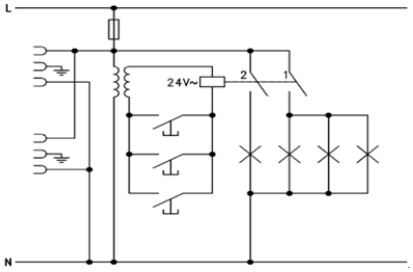


Fig .8.2

To implement this circuit, the following modular elements are introduced
AZ15 (transformer)

AZ7 (switching relay). As shown partially connected in Fig. 8.3.

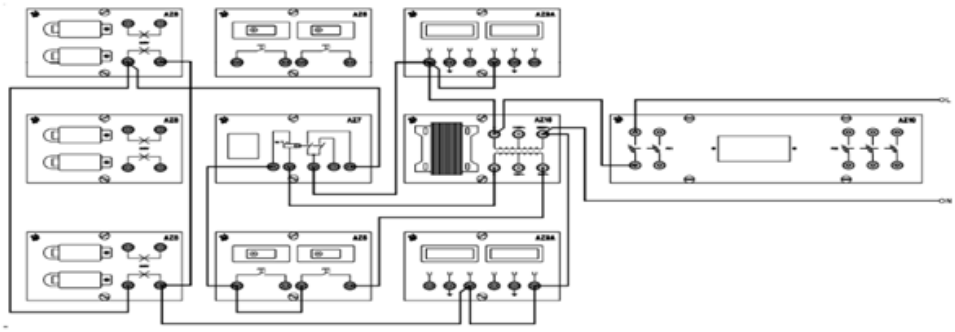


Fig. 8.3.

Exercise 9- Controlling a fluorescent lamp.

FLUORESCENT LAMP

The light source used up to this point has been the classical incandescent lamp, but it is possible to construct, in a special way a light for domestic use of another type: the fluorescent light using a heated cathode.

In the incandescent lamp, the light originates from the tungsten filament which is heated, by the passage of electric current, to a temperature at which it emits visible light. In the fluorescent lamp, we utilize the property of a fluorescent substance which, when excited, will emit light.

The light so produced covers a wider range of the visible spectrum than that produced in an incandescent lamp and being a cold light source produces a more natural color. Above all, it has a much higher efficiency and longer life.

As stated earlier, the incandescent lamp has a life expectancy of about 1000 hours, with an efficiency of 15 to 20 lumen/watt compared with 4000 hours and luminous efficiency of 40-50 lumen/watt. The fluorescent lamp consists substantially of a long glass tube into the two ends up which are introduced two conductive electrodes. Inside the tube is an inert gas and a small quantity of mercury and the fluorescent material which determines the color of light emitted. When the electrodes of the lamp are supplied with electricity, they heat up and produce an ionized gas inside the tube. When the discharge from the electrodes inside the tube allows the mercury to evaporate; the particles of mercury bombard the fluorescent substance, thus providing the excitation to emit light. In order to implement a fluorescent lamp circuit, there are some additional accessories required.

a) The holder may take on many different forms in order to accommodate the different sizes of tube. However the function is always the same; to establish metallic contact with the tube and hold the lamp in place.
b) The ballast choke with the following symbols

c) 

It is in fact an autotransformer with a high current density (6-8 A/mm2) and magnetic saturation to perform two functions:-
1- To provide a high voltage between the electrodes (Lenz law) ,which is higher than the supply voltage to initiate the discharge within the tube.
2- To limit the lamp current, in operation. This is necessary because the internal resistance of a normally functioning tube is too low for it to be connected directly to the supply. The series reactance of the choke between supply and lamp limits the value of lamp current, so maintaining a potential difference across the tube of 90-100 volts.

c) The starter is identifiable by the symbol  and is a bimetallic switch inserted to provide a time delay for the fluorescent tube filaments to heat up and then, when it opens, to provide a discharge inside the tube. A small capacitor is provided across the starter terminals to suppress disturbances which would cause interference to radio and TV receivers.

d) The phase correction capacitor, having symbol  is necessary to correct for the phase delay introduced by the reactance of the ballast choke. For normal lighting circuits, the power factor should be at least 0.9, but for these lamps, without compensation, it is about 0.8. The value of the capacitor required is determined by the rating of the lamp and consequently on the characteristics of the choke. The value normally chosen is of the order of 4-6 µF (microfarads).
The schematic for a fluorescent lamp installation is shown in Fig. 9.1.

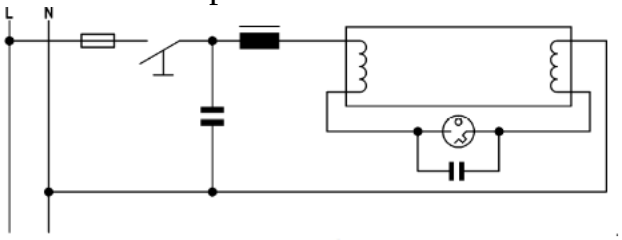


Fig. 9.1

To realize this circuit in practice the following modules are required:
AZ11, AZ12-13, AZ14 as are shown partially connected in Fig. 9.2.

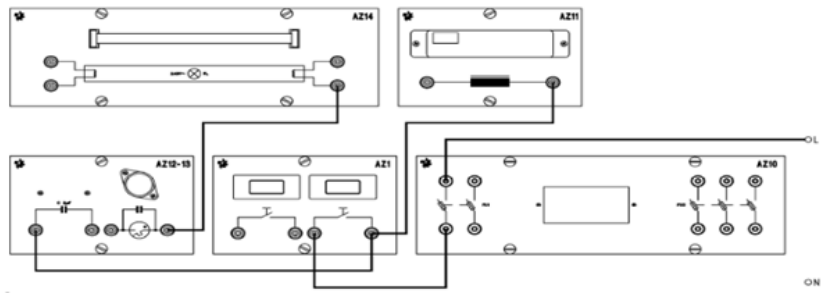


Fig. 9.2

9.1 -Determination of installed power and concept of conventional load.

The determination of the installed power is reduced to a simple sum of the users target consumptions where the numbers and characteristics of the users are known. However, for the purpose of the project this data is not available and so we approach the problem in a different way.

A calculation can be based on the area of the apartment. Obviously, as the apartment is made larger, with larger surfaces and more rooms, so too will the installed power increase.

We must distinguish between lighting supplies and those used for domestic devices; from statistical data the following figures for installed power have been derived:

a) For lighting, a power of 15 W per square meter of surface with a minimum of 500 W per room.

b) For domestic appliances, 60 W per square meter of surface

c) for hot water (electric), a power of 1000 W per apartment with up to 3 rooms and 2000 W per apartment with more than three rooms.

d) For electric cookers (if this is expressly required in the installation) we allow 2500 W.

On the above basis, for a 3 room apartment with a surface area of 80 m^2 the resulting installed power will be:

For lights	15x80	1200 W
For domestic appliances	60x80	4800 W
For hot water	1000	1000 W
For electric cooker	non required	
Total installed power	7000 W	

In reality the power consumed by the apartment at any instant in time will not be as high as the installed power. It is unlikely that all the lamps will be an at once, and

almost impossible that all of the appliances will be being operated at the same time. The nominal load represents the actual consumption of the apartment and will normally be about 60 % of the installed power.

Installed Power 7000 W.

Nominal Load 4200 W.

9.2- Determination of the number of wall sockets.

The determination of the number of wall sockets to install in an apartment in governed by practical, experience of the designer. As a guide line however, we must always keep to the following:

a) For each user there must be at least one wall socket.

b) It is not advised to install multiple plugs since these are like to cause overloading of the secondary circuits to the wall sockets.

c) The kitchen must be considered as an. At typical room.

d) It is better to provide a socket in advance than to have to add one at a later date.

An example of the procedure in as follows

a) The installation has two main circuits, one for lamp sockets and the other for domestic appliances: one lamp socket (10 A) and one wall socket (15 A) for each 7 meters (or fraction) of the perimeters of each room;

b) The installation has a single supply line common to all the wall sockets: a wall sockets every 5 meters (or fraction) of the perimeter of each room;

c) The kitchen has one lamp socket and four wall sockets for domestic appliances.

POSITIONING OF THE SWITCHES AND OUTLETS

In this case there are no definite rules; the choice is almost entirely one of personal preference. An far as the positioning of the switches are concerned, it is generally Wise to place them to the right of the door at about 110 cm from the ground. Possible exceptions to this are for the bathroom mirror light and bedside lamp.

For the bathroom, mirror lamp, the switch is put to the right of the basin, over suitable console. For the bed lamp, about 30 cm from the ground for the switch.

As for as the sockets are concerned, these should be positioned no less than 15 cm above the ground, with the following exceptions;

a) The socket to supply the hair drier or electric shaver inserted at 1.10-1.30 m from the floor on the same box as the one used for the mirror lighting switch.

b) The sockets installed in the bedroom to correspond to the positions of the beds (to supply the table lamps) are mounted on the same distribution box as is used for the switches.

c) The lamp socket in the kitchen is positioned according to the possible position of a suction hood at about 1.90÷2.10 m from the ground. Always bear in mind that

sockets and switches cannot be placed in the vicinity of the bath. That is, within hands reach of the bath.

Exercise 10- Illumination with dimmer control.

To adjust the intensity of light, it is possible to use a "dimmer" which works as described below.
This exercise provides an example of how such a device may be inserted in the electrical system. Substantially, it is a small electronic device which is inserted in series with the lamp to control the voltage applied. Manual control in effected by rotating the small knob on the front of the device, which has the same dimensions as a switch to allow the replacement of a switch by one of these devices. The dimmer must always be inserted in series with a control device (switch) as shown in figure 10.1 and 10.2.

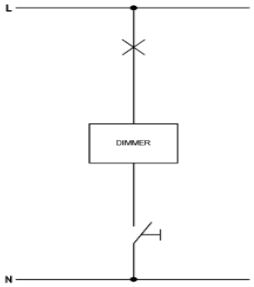


Fig.10.1

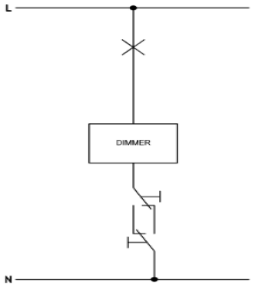


Fig.10.2

This avoids the device being always inserted, for safety reasons. Because of the way the device is constructed, it must only be used for filament lamps with power consumption of at least 40-60 W. Only then is it possible to have correct regulation of light emission. With the application diagrams shown in fig. 10.3 and 10.4 two lamps are controlled using 2 switches.

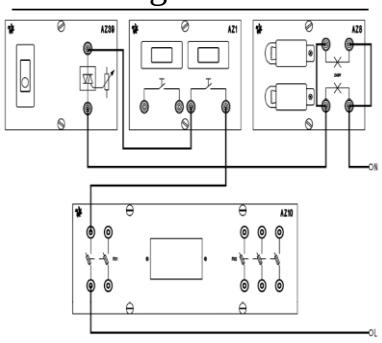


Fig.10.3

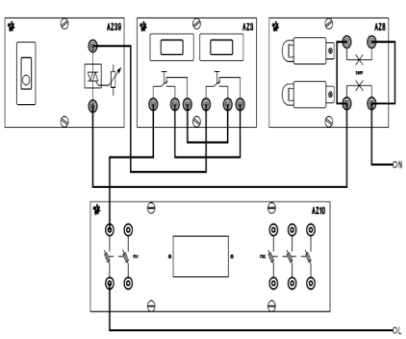


Fig.10.4

Exercise 11 - Installations in master or double bedrooms.

OBJECTIVE

Carry out the connections to make the electrical installation work in a room used as main bedroom (master or double bedroom); this installation includes an inverted light source, 1 socket for light circuits (night table lamp), one socket for electrical appliances and one for the buzzer.

NECESSARY EQUIPMENT

- 1 Panel mod. A-CE/EV.
- 1 fixed single-phase power supply of 220-230 V_{AC}.
- 1 Set of leads with safety plugs (Ø 4 mm).

PREPARING THE EXERCISE

Carry out the connections as indicated in the lay-out shown in Fig .11.1.

OPERATIONAL STEPS

Power the panel, turn the protection devices of the switchboard to ON position and verify that:

- It is possible to turn on/off the main light using the 3corresponding control devices.
- When the button is pressed, the doorbell rings.
- The light socket is powered and included in the light circuit protected by the TMCB of 6 A.
- The socket for electrical appliances is powered and included in the circuit protected by the TMCB of 16 A.

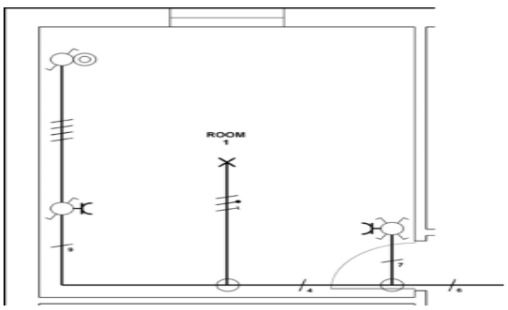


Fig 11.1: Topographic representation of an electrical installation for a master or double bedroom.

Exercise 12- Installations in single rooms.

OBJECTIVE

Carry out the connections to make the electrical installation work in a room used as single room; this installation includes a light source1 socket for light circuits (night table lamp) and one socket for electrical appliances.

NECESSARY EQUIPMENT

- 1 Panel mod. A-CE/EV.
- 1 fixed single-phase power supply of 220-230 V_{AC}.
- 1 Set of leads with safety plugs (Ø 4 mm).

PREPARING THE EXERCISE

Carry out the connections as indicated in the lay-out shown in Fig. 12.1

OPERATIONAL STEPS

Power the panel, turn the protection devices of the switchboard to ON position and verify that:

- It is possible to turn on/off the main light using the corresponding control device.
- The light socket is powered and included in the light circuit protected by the TMCB of 6 A.
- The socket for electrical appliances is powered and included in the circuit protected by the TMCB of 16 A.

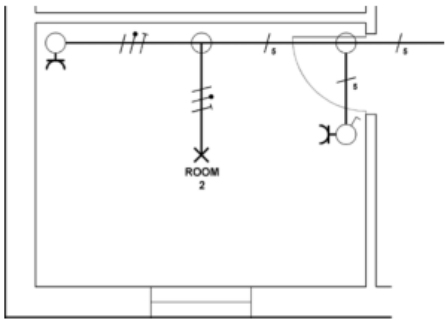


Fig 12.1: Topographic representation of an electrical installation for a single room.

Exercise 13- Installations in bathrooms.

OBJECTIVE

Carry out the connections to make the electrical installation work in a room used as bathroom; this installation includes a light source with relay and door button provided with state LED, and 1 socket for light circuits controlled by switch (socket for mirror lamp).

NECESSARY EQUIPMENT

- 1 Panel mod. A-CE/EV.
- 1 fixed single-phase power supply of 220-230 VAC.
- 1 Set of leads with safety plugs (Ø 4 mm).

PREPARING THE EXERCISE

Carry out the connections as indicated in the lay-out shown in Fig. 13.1.

OPERATIONAL STEPS

Select the operating mode IT in the timing relay

Power the panel, turn the protection devices of the switchboard to ON position and verify that:

- The main light can be turned on/off by the door button switch and that the LED of this switch indicates the state of the same light.
- The light socket is controlled by the switch.

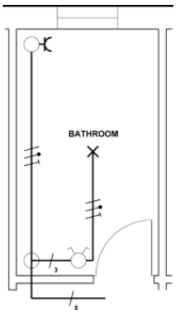


Fig. 13.1: Topographic representation of an electrical installation for a bathroom.

Exercise 14- Installations in living rooms.

OBJECTIVE

Carry out the connections to make the electrical installation work in a room used as living or dining room; this installation includes a double light source and two sockets for electrical appliances.

NECESSARY EQUIPMENT

- 1 Panel mod. A-CE/EV.
- 1 fixed single-phase power supply of 220-230 V_{AC}.
- 1 Set of leads with safety plugs (Ø 4 mm).

PREPARING THE EXERCISE

Carry out the connections as indicated in the lay-out shown in Fig. 14.1.

OPERATIONAL STEPS

Power the panel, turn the protection devices of the switchboard to ON position and verify that:

- The main light can be turned on/off by the corresponding switch.
- The sockets for electrical appliances are powered and included in the circuit protected by the TMCB of 16 A.

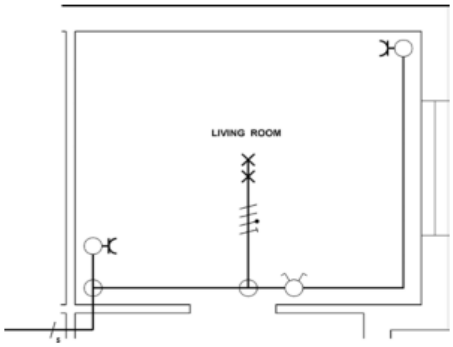


Fig. 14.1: Topographic representation of an electrical installation for a living or dining room.

Exercise 15 -Installations in kitchens and in terraces.

OBJECTIVE

Carry out the connections to make the electrical installation work in a room used as kitchen with a terrace; this installation includes a light source in the kitchen, another light source in the terrace with switch and LED for signaling the state of outdoor light, and two sockets for electrical appliances.

NECESSARY EQUIPMENT

- 1 Panel mod. A-CE/EV.
- 1 fixed single-phase power supply of 220-230 V_{AC}.

PREPARING THE EXERCISE

Carry out the connections as indicated in the lay-out shown in Fig .15.1.

OPERATIONAL STEPS

Power the panel, turn the protection devices of the switchboard to ON position and verify that:

- The main light can be turned on/off by the corresponding switch.
- The light on the terrace can be turned on/off by the corresponding switch which will also indicate its state by its own LED.
- The sockets for electrical appliances are powered and included in the circuit protected by the TMCB of 16 A.

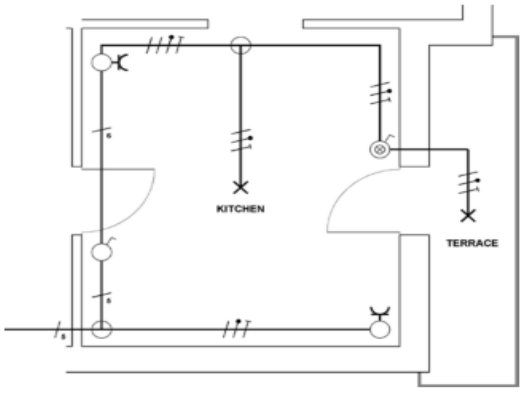


Fig. 15.1: Topographic representation of an electrical installation for a kitchen with terrace.

Exercise 16- Installations in entrances or in stairwells.

OBJECTIVE

Carry out the connections to make the electrical installation work in a room used as entrance or stairwell; this installation includes a light source controlled by electronic relay for the automatic timed switching off, the control button switch with LED for its identification in the dark.

NECESSARY EQUIPMENT

- 1 Panel mod. A-CE/EV.
- 1 fixed single-phase power supply of 220-230 V_{AC}.
- 1 Set of leads with safety plugs (Ø 4 mm).

PREPARING THE EXERCISE

Carry out the connections as indicated in the lay-out shown in Fig. 16.1.

OPERATIONAL STEPS

Select the operating mode BE in the timing relay

Power the panel, turn the protection devices of the switchboard to ON position and verify that:

- The LED of the button switch is ON for its identification in the dark.
- The light can be turned on by an action on the suitable button switch.
- The light is turned off automatically after the time set by the relay.
- As soon as the button is pressed, the doorbell starts sounding.

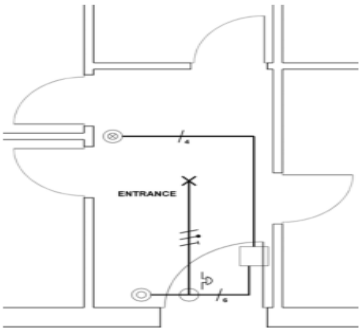


Fig. 16.1: Topographic representation of an entrance.

Exercise 17-General lighting installation of a house

OBJECTIVE

Carry out the connections to make the general lighting installation of a house work. This installation must power the following rooms:

- Master or double bedroom with inverted light source.
- Single room with cut-off light source.
- Bathroom with cut-off light source.
- Living or dining room with two switched light sources.

- Kitchen and terrace with cut-off light source for the kitchen and a cut-off light source for the terrace.
- Entrance or stairwell with light source controlled by multifunction timing relay.

NECESSARY EQUIPMENT

- 1 Panel mod. A-CE/EV.
- 1 fixed single-phase power supply of 220-230 V_{AC}.
- 1 Set of leads with safety plugs (Ø 4 mm).

PREPARING THE EXERCISE

Carry out the connections as indicated in the lay-out shown in Fig. 17.1.

OPERATIONAL STEPS

Power the panel, turn the protection devices of the switchboard to ON position and test the various light sources.

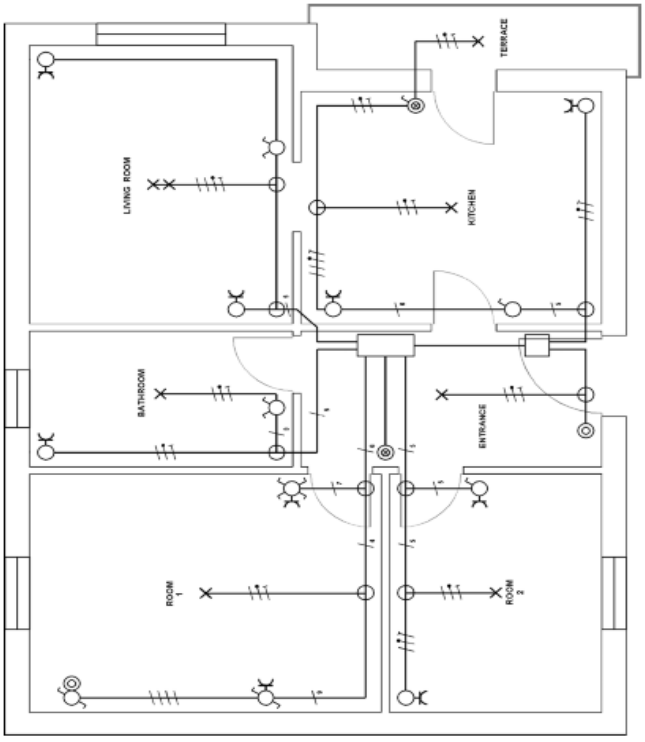


Fig. 17.1: Topographic representation of an electrical lighting installation of a house.

Exercise 18- System with a bell controlled from a point.

OBJECTIVE

Carry out the connections for the operation of an electric system enabling a bell (sound signaling) by a pushbutton. This system can be installed inside a house, for instance, in a bedroom with the pushbutton on the headboard of the bed, and the bell in the hall/kitchen.

NECESSARY EQUIPMENT

- 1 Panel mod. B-IS/EV.
- 1 Fixed single-phase power supply unit of 220-230 V_{AC} .
- 1 Set of leads with safety plugs (Ø 4 mm).

PREPARING THE EXERCISE

Position the panel on the working top so that it is perfectly stable. Connect the various electrical components according to the wiring diagram shown in Fig. 18.1

OPERATIONAL MODE

Power the circuit and check whether pressing the button makes the bell ring.

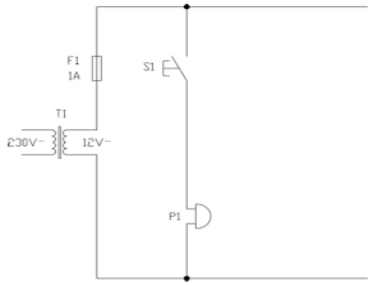


Fig. 18.1: Wiring diagram for the control of a bell from a point.

Exercise 19 - System with a bell controlled from two or more points.

OBJECTIVE

Carry out the connections for the operation of an electric system enabling a bell (sound signaling) by two or more pushbuttons. This system can be installed inside a house, for instance, the bell in the hall/kitchen can be controlled from the beds of two or more bedrooms.

NECESSARY EQUIPMENT

- 1 Panel mod. B-IS/EV.
- 1 Fixed single-phase power supply unit of 220-230 V_{AC}.
- 1 Set of leads with safety plugs (Ø 4 mm).

PREPARING THE EXERCISE

Position the panel on the working top so that it is perfectly stable. Connect the various electrical components according to the wiring diagram shown in Fig. 19.1.

OPERATIONAL MODE

Power the circuit and check whether pressing all the connected pushbuttons makes the bell ring.

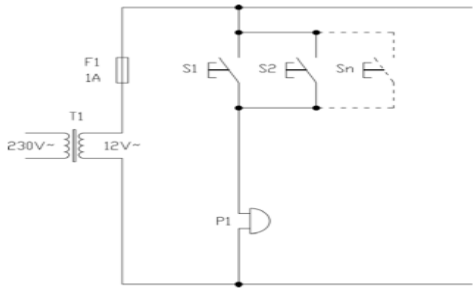


Fig. 19.1: Wiring diagram for the control of a bell from two or more points.

Exercise 20- System with two or more bells controlled from a point.

OBJECTIVE

Carry out the connections for the operation of an electric system enabling two or more bells (sound signal repeated in several rooms) by a pushbutton. This system can be installed inside a house, for instance, to repeat the call arriving at the hall, also in the basement room and in the garden.

NECESSARY EQUIPMENT

- 1 Panel mod. B-IS/EV.
- 1 Fixed single-phase power supply unit of 220-230 V_{AC}.
- 1 Set of leads with safety plugs (Ø 4 mm).

PREPARING THE EXERCISE

Position the panel on the working top so that it is perfectly stable. Connect the various electrical components according to the wiring diagram shown in Fig. 20.1.

OPERATIONAL MODE

Power the circuit and check whether pressing a single button makes all the bells ring.

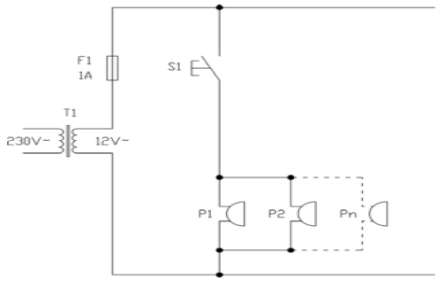


Fig. 20.1: Wiring diagram for the control of two or more bells from a point.

Exercise 21- System with two bells controlled from a point (diverted bells)

OBJECTIVE

Carry out the connections for the operation of an electric system where a pushbutton must enable two bells mounted in two different rooms, with the possibility of choosing the room receiving the call. This system can be installed in a house, for instance, to direct the call to the hall or to the basement room, but not to both rooms at the same time.

NECESSARY EQUIPMENT

- 1 Panel mod. B-IS/EV.
- 1 Fixed single-phase power supply unit of 220-230 V_{AC}.
- 1 Set of leads with safety plugs (Ø 4 mm).

PREPARING THE EXERCISE

Position the panel on the working top so that it is perfectly stable. Connect the various electrical components according to the wiring diagram shown in Fig. 21.1.

OPERATIONAL MODE

Power the circuit and check whether pressing a single button makes the bells ring according to the choice.

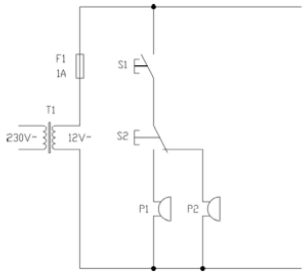


Fig. 21.1: Wiring diagram for the control of two bells from a point (diverted bells).

Exercise 22- System of bells with call and answer.

OBJECTIVE

Carry out the connections for the operation of an electric system of sound signaling including bells with call and answer between two offices. Actually two bells (one in each office) are controlled by two pushbuttons (a pushbutton in each office) connected so that two separate phone signals can be obtained between the offices.

NECESSARY EQUIPMENT

- 1 Panel mod. B-IS/EV.
- 1 Fixed single-phase power supply unit of 220-230 V_{AC} .
- 1 Set of leads with safety plugs (Ø 4 mm).

PREPARING THE EXERCISE

Position the panel on the working top so that it is perfectly stable. Connect the various electrical components according to the wiring diagram shown in Fig. 22.1a

OPERATIONAL MODE

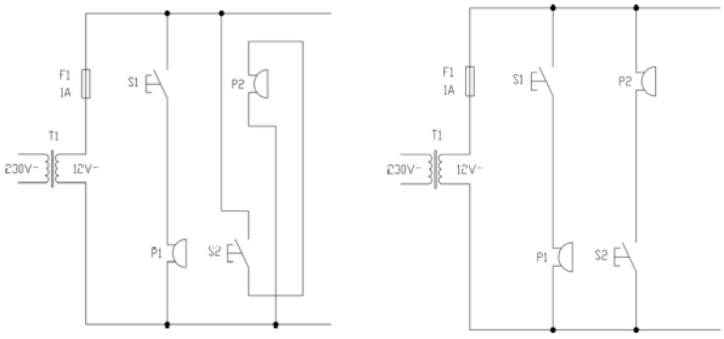


Fig. 22.1a, b: Wiring diagram and simplified wiring diagram for the control of bells with call and answer.

Exercise 23- Sound signaling system for a flat (bell and electric lock with door opener).

OBJECTIVE

Carry out the connections for the operation of an electric system of sound signaling that includes a bell with call from an outdoor gate and the control of an electric lock inside the building for opening the way for pedestrians. Actually this system consists of two circuits: a control circuit for the bell and a similar circuit for the electric lock.

NECESSARY EQUIPMENT

- 1 Panel mod. B-IS/EV.
- 1 Fixed single-phase power supply unit of 220-230 V_{AC}.
- 1 Set of leads with safety plugs (Ø 4 mm).

PREPARING THE EXERCISE

Position the panel on the working top so that it is perfectly stable. Connect the various electrical components according to the wiring diagram shown in Fig. 23.1.

OPERATIONAL MODE

Power the circuit and check whether the bell rings as the outdoor call arrives, and the electric lock opens the gate as it receives the control signal sent from a room inside the building.

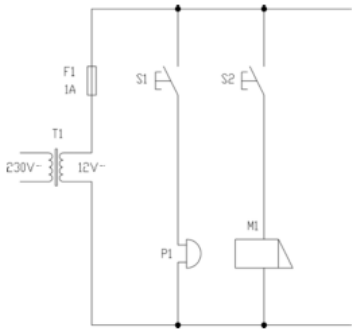


Fig. 23.1: Wiring diagram of a sound signaling system for a flat (bell and electric lock with door opener).

Exercise 24- Sound signaling system for a flat (outdoor dingdong bell, bell for calls from bathroom and buzzer for calls from bedrooms).

OBJECTIVE

Carry out the connections for the operation of an electric system of sound signaling for a flat. This installation includes three different ringers: a ding-dong bell for visitors' announcement with control provided with outdoor lighted nameplate, a bell for emergency calls from bathroom with cord-operated control button, a buzzer for courtesy calls from the bedroom.

NECESSARY EQUIPMENT

- 1 Panel mod. B-IS/EV.
- 1 Fixed single-phase power supply unit of 220-230 V_{AC} .
- 1 Set of leads with safety plugs (Ø 4 mm).

PREPARING THE EXERCISE

Position the panel on the working top so that it is perfectly stable. Connect the various electrical components according to the wiring diagram shown in Fig. 24.1.

OPERATIONAL MODE

Power the circuit and check the operation of the three ringers enabling the corresponding control buttons. Moreover, when pressing the button on the nameplate, make sure that the nameplate is lighted correctly.

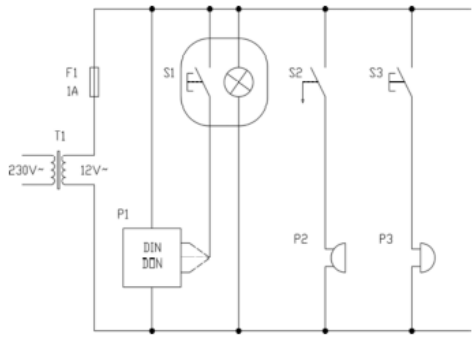


Fig. 24.1: Wiring diagram of a sound signaling system for a flat.

Exercise 25 - System of bells referred to an outdoor unit connected with two or more flats.

OBJECTIVE

Carry out the connections for the operation of an electric system of sound signaling including an outdoor unit (on a gate) from which calls can be sent to two flats, and the corresponding buttons inside the flats enabling to control an electric lock for opening the way for pedestrians.

NECESSARY EQUIPMENT

1 Panel mod. B-IS/EV.
1 Fixed single-phase power supply unit of 220-230 V_{AC} .
1 Set of leads with safety plugs (Ø 4 mm).

PREPARING THE EXERCISE

Position the panel on the working top so that it is perfectly stable. Connect the various electrical components according to the wiring diagram shown in Fig. 25.1.

OPERATIONAL MODE

Power the circuit and check whether the bells ring as outdoor calls arrive, and the electric lock opens the gate as it receives the control signals sent from the flats inside the building.

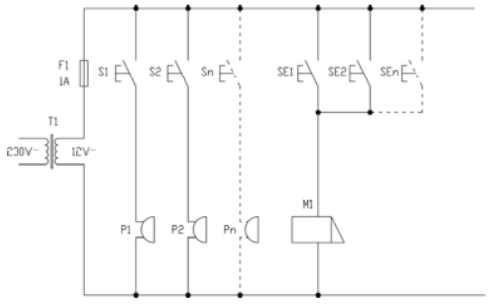


Fig. 25.1 : Wiring diagram of a sound signaling system referred to an outdoor unit connected with two or more flats.

Exercise 26-Light & sound signaling system for alarm calls, with bistable relay.

OBJECTIVE

Carry out the connections for the operation of an electric system of light & sound signaling which must store a call condition; the state of call is maintained until it is cancelled by a proper command.

NECESSARY EQUIPMENT

- 1 Panel mod. B-IS/EV.
- 1 Fixed single-phase power supply unit of 220-230 V_{AC}.
- 1 Set of leads with safety plugs (Ø 4 mm).

PREPARING THE EXERCISE

Position the panel on the working top so that it is perfectly stable. Connect the various electrical components according to the wiring diagram shown in Fig. 26.1

OPERATIONAL MODE

Power the circuit and check whether the light (two warning lights) and sound signaling is enabled; the sound signal must be heard until button S_1 is pressed; whereas the light signal is permanent (it is kept stored). In case of blackout, this condition will be displayed when the system is powered again. Check whether pressing button S_2 will cancel (reset) the alarm condition.

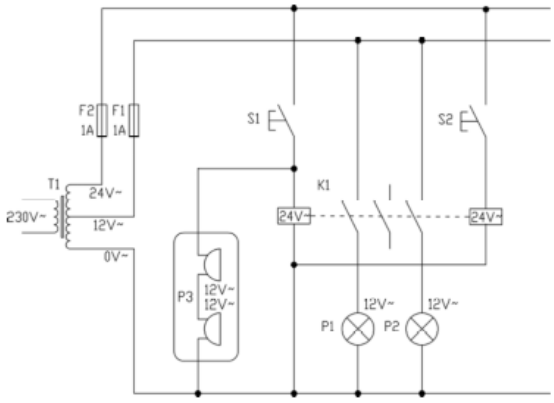


Fig. 26.1: Wiring diagram of a light & sound signaling system for alarm calls, with bistable relay.

Exercise 27- Light & sound signaling system with display.

OBJECTIVE

Carry out the connections for the operation of an electric system of light & sound signaling with a display for indicating the calling number. Use a system with simplified wiring where 2 only wires enable to manage up to 12 calling buttons (12 numbers). Typical applications of this type of installation can be found, for instance, in school classrooms, small hotels, bedrooms of hospitals and nursing homes, etc…

NECESSARY EQUIPMENT

- 1 Panel mod. B-IS/EV.
- 1 Fixed single-phase power supply unit of 220-230 V_{AC} .
- 1 Set of leads with safety plugs (Ø 4 mm).

PREPARING THE EXERCISE

Position the panel on the working top so that it is perfectly stable.
Connect the various electrical components according to the wiring diagram shown in Fig.27.1 .

OPERATIONAL MODE

Power the circuit and check whether it works as explained above.

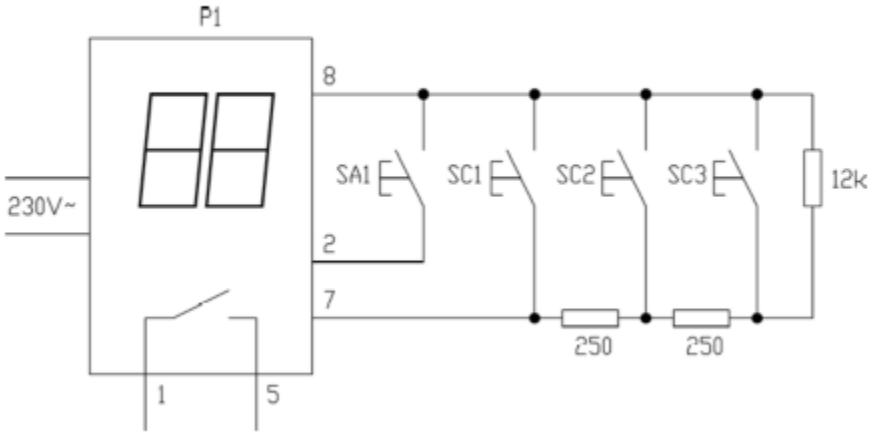
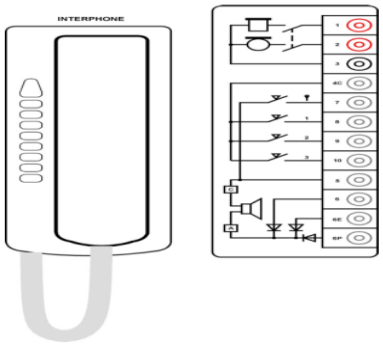


Fig. 27.1: Wiring diagram of a light & sound signaling system with display.

INTERPHONE 1…3

Wall-mounted interphone for analog system with calling loudspeaker, provided with button of lock opening and with 3 buttons for additional functions such as intercommunication or switching on of lights.

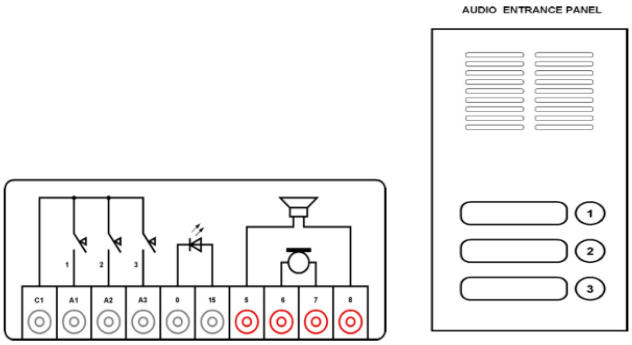


Wall-mounted interphone. INTERPHONE 1…3

1 Terminal of the receiver of interphone handset
2 Terminal of the microphone of interphone handset
3 Common terminal of interphone handset
4C Common terminal of additional buttons
7 Terminal of door-opening button (control of electric lock)
8-9-10 Output terminals of additional buttons
5 Common terminal of door-opening button and of calling loudspeaker
6-6E-6P Control terminals of calling loudspeaker

AUDIO ENTRANCE PANEL

Analog phone module with 3 calling buttons and lighting plate

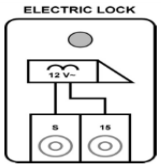


C1 Common terminal of calling buttons
A1…A3 Terminals of calling buttons

0 - 15 Terminals of the lamp of the lighting plate **5 - 8** Terminals of loudspeaker
6 - 7 Terminals of microphone

ELECTRIC LOCK

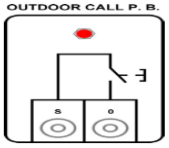
Simulator with warning light for reproducing the operation of the electric lock at 12 V~.



S - 15 Terminals of the electric lock (12 V~).

OUTDOOR CALL P. B

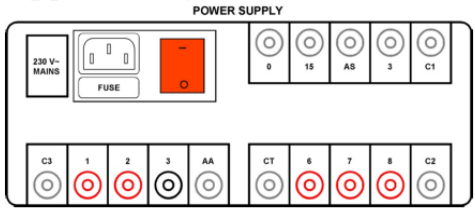
Additional push-button which can be used to control the floor call, or as local control of the electric lock.



S - 0 Terminal of push-button contact

POWER SUPPLY

Power supply unit for intercommunicating interphones and outdoor unit with three-note electronic generator; supply voltage of 230 V~ 50 – 60 Hz, power of 55 VA



230 V~ Input plug of power supply 230 V~: it includes the main switch with protection fuse 5x20 In 2 A
0 Common terminal of outputs 15 V ~ and =
15 Terminal of output 15 V~ - 1 A, intermittent service
AS Terminal of output 15 V= - 1 A, intermittent service
3 Common terminal of handset receiver and microphone
C1 Output terminal of call generator with modulated sound

C3 Output terminal of call generator with intermittent sound
1 Terminal of handset receiver
2 Terminal of handset microphone
3 Common terminal of handset receiver and microphone
AA Terminal for self-connection of outdoor unit
CT Terminal of calling signal on the outdoor unit
6 Common terminal of microphone and loudspeaker of outdoor unit **7** Terminal of microphone of outdoor unit
8 Terminal of loudspeaker of outdoor unit
C2 Output terminal of call generator with continuous sound.

Exercise 28- Single-family interphone system.

OBJECTIVE
Carry out the connections for the operation of a single-family interphone system with an indoor unit (interphone 1), an outdoor unit and electric lock.

NECESSARY EQUIPMENT
- 1 Panel mod. B-II/EV.
- 1 fixed single-phase power supply unit of 230 V~.
- 1 set of leads with 4-mm safety plugs.

PREPARING THE EXERCISE
- Install the panel so that it can be perfectly stable.
- Extrapolate the necessary connections for the exercise (power supply unit, outdoor unit, interphone, electric lock).
- Connect the various electrical devices according to the wiring diagram resulting from this operation, or carry out the connections as shown in the layout of Fig.28.1

OPERATIONAL MODE

Power the circuit and verify the possibility of:
- Calling interphone 1 by pressing button 1 of the outdoor unit.
- Talking between outdoor unit and interphone 1.

- Controlling the electric lock with the button "key" of interphone 1.

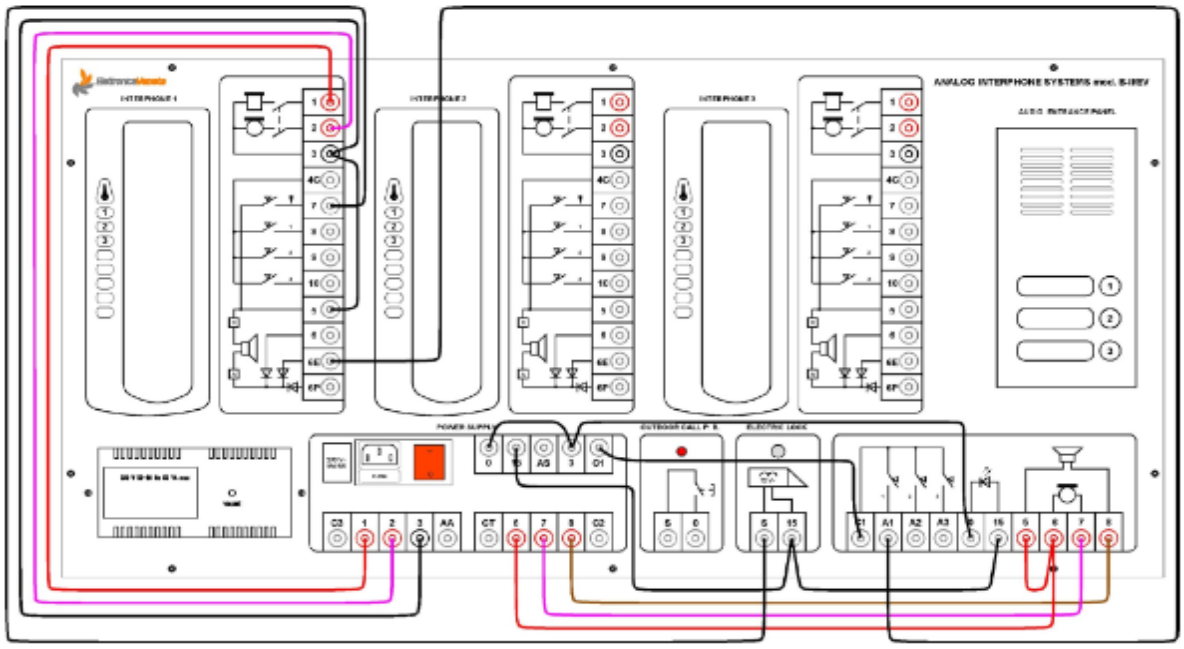


Fig. 28.1: Connections for a single-family interphone system.

Exercise 29- Single-family interphone system with additional control of the electric lock

OBJECTIVE

Carry out the connections for the operation of a single-family interphone system with an indoor unit (interphone 1), an outdoor unit and an electric lock controlled also by an additional push-button.

NECESSARY EQUIPMENT

- 1 Panel mod. B-II/EV.
- 1 fixed single-phase power supply unit of 230 V~.
- 1 set of leads with 4-mm safety plugs.

PREPARING THE EXERCISE

- Install the panel so that it can be perfectly stable.
- Extrapolate the necessary connections for the exercise (power supply unit, outdoor unit, interphone, electric lock and additional pushbutton).

- Connect the various electrical devices according to the wiring diagram resulting from this operation, or carry out the connections as shown in the layout of Fig. 29.1.

OPERATIONAL STEPS

Power the circuit and verify the possibility of:

- calling interphone 1 by pressing button 1 of the outdoor unit;
- talking between outdoor unit and interphone 1,
- controlling the electric lock with the button "key" of interphone 1
- Controlling the electric lock also with the additional push- button.

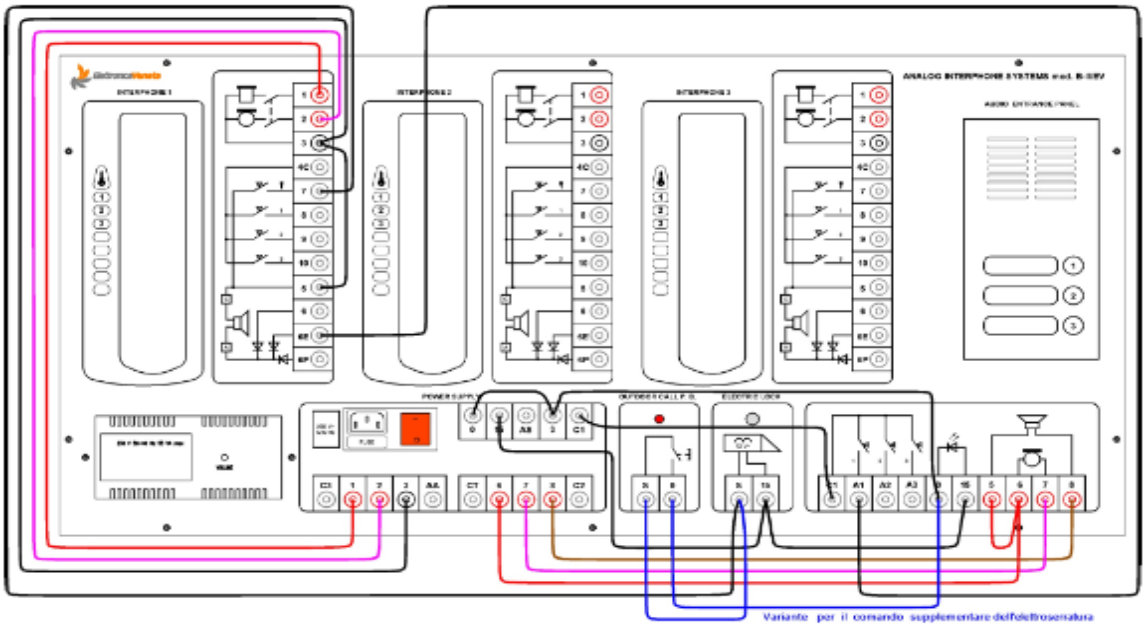


Fig. 29.1: Connections for a single-family interphone system.

Exercise 30 - Single-family interphone system with addition of floor call (entrance doorbell).

OBJECTIVE

Carry out the connections for the operation of a single-family interphone system with an indoor unit (interphone 1), an outdoor unit and an electric lock. Furthermore, add the function of floor call (doorbell).

INTERPHONE SYSTEMS

NECESSARY EQUIPMENT

- 1 Panel mod. B-II/EV.
- 1 fixed single-phase power supply unit of 230 V~ .
- 1 set of leads with 4-mm safety plugs.

PREPARING THE EXERCISE

- Install the panel so that it can be perfectly stable.
- Extrapolate the necessary connections for the exercise (power supply unit, outdoor unit, interphone, electric lock).

OPERATIONAL STEPS

Power the circuit and verify the possibility of:

- Calling interphone 1 by pressing button 1 of the outdoor unit.
- Talking between outdoor unit and interphone 1.
- Controlling the electric lock with the button "key" of interphone 1.
- Sending another sound signal to interphone 1 by pressing the button of floor call.

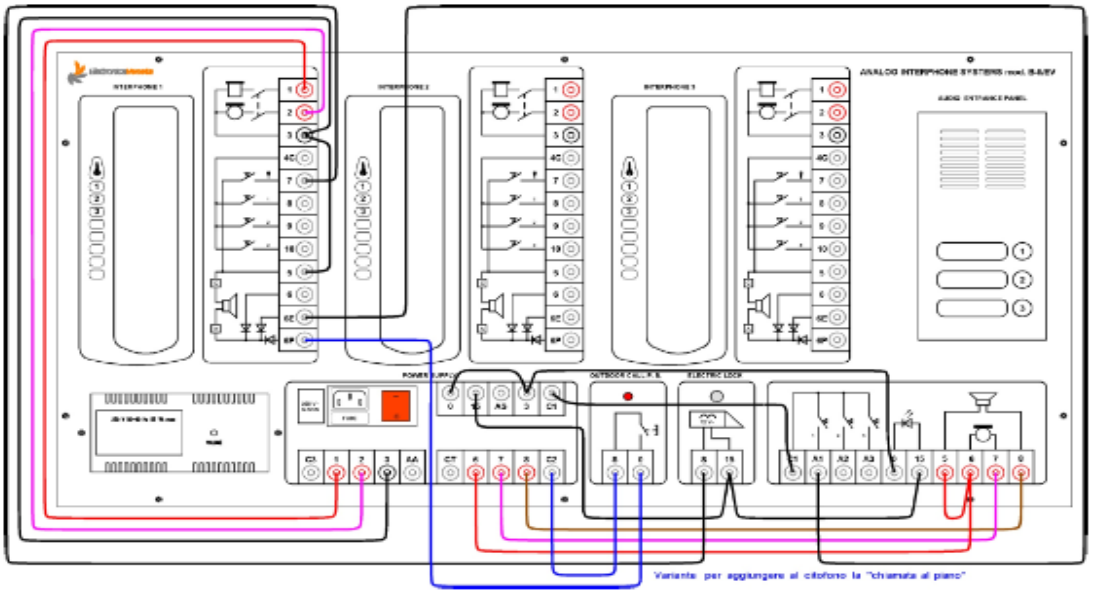


Fig. 30.1: Connections for a single-family interphone system.

Exercise 31- Realization of a TN-C distribution system.

OBJECTIVE

Assembling and studying a TN-C distribution system

NECESSARY EQUIPMENT

- Demonstration panel mod. PDG-R/EV.
- Set of leads and jumpers with safety plugs with diameter of 4 mm.
- Digital auto ranging multi-meter.
- Ammeter tongs for rated and leakage currents.
- Instrument for the verification of electric systems.

OPERATIONAL STEPS

- Connect a jumper between the Neutral jack and that of the earthing terminal ET1.
- Insert the jumper RE1 0.3 Ω.
- Connect the electric devices via the leads of the equipment as it is indicated in the lay-out shown in the Fig. 31.1.
- Turn the selector EQUIPMENT to OFF, or make sure that it is in this position.
- Power the system (turn the main switch of the right side board to ON).
  Set the magneto thermal switch Q11 to ON.
  Turn the selector EQUIPMENT to the position ~, the warning light on indicates that the power-absorbing equipment is powered correctly.

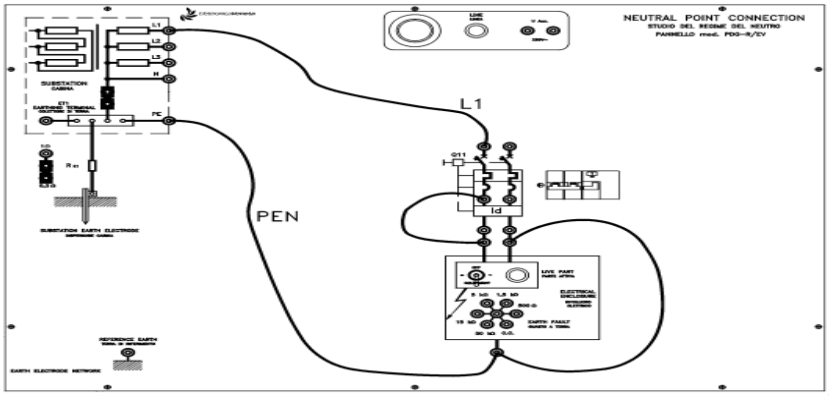


Fig. 31.1: TN-C system: practical realization on the panel.

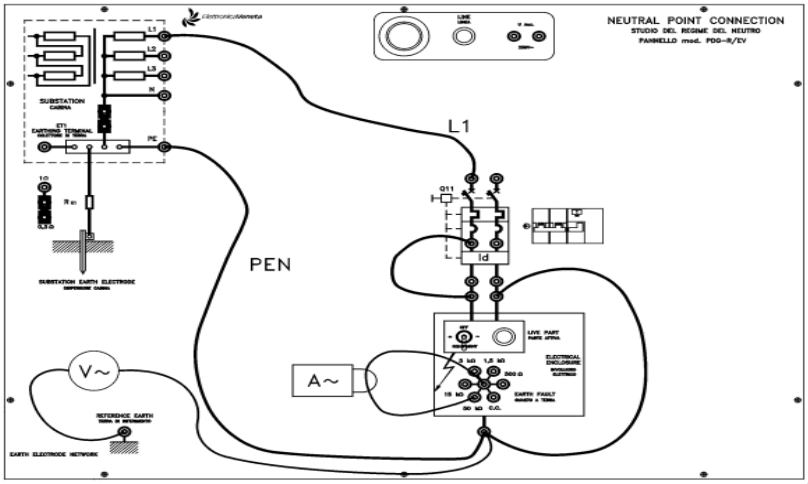


Fig. 31.2: TN-C system: measurement of the touch voltage in earth fault condition.

Example of table for recording the touch voltage versus the fault resistance / impedance

Touch voltage versus fault resistance / impedance						
Point	Condition R_F	I_F (A)	U_{ST} (V)	Zs computed (Ω)	Zs measured (Ω)	Voltage Uo (V)
1	No fault	0	0			225 V
2	50 kΩ	4.6 mA	0			225 V
3	15 kΩ	15 mA	0			225 V
4	5 kΩ	46 mA	0			225 V
5	1.5 kΩ	150 mA	0			225 V
6	500 Ω	450 mA	0			225 V
7	Clear fault	15 A	0.3 V			//

Table 31.1: Recording the measures of touch voltage.

Exercise 32- Realization of a TN-C-S distribution system.

OBJECTIVE

Assembling and studying a TN-C-S distribution system.

NECESSARY EQUIPMENT

- Demonstration panel mod. PDG-R/EV.
- Set of leads and jumpers with safety plugs with diameter of 4 mm.
- Digital auto-ranging multimeter.
- Ammeter tongs for rated and leakage currents.
- Instrument for the verification of electric systems.

OPERATIONAL STEPS

- Insert a jumper between the Neutral jack and that of the earthling terminal ET1.
- Insert the jumper RE1 of 0.3 Ω.
- Connect the electrical devices via the cables of the equipment as indicated in the lay-out shown in the Fig. 2.1.
- Turn the selector EQUIPMENT to OFF, or make sure that it is in this position.
- Power the system (turn the main switch of the right side board to ON).
- Set the magneto thermal switch Q11 to ON.
- Turn the selector EQUIPMENT to the position ~, the warning light on indicates that the power-absorbing equipment is powered correctly.

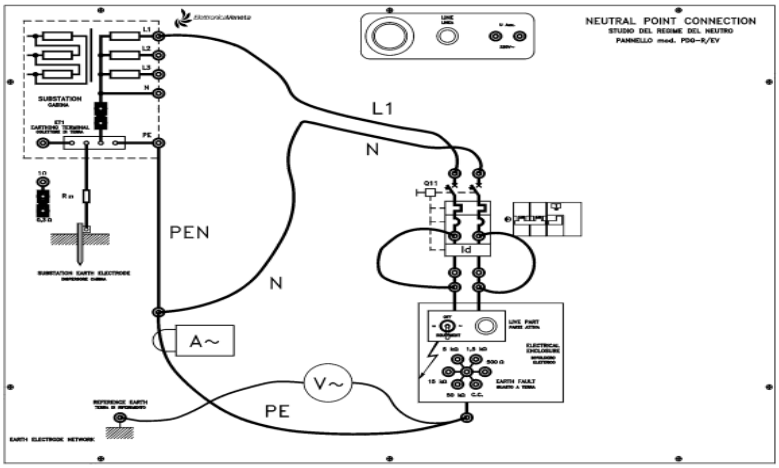


Fig. 32.1: TN-C-S system: practical realization on the panel.

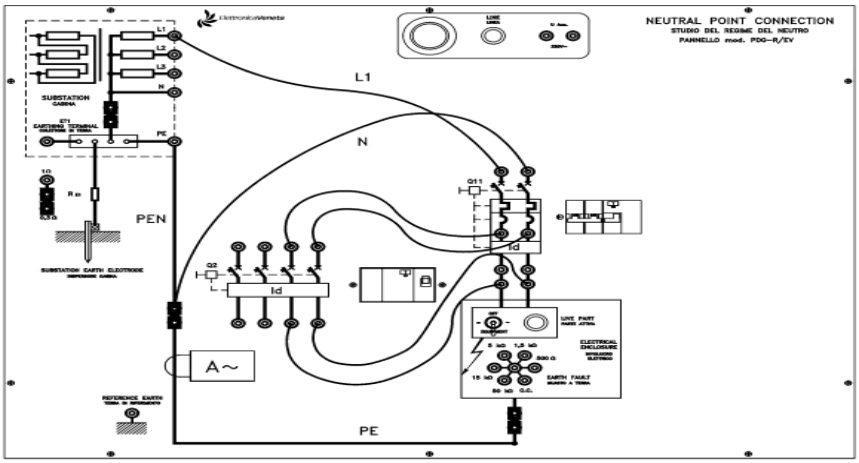


Fig. 32.2: TN-C-S system with differential protection: practical realization on the panel.

Exercise 33- Realization of a TN-S distribution system.

OBJECTIVE

Assembling and studying a TN-S distribution system.

NECESSARY EQUIPMENT

- Demonstration panel mod. PDG-R/EV.
- Set of leads and jumpers with safety plugs with diameter of 4 mm.
- Digital auto-ranging multimeter.
- Ammeter tongs for rated and leakage currents.
- Instrument for the verification of electric systems.

OPERATIONAL STEPS

- Insert a jumper between the Neutral jack and that of the earthing terminal ET1, and another jumper in RE1 of 0.3 Ω.
- Insert these two jumpers to connect the exposed-conductive-part of the left power-absorbing equipment (EQUIPMENT SX) with the earthling terminal ET1.
- Connect the electrical devices via the leads of the equipment as indicated in the lay-out shown in the Fig. 33.1.
- Turn the selector EQUIPMENT to OFF, or make sure that it is in this position.

- Power the system (turn the main switch of the right side board to ON). Set the magneto thermal switch Q11 to ON.
- Turn the selector EQUIPMENT to the position ~, the warning light on indicates that the power-absorbing equipment is powered correctly.

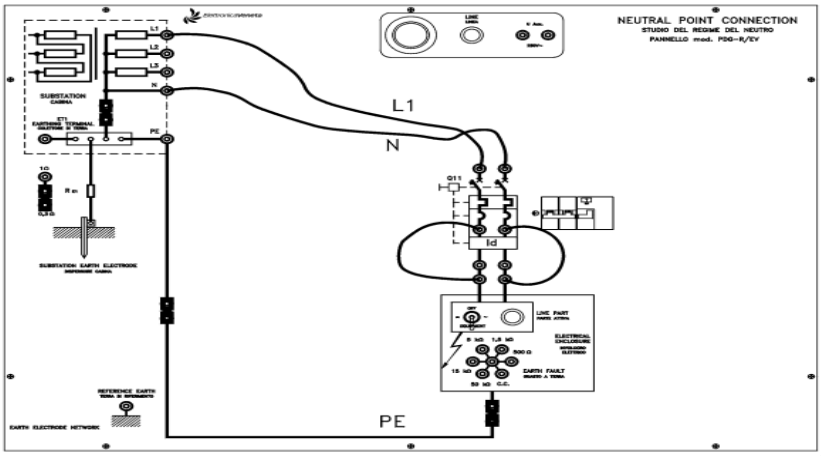


Fig. 33.1: TN-S system: practical assembly on the panel.

Exercise 34-TN distribution system.

OBJECTIVE

Examining a TN distribution system with a fault between a phase conductor and an extraneous conductive-part not connected with a protective conductor.

OPERATIONAL STEPS

- Insert a jumper between the Neutral jack and that of the earthing terminal ET1.
- Insert the jumper RE1 of 0.3 Ω.
- Insert the jumper RE2 of 20 Ω (to simulate an extraneous conductive part).
- Connect the electrical devices via the leads of the equipment as indicated in the lay-out shown in the Fig. 34.1.
- Turn the selector EQUIPMENT to OFF, or make sure that it is in this position.
- Power the system (turn the main switch of the right side board to ON).
- Set the magneto thermal switch Q11 to ON.

- Turn the selector EQUIPMENT to the position ~, the warning light on indicates that the power-absorbing equipment is powered correctly.

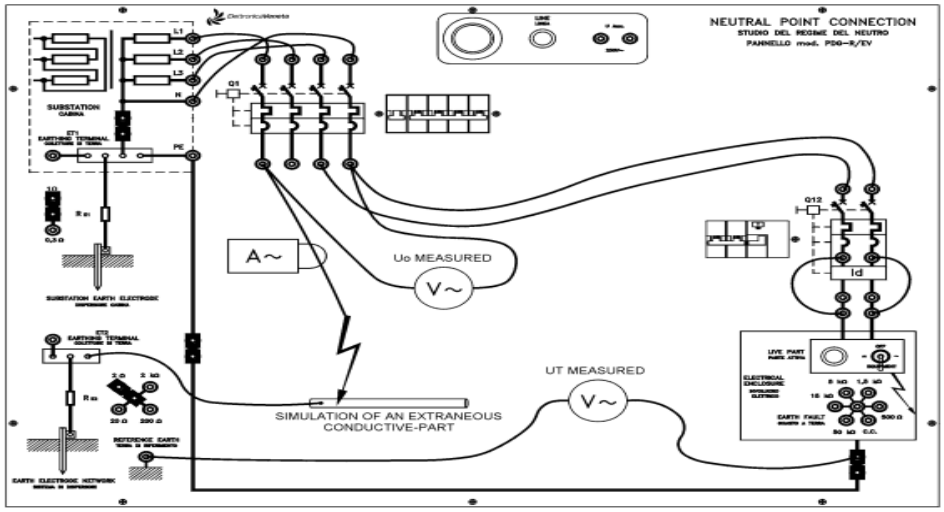


Fig. 34.1: TN system: fault of a phase to an extraneous conductive-part not connected with the protection system. Practical assembly on the panel

Exercise 35- Realization of a TT distribution system.

OBJECTIVES

Assembling and examining a TT distribution system.

MATERIAL

- Demonstration panel mod. PDG-R/EV.
- Set of leads and jumpers with safety plugs with diameter of 4 mm.
- Digital auto-ranging multimeter.
- Ammeter tongs for rated and leakage currents.
- Instrument for the verification of electric systems.

OPERATIONAL STEPS

- Insert a jumper between the Neutral jack and that of the earthing terminal ET1.
- Insert the jumper RE1 of 1 Ω and RE2 of 2 Ω.

- Insert the jumper between the PE jack of the earthing terminal ET2 and that of the lead connecting the exposed-conductive-parts of power absorbing apparatuses.
- Insert the jumper between the jack of the user earth conductor and that connecting the exposed-conductive-part of the right power-absorbing equipment.
- Connect the electrical devices via the leads of the equipment as indicated in the lay-out shown in the Fig. 35.1.
- Turn the right selector EQUIPMENT to OFF, or make sure that it is in this position.
- Power the system (turn the main switch of the right side board to ON).
- Set the magneto thermal switch Q12 to ON.
- Turn the selector EQUIPMENT to the position ~, the warning light on indicates that the power-absorbing equipment is powered correctly.

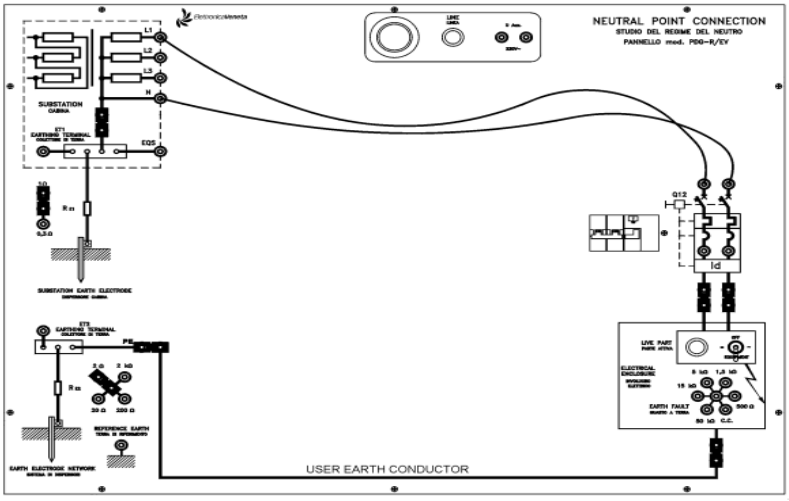


Fig. 35.1: TT system: practical assembly on the panel

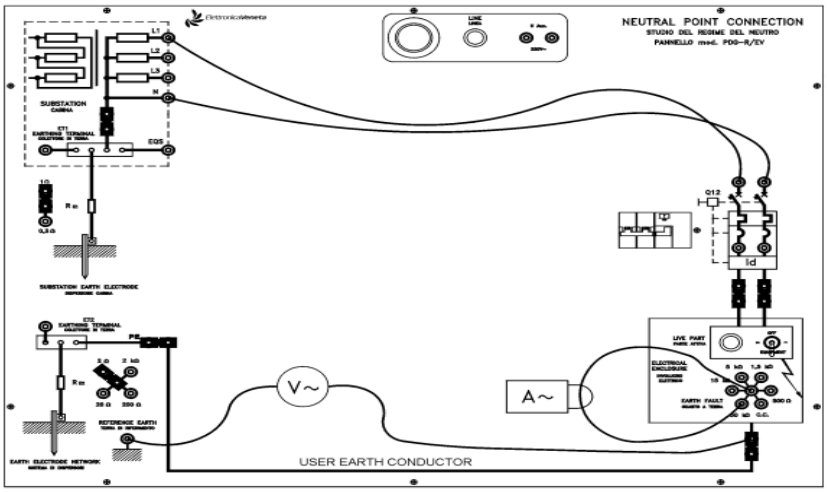


Fig. 35.2 :TT system: measurement of touch voltage in earth fault condition, with a differential protection of 30 mA.

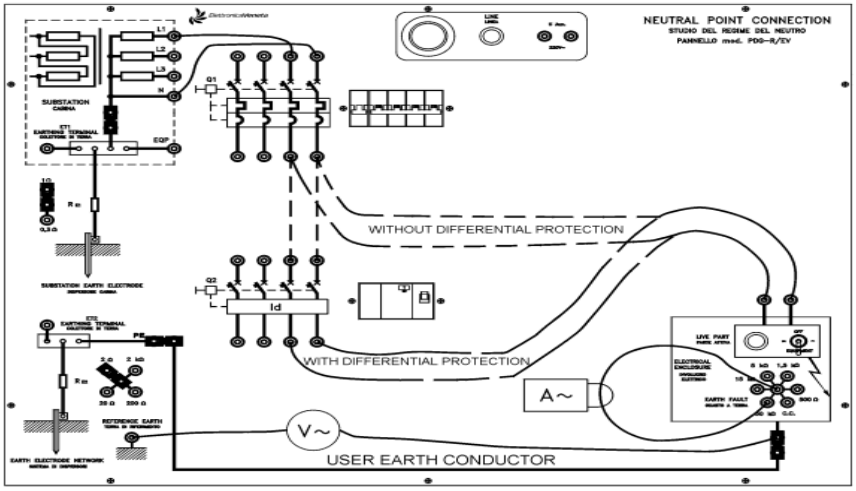


Fig. 35.3 : TT system: measurement of touch voltage in earth fault condition, with a differential protection of 0.3 A

Exercise 36- Realization of an IT distribution system.

OBJECTIVES

- Assembling and examining an IT distribution system
- Assembling and examining an IT distribution system in condition of double fault with the exposed-conductive-parts earthed separately.
- Assembling and examining an IT distribution system in condition of double fault with the exposed-conductive-parts earthed in group.

MATERIAL

- Demonstration panel mod. PDG-R/EV.
- Set of leads and jumpers with safety plugs with diameter of 4 mm.
  Digital auto ranging multi meter.
- Ammeter tongs for rated and leakage currents.
- Instrument for the verification of electric systems.

OPERATIONAL STEPS

The power supply must be insulated from the earth, do not insert any jumper between the Neutral jack and that of the earthing terminal ET1.

- Insert the jumper RE2 of 2 Ω.
- Insert the jumper between the PE jack of the earthing terminal ET2 and that of the lead connecting the exposed-conductive-parts of power absorbing apparatuses.
- Insert the jumper between the jack of the user earth conductor and that connecting the exposed-conductive-part of the right power-absorbing equipment.
- Connect the electrical devices via the leads of the equipment as indicated in the lay-out shown in the Fig. 36.1.
- Turn the selector EQUIPMENT to OFF, or make sure that it is in this position.
- Power the system (turn the main switch of the right side board to ON).
- Set the magneto thermal switch Q12 to ON.
- Turn the selector EQUIPMENT to the position ~, the warning light on indicates that the power-absorbing equipment is powered correctly.

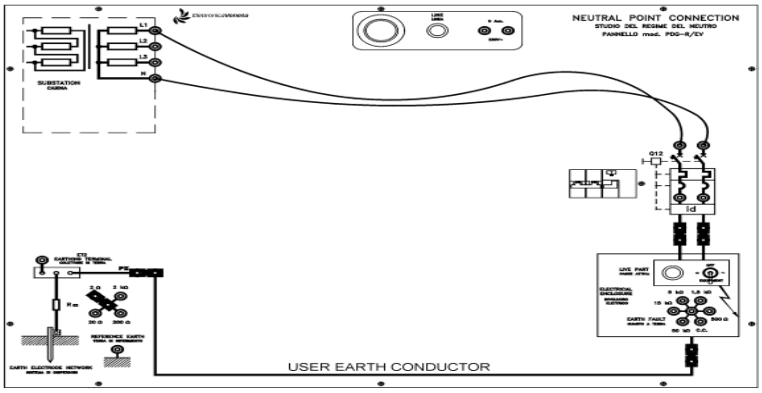


Fig. 36.1: IT system: practical assembly on the panel.

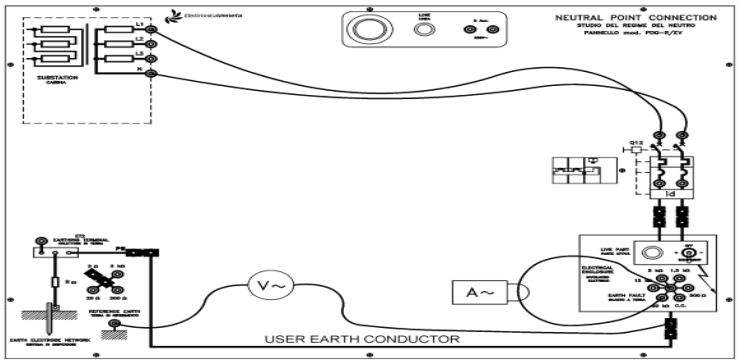


Fig. 36.2: IT system: measurement of the touch voltage and of the first earth fault current.

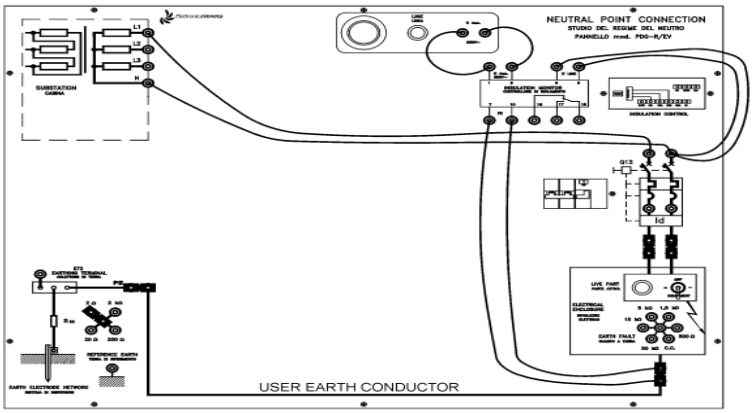


Fig. 36.3: IT system: insulation monitor for signaling the first fault.

Exercise 37- IT distribution.

IT distribution system where the exposed-conductive-parts are earthed separately (with different earth electrodes): behavior in double fault.

OPERATIONAL STEPS

The power supply must be insulated from the earth, do not insert any jumper between the Neutral jack and that of the earthing terminal ET1.

- Insert the jumper RE1 of 1 Ω and RE2 of 20Ω..
- Connect the exposed-conductive-part of the left power-absorbing equipment with the earthing terminal ET1, via a lead.
- Connect the exposed-conductive-part of the right power-absorbing equipment with the earthing terminal ET2, via a lead.
- Connect the electrical devices via the leads and jumpers of the equipment as indicated in the lay-out shown in the Fig. 37.1.
- Turn the selectors EQUIPMENT to OFF, or make sure that they are in this position.
- Turn the selector C_1/C_2 of the right side board to OFF, or make sure that it is in this position.
- Power the system (turn the main switch of the right side board to ON). Set the magneto thermal differential switches Q11 and Q12 to ON.
- Turn the selectors EQUIPMENT to the position ~, the warning lights on indicate that the power-absorbing apparatuses are powered correctly. As mentioned before, the situation described above leads to consider the IT system with double fault as if it were a TT system.

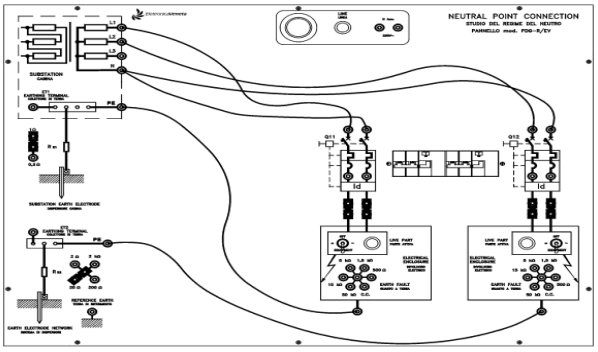


Fig. 37.1: IT system with exposed-conductive-parts earthed separately

EXERCISE 38- Measurement of the insulation resistance of the system.

OBJECTIVES

Measuring the insulation resistance of the electric system.

MATERIAL

- Demonstration panel mod. PDG-R/EV
- Set of leads and jumpers with safety plugs with diameter of 4 mm
- Instrument for the verification of electric systems.

OPERATIONAL STEPS

- Disconnect the voltage from the system (panel).
- Assemble a TT distribution system as indicated in the Fig.38.1. The two power-absorbing apparatuses must be earthed correctly.
- Insert the jumpers RE1 of 0.3 Ω, RE2 of 20 Ω.
- Do not insert any earth fault jumper.
- Connect the measuring instrument between the earthing terminal and the live leads (connected together) coming out of the device Q1.

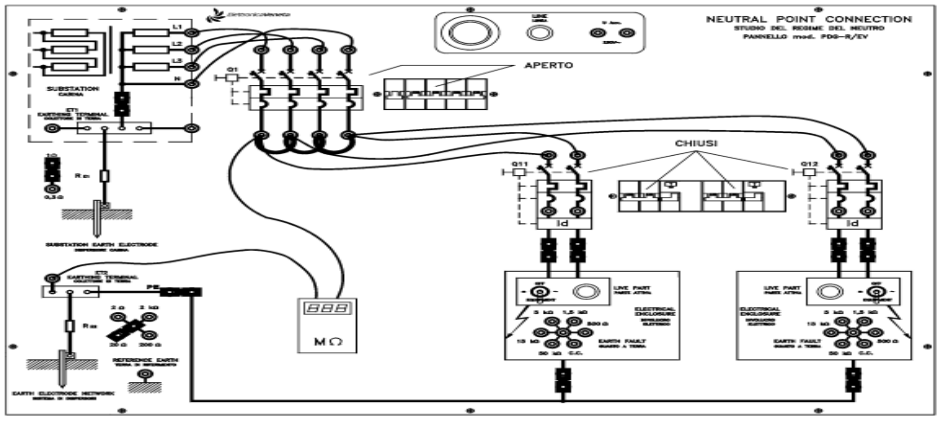


Fig. 38.1 : Connection of the instrument for measuring the insulation resistance at the origin of the electric system.

Exercise 39- Automatic Transfer Switch (ATS).

OBJECTIVES

An ATS is a device designed to automatically switch (transfer) between (2 or 3) sources of power to improve the reliability of the electrical supply to a connected load. It automatically switches when it senses one of the sources has lost or gained power.

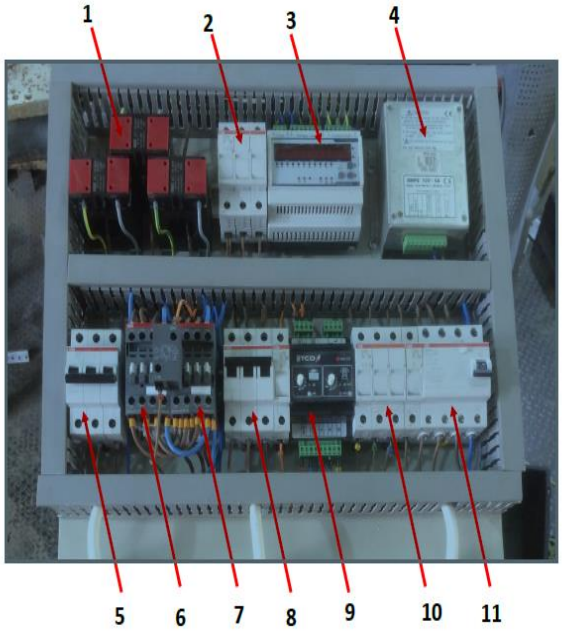
MATERIAL

- Two contactor (with mechanical interlock).
- One MCCB for the main load.
- Two MCB to control circuit.
- Three timers (on delay) at least two timers.
- Over and under voltage relay.
- Phase sequence and failure relay.
- Charger to generator battery with over current protection.
- Two power relay.
- Four indication lamps.

OPERATIONAL STEPS

- From the ATS controller, set the required delay time for primary (utility) and secondary (generator).
- Turn on the primary line circuit breaker, to energize the load from the primary line.
- Turn on the secondary line circuit breaker, and notice that the ATS controller senses that the secondary line is energized.
- To test the ATS, turn off the primary line, and notice the operation of transferring. (Connecting the load to the secondary line).
- Turn ON again the primary line (while the secondary is turned ON), and notice the operation of reconnecting the load to the primary line and disconnecting the secondary line.

- Using the multi-meter, take the reading related to the load electric consumption.



Item	Name
1	Current Transformers.
2	Fuses.
3	Multi-meter.
4	Charger.
5	Secondary line Circuit breaker. (Generator)
6	Secondary line contactor. (Generator)
7	Primary line contactor (Utility)
8	Primary line circuit breaker. (Utility)
9	ATS controller.
10	Fusses
11	Load circuit breaker.

Fig. 39.1: ATS circuit

Sequence of Operation

Transfer switches are responsible for transitioning electrical power from the primary source to a secondary source in the event of primary source interruption, maintenance, or failure. The primary source most commonly consists of the utility service. The secondary source typically consists of the backup or emergency power source. The sequence of operation typically occurs as follows:

1. The primary source is interrupted or fails.
2. When the secondary source is stable and within voltage and frequency tolerances, the transfer switch transitions to the secondary power source. This transition can occur automatically or manually.
3. When the primary source is restored and stabilized, the transfer switch transitions back to the primary source and resumes under normal operation. This transition back to the primary source can occur automatically or manually.

Exercise 40-Continuity test of EQP – EQS equipotential bonding conductors.

OBJECTIVE
Continuity test of EQP – EQS equipotential bonding conductors.

MATERIAL

Demonstration panel mod. PDG-1/EV.
Continuity meter (Instrument for electrical checks).

OPERATIONAL STEPS

- Disconnect the power from the installation (panel).
- Connect the U bolts RDA 20 Ω, RDN 20 Ω, RPE 1 Ω, EQS, RME 1 kΩ.
- Do not connect the U bolts EQP,

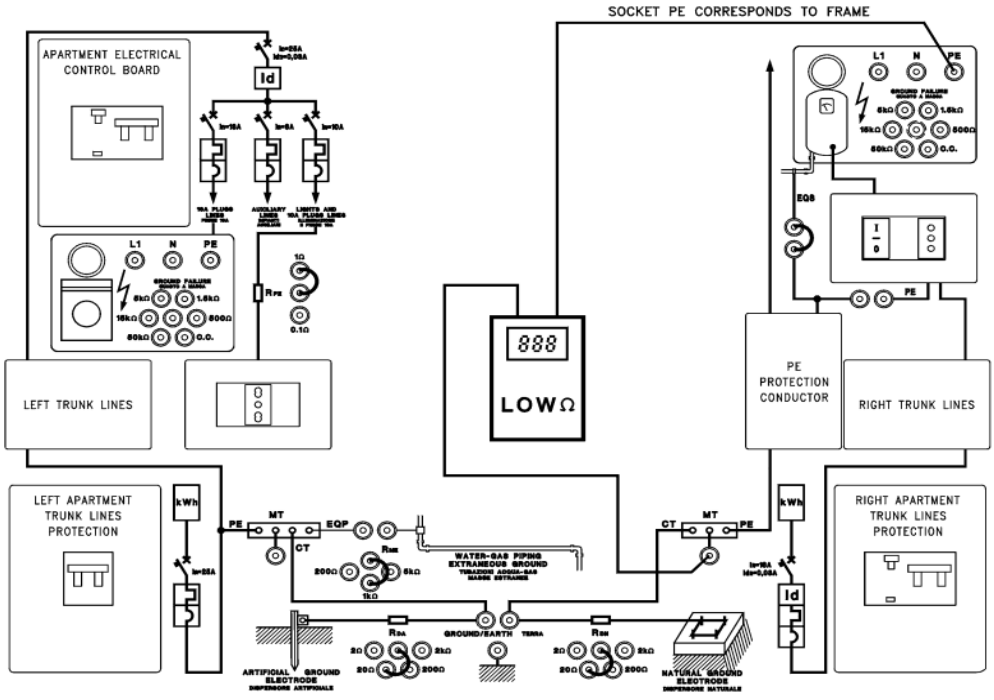


Fig. 40.1: Instrument connection for the continuity test of the EQS conductors.

- Disconnect the power from the installation (panel).
- Connected the U bolts RDA 20Ω, RDN 20Ω, RME 1 kΩ, RPE 1 Ω, EQP.

- Do not connect the U bolts EQS, PE

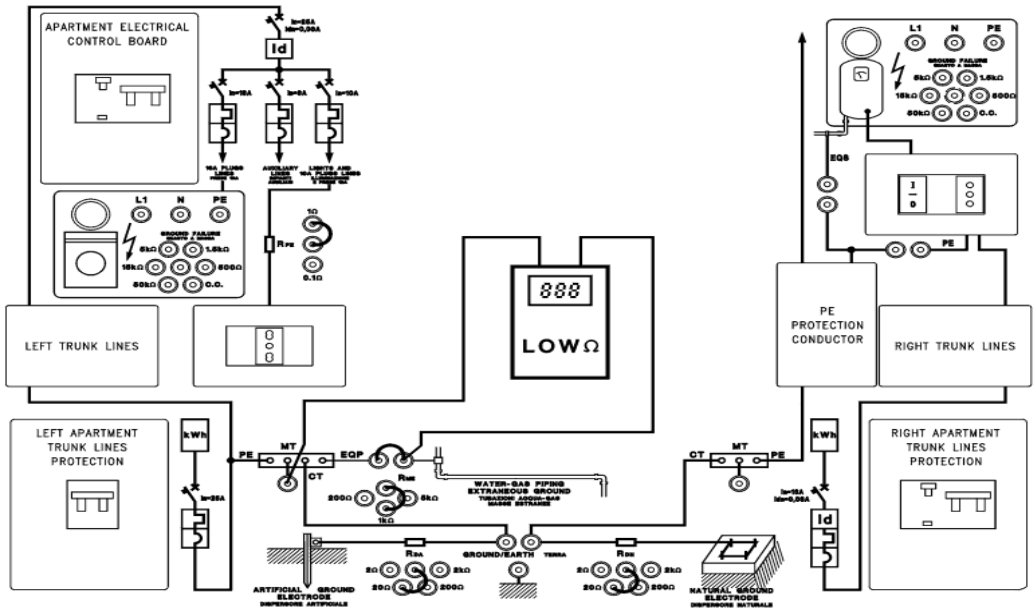


Fig. 40.2: Instrument connection for the continuity test of EQP conductors.

EXERCISE 41- Measurement of a user insulation resistance.

OBJECTIVE

Measurement of a user insulation resistance.

MATERIAL

- Demonstration panel mod. PDG-1/EV.
- Continuity meter (Instrument for electrical checks).

OPERATIONAL STEPS

- Disconnect the power from the installation (panel).
- Open the command and control switch to insulate the user to be tested. If the user is powered via plug socket, disconnect the plug from the socket.
- Connect the power supply terminals of the stationary user together. (short-circuit the terminals)

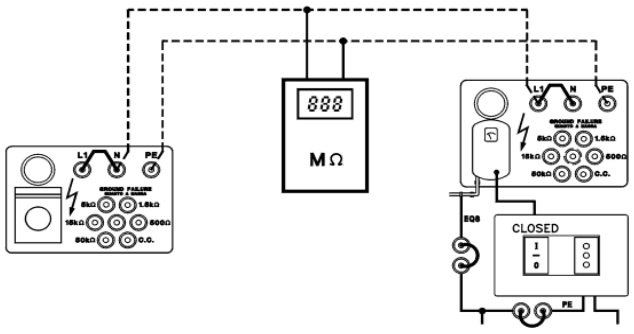


Fig. 41.1: Connection of the measurement instrument of the electrical user insulation resistance.

Exercise 42-Total grounding resistance measurement

OBJECTIVE

Total grounding resistance measurement.

MATERIAL

- Demonstration panel mod. PDG-1/EV.
- Total grounding resistance meter (Instrument for electrical checks).
- A.C. voltage multi-meter.

OPERATIONAL STEPS

- Disconnect the power from the installation (panel).
- Insert only a U bolt on the RDA terminals to give the artificial ground electrode a resistance value (possible values are: 2 Ω, 20 Ω, 200 Ω, 2000 Ω).

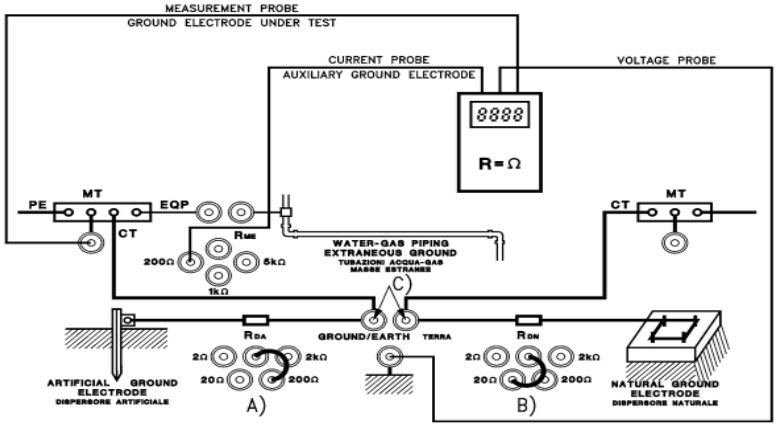


Fig. 42.1 Instrument connection for the total grounding resistance measurement.

Exercise 43- Checking the operation of the E.L.C.B.s type AC and A Idn 30 mA

OBJECTIVE

Checking the operation of the E.L.C.B. type AC and type A with nominal residual current Idn = 30 mA.

MATERIAL

- Demonstration panel mod. PDG-1/EV.
- Multimeter for A.C. voltages.
- Meter for the operation of E.L.C.B.s (instrument for electrical testing).

PREPARING THE EXERCISE

OPERATIONAL STEPS

- Power the installation.
- Connect the U bolts RDA 20 Ω, RDN 20 Ω, RME 1 kΩ, EQP, RPE 1 Ω, EQS, PE.

Current(mA)	Faults Combinations	
	Fault1	**Fault2**
	50	
	50kΩ	**50 kΩ**
	15 kΩ	
	15 kΩ	**50 kΩ**
	15kΩ	**15 kΩ**
	500Ω	
	500Ω	**500Ω**

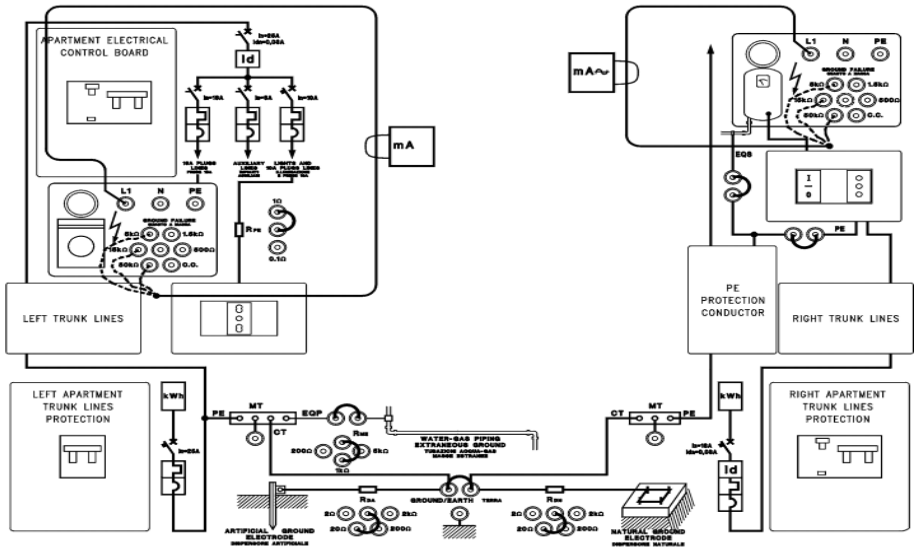


Fig. 43.1: Instrument connection to check the E.L.C.B.s intervention current.

EXERCISE 44- Checking the operation of the E.L.C.B. with dedicated instruments.

OBJECTIVE

Checking the operation of the E.L.C.B.s with dedicated instruments.

MATERIAL

- Demonstration panel mod. PDG-1/EV.
- Multimeter for A.C. voltages.
- Meter for the operation of E.L.C.B.s (Instrument for electrical testing).

OPERATIONAL STEPS

- Power the installation.
- Connect the U bolts RDA 20 Ω, RDN 20 Ω, RME 1 kΩ, EQP,RPE 1 Ω, EQS, PE.

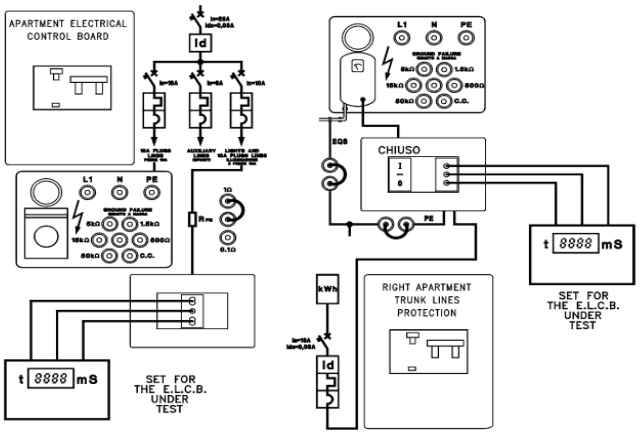


Fig. 44.1: Connection of instruments for checking the current and/or intervention time of the E.L.C.B.s .

EXERCISE 45- Protection against overload currents.

OBJECTIVE

• Protection against overload currents.

OPERATING MODE

• Power the installation.
• Connect the U bolts RDA 20 O, RDN 20 O, RME 1 kO, EQP, RPE 1 O, EQS, PE.

NOTE: BEFORE REPEATING THE SAME TEST WAIT AT LEAST 15 MINUTES; THIS TO MAKE THE INNER TRANSFORMER CONSTITUTING THE POWER SUPPLY SOURCE TO EMPLOY THE HEAT PRODUCED IN THE OVERLOAD CONDITION.

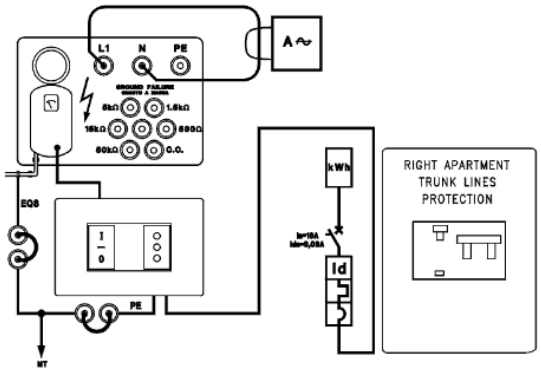


Fig. 45.1 :Switch intervention for overload.

Exercise 46 - Protection against short-circuit currents.

OBJECTIVE

Protection against short-circuit currents.

OPERATING MODE

• Power the installation.
• Connect the U bolts RDA 20 O, RDN 20 O, RME 1 kO, EQP, RPE 1 O, EQS, PE.

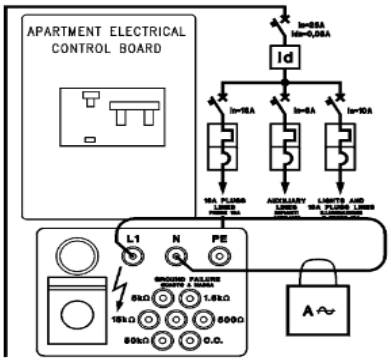


Fig. 46.1 :Switch intervention for short-circuit.

EXERCISE 47- Measurement of fault circuit resistance for TT systems.

OBJECTIVE

Measurement of fault circuit resistance (TT system).

OPERATIONAL MODE

- Disconnect the voltage from the system (panel). Assemble a TT distribution system as indicated in the layout diagram of Fig. 47.1.
- Insert the jumper connecting the Neutral of the transformer with earth terminal MT1.
- Insert a jumper on the jacks RE1 to assign a resistance value to the substation earth electrode (first letter T) (possible values are: 0.3 Ω, 1 Ω).
- Insert a jumper on the jacks RE2 to assign a resistance value to the user earth electrode (second letter T) (possible values are: 1 Ω, 2 Ω, 20 Ω, 200 Ω).
- Insert the jumper shunting conductor PE from earth terminal MT2.
- Insert the two jumpers connecting the exposed-conductive-part of the power-consuming apparatus with wire PE.
- Using two leads (1 Black lead and 1 Blue lead) connect the line coming out of transformer L1 and N, with the input of E.L.C.B. available in the right lower part of the panel.
- Connect the output of the E.L.C.B. with the power-consuming apparatus available immediately below (right lower part), via two jumpers.
- Connect the measuring instrument with terminals L – N – PE of the power-absorbing apparatus (in the right lower part) according to the manufacturer's indications. Note: a normal socket is used in an actual installation.
- Power the system, close the main switch (ON state) powering the line which the instrument is connected with.

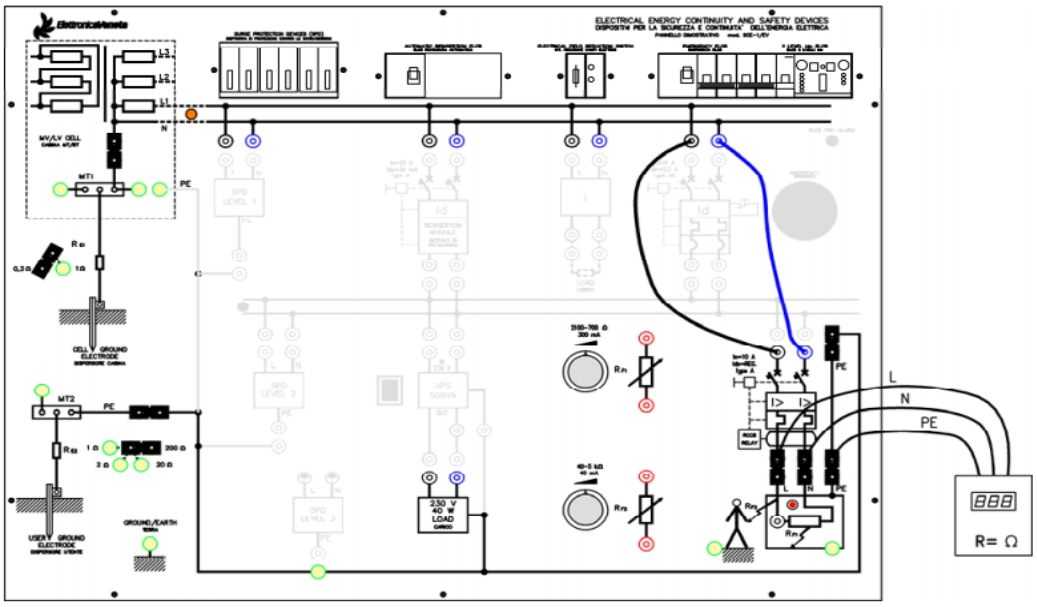


Fig. 47.1: Connection of the instrument for measuring the fault circuit resistance, in TT systems.

Exercise 48- Checking the operation of differential switches - 30 mA.

OBJECTIVE

Checking the operation of a differential switch of general type –Idn=30mA

OPERATING MODE

- Disconnect the voltage from the system (panel). Assemble a TT distribution system as indicated in the layout diagram of Fig. 47.1.Before carrying out this check read and know the rating of the circuit breaker, in particular the rated residual current Idn. **Note: exclude the automatic reset device of the circuit breaker, for the moment.**
- Insert the jumper connecting the Neutral of the transformer with earth terminal MT1.
- Insert a jumper across jacks RE1 to assign a resistance value to the substation earth electrode (first letter T) (possible values are: 0.3 **Ω**, 1 **Ω**).

- Insert a jumper across jacks RE2 to assign a resistance value to the earth electrode of power-consuming apparatus (second letter T) (possible values are: 1 Ω, 2 Ω, 20 Ω, 200 Ω).
- Insert the jumper shunting conductor PE from earth terminal MT2.
- Using two jumpers connect the line coming out of transformer (L1 and N), with the input of E.L.C.B...
- Using 2 leads connect the output of the E.L.C.B. with the power consuming apparatus (load).
- Connect the variable resistance between the phase terminal coming out of the E.L.C.B. and the neutral terminal before it.
- Connect the milli-ammeter or the ammeter tongs for measurements of stray currents in series with the rheostat.
- Power the system, close the main switch (ON state) powering the line which the instrument is connected with.
- Read the differential current; exclude the variable resistance slowly until the device trips; record the tripping current.

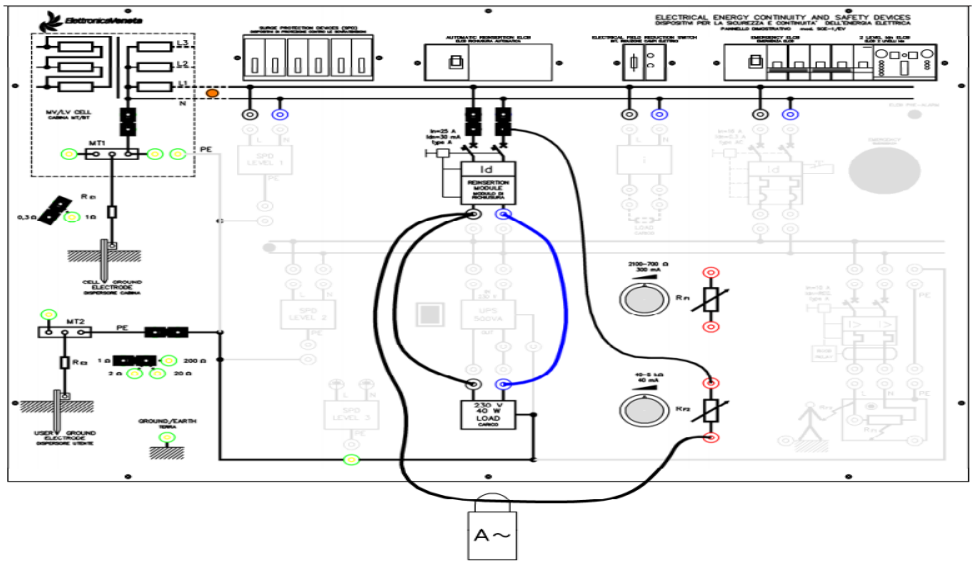


Fig. 48.1: Checking the operation of the differential protection of 30 mA.

Exercise 49- Checking the operation of differential switches - 0.3 A.

OBJECTIVE

Checking the operation of a differential switch of general type –Idn=0.3A

OPERATIONAL MODE

- Disconnect the voltage from the system (panel). Assemble a TT distribution system as indicated in the layout diagram of Fig.49.1.Before carrying out this check read and know the rating of the circuit breaker, in particular the rated residual current Idn. **Note: exclude the automatic reset device of the circuit breaker, for the moment; check that the mushroom-head push-button is not pressed.**
- Insert the jumper connecting the Neutral of the transformer with earth terminal MT1.
- Insert a jumper across jacks RE1 to assign a resistance value to the substation earth electrode (first letter T) (possible values are: 0.3 Ω, 1 Ω).
- Insert a jumper across jacks RE2 to assign a resistance value to the earth electrode of power-consuming apparatus (second letter T) (possible values are: 1 Ω, 2 Ω, 20 Ω, 200 Ω).
- Insert the jumper shunting conductor PE from earth terminal MT2.
- Using two jumpers connect the line coming out of transformer (L1 and N) with the input of E.L.C.B...
- Using 2 leads connect the output of the E.L.C.B. with the power consuming apparatus (load).
- Connect the variable resistance between the phase terminal coming out of the E.L.C.B. and the PE of the power-consuming apparatus.
- Connect the milli -ammeter or the ammeter tongs for measurement of stray currents in series with the rheostat.
- Connect the voltmeter to determine whether the touch voltage becomes dangerous.
- Power the system, close the main switch (ON state) powering the line which the instrument is connected with.
- Read the differential current; exclude the variable resistance slowly until the device trips; record the tripping current.

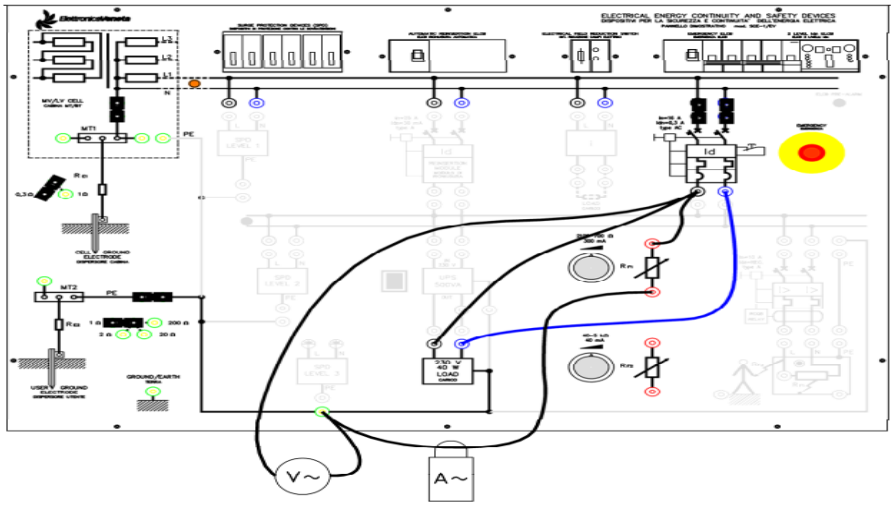


Fig. 49.1: Checking the operation of the differential protection of 0.3 A

Exercise 50- Checking the operation of differential switches with rated residual operating current Idn and time t = adjustable

OBJECTIVE

Checking the operation of differential circuit breaker with adjustable rated operating current Idn and time –type A.

OPERATING MODE

- Disconnect the voltage from the system (panel). Assemble a TT distribution system as indicated in the layout diagram shown in Fig.50.1.

  Before carrying out this check read and knows the rating of the circuit breaker, the parameters adjusted for it must be known or they have to be adjusted according to the design indications.
- Insert the jumper connecting the Neutral of the transformer with earth terminal MT1.

  • Insert a jumper across jacks RE1 to assign a resistance value to the substation earth electrode (first letter T) (possible values are: 0.3 Ω, 1 Ω).

  • Insert a jumper across jacks RE2 to assign a resistance value to the earth electrode of power-consuming apparatus (second letter T) (possible values are: 1 Ω, 2 Ω, 20 Ω, 200 Ω).

• Insert the jumper shunting conductor PE from earth terminal MT2.
• Insert the two jumpers connecting the exposed-conductive-part of the power-consuming apparatus with wire PE.
• Using two leads (1 Black lead and 1 Blue lead) connect the line coming out of transformer (L1 and N) with the input of E.L.C.B. available in the right lower part of the panel.
• Connect the output of the E.L.C.B. with the power-consuming apparatus available immediately below (right lower part), via two jumpers.
• Connect the measuring instrument with terminals L – N – PE of the power-absorbing apparatus (in the right lower part) according to the manufacturer's indications. Note: a normal socket is used in an actual installation.
• First of all, set the differential relay, for example, at 30 mA – fast: trimmer **Idn** = 0.3 A and DIP switch 3 to ON – 4 to OFF (Idn x 0.1), trimmer **t** = 0.03 s (30 ms) and DIP switch 5 to ON (t x 1), operating logic of relay N/P to P. Other indications about the correct setting of the differential relay, for example, N mode (negative safety) or P mode (positive safety), can be found in the panel description.
• Power the system, close the main switch (ON state) powering the line which the instrument is connected with. This check does not consider the fact that the differential relay is provided with a double-threshold detector that is enabled at 30% or 60% of the regulated rated residual current.

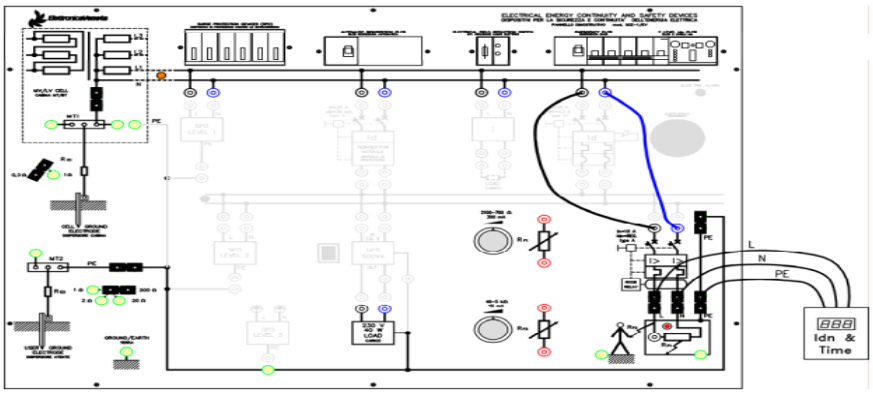


Fig. 50.1: Checking the operation of the adjustable differential protection, detecting current and operate time with a dedicated instrument.

Exercise 51-Automatic reset device for residual current circuit breakers.

Apply an automatic reset device to a residual current circuit breaker after a non-permanent earth fault in order to restart the power supply.

OPERATING MODE

- Disconnect the voltage from the system (panel).Assemble a TT distribution system as indicated in the layout diagram shown in Fig. 51.1, or a TN system as in Fig. 51.2.
- Make sure that the automatic reset device of the residual current circuit breaker is operating.
- Power the system, turn the switch to ON.
- Simulate an earth fault by excluding the variable resistance until the device trips; it is not important for this exercise to read and record the residual current in the ammeter.

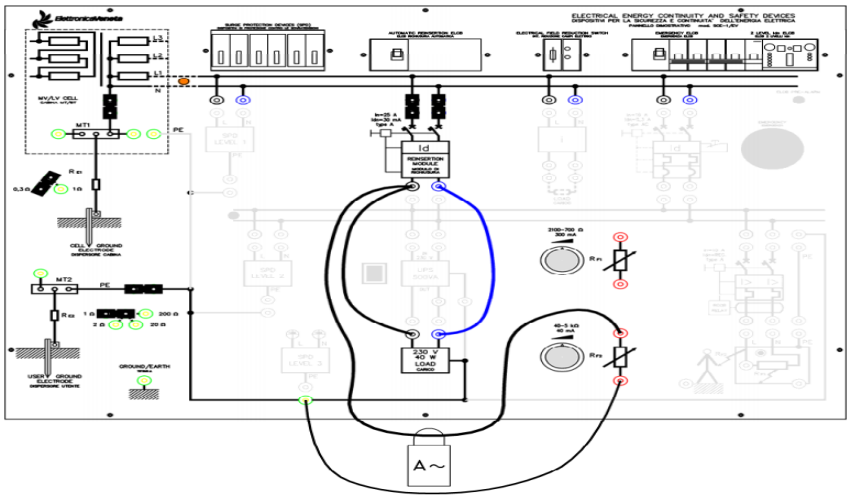


Fig. 51.1: Checking the operation of the automatic reset device of the differential protection, TT system.

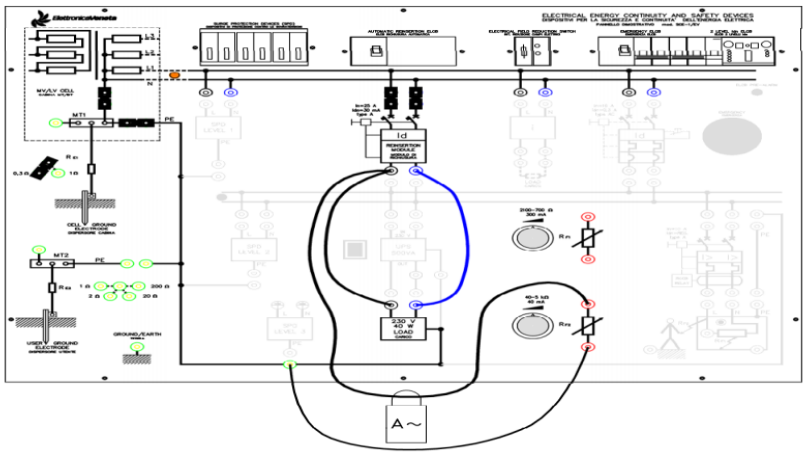


Fig. 51.2: Checking the operation of the automatic reset device of the differential protection, TN system.

Exercise 52-Emergency stop with a TM/ELCB

Apply an automatic magneto thermal residual current circuit breaker for emergency stop in positive safety (NC contact/s).

OPERATING MODE

- Disconnect the voltage from the system (panel). Assemble a TT distribution system as indicated in the layout diagram shown in Fig. 52.1
- Power the system.
- Press the emergency stop button and check the opening of the protection device.

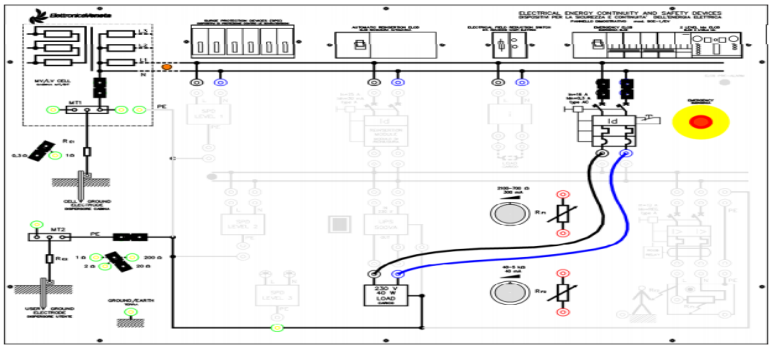


Fig. 52.1 : Checking the operation of the automatic magneto thermal residual current circuit breaker for emergency stop in positive safety, TT system

Exercise 53- Fire detection and alarm system.

OBJECTIVE

Installation of an effective fire alarm system.

NECESSARY EQUIPMENT

DEVICE	SPECFICATIONS
ADDRESSABLE FIRE ALARM CONTROL PANEL 	- 220/240V 50/60Hz system powered. - 24v DC. Battery powered. - Control panel can be increased from 1 loop to 32 loops. - Each loop has an address capacity which equals to 200 and can control 128 Addressed devices simultaneously. - There is one automatic extinguishing output, one burglary output, two relay Output, one fault output and one buzzer output in the panel. - Detection from the control panel. - Faulty or normal functioning; 4X20 distinctive LCD displayer warns via lightened Displayers and buzzer. - All cases on the control panel recorded by the alarm counter real-timely. - All detectors have their distinctive adjustable alarm level. - Thanks to Walk Test feature instant detector, input – output modules Monitoring and testing. - Connecting by conventional input modules. - Central input – outputs and related devices are taken out on the panel.
ADDRESSABLE HEAT DEDECTOR 	-Microprocessor controlled system. - It detects an increase of more than 7 degree in ambient temperature. - It gives alarm when the ambient temperature increases between to 57 degree or 70 degree (adjustable). - Electromagnetic or electrostatic noise does not affect it. - Detector has its own address number which is given. - Each detector's detection level is adjusted. - Its normal working and alarm position are monitored via the two leds on it. - External summer lamb link end has been removed.
ADDRESSABLE OPTICAL SMOKE DEDECTOR	- Sensitive to visible smoke and gases. - Electromagnetic or electrostatic noise does not affect it. - Each detector's detection level is adjusted.

	- Its normal working and alarm position are monitored via the two leds on it. - External summer lamb link end has been removed.
ADDRESSABLE GAS DEDECTOR (LPG-LNG) 	- Sensitive to LPG - LNG gases. - Electromagnetic or electrostatic noise does not affect it. - Each detector has its own address which is given. - Each detector's detection level is adjusted. - Its normal working and alarm position are monitored via the two leds on it. - It needs an external 12v DC. Feeding.
ADDRESSABLE FIRE ALARM BUTTON 	- It has a test hanger which the glass should be broke and the button should be pressed. - Loop is connected to (+L , -L) points. - It has an address number which is given.
FLASHER SIREN 	- 12/24V DC. Operating voltage. - It is powered by the siren output. - In the alarm position optic and aural warning is given. - Line end voltage has been removed from the panel.
INPUT MODULE 	- Loop is connected to (+L , -L) points. - Any sensor or such devices transmit the data to the central. - It is used to connect the security devices. - It locates the data location with the given address.
ADDRESSABLE INPUT MODULE 	- Addressing unit 12v DC. is supported by external powering. - It serves to address the detectors and the devices. - +L, -L points of the detectors and the devices are connected to the unit. - The detectors and the devices connected to the addressing module are tested and their measuring levels are controlled.
BATTERY 	- Two 12v DC. 2Ah have been used. - Batteries have been used coupled in series. - Battery module output is 24v DC.
POWER SUPPLY 	- 220v AC/12-24v DC. SMPS has been used. - SMPS has been protected against short circuits. - Except from the feeding detector 12v DC is used. - 24v DC is used from the battery charger.

OPERATIONAL STEPS

As shown in the Fig .53.1 below, you can see the locations of the materials used in fire detection and alarm system.

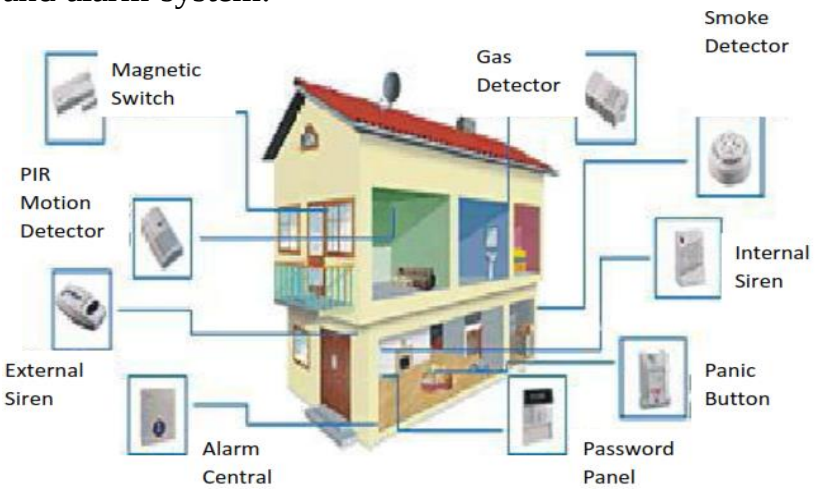


Fig. 53.1: Assembly drawing of fire alarm systems

SYMBOL	EXPLANATION
	Key
	Fire Alarm Installation
	Fire Alarm Device
$	Single Phase Switch
	Fire System Distribution Panel
$_3$	Three Phase Switch
	Panel
Y-i-s	Fire Alarm System Panel
S	Smoke Detector
P	Beam Detector
H	Heat Detector
A	Break and Press Button
	Loudspeaker

Table 53.1: Symbols used for fire detection and alarm system

Below you can see the layout of the units of fire alarm system in an office:

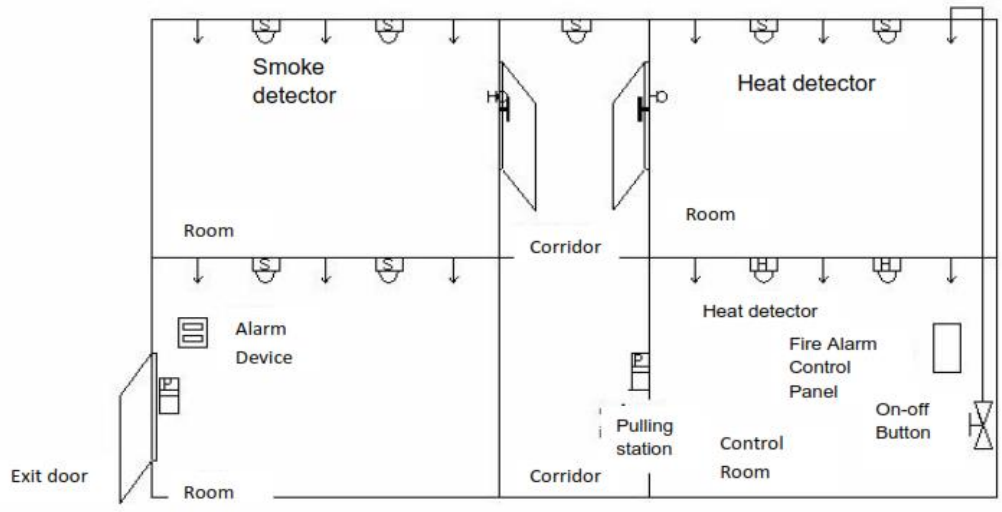


Fig.53.2: Layout of the units of fire alarm system

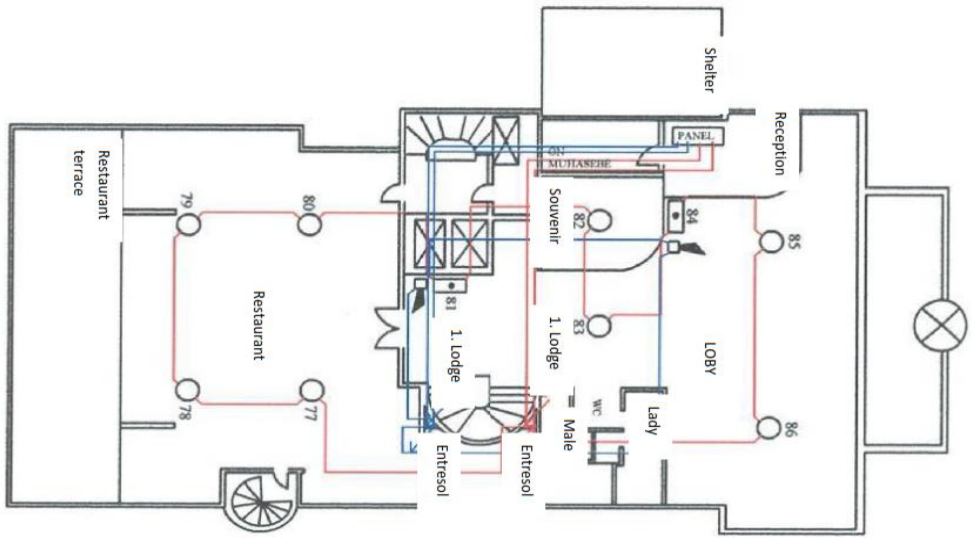
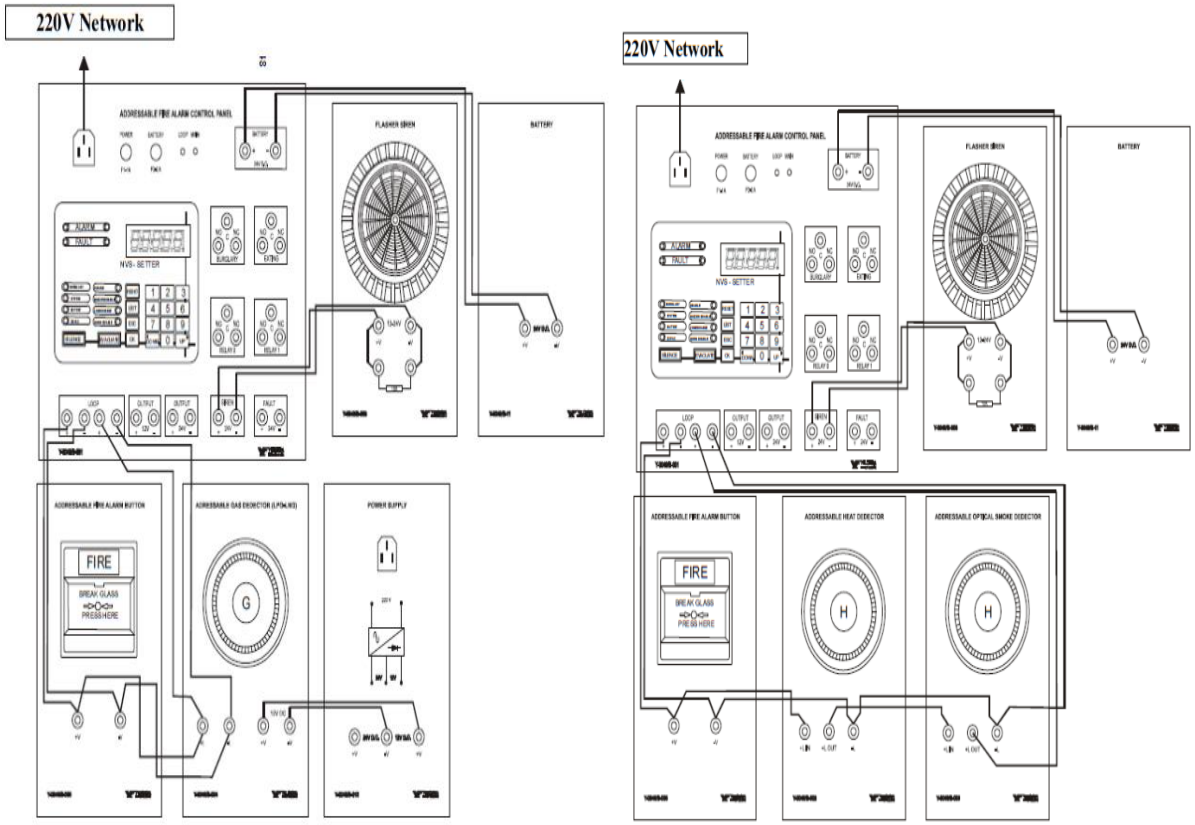
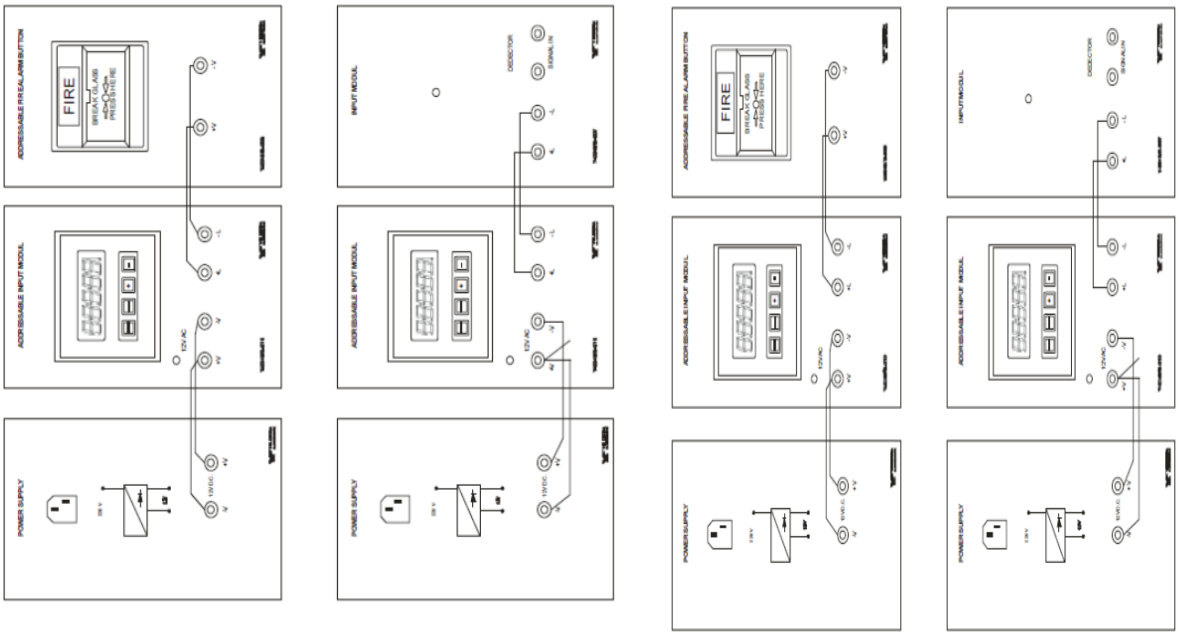


Fig.53.3: Model Application


220V Network
220V Network
FIRE
BREAK GLASS
PRESS HERE


FIRE
BREAK GLASS
PRESS HERE

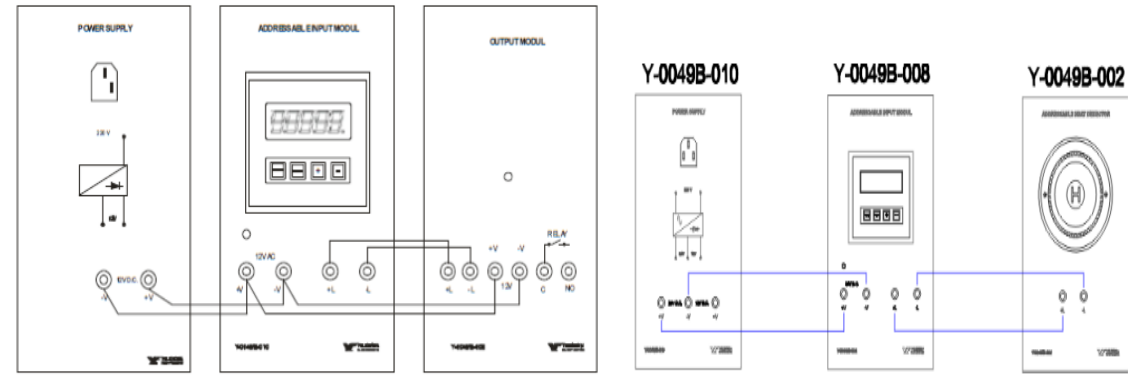


Fig.53.4: Fire alarm control panel simple schematic diagram

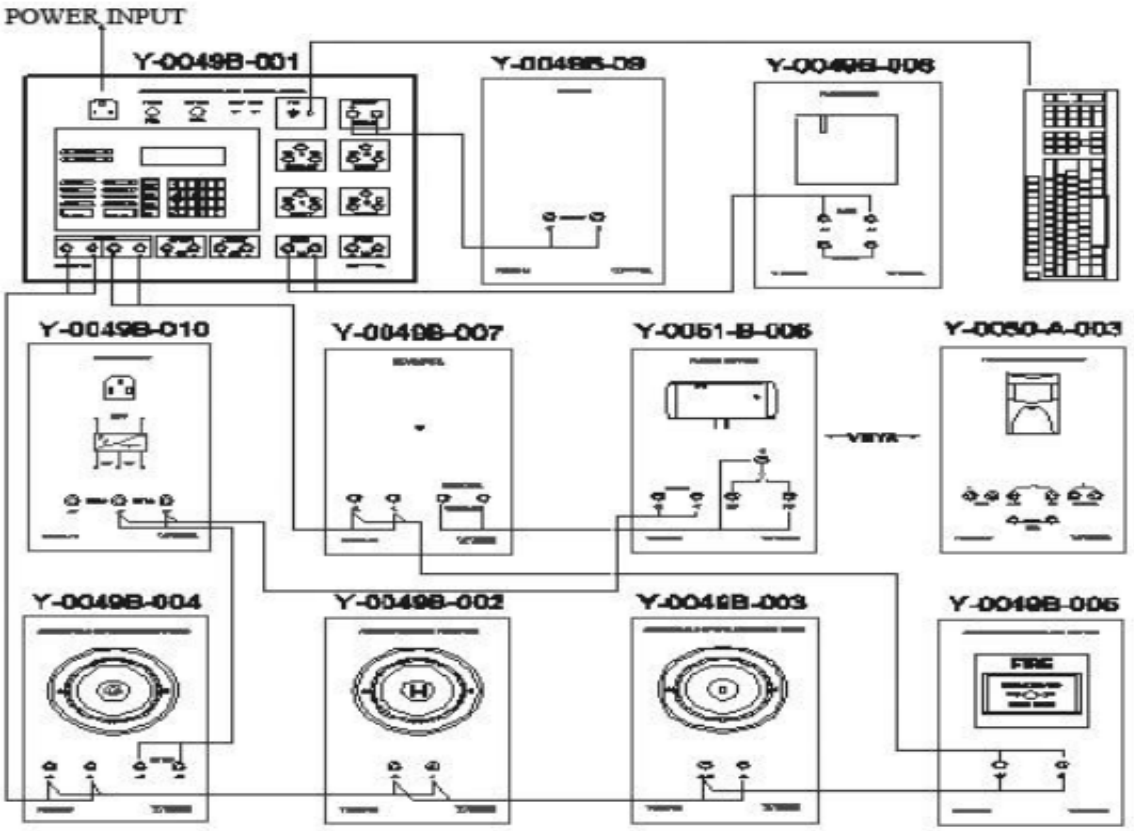


Fig.53.5: Addressing the input module of fire alarm control panel

Exercise 54-Burglar alarm system.

OBJECTIVE
Installation of an effective burglar alarm system.

NECESSARY EQUIPMENT

DEVICE	SPECFICATION
ALARM PANEL 	- The center of the system. They interpret the information coming from the inlets and activate the outlets.
PASSWORD PANEL 	- The keyset to enter the passwords into the system and to activate /deactivate the system (ON/OFF). They have different models with LED and LCD screens. Messages can be viewed in Turkish in models with LCD screens.
EXTERNAL SIREN 	- The gadget that alerts the emergencies with sound or flashes. The alarm is set off when its cable is cut off or removed as well.
MAGNETIC CIRCUIT 	- The gadget that senses the opening of a door or a window. It is placed at points that can be opened. They have wire and wireless models.
PIR – MOTION DETECTOR 	- The gadget that senses the movement of all living things where it's facing. It can sense with a 90-degree angle for up to 15 m. There are also models that can be set not to sense animal movement. Wire and wireless models are available.
REMOTE CONTROL 	- The gadget that sets up and shuts down the system remotely.
WINDOW SHATTERING DETECTOR	- It is sensitive to the shattering sound of windows. A detector Installed at a point near to the window in a room can be enough to protect all the windows in a room.

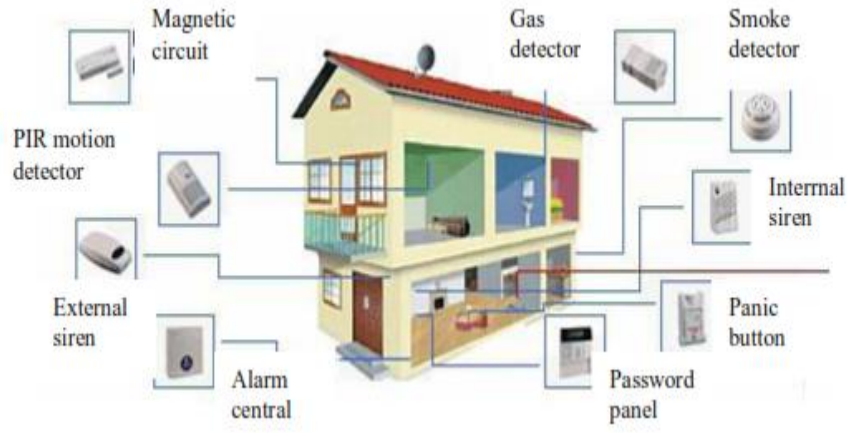
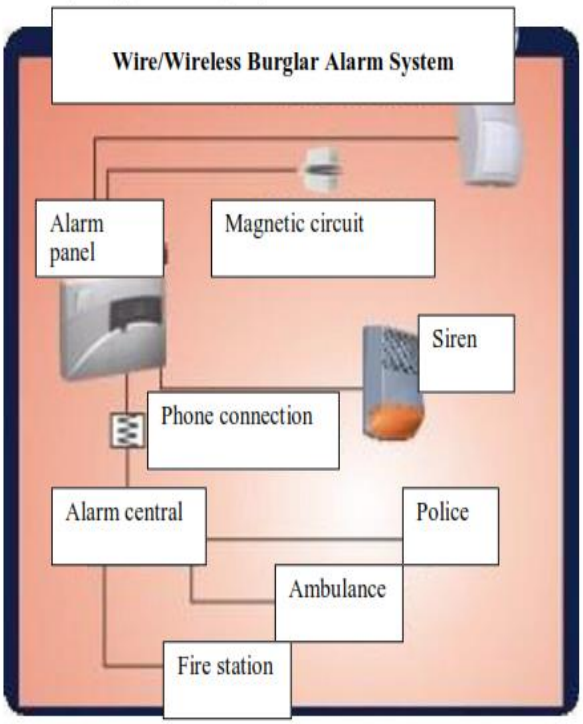


Fig.54.1: A house protected by burglar alarm system

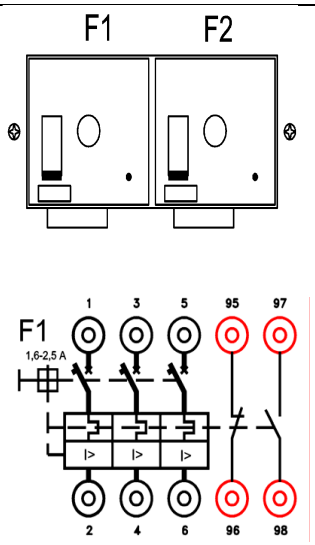
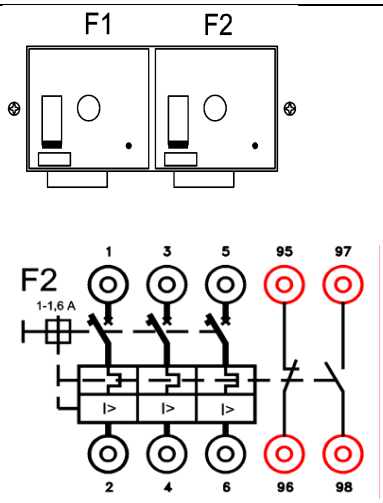
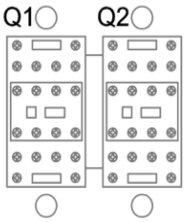


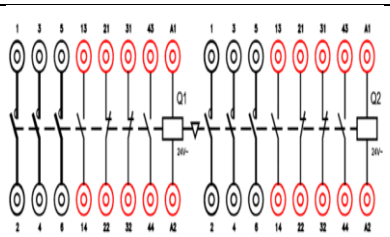
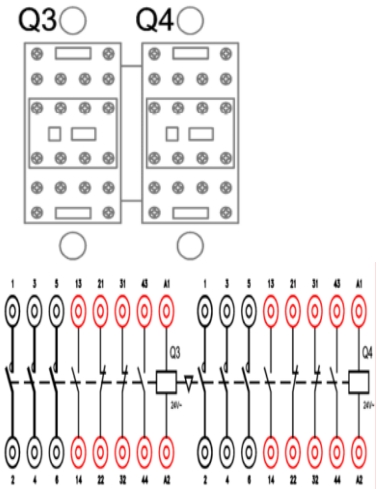
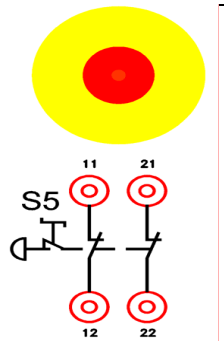
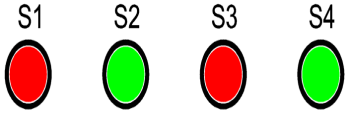
The system has 3 main functions:

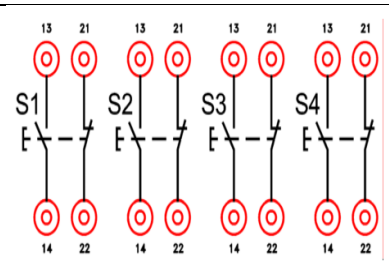
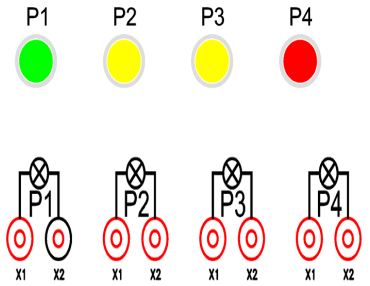
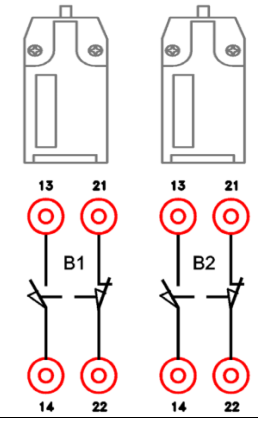
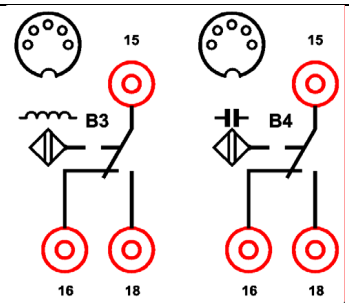
- Deterring

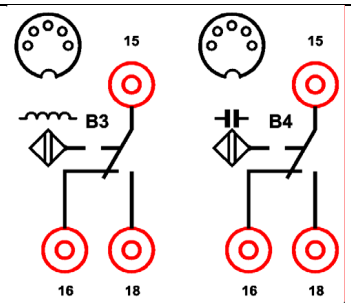
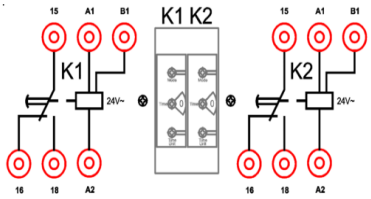
- Informing

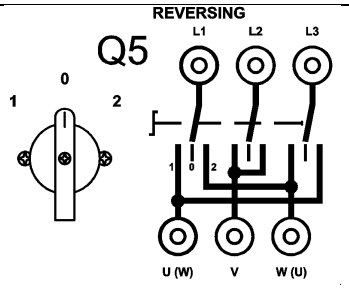
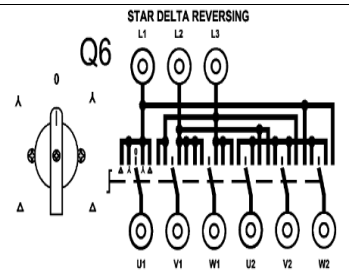
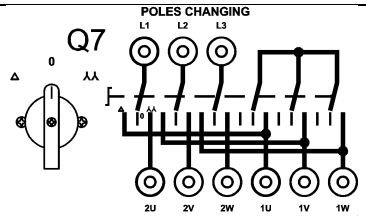
- Showing Directions to the Authorities

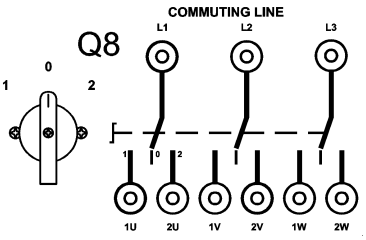
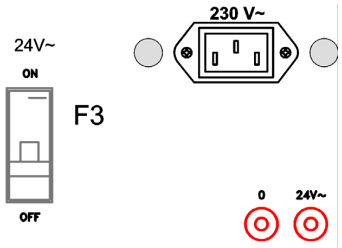
F13-pole circuit breaker motor overload protection switch. **I_n**: a thermal release adjustable between 1.6 and 2.5 A, with rated breaking capacity of **I_{cu}** at 400 V - **I_{cs}** =100 kA, magnetic trip 12 **I_n** max. (terminals 1-2, 3-4, 5-6), degree of protection IP 20, mounting in any position on a 35 mm omega rail complete with NO / NC In 6 A auxiliary contacts (terminals 95-96, 97-98).		**1- 3-5** Three-phase input line terminals. **2 - 4 -6** Output line terminals. **95- 96** NC motor overload protection auxiliary contact terminal. The state of contact refers to the switch when closed. **97 -98** NO motor overload protection auxiliary contact terminal. The state of contact refers to the switch when closed.
F23-pole circuit breaker motor overload protection switch. **I_n** :a thermal release adjustable between 1 and 1.6 A, with rated breaking capacity of **I_{cu}** at 400 V - **I_{cs}** =100 kA, magnetic trip 12 In max. (terminals 1-2, 3-4, 5-6), degree of protection IP 20, mounting in any position on a 35 mm omega rail complete with NO / NC **I_n**= 6 A auxiliary contacts (terminals 95-96, 97-98).		**1- 3 -5** Three-phase input line terminals. **2- 4-6** Output line terminals. **95 - 96** NC motor overload protection auxiliary contact terminal .The state of contact refers to the switch when closed. **97 - 98** NO motor overload protection auxiliary contact terminal. The state of contact refers to the switch when closed.
Q1 - Q2 24 V_{AC} 50-60 Hz coil contactors (terminals A1-A2), 3 main contacts **I_{th}** =25 A **I_e** =9 A - 4,2 kW at 400 V (AC3) (terminals 1-2, 3-4, 5-6), complete with 2 auxiliary contacts NO and 2 NC **I_{th}** =10 A (terminals 13-14,21-22, 31-32, 43-44), **$U_{i=}$** 690 V. The two contactors		**1 - 3 - 5** Input power contact terminals. **2 - 4 - 6** Output power contact terminals. **13 - 14, 43 - 44** NO auxiliary contact terminals. **21 - 22, 31 - 32** NC auxiliary contact terminals.

are mechanically interlocked by way of a removable device **(the interlock is between the two contactors)**		**A1 - A2** Contactor coil terminals, supplied in 24 V_{AC}
Q3 - Q4 24 V_{AC} 50-60 Hz contactor coils, 3 main contacts $\mathbf{I_{th}}$ =25 A **Ie** =9 A - 4.2 kW at 400 V (AC3) (terminals 1-2, 3-4, 5-6), complete with 2 auxiliary contacts NO and 2 NC I_{th} 10 A (terminals 13-14,2122, 31-32, 43-44), $\mathbf{U_i}$ 690. The two contactors are mechanically interlocked by way of a removable device **(the interlock is between the two contactors)**		**1 - 3 - 5** Input power contact terminals. **2 - 4 - 6** Output power contact terminals. **13 - 14, 43 - 44** NO auxiliary contact terminals. **21 - 22, 31 - 32** NC auxiliary contact terminals. **A1 - A2** Contactor coil terminals, supplied in 24 V_{AC}
S5 E-stop push button. red mushroom-head switch having a diameter of 40 mm, mechanical connection and rotating release, complete with 2 NC $\mathbf{I_{th}}$=10 A auxiliary contactors supplied in AC 15 (6 A–24 V_{AC}) /(3 A-240 V_{AC}), supplied in DC 13 (3 A–24 V_{DC}) / (0,27 A-250 V_{DC}).		**11 - 12, 21 - 22** NC auxiliary contact terminals.
S1, S3 Red E-stop extended switch. Complete with auxiliary contacts in NO-NC, $\mathbf{I_{th}}$ =10 A supplied in AC 15 (6 A–24 V_{AC}) / (3 A-240 V_{AC}), supplied in DC 13 (3 A–24 V_{DC}) / (0.27 A-250 V_{DC}). **S2, S4 green command push**		

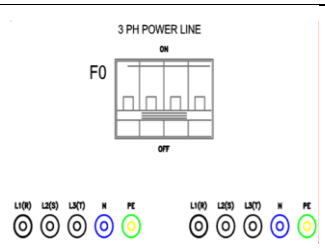
button. Complete with auxiliary contacts in NO-NC, $\mathbf{I_{th}}$ =10 A supplied in AC 15 (6 A–24 V_{AC}) / (3 A-240 V_{AC}), supplied in DC 13 (3 A–24 V_{DC}) / (0.27 A-250 V_{DC}).		
P1-P4 luminous engine block indicators. having different coloured diffusers complete with LED BA9s 24 V lamps of the same color as the diffuser. **Note: the buttons are interchangeable with each other based on the color required for each function.**		**X1 - X2** 24 V power terminal indicator light
B1-B2 position limit switch with NO or NC contact. $\mathbf{I_{th=}}$ 10 A.		**13 - 14** NO contact terminals. **21 - 22** NC contact terminals.
B3 12 mm diameter inductive proximity sensor, activation distance between 2 and 15 mm, LED status indication, supply 10 to 40 V_{DC}. The inductive sensor is connected via the DIN B3 **connector** to the panel where it is interfaced by means of a relay with an Ith 10 A exchange contact in order to avoid damage. To avoid dispersion of the parts, a stainless		**15** Common NO / NC exchange contact terminals. **16** NC contact terminals. **18** NO contact terminals.

steel bracket enables the sensor to be fixed to one side of the panel next to the capacitive sensor.		
B4 18 mm capacitive proximity sensor, activation distance between 2 and 10 mm (depending on the size and density of the material to detect), LED indication status, supply between 10 and 40 V_{DC}. The inductive sensor is connected by way of a DIN B4**connector**to the panel where it is interfaced by means of a relay with an Ith 10 A exchange contact in order to avoid damage. To avoid dispersion of the parts, a stainless steel bracket enables the sensor to be fixed to one side of the panel next to the inductive sensor.		**15** Common NO / NC exchange contact terminals. **16** NC contact terminals. **18** NO contact terminals.
K1-K2 electronic timer, multi-voltage 24…230 V_{AC} - 24…110 V_{DC} (terminals A1-A2), multi-scale adjustable times between 0 and 1 and full scale 1-5-10-30 s 1-5-10-30 min 1-10 h, multi-functions selected among: **B** excitation delay with Start command (terminal B1) **C** excitation through a Start command (terminal B1) **Ci** pause-work oscillator with Start command (terminal B1) **Ca** pause-work oscillator with Start command (terminal B1) **Da** De-excitation delay of the Start command (terminal B1) **Tv** totalizer closure command:		**A1 - A2** Coil time-switch terminals supplied in 24 V_{AC} **B1** Star terminals supplied in 24 V_{AC} as in A_1. If you do not wish to use the function, connect it to A_1. **15** Common NO / NC exchange contact terminals. **16** NC contact terminals. **18** NO contact terminals.

delayed excitation exit **Ta** totalizer closure command: excitation passage exit **W** excitation delay and de-excitation Start Command **Wa** delay excitation passage and de-excitation command **K** impulse opening of the Start command (terminal B1)		
REVERSING SWITCH (Q5) Three-pole manipulator In=16 A Un=400 V (AC1). It carries out the function of a three-pole switch considering the position of 0-1, 0-2 or the function of a three-phase line reverse control considering the position of 1-0-2.		**L1- L2- L3** Input line terminals. **U - V- W** Output terminals for the load or for a three-phase induction motor.
STAR DELTA REVERSING SWITCH (Q6) reverse control star/delta Manipulator starter $\mathbf{I_n}$=16 A $\mathbf{U_n}$=400 V (AC1).		**L1- L2- L3** Input line terminals. **U1- V1- W1** Output terminals for the beginning of the windings of the three-phase induction motor. **U1- V1- W1** Output terminals for the end of the windings of the three-phase induction motor.
POLES CHANGING SWITCH (Q7) Delta double star three-phase induction motor manipulator starter with 2 speeds and one "DAHLANDER" winding In=16 A Un=400 V (AC1).		**L1 - L2 - L3** Input line terminals. **2U - 2V - 2W** Output terminals to connect the same brand of windings of the Dahlander three-phase induction motor. **1U - 1V - 1W** Output terminals to connect the same brand of windings of

		the Dahlander three-phase induction motor.
COMMUTING LINE SWITCH (Q8) Commuting line switch manipulator **I_n**=16 A **U_n**=400 V (AC1). It carries out the function of a switch and separately activates two loads (or two electric motors) or a 2-speed motor with separate windings. It carries out the function of a selection switch between two electrical lines, which enter the terminals from the bottom. Moreover, it carries out the function of a three-pole switch taking into consideration position 0-1 or 0-2.		**L1 - L2 - L3** Input line terminals. **1U - 1V - 1W** Output terminals to connect the first slow-speed motor or winding. **2U - 2V - 2W** Output terminals to connect the second high-speed or winding motor. Use as a commuting line selector: **1U - 1V -1W** First line, three-phase input terminals. **2U - 2V - 2W** Second line, three-phase input terminals. **L1 - L2 - L3** Three-phase output line terminals.
0-24 V~ 1-pole automatic circuit breaker switch I_n 3 A, specifications C, P_{di} =6 kA, prevention against output overloads 24 V_{AC} PELV (extremely low voltage protection) generated from the single-phase transformer 115-230 V / 24 V – 96 VA, lamp indicator signal of auxiliary voltage 24 V_{AC}. The single-phase auxiliary power supply line should be connected to the panel via the plug on the panel.		**0 - 24 V~** Output voltage terminals 24 V_{AC} - 3A.
3 PH POWER LINE automatic circuit breaker. (F0)4-pole, **I_n**= 4A, curve C, **P_{di}** =6 kA, protects against three-phase output overload		**L_1 - L_2 - L_3 - N - PE** Terminal board to withdraw the three-phase line with neutral and earth protection.

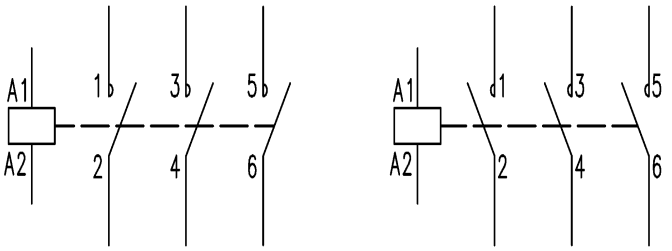
with neutral available at terminals L_1-L_2-L_3-N and earth protection, inspection lamp signal of three-phase voltage 380-400 V_{AC}.



CONTACTOR

Is what is classified as a particular type of remote control switch that has the function of establishing or interrupting the wire continuity of an under-loaded electrical circuit . It is essentially made up of:

a) a magnetic circuit
b) an excitation coil
c) main contacts
d) auxiliary contacts

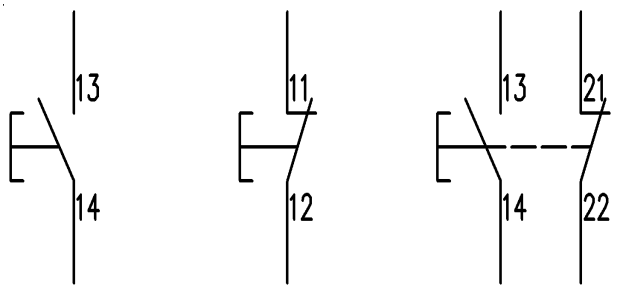


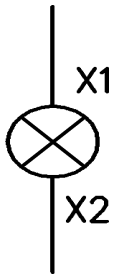
PUSH BUTTONS

As already mentioned earlier, the command of the contactors is normally realized with the use of temporary contacts. They are divided into:

a) push buttons normally open for start operations,
b) push buttons normally closed for block functions.

n practice, the start button, characterized by a normally open contact, has a "button" that is used to carry out BLACK or GREEN functions; the stop "button", identified by a normally closed contact, is RED. Moreover, you can also have combinations of the type shown below in Figure 8a, which normally occurs in the condition in which pressing the button determines the opening



of the normally closed contact and closing of the normally open contact.	
LAMP HOLDER INDICATOR The lamp holder indicators (Figure 8b) are normally the type of small connection for filament lamps of 2-3 W and with the development of LED technology. The gems are colored to represent the various operating conditions; green to detect a state of rest or safe conditions, yellow in the case of temporary situations, red to indicate the intervention of protective equipment.	

Exercise 55- Contact or command from a point

OBJECTIVE

Realize the complete electrical system of the power, control and signaling circuit related to the three-phase supply device, controlled from a point.

NECESSARY EQUIPMENT

- 1 Panel mod. C-IIC/EV.
- 1 Fixed single-phase power supply 220-230 V_{AC} for a control circuit
- 1 Fixed three-phase power supply 380-400 V_{AC} for a power circuit.
- 1 Series of cables with 4 mm diameter safety plugs.

PREPARING THE EXERCISE

Place the panel onto the worktable in a way that it is perfectly stable. Connect the various electrical components by following the wiring diagram in Fig.55.1.

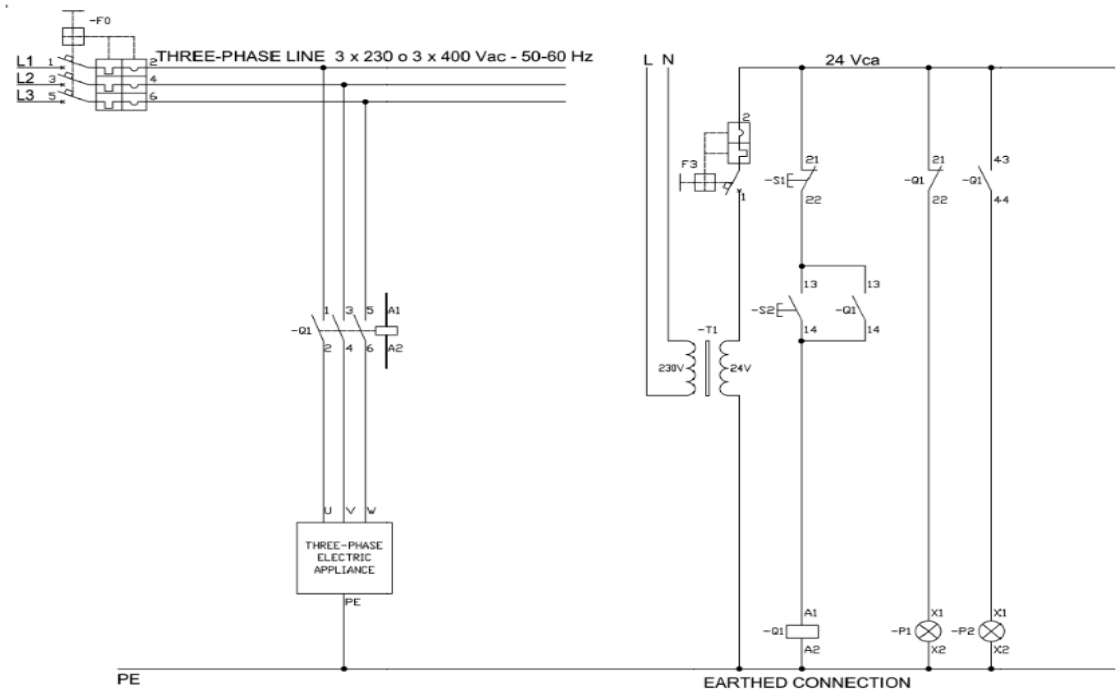


Figure 55.1 Control of a generic three-phase load with a contactor.

OPERATIONAL STEPS

The student is invited to trace, as a preliminary step, the connections between the electrical devices using the layout of the panel shown it is good to make two photocopies and draw the control signal circuit and the power circuit separately. An example that shows the connections on the didactic panel is shown in Figure 1.3.

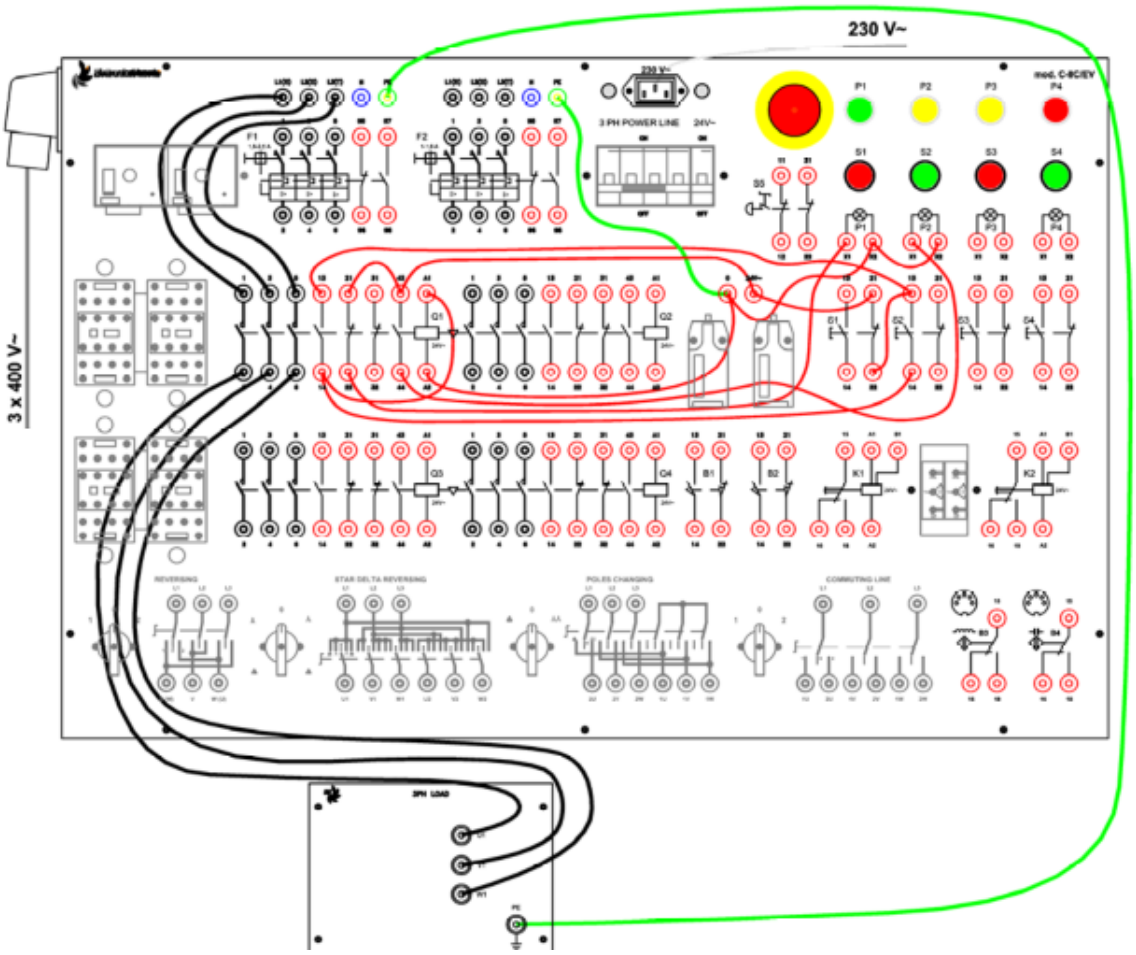


Fig. 55.3 Panel connections to control a three-phase load with a contactor

Exercise 56- Three-phase induction motor remote starter

OBJECTIVE

Realize the complete electrical system of the power, control and signaling circuit related to the three-phase cage induction motor starter 0.3-1 kW, controlled from a point.

NECESSARY EQUIPMENT

- 1 Panel mod. C-IIC/EV.
- 1 Fixed single-phase power supply 220-230 V_{AC} for a control circuit
- 1 Fixed three-phase power supply 380-400 V_{AC} for a power circuit.
- 1 Series of cables with 4 mm diameter safety plugs.

- 1 Three-phase cage induction motor 0,3-1 kW mod. M-4/EV or P4/EV, if available.

PREPARING THE EXERCISE

Place the panel onto the worktable in a way that it is perfectly stable. Connect the various electrical components by following the wiring diagram in Fig. 56.1.

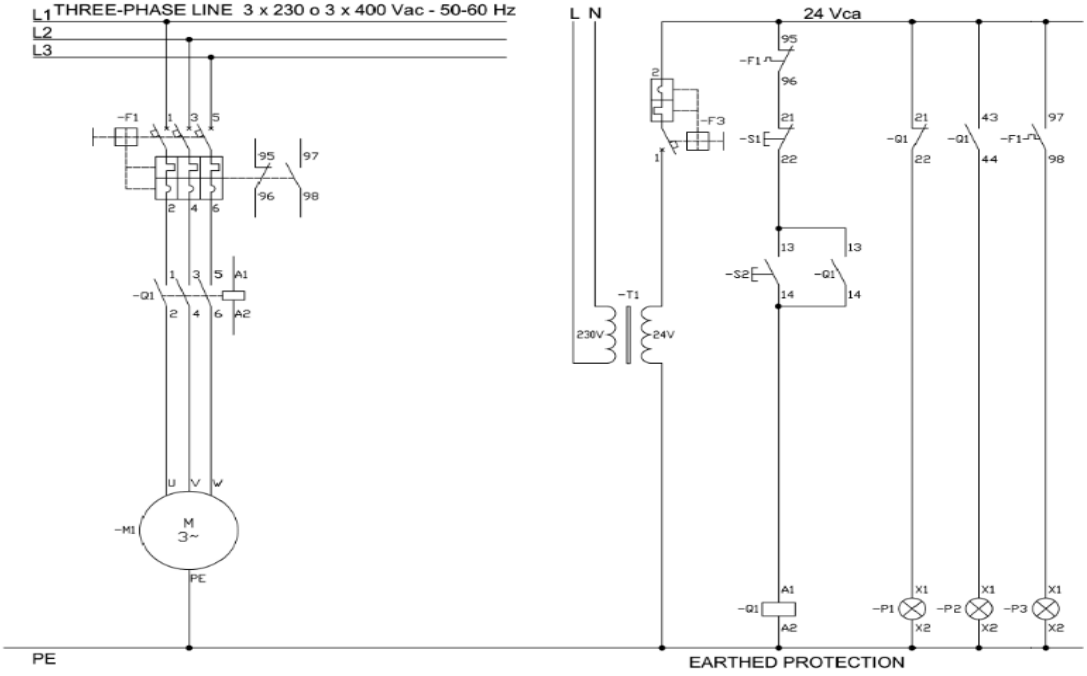


Figure 56.1: Three-phase induction motor remote starter.

OPERATIONAL STEPS

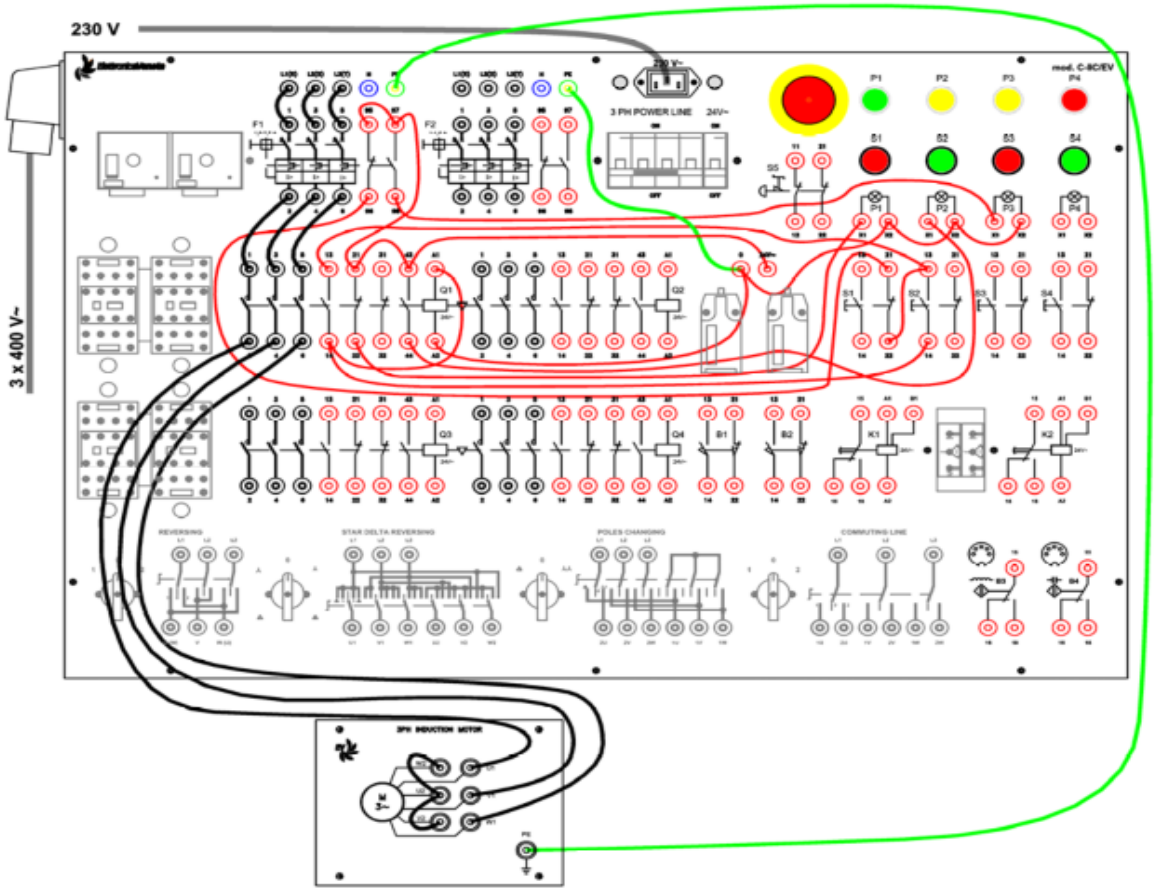


Fig.56.2: Panel connections to control a three-phase motor with a contactor.

Exercise 57- Remote motor reversing switch for an electric gate with a three-phase induction motor, control via a limit switch and timer.

OBJECTIVE

Realize the base system of control of a three-phase induction motor to automate a sliding gate, verifying the following conditions:

a) With the open button, activate the motor that drags the gate until it is fully open, maximum opening is controlled by the B2 limit switch

b) After 20 s from opening, automatically turn on the motor to shut the gate, closure detected by the B1 limit switch

c) you can permanently block the gate with the stop button at any time d) if the gate is open, with the close button, activate the motor to shut the gate, closing limit switch detected B1.

NECESSARY EQUIPMENT

- 1 Panel mod. C-IIC/EV.
- 1 Fixed single-phase power supply 220-230 V_{AC} for a control circuit.
- 1 Fixed three-phase power supply 380-400 V_{AC} for a power circuit.
- 1 Series of cables with 4 mm diameter safety plugs.
- 1 Three-phase cage induction motor 0,3-1 kW mod. M-4/EV or P4/EV, if available.

PREPARING THE EXERCISE

Place the panel onto the worktable in a way that it is perfectly stable. Connect the various electrical components by following the wiring diagram in Fig.57.1.

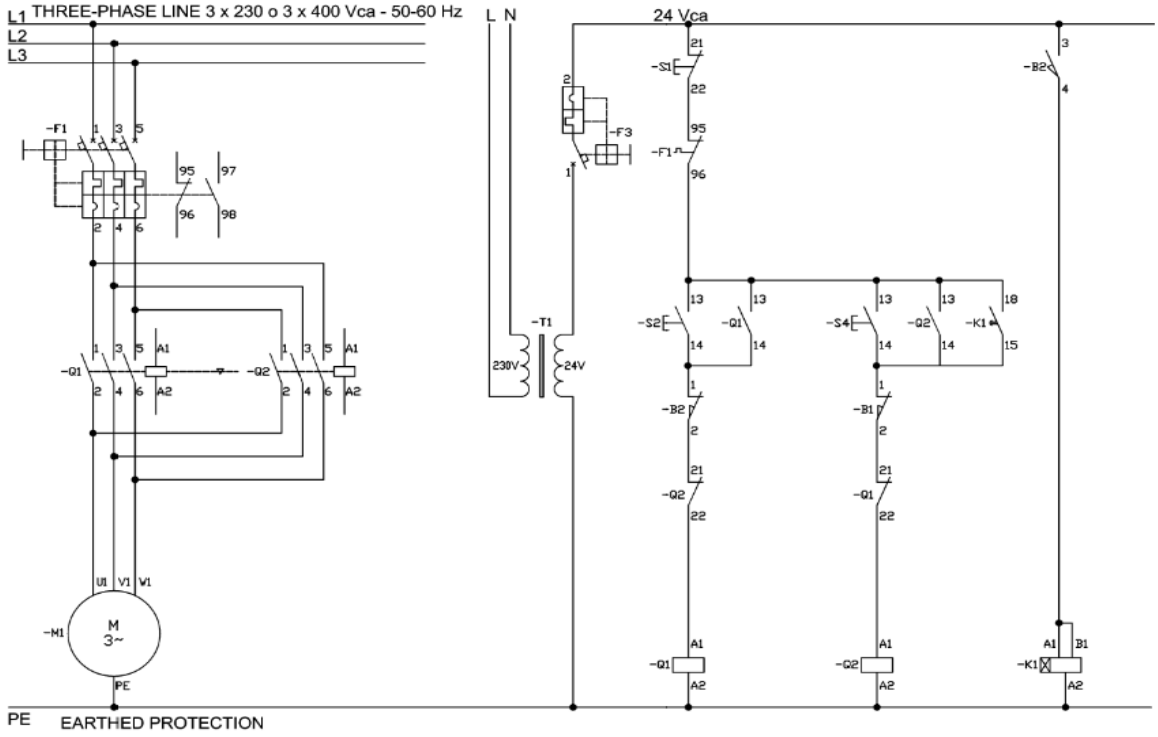


Fig. 57.1: Remote motor reversing switch for a three-phase electric gate induction motor Control via the limit switch and automatic closing timer.

Exercise 58 –Star/Delta starters

OBJECTIVE

Realize an electrical system complete with a power, control and signaling circuit attributed to the start-up of a Star Delta three-phase cage induction motor. The system must be completed with a signaling circuit that indicates:

- Motor in rest mode.
- Motor in starting phase.
- Motor started.
- Protection intervention against overloads.

NECESSARY EQUIPMENT

- 1 Panel mod. C-IIC/EV.
- 1 Fixed single-phase power supply 220-230 V_{AC} for a control circuit.
- 1 Fixed three-phase power supply 380-400 V_{AC} for a power circuit.
- 1 Series of cables with 4 mm diameter safety plugs.
- 1 Three-phase cage induction motor mod. M-4A/EV or P-4A/EV, if available.

PREPARING THE EXERCISE

Place the panel onto the worktable in a way that it is perfectly stable. Connect the various electrical components by following the wiring diagram in Fig. 58.1.

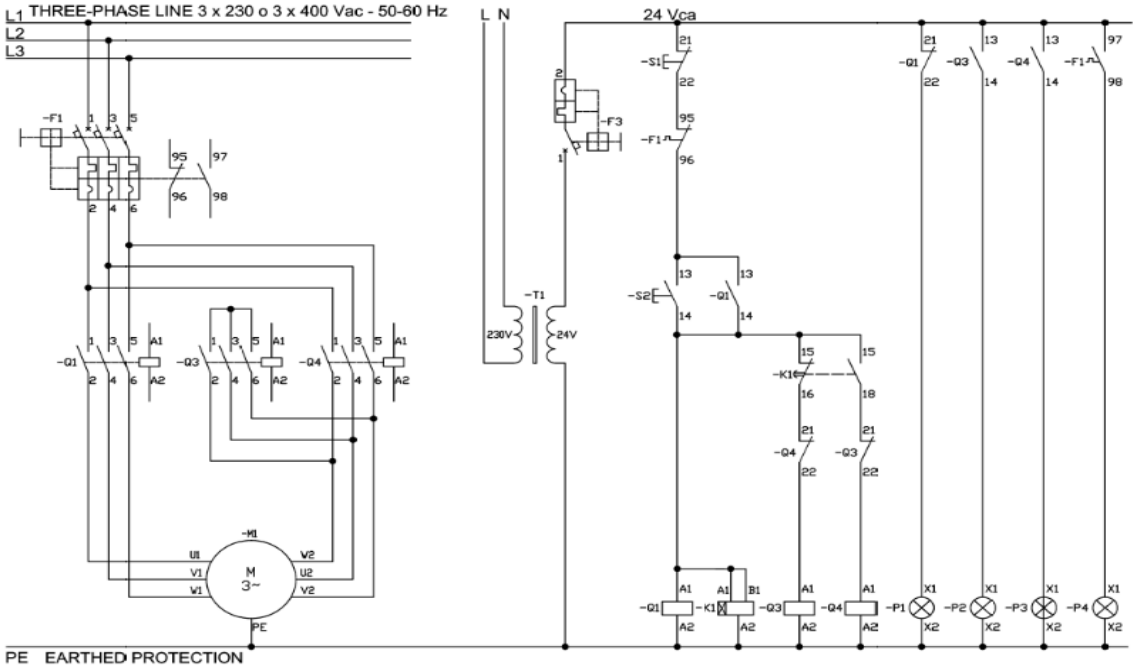


Fig. 58.1: Star-Delta starting device

Exercise 59– System for powering three-phase power consuming devices with presence asymmetry and sequence failure phase relay.

OBJECTIVE

- The first aim of this exercise consists in assembling the electric system of a machine with one or more three-phase asynchronous motors controlled by presence, asymmetry and sequence failure phase relay. The machine cannot start if a phase is missing or the phase sequence is not correct; that prevents motors from running in opposite direction to that required; in this case, invert two wires of the power supply of the machine.
- The second target of this exercise consists in assembling the electric system of a machine with one or more three-phase asynchronous motors controlled by presence, asymmetry and sequence failure phase relay, but in this case phase sequence is automatically corrected if it does not match the machine.

NECESSARY EQUIPMENT

- 1 Panel mod. C-IID/EV.
- 1 Panel mod. C-IIC/EV with start and stop pushbuttons and contactors
- 1 fixed single-phase power supply unit of 220-230 V_{AC} for auxiliary circuits
- 1 fixed three-phase power supply unit of 380-400 V_{AC} for power circuit
- 1 set of leads with safety plugs with diameter of 4 mm.

Remark: if panel mod. C-II/CEV is not available, however it is possible to connect the presence asymmetry and sequence failure phase relay, considering the LEDs of its fore panel and the contact of the internal relay, and to analyze its operation.

PREPARING THE EXERCISE

- Position the panel/s on the working top so that it/they is/are perfectly stable. Connect the various electrical components according to the wiring diagram Shown in Fig. 59.1, or carry out the connections as indicated in the lay-out Shown in Fig. 59.2.
- Position the panel/s on the working top so that it/they is/are perfectly stable. Connect the various electrical components according to the wiring diagram shown in Fig. 59.3, or carry out the connections as indicated in the lay-out shown in Fig 59.4a and 1.4b.

OPERATIONAL STEPS

- Carry out a visual check (also using the tester prearranged for measurements of continuity) to detect any error in the connections.
- Check the control and signaling circuits: only if these last circuits are OK
- Power circuit will be enabled and the final testing of the system will be carried out.

- Make sure that the machine does not start when the phase sequence is not correct. Check that if a phase is missing, the machine cannot start, although the sequence is correct, and it stops, if it is switched on. Checking whether the relay trips in a line with asymmetric phases will require the reduction of the voltage of one of the three leads below the value set in ASYMMETRY % Ue, for instance, and to wait for the time set in DELAY.

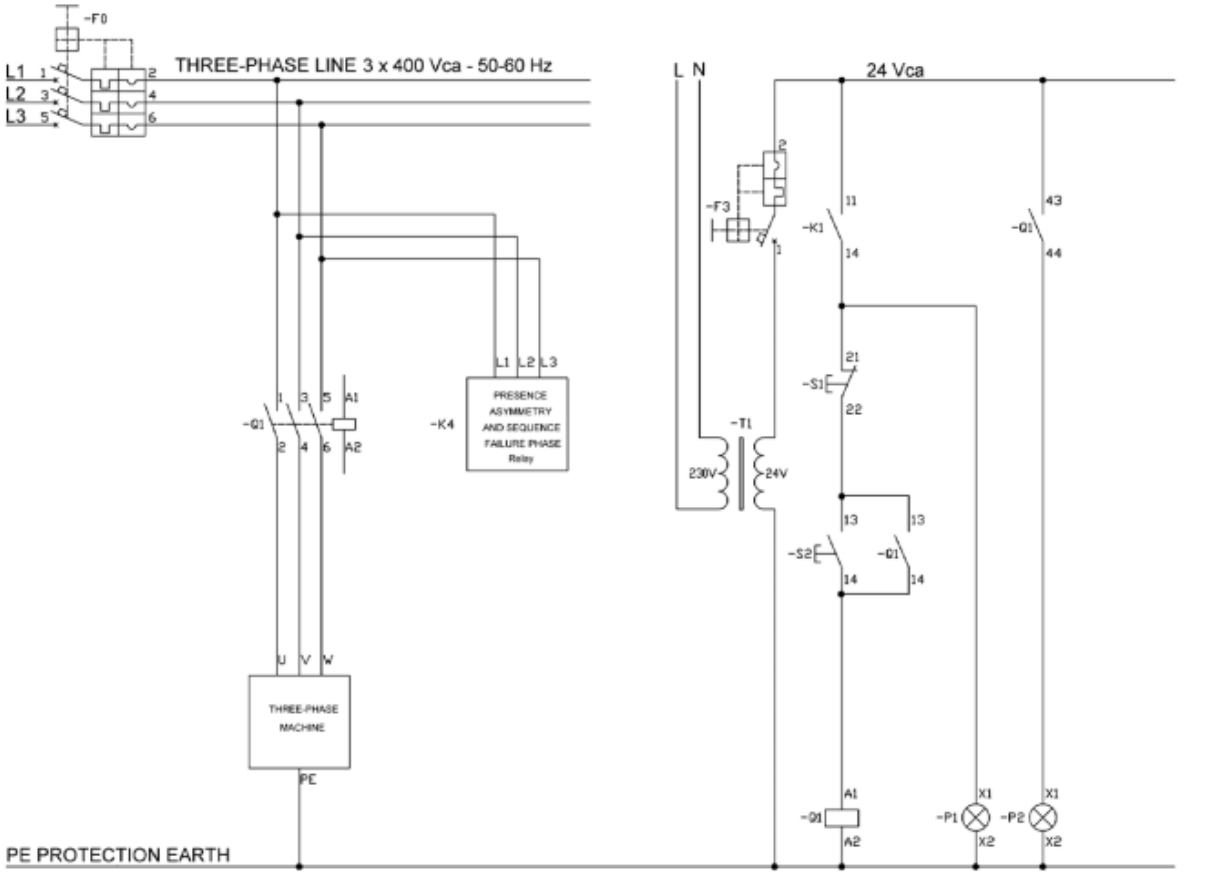


Fig. 59.1: Control of a machine with presence asymmetry and sequence failure phase relay.

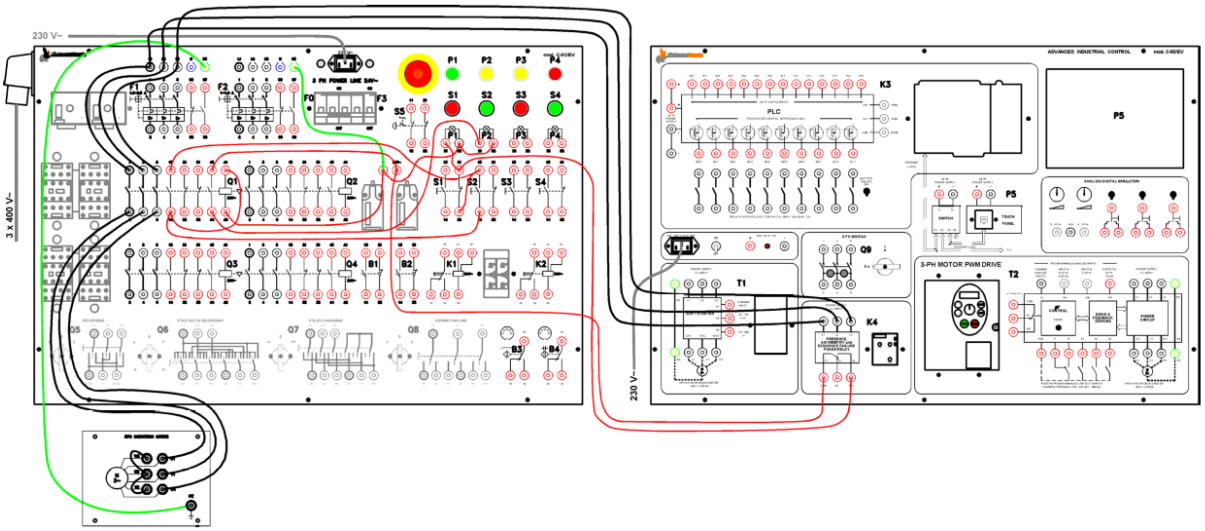


Fig. 59.2: Connections on the panels for the control of a machine with presence asymmetry and sequence failure relay.

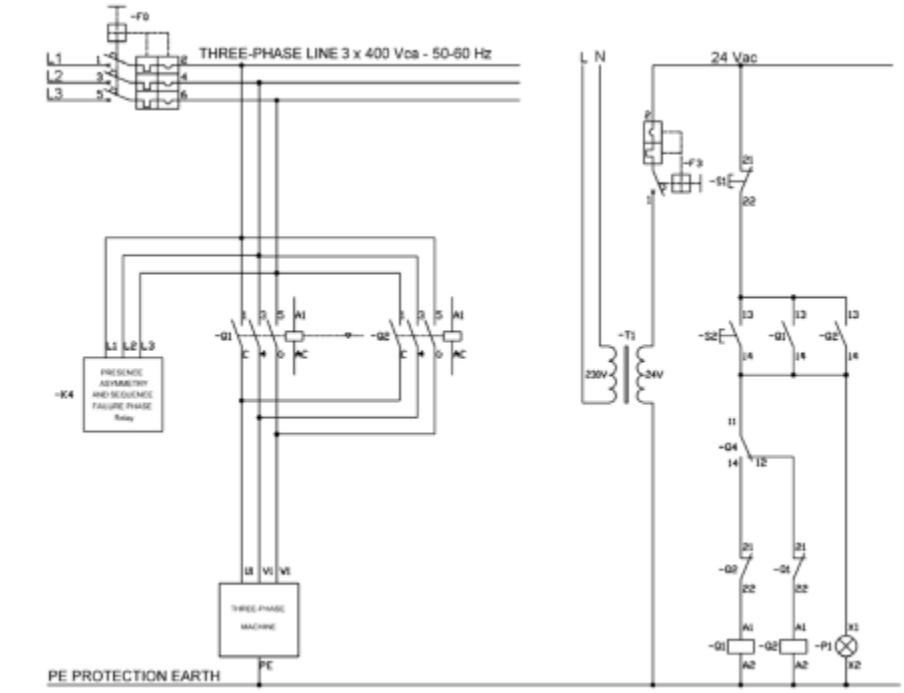


Fig. 59.3: Automatic change of line phase sequence if this does not comply.

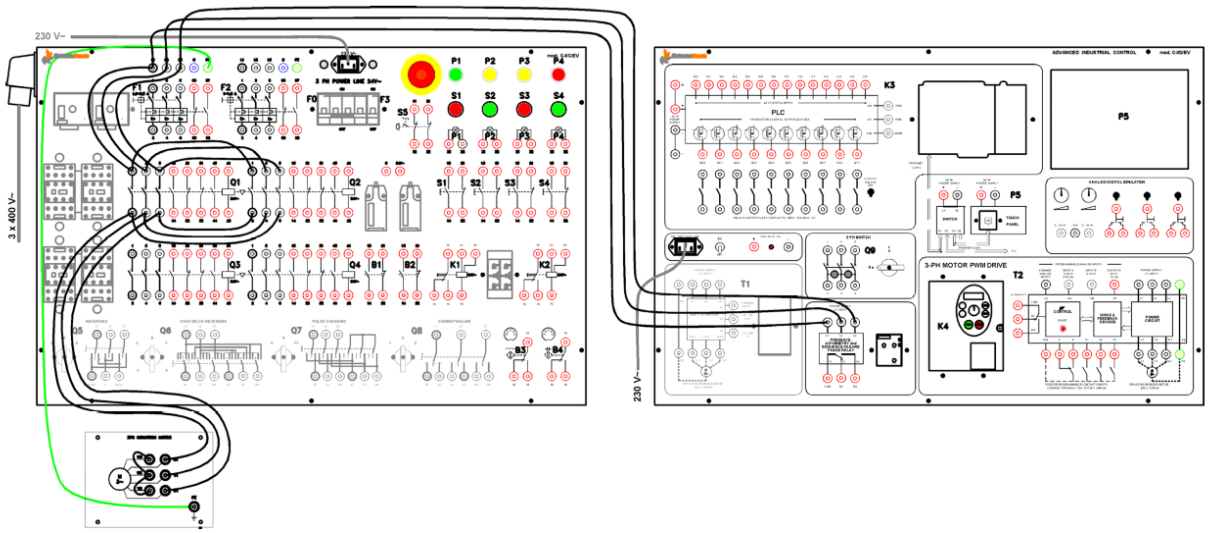


Fig. 59.4a: Connections of the power circuit for the control of a machine with phase sequence relay for the automatic change of line phase if they do not comply.

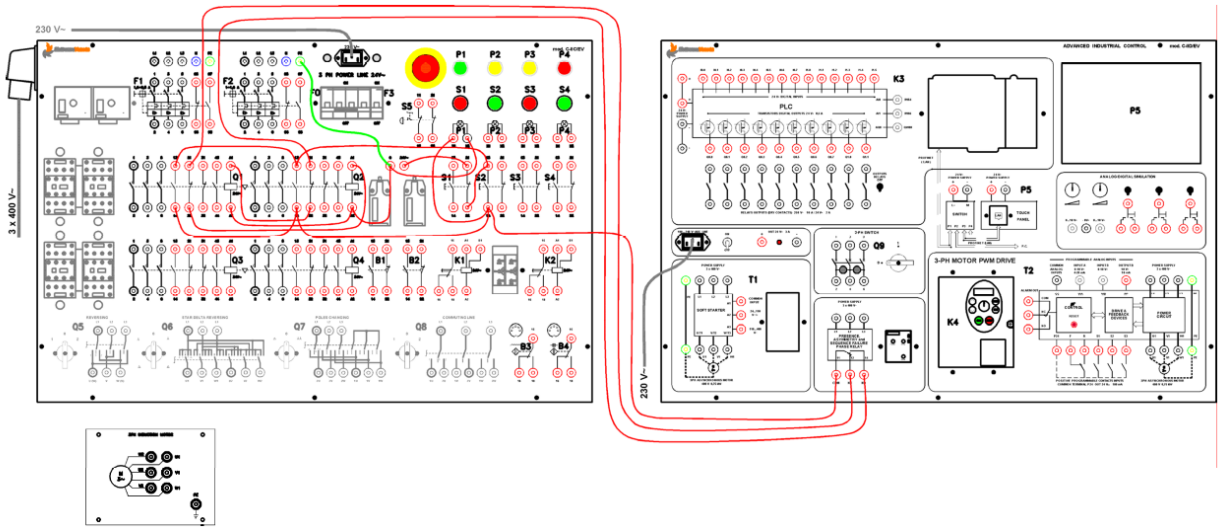


Fig. 59.4b: Connections of the control circuit for the control of a machine with phase sequence relay for the automatic change of line phase if it does not comply.

Exercise 60 - Gradual start-stop of a three-phase asynchronous motor by soft starter .

ELECTRONICALLY CONTROLLED INDUSTRIAL SYSTEM

OBJECTIVE

When RPM must not be modified, but the three-phase asynchronous motors included in a machine (such as conveyor belts, water pumps, fans, etc…), must start and stop "softly", some phase choking devices, commonly known as soft starters, can be used.

NECESSARY EQUIPMENT

- 1 Panel mod. C-IID/EV
- 1 Panel mod. C-IIC/EV for control and protection devices
- 1 fixed single-phase power supply unit of 220-230 V_{AC} for control circuit
- 1 fixed three-phase power supply unit of 380-400 V_{AC} for power circuit
- 1 set of leads with safety plugs with diameter of 4 mm.
- 1 three-phase asynchronous squirrel-cage motor of 0.3-1 kW mod. M4/EV Or P-4/EV (if available)

Remark:
If panel mod. C-IIC/EV is not available; however it is possible to connect the soft starter and to analyze its operation.

PREPARING THE EXERCISE

- Position the panels on the working top so that they are perfectly stable.
- Connect the various electrical components according to the lay-out shown in Fig. 60.1.

OPERATIONAL STEPS

- Before powering the system assembled as described above, it is better to carry out a visual check (also using the tester prearranged for measurements of continuity) to detect any error in the connections.
- Make sure that the phase sequence is correct (the consent signal has been received from the presence asymmetry and sequence failure phase relay), and then start the motor.
- Check and adjust the times of ramps and the starting torque with the trimmers available on the fore panel of the soft starter.

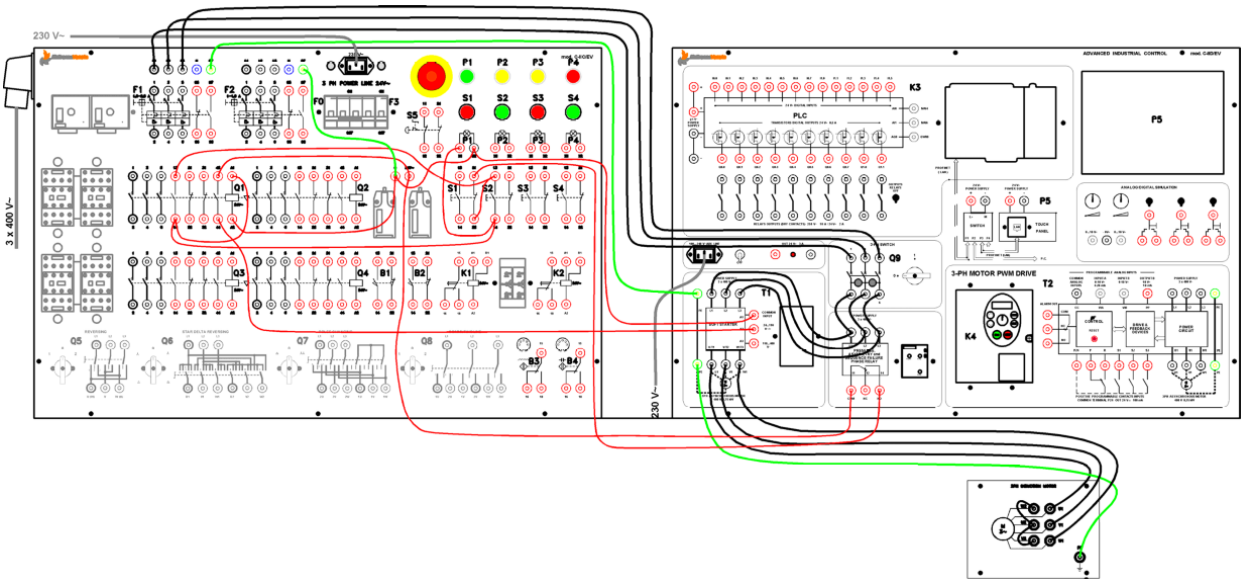


Fig. 60.1: Connections on the panels for a Soft Starter with control of 24 V_{AC}.

Exercise 61- Reversing contactor for three-phase asynchronous motor with limit switches, control by PLC and HMI Panel.

OBJECTIVE

Use a PLC and the HMI to assemble a reversing contactor for a three- phase asynchronous motor of forward-reverse running for conveyor belt, with control pushbuttons and limit switches in the two extreme positions; include also the overload protection and the warning lights for signaling forward running, reverse running and tripping of thermal relay. Operational phases:

- Wire the electric system of power circuit.
- Wire the control circuit and the warning lights controlled by PLC (PLC inputs and outputs).
- Write and transfer the program into the PLC and HMI.

NECESSARY EQUIPMENT

- 1 Panel mod. C-IID/EV
- 1 Panel mod. C-IIC/EV for control and protection devices
- 1 fixed single-phase power supply unit of 220-230 V_{AC} for control circuit
- 1 fixed three-phase power supply unit of 380-400 V_{AC} for power circuit
- 1 set of leads with safety plugs with diameter of 4 mm.

- 1 three-phase asynchronous squirrel-cage motor of 0.3-1 kW mod. M4/EV or P-4/EV (if available)

Remark:
If panel mod. C-IIC/EV is not available, however enabling the PLC inputs suitably will allow to program the PLC and HMI and to analyze the circuit operation.

PREPARING THE EXERCISE

Position the panel/s on the working top so that they are perfectly stable.
Complete/modify the control section of the wiring diagram shown in Fig. 61.1, for the automation with the PLC and HMI; power circuit does not change.

OPERATIONAL STEPS

First of all enable the operation of the PLC and HMI with the auxiliary supply voltage of 24 V_{DC} and the auxiliary supply voltage of 24 V_{AC}. After the positive testing of the (Hardware and Software) control section, enable also the power supply of power circuit and complete the testing

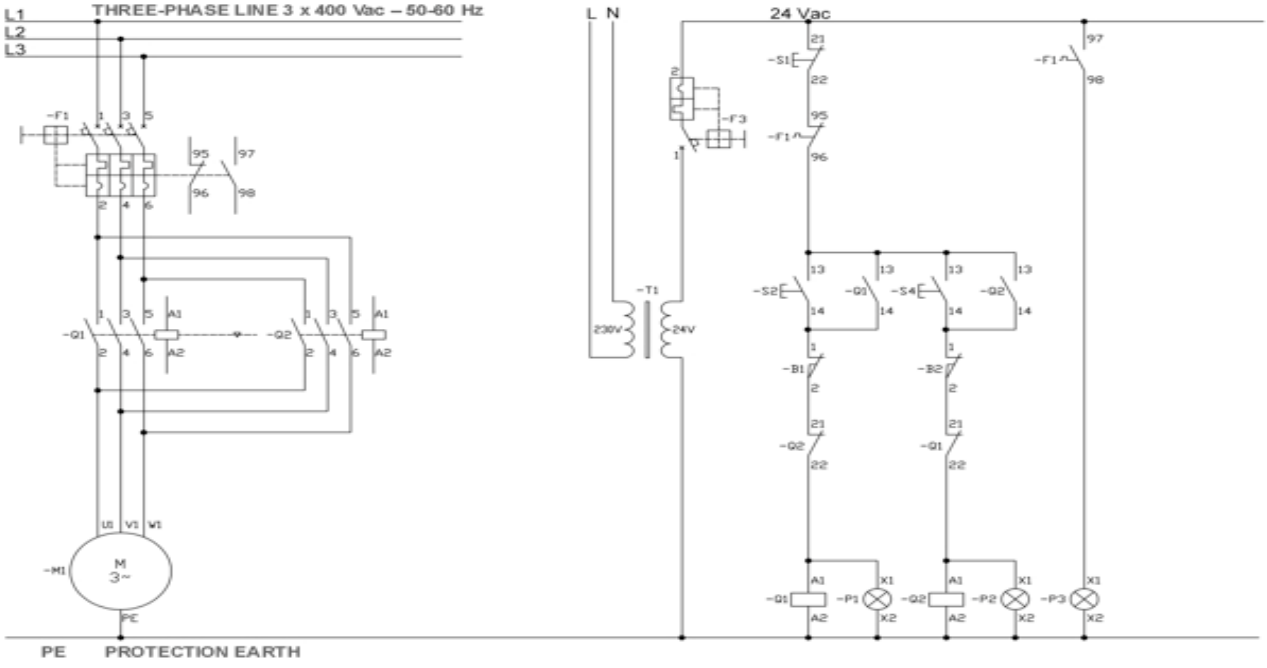


Fig. 61.1: Reversing contactor for three-phase asynchronous motor with limit switches

Meaning of the variables of the PLC and of HMI panel				
	Name	Type	Address	Description
1	**F1**	NO	%I0.0	Motor protector
2	**S1**	NC	%I0.1	Motor stop button
3	**S2**	NO	%I0.2	Forward running button
4	**S4**	NO	%I0.3	Reverse running button
5	**Q1_C**	NO	%I0.4	Auxiliary contact of Q1
6	**Q2_C**	NO	%I0.5	Auxiliary contact of Q2
7	**B1**	NC	%I0.6	Limit switch of Forward run
8	**B2**	NC	%I0.7	Limit switch of Reverse run
9	**Q1**	Coil of 24 Vac	%Q0.0	Coil of contactor for Forward run
10	**Q2**	Coil of 24 Vac	%Q0.1	Coil of contactor for Reverse run
11	**P1**	24 V	%Q0.2	Warning light of motor Forward running
12	**P2**	24 V	%Q0.3	Warning light of motor Reverse running
13	**P3**	24 V	%Q0.4	Warning light for motor overload

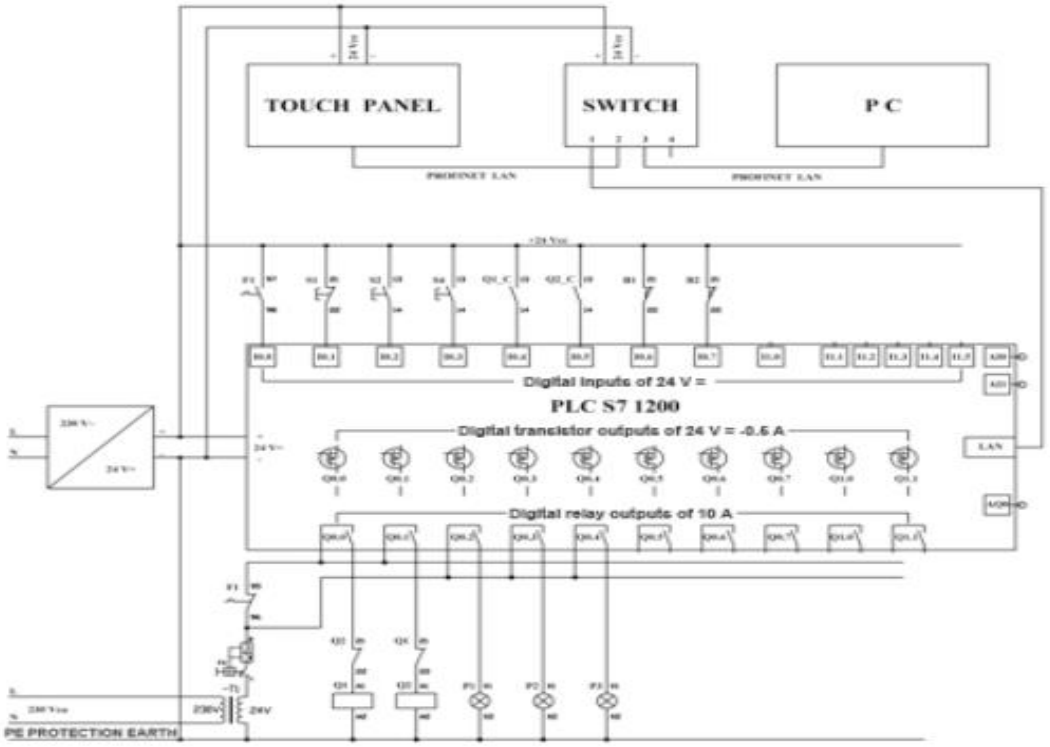


Fig. 61.2: Wiring diagram for reversing contactor for three-phase asynchronous motor, control by PLC and HMI Panel

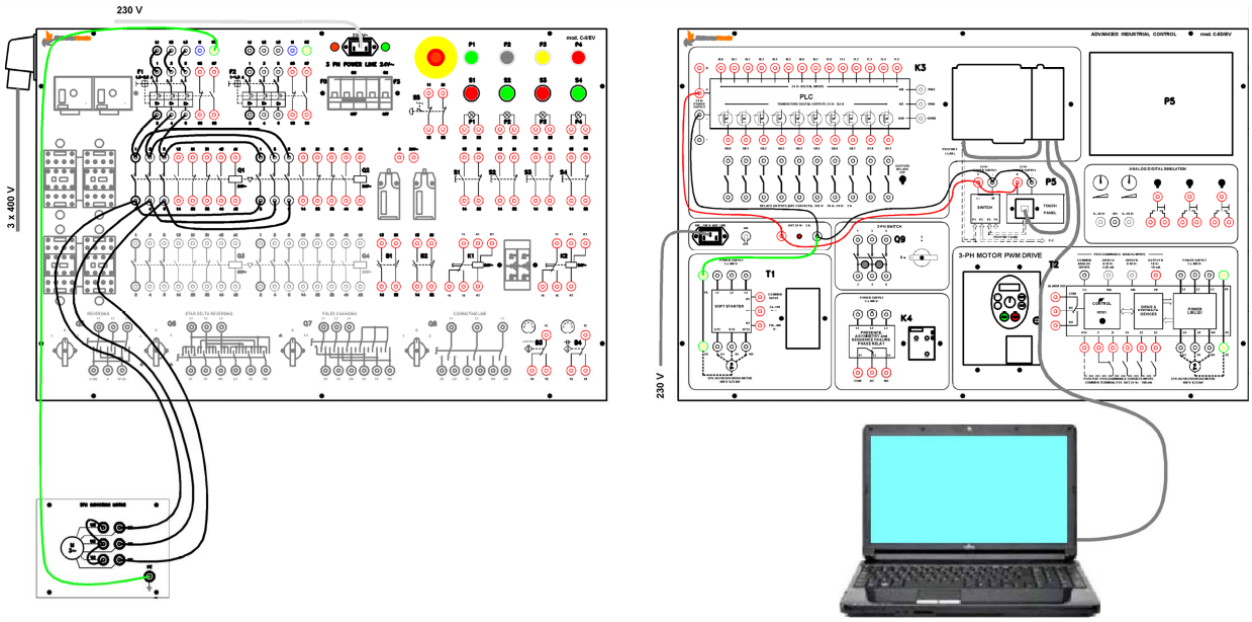


Fig. 61.3a: Connections on the panels for the reversing contactor of a three-phase asynchronous motor with limit switches, PLC and HMI. Power connections at 400 V, aux. power supply of PLC and HMI at 24 V_{DC}.

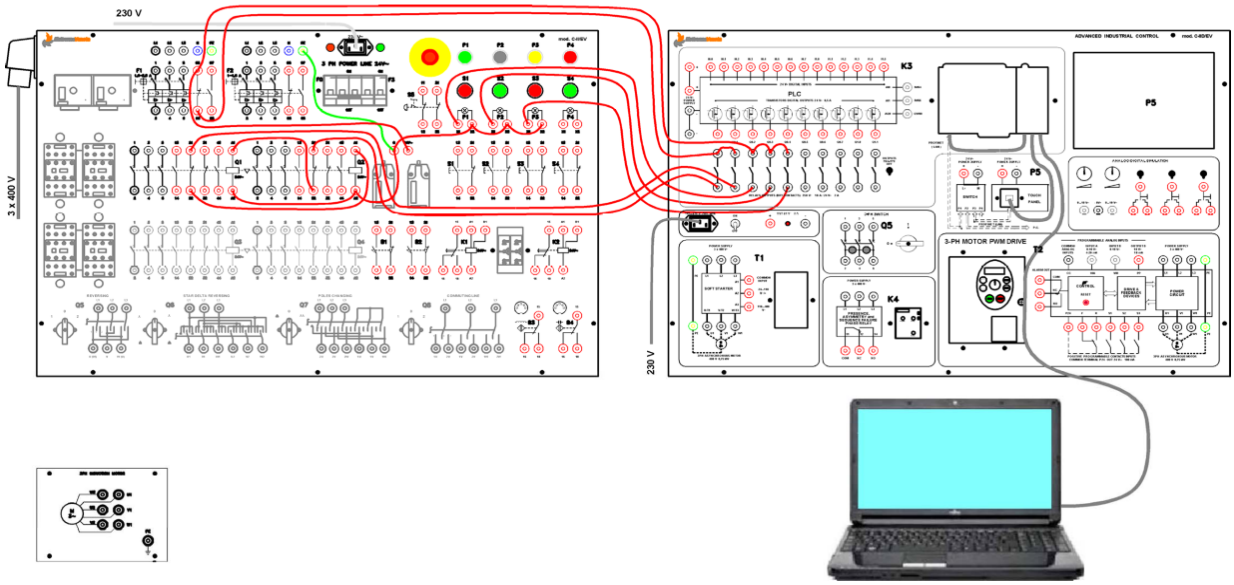


Fig. 61.3b : Connections on the panels for the reversing contactor of a three-phase asynchronous motor with limit switches, PLC and HMI. Connections of PLC outputs at 24 V_{AC}.

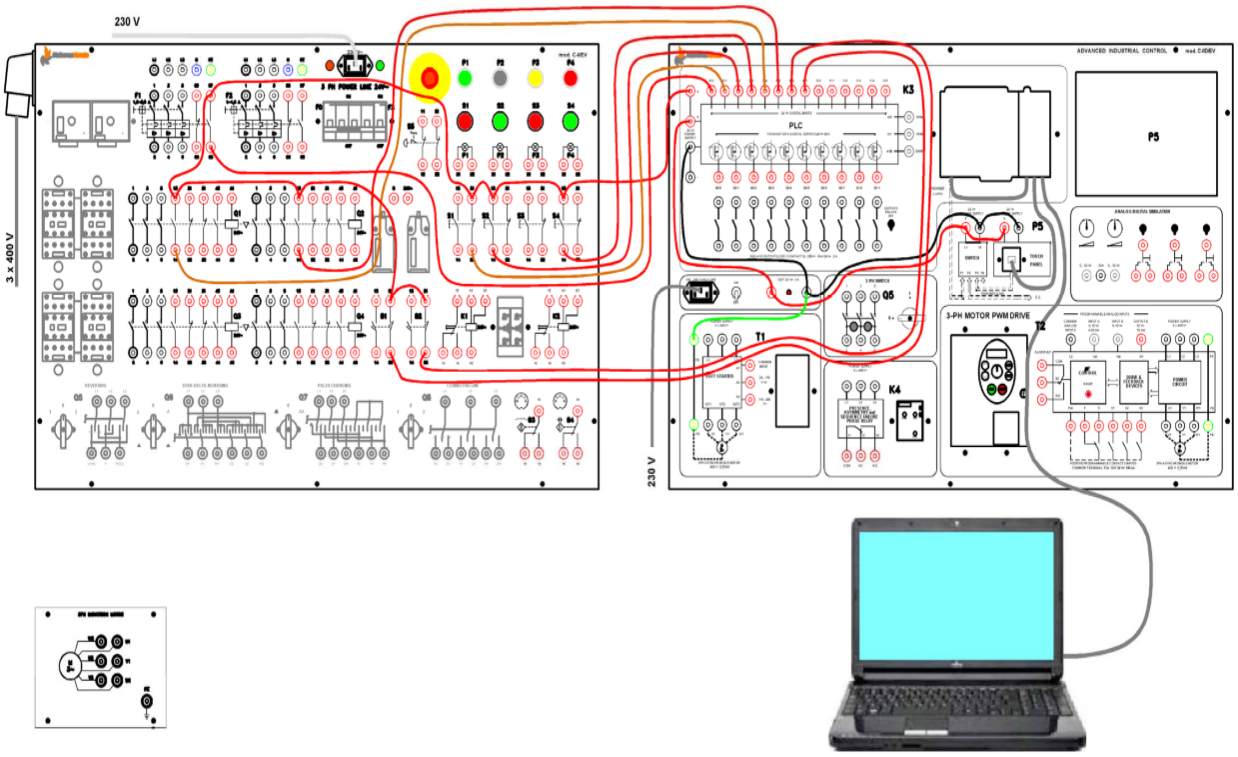
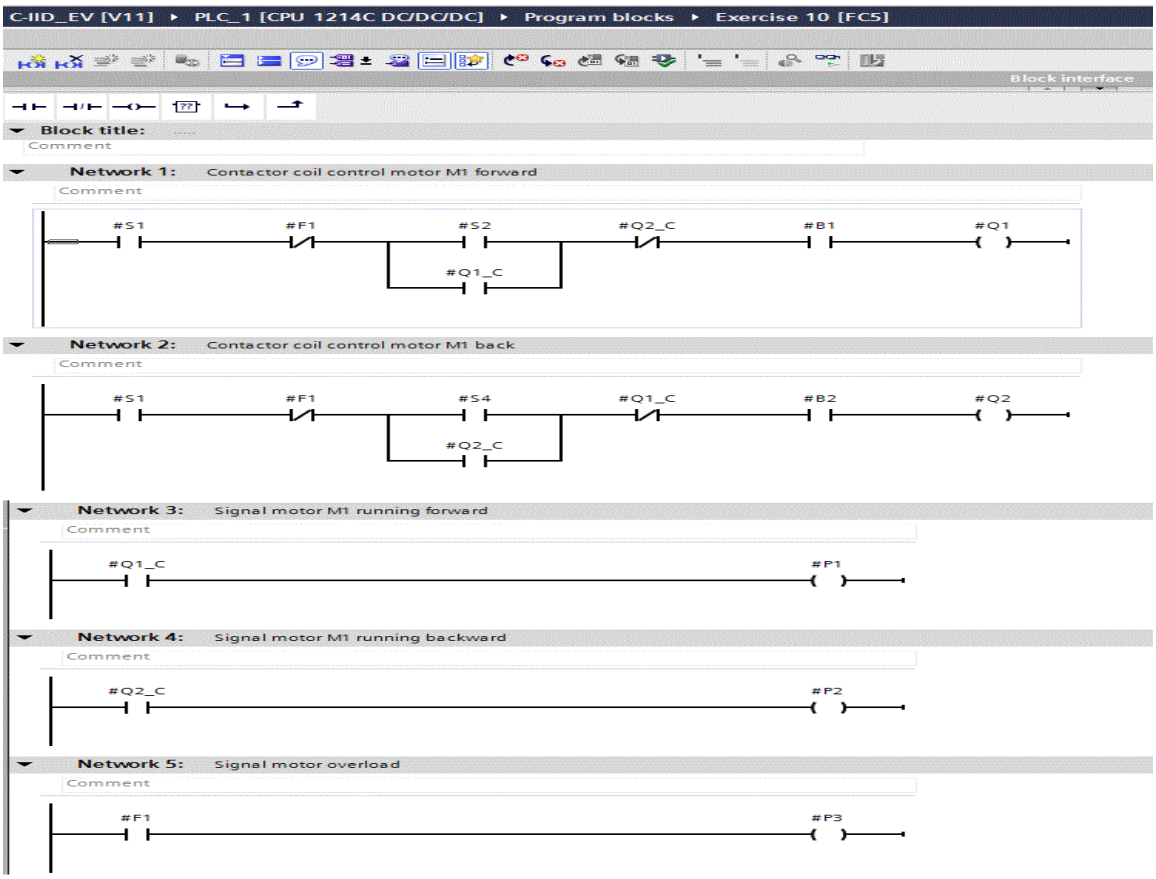


Fig. 61.3c :Connections on the panels for the reversing contactor of a three-phase asynchronous motor with limit switches, PLC and HMI.

Example of program for reversing contactor for three-phase asynchronous motor, with limit switches, PLC and HMI.



Example of a page of HMI panel for displaying the state of a motor: forward run, reverse run, overload.