Magnetic Switches

(Electrical Workshop II - ECEG-3153)

School of Electrical and Computer Engineering
Addis Ababa institute of Technology

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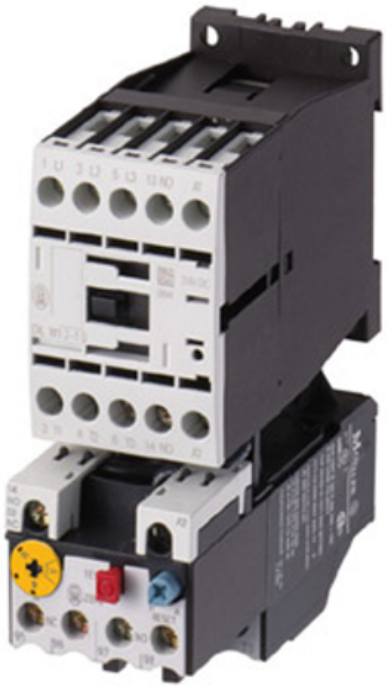
Outline

- Introduction
- Working principle and operation of Relays
- Types of relays
- Advantage and Disadvantages of relays
- Contactors
- Magnetic Starters
- Relay Timers

Introduction

Electrical Switches : is any device used to interrupt the flow of electrons in a circuit. Switches are essentially binary devices: they are either completely on ("closed") or completely off ("open").

- There are many different types of switches :
  - Push button
  - Coil-based electromagnetic : starters, relays and contactors are also known as magnetic switches



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Introduction (contd...)

What are magnetic switches?

- Is just like a light switch
- The only difference they are operated by a magnets
- electromagnetic switch

Figure: 2. electromagnetic switches

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Relays

- A relay is an electrically operated switch.
- Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relay.
- Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal.

Relays principle

- A relay may also be called an **“electromagnetic switch”**
- Relays use a “low amperage circuit” to control a “high amperage circuit”
- The low amperage circuit controls an electromagnetic device.
- The electromagnetic device “closes/opens” the high amperage circuit.

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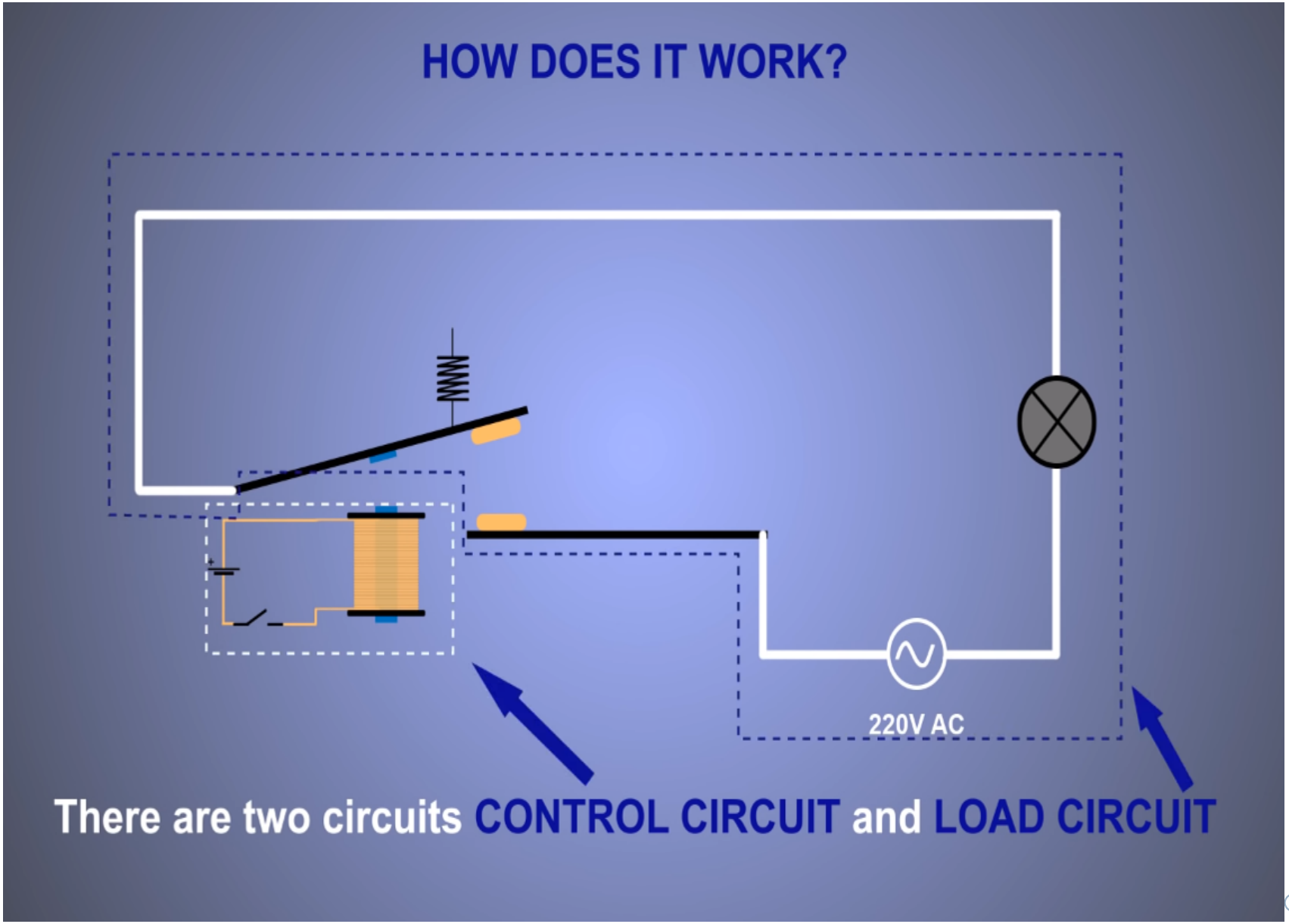
Relay working principle



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Relay Operation

- A simple electromagnetic relay consists of a coil of wire wrapped around a soft iron core, an iron yoke which provides a low reluctance path for magnetic flux, a movable iron armature, and one or more sets of contacts.
- The armature is hinged to the yoke and mechanically linked to one or more sets of moving contacts.
- It is held in place by a spring so that when the relay is de- energized there is an air gap in the magnetic circuit.
- In this condition, one of the two sets of contacts in the relay pictured is closed, and the other set is open. Other relays may have more or fewer sets of contacts depending on their function.

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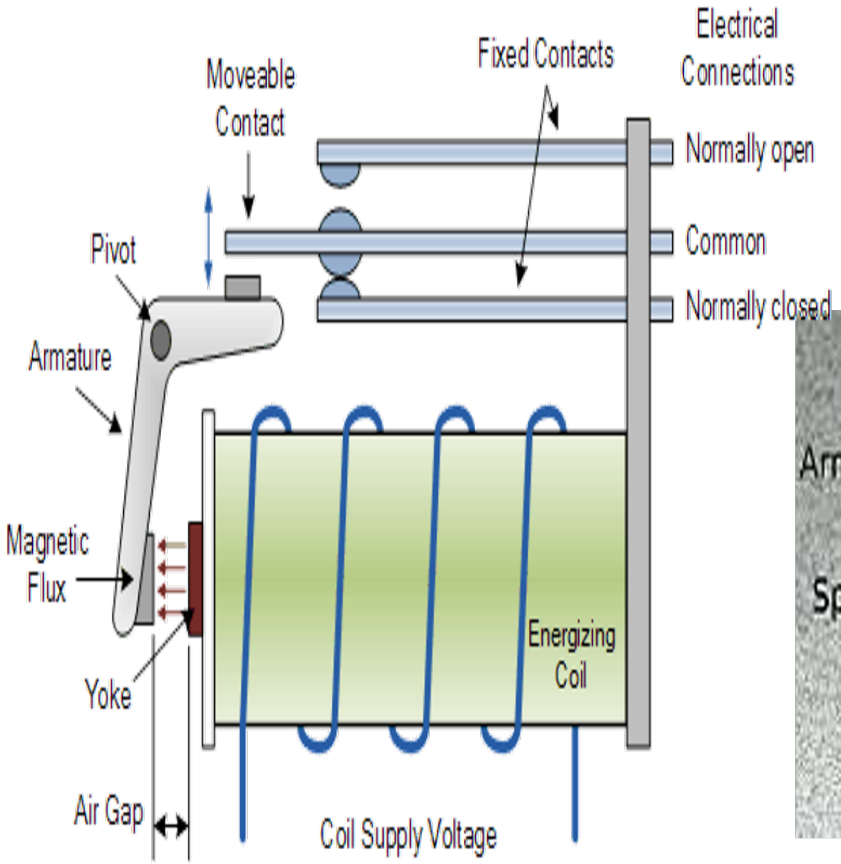
Relay operation

- The relay in the picture also has a wire connecting the armature to the yoke.



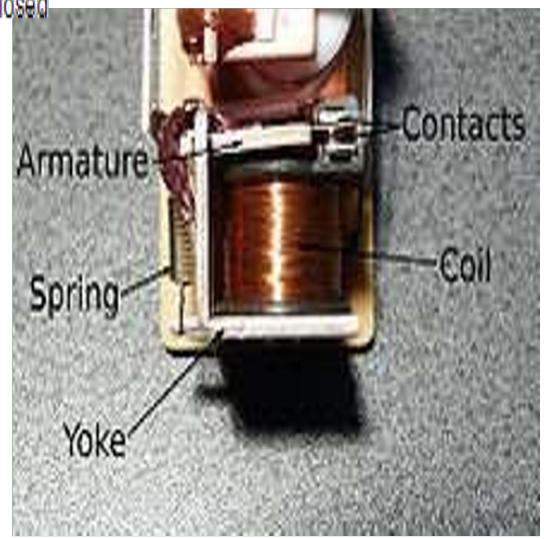


Figure: 4. Relay operation

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Relay Operation

- When an electric current is passed through the coil it generates a magnetic field that activates the armature, and the consequent movement of the movable contact(s) either makes or breaks (depending upon construction) a connection with a fixed contact.
- If the set of contacts was closed when the relay was de- energized, then the movement opens the contacts and breaks the connection, and vice versa if the contacts were open.
- When the current to the coil is switched off, the armature is returned by a force, approximately half as strong as the magnetic force, to its relaxed position. Usually this force is provided by a spring, but gravity is also used commonly in industrial motor starters.

Relay Operation

- Most relays are manufactured to operate quickly. In a low-voltage application this reduces noise; in a high voltage or current application it reduces arcing.
- When the coil is energized with direct current, a diode is often placed across the coil to dissipate the energy from the collapsing magnetic field at deactivation, which would otherwise generate a voltage spike dangerous to semiconductor circuit components.

Types of Relay

- Latching relay
- Induction type relay
- Reed relay
- Mercury-wetted relay
- Solid State relay

Advantage and disadvantage of relays

- Advantages
  - Electromagnetic relays have fast operation and fast reset.
  - They can be used for both ac and dc systems for protection of ac and dc equipment.
  - They have the properties such as simple, robust, compact and most reliable These relays are almost instantaneous.
- Disadvantages
  - The directional feature is absent in electromagnetic relays. Requires periodic maintenance and testing unlike static relays.
  - Relay operation can be affected due to ageing of the components and dust, pollution resulting in spurious trips.

Applications

- The over/under current and voltage protection of various ac and dc equipments.
- Used as auxiliary relays in the contact systems of protective relay schemes.
- some application areas are:
  - Automobiles
  - Air conditioning
  - Ventilators
  - Heaters
  - Power Conditioning

Contactors

- Contactors are relays that switch high current loads also known as magnetic starters

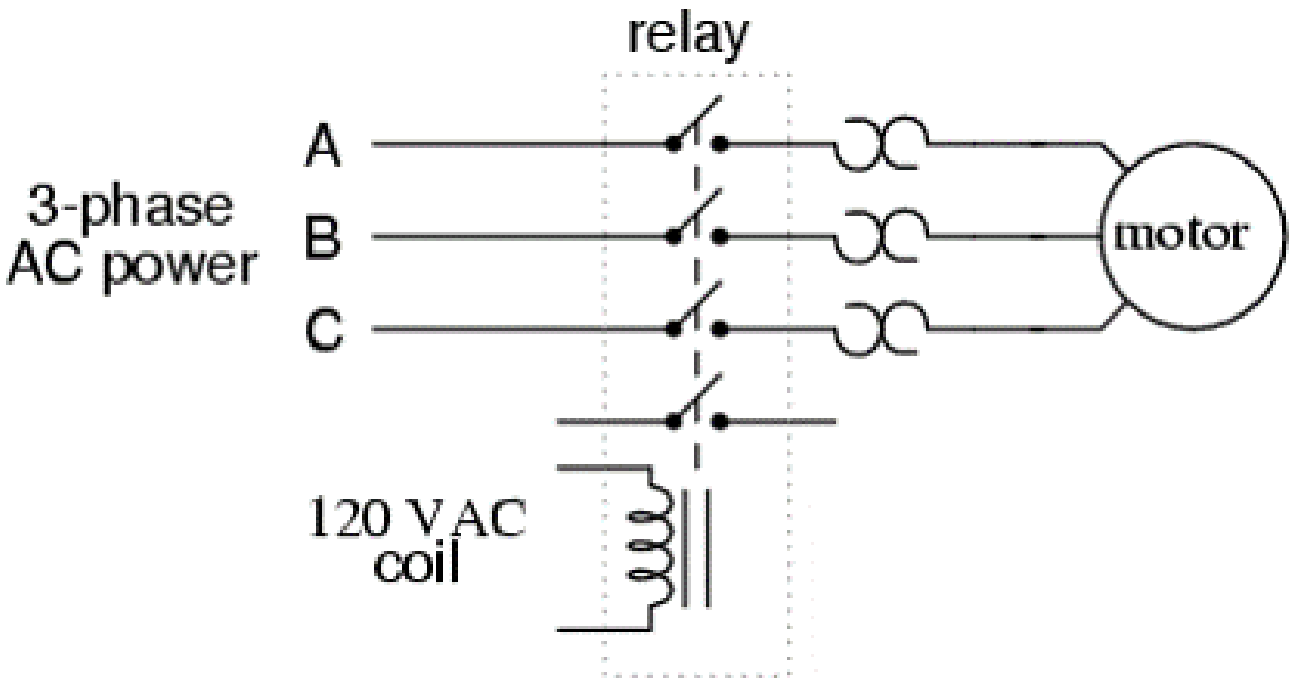

Figure: 5. Contactor circuit

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Contactors

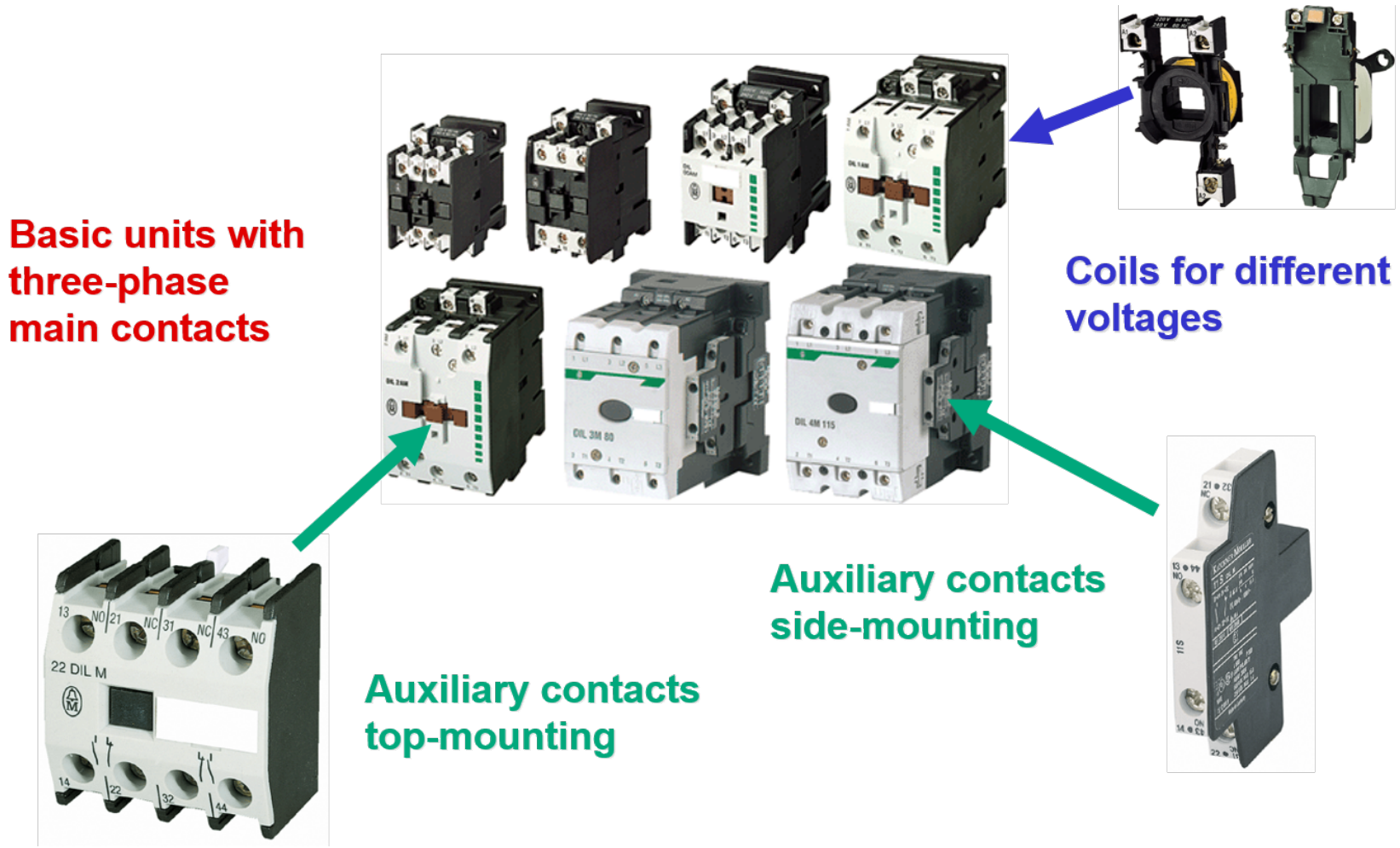
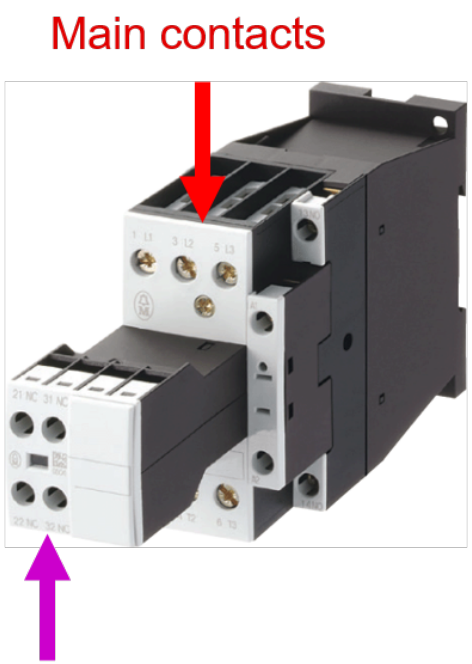
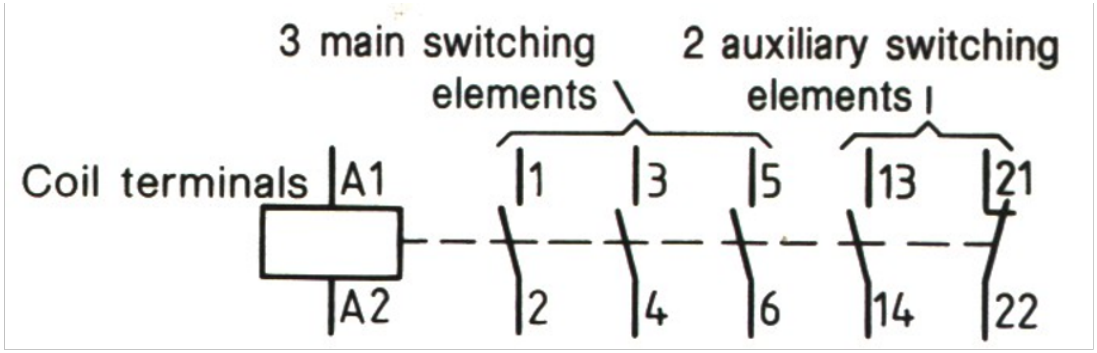


Figure: 6. Contactors and contacts

Contactors





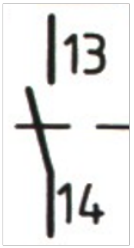
Type of contact	Symbol	Function digit
Normally Open (NO) Make contact		**3** and **4**
Normally Closed (NC) Break contact		**1** and **2**

Figure: 10. Contactors and contacts

Magnetic motor starters

- A magnetic motor starter is an electrically-operated switch (contactor) that includes motor overload protection.
- Magnetic motor starters are identical to contactors except that they have overloads attached to them.
- The overloads have heaters or electronic overloads (located in the power circuit) which sense excessive current flow to the motor.
- The heaters open the NC overload contacts (located in the control circuit) when the overload becomes dangerous to the motor.

magnetic motor starters

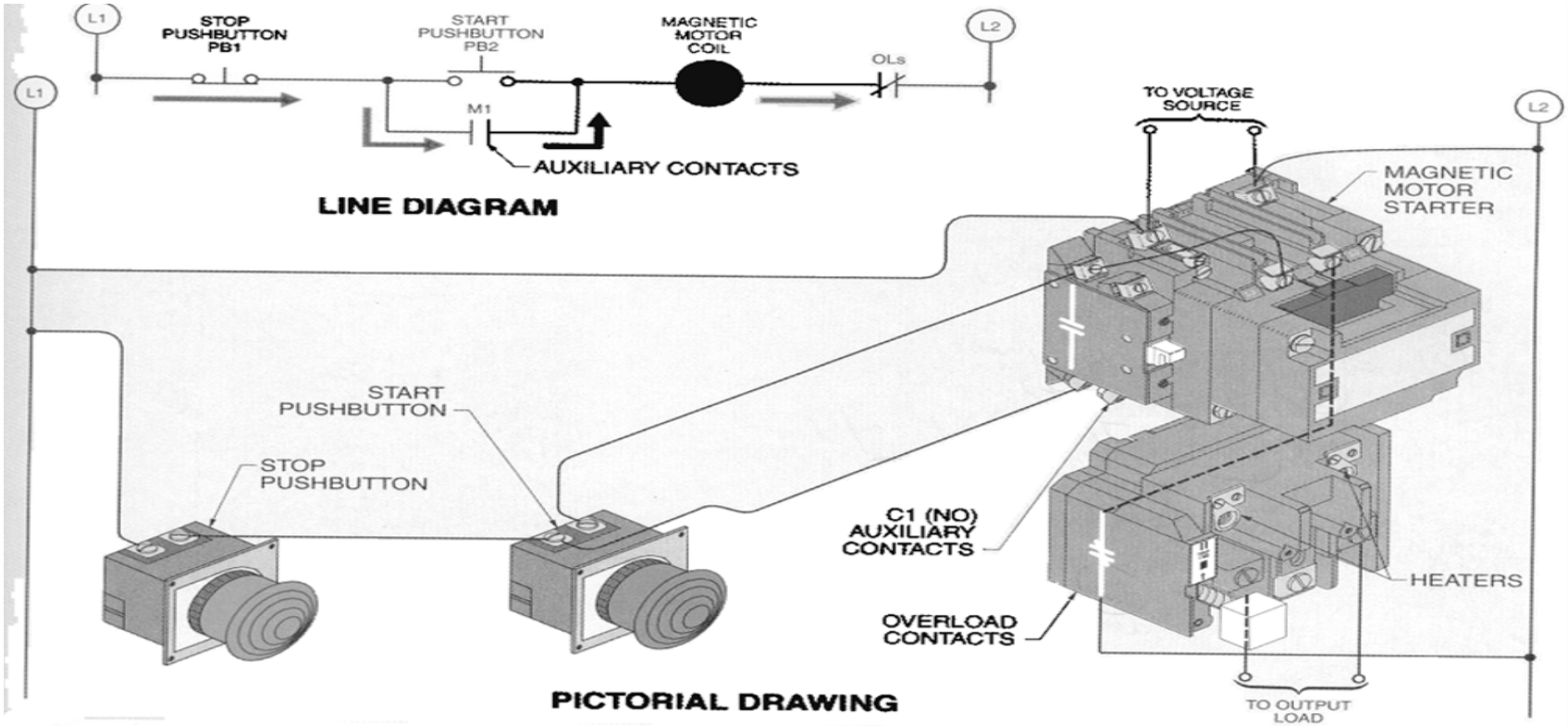


Figure: 11. Magnetic motor starters

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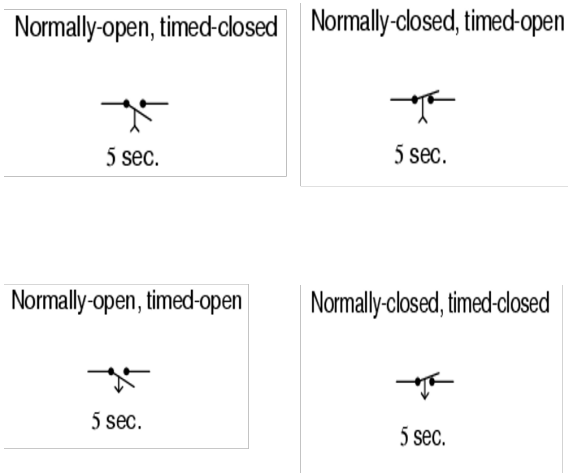
Relay Timers

- ON delay timers
  - Normally-Open, timed-closed
  - Normally-Open, timed-open
- OFF delay timers
  - Normally-Open, timed-closed
  - Normally-Open, timed-open



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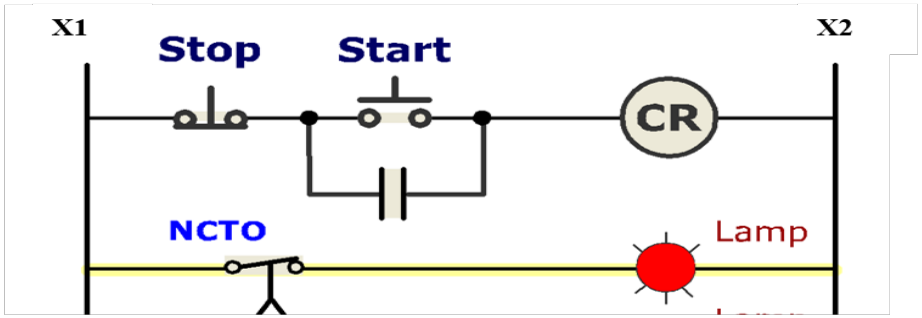
Wired ON Delay



1. Energy applied to power rails

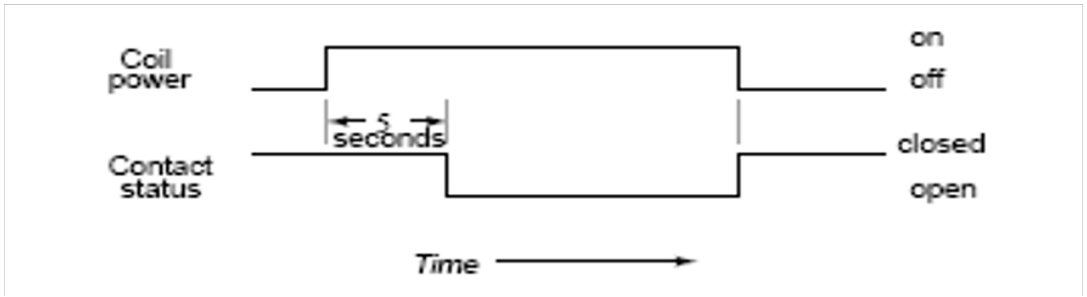


Figure: 12. ON delay timers

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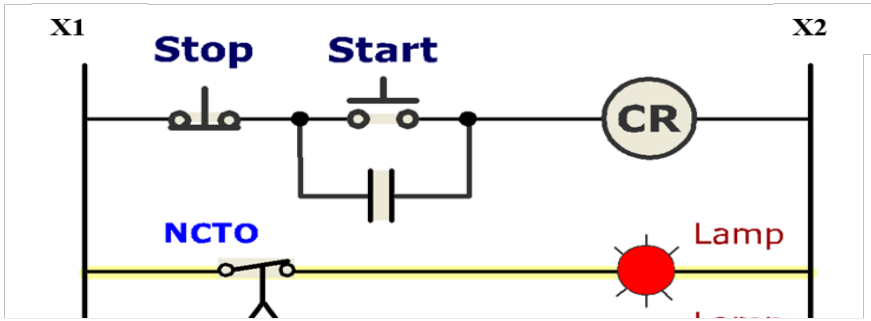
Wired ON Delay - NCTO



1. Energy applied to power rails
2. **Start PB is pressed**
   - **Coil is energized**
   - **Holding contact close**
   - **Timer contact stays closed, lamp stays on.**
   - **Count begins (5 sec)**

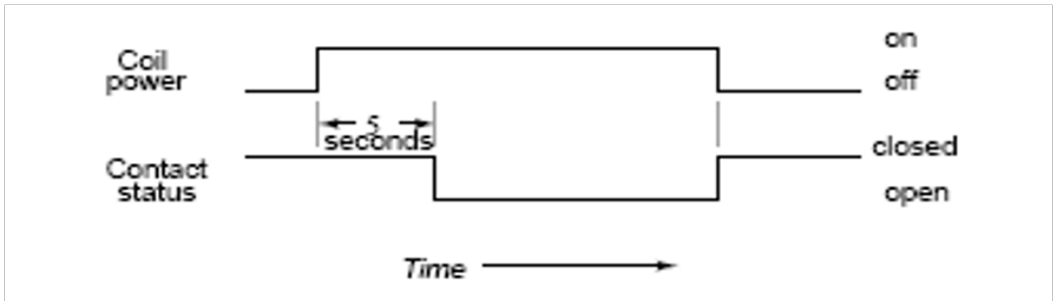
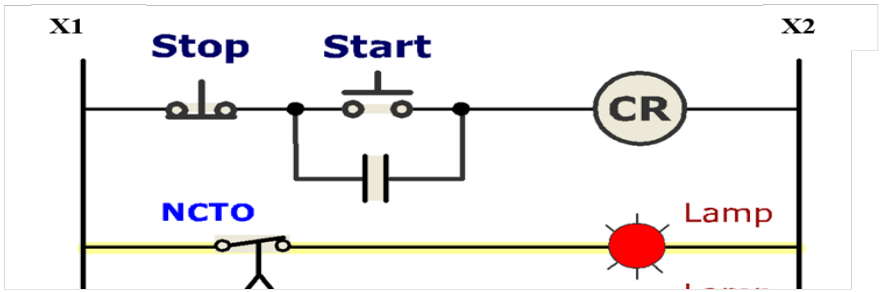


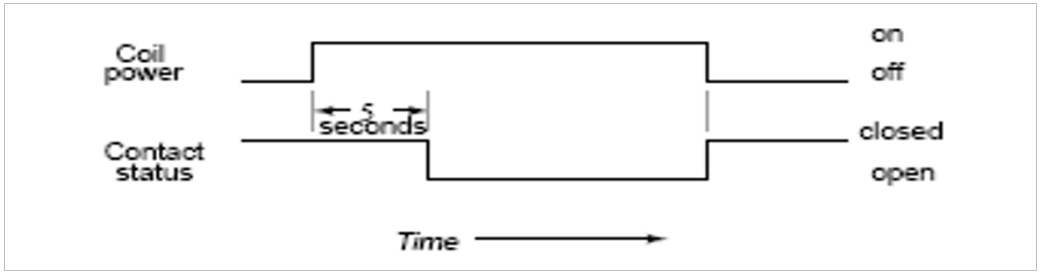
Figure: 13. ON delay timers

Wired ON Delay - NCTO



3. Timer count ends
   - Coil is still energized
   - Timer contact open
   - lamp goes off.

4. Timer contacts remain open until the coil is de-energized



The **N**ormally **C**losed contact will take 5 seconds **T**o **O**pen when the coil is energized.

Figure: 14. ON delay timers

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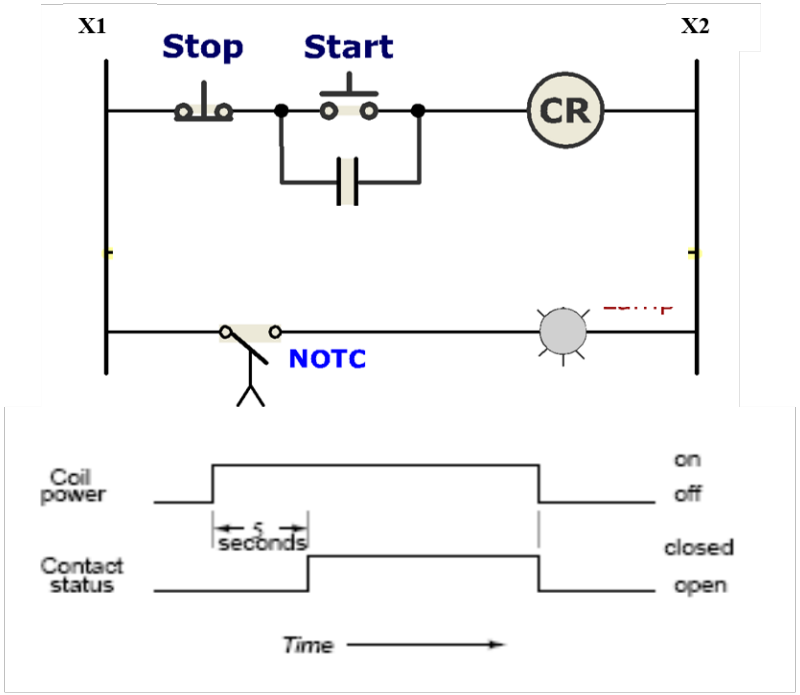
ON Delay - NOTC



1. Power is applied to rails

The Normally Open contact will take 5 seconds To Close when the coil is energized.

Figure: 15. ON delay timers

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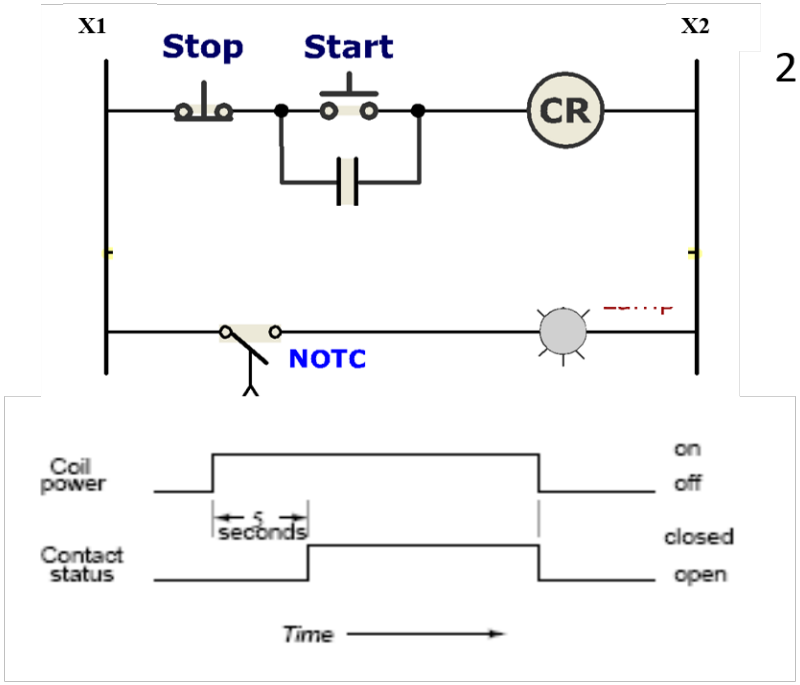
ON Delay - NOTC



2. Start PB is pressed
   - Coil energizes
   - Holding contacts close
   - Timer contacts stay open
   - Lamp stays off
   - Counter starts to count (5 sec)

The Normally Open contact will take 5 seconds To Close when the coil is energized.

Figure: 16. ON delay timers

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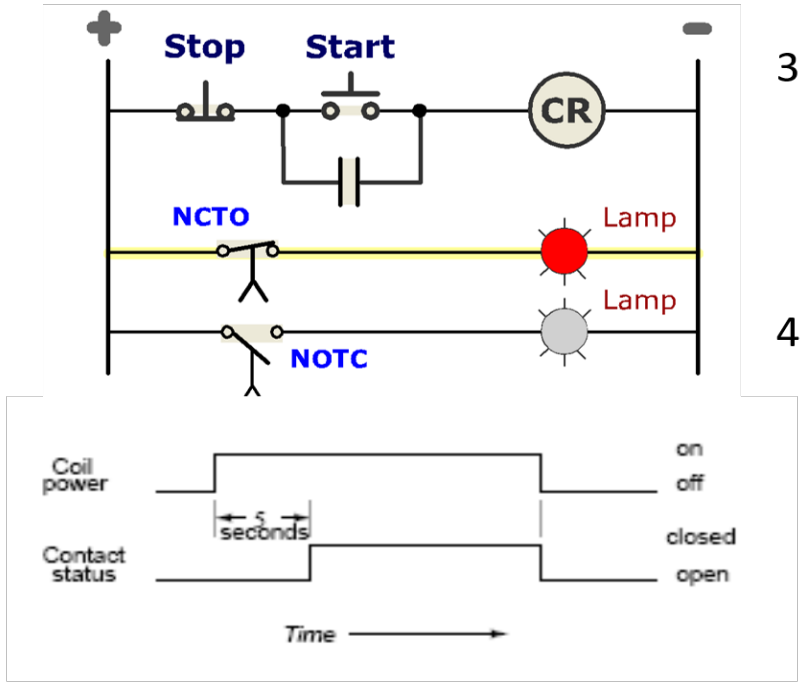
ON Delay - NOTC



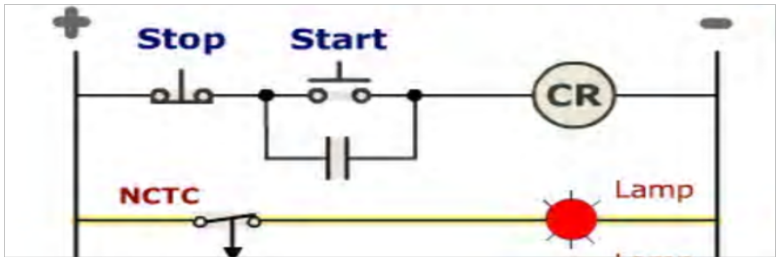
3. Counter finishes count
   - Coil stays energized
   - Timer contacts close
   - Lamp goes on

4. Timer contacts will open when relay coil is de-energized.

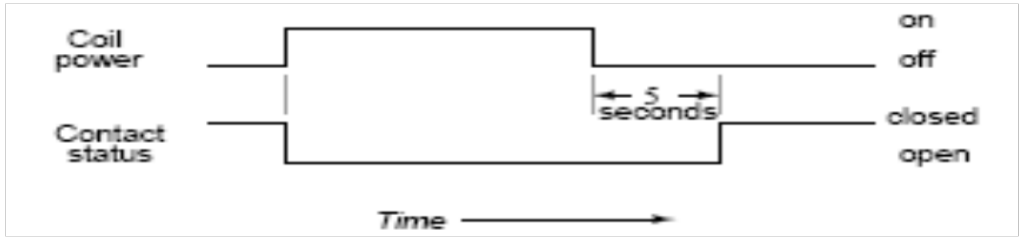
The Normally Open contact will take 5 seconds To Close when the coil is energized.

Figure: 17. ON delay timers

OFF Delay - NCTC



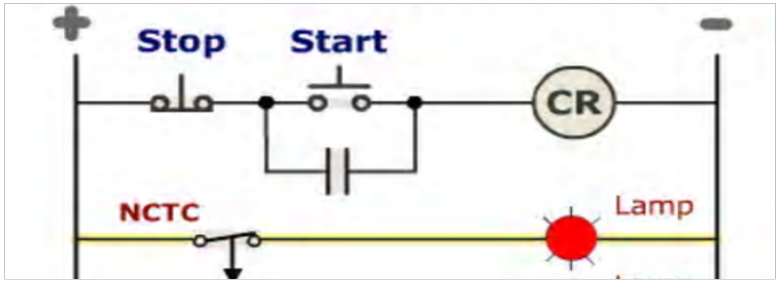
1. Power is applied to rails
2. Coil is off, contacts are closed, lamp is on



The timer contacts will close 5 seconds after the coil is *de-energized*

Figure: 18. OFF delay timers

OFF Delay - NCTC



3. Start PB is pressed
4. Timer contacts open
5. Counter will start to count only when coil is de-energized.

Figure: 19. OFF delay timers

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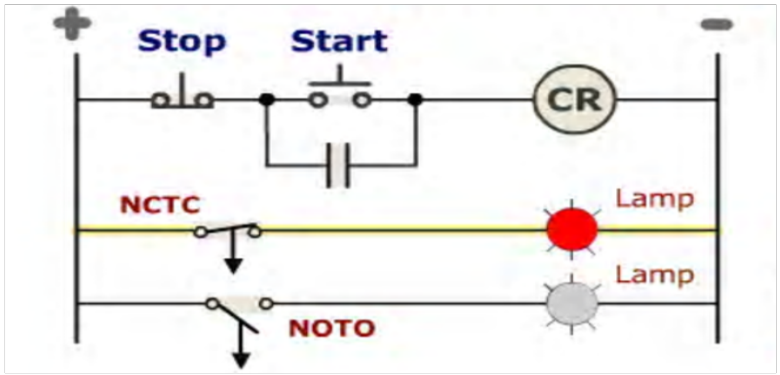
OFF Delay - NOTO



1. Power is applied to rails
2. Coil is off, contacts are closed, lamp is on

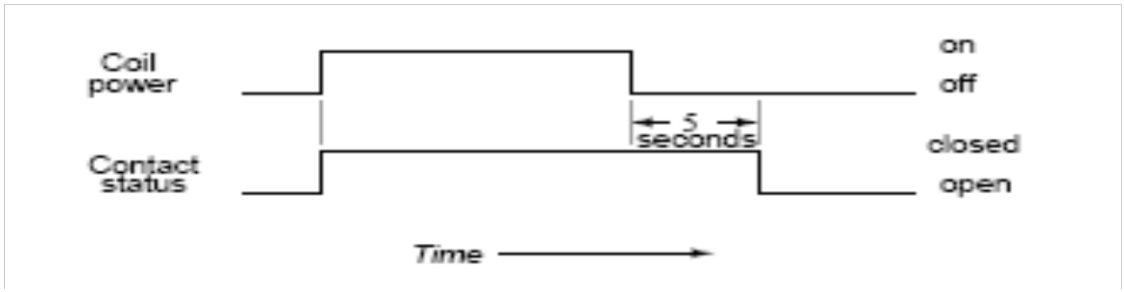


Figure: 20. OFF delay timers

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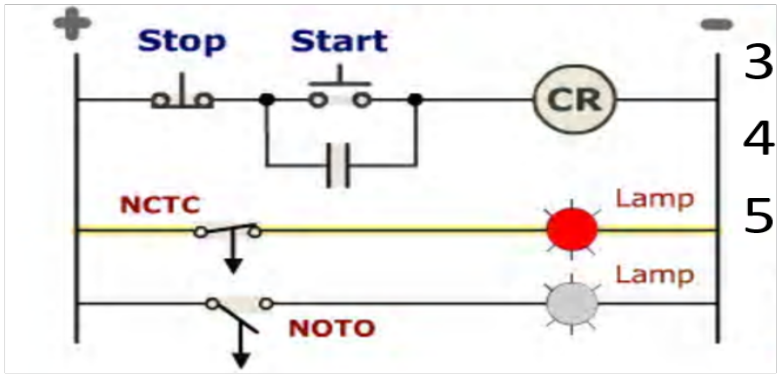
OFF Delay - NOTO



3. Start is pressed.
4. Contacts close, lamp on
5. Counter only starts when coil is de-energize

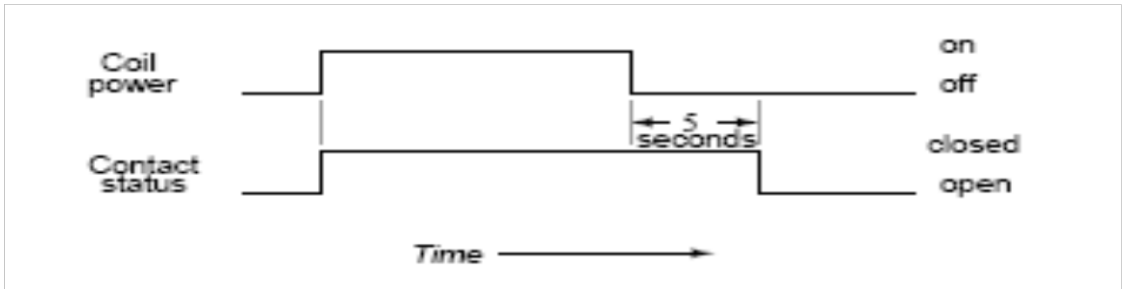


Figure: 21. OFF delay timers

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END

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