



# **ELECTRO MECHANICAL EQUIPMENT OPERATION AND MAINTENANCE**

**NTQF Level III**

## **Learning Guide #30**

**Unit of Competence: Install Electro Mechanical  
Machine and drives**

**Module Title: Installing Electro Mechanical  
Machine and drives**

**LG Code: EIS EME3 M03 L01-30**

**TTLM Code: EIS EME3 TTLM 0219v1**

### **LO 1: Plan and prepare for Installation**

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## Instruction Sheet

## Learning Guide 30

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- Reading and interpreting Work instructions
- Tools and testing devices of electro mechanical installation
- Installation Materials

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- Work instructions are read and interpreted to determine job requirements.
- Tools and testing devices needed to carry out the installation work are selected in accordance with established procedures and checked for correct operation and safety.
- Materials necessary to complete the work are obtained in accordance with job requirements.

### Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described in number 3 to 15.
3. Read the information written in the “Information Sheets 1”. Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
4. Accomplish the “Self-check 1” in page 7.
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 1).
6. If you earned a satisfactory evaluation proceed to “Information Sheet 2”. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity #1.

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7. Submit your accomplished Self-check. This will form part of your training portfolio.
8. Read the information written in the “Information Sheet 2”. Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
9. Accomplish the “Self-check 2” in page .
10. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check 2).
11. Read the information written in the “Information Sheets 3 . Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
12. Accomplish the “Self-check 3” in page .
13. Do the “LAP test” in page \_\_ (if you are ready). Request your teacher to evaluate your performance and outputs. Your teacher will give you feedback and the evaluation will be either satisfactory or unsatisfactory. If unsatisfactory, your teacher shall advice you on additional work. But if satisfactory you can proceed to Learning Guide #31.

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## Introduction

Work instruction is the most detailed description of a task. It's sole purpose is to explain step by step how to do a specific task. A work instruction is a tool provided to help someone to do a job correctly. This simple statement implies that the purpose of the work instruction is quality and that the target user is the worker. Unfortunately, in many workplaces, today's work instructions have little connection with this fundamental focus. Factories have encumbered work instructions with content that has been added to satisfy auditors, lawyers, engineers, accountants and yes, even quality managers. We've piled on so much extraneous material that we've lost sight of the intended purpose of work instructions.

### 1.1 Instructions

New products must be accompanied by information, most often in the form of an Instruction Manual. All product safety Directives require information to be made available to end users to enable the safe use of products. Others, such as installers, may also need information to enable the product to be safely installed before use. User instructions should be comprehensive, easy to understand, and in the user's own language (except certain parts for specialist maintenance activity where this will not be undertaken by the user). Other information provided on the product such as warnings, which may be given in pictorial form, should be explained in the user instructions. User instructions essential for safety should normally be provided in a printed form.

#### 1.1.1 Instructions cover

This depends on the relevant product safety Directive, but can be summarized as sufficient detail about the product regarding:

- intended use, and ways the product should not be used
- the manner of installation

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- correct use to ensure health and safety, and
- safe maintenance, including cleaning

Instructions should cover not only intended use of a product, but take account of reasonably foreseeable misuse, warning of ways the product should not be used. Where the product is intended to be used by non-professionals instructions should be worded and laid out taking account of the level of general education and understanding that can be expected of such users.

In the case of partly completed machinery assembly instructions must be provided instead. Assembly instructions must contain a description of the conditions which must be met with a view to the correct incorporation of the partly completed machinery into the final machinery, so as not to compromise safety and health.

### 1.1.2. Language of instruction

Instructions, and warnings given on products must be in the official Community language or languages of the European state(s) in which the product is placed on the market and put into service. This may require dedicated language versions for each member state the product is marketed in, or, as is often seen, multi-language instructions / warnings including all languages of all the members states the product is placed on the market. Where pictorial warnings are given on the product these, along with the meanings of any warning devices, should be explained in the Instruction Manual.

A copy of the original Instruction Manual should be included as part of the technical file for a product, along with any translations made into other Community languages.

### 1.1.3 Instructions for employee

It is the employer's responsibility to instruct you in how to use machinery and equipment safely. Always use machinery and equipment and their safety and protective features in accordance with the employer's instructions.

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Ensure that you are aware of the hazards present in your workplace and all the risk factors due to equipment in your work environment, regardless of whether you actually use that equipment yourself. Follow all instructions given and take all due care and diligence in using equipment.

Immediately inform the employer of any defects or shortcomings in machinery or equipment that could cause harm or a hazard to your safety or health or that of any other employee. If you do not know what to do or have not been instructed, ask the employer.

### 1.1.4 Operating Instructions

The manufacturer of a machine is responsible for ensuring that operating instructions and any other instructions are supplied with the machine. The manufacturer of a used machine must also supply its operating instructions to the user.

Requirements concerning the content of operating instructions for machines may be found for instance in the appendix to the Machinery Decree. Operating instructions must include for instance the following items:

- instructions on how to introduce and use the machine and, if necessary, how to train its operators
- information on any personal protective equipment required
- information on maintenance measures to be performed by the user
- instructions for installing, assembling and disassembling the machine.

### 1.1.5 Instruction for minimization and elimination of risks

If, in the investigation and assessment of the hazards caused by a machine, it is found that using the machine creates a hazard or causes harm to any employee, the employer must take immediate action to eliminate the hazard or harmful impact.

A three-step procedure and hierarchy should be employed in eliminating or minimizing risks:

1. Eliminate risks through safety planning and structural means.
2. If risks cannot be eliminated or sufficiently minimized through safety planning and structural means, introduce protective technology.

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3. Other safety measures such as instructions, warnings, training and personal protective equipment should only be introduced if the risks cannot be eliminated.

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|                     |                     |
|---------------------|---------------------|
| <b>Self-Check 1</b> | <b>Written Test</b> |
|---------------------|---------------------|

Name: \_\_\_\_\_

Date: \_\_\_\_\_

*Directions:* Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. What is work instruction? (2 point)
2. what is the tips cover in work instruction? (2 point)
3. who can develop the work instruction? (2 point)
4. how can minimize or eliminate the risk of work?(2 point)
5. What to be the language of instruction? (2 point)

**Note: Satisfactory rating - 10 points**

**Unsatisfactory - below 10 points**

**Answer Sheet**

Score = \_\_\_\_\_

Rating: \_\_\_\_\_

Name: \_\_\_\_\_

Date: \_\_\_\_\_

**Short Answer Questions**

1. \_\_\_\_\_  
\_\_\_\_\_
2. \_\_\_\_\_  
\_\_\_\_\_
3. \_\_\_\_\_  
\_\_\_\_\_
4. \_\_\_\_\_  
\_\_\_\_\_
5. \_\_\_\_\_  
\_\_\_\_\_



## Information Sheet 2

## Tools and testing devices of installation work

### Introduction

Installation work can't be done without the right tools. As basic tools have been improved over the years and new specialized tools are developed, the list of tool choices for electricians and all other technicians becomes even longer.

### 2.1 Tools for Installation Work

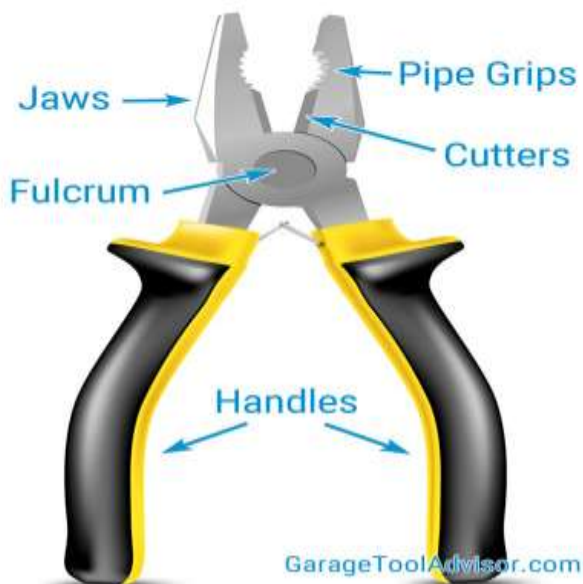
#### 2.1.1 pliers

When you need to grip, position, twist, cut, tighten or loosen various things, pliers can cover a pretty broad range of applications. Because of their general design – consisting of two handles, a pivot, and a head – there are many different types of pliers tailor-made for particular applications.

#### I. Parts of Pliers

There are only a few parts to pliers, but all of them have an important function. In a few cases, the parts may vary to complete a specific function.

**Cutters** – These surfaces are generally located close to the fulcrum and are used for cutting wire and cables.



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**Fulcrum (or Pivot Point)** – Not only is this the place where the handles and jaws connect, it also serves to create enough force for the jaws to perform their duty.

**Handles** – The part you hold. These can be straight or curved, and the surface will either be bare metal or plastic coated.

**Jaws (or Nose)** – The working end of pliers are used primarily for gripping. Combination pliers have jaws which also contain cutters and/or pipe grips.

figure 2.1 parts of plier

**Pipe Grips** – A rounded opening in the jaws, pipe grips are designed to do what the name implies, and are very useful for gripping round objects.

## II. Types of plier

### ❖ Linesman Pliers



figure 2.2 lineman Plier

While the name might not seem familiar, chances are you've seen or used these at some point. Easily identified by the jaws, which have a shorter gripping

surface towards the tip and a cutting surface in the middle, this is a highly versatile tool used most often in electrical work. Due to the multi-tool function and strength of the jaws, this tool can be used to bend, twist, and cut metal that might be too tough for other pliers. In some cases, the insulated handles are capable of protecting the user from electrical shocks, although most models are not rated against shock.

### ❖ Combination Pliers

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figure 2.3 combination plier

These multipurpose tools have three separate sections in the jaws. From the tip, the first part is a serrated gripping surface. A round serrated section behind this makes gripping tubes and other thick round objects easier. Finally, the section closest to the fulcrum contains a cutting surface. Often mistaken for linesman pliers, the latter lacks a rounded center section in the jaws.

#### ❖ Slip Joint Pliers



figure 2.4 Slip Joint Pliers

Closely related to the adjustable wrench, these pliers have an adjustable fulcrum to alter the width of the jaws. Many variants have notches for the fulcrum's bolt to slip into when the jaws are open, letting you lock on a specific width. They are often used for plumbing applications and can perform many of the same duties as wrenches.

### III. Safety Measures When Using Pliers

Below are some general safety rules that apply to pliers, regardless of style:

- choose the appropriate pliers for the application. Take the time to educate yourself on the different pliers and their features, such as cutting capacity, the types of wires a plier is able to cut, etc. Failing to do so can result in premature wearing of the tool, jaw damage, inability to perform the job, and even personal injury.
- check pliers wire cutting capacities and capabilities before selecting a particular model for the job; failing to do so can result in premature wearing of the cutting jaws, and the inability to perform the task.

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- pliers with insulated handles should always be used when working near live wires. Non - insulated handles can easily be confused with insulated ones. A plier with insulated handles features the double triangle symbol or the VDE logo. For more on insulated tools read here.
- always cut at right angles for a clean, effective cut. Avoid bending the wire back and forth; instead, use a bigger size or a model with a bigger cutting capacity.
- wear safety glasses when you operate pliers as pieces of material fly unexpectedly.
- use the appropriate size pliers for your hand and personal comfort. Using smaller pliers can result in pinched hands and fingers, while a size too big can lead to the tool being dropped or an inability to operate it efficiently.
- do not use pliers as a hammer or hammer on the pliers handles to cut thicker wires or bolts.
- clean and maintain your pliers regularly; cleaning the jaws and adding a drop of oil on the rivet will ensure years of dependable use.
- do not use pliers for tightening or breaking nuts loose; use a wrench instead to avoid damage to the nut.
- do not expose pliers to excessive heat, as the tool's properties might change.
- always inspect the condition of the plier before using; always use tools that are in safe working order.
- if the plier is damaged, stop using it and invest in a new set of pliers

## 2.1.2 Screwdrivers

The screwdriver has been considered as the one of the greatest invention among tool.. If you ever visited a tool shop, you must have seen hundreds of screwdriver of different styles, shape, size or anything else. Screwdriver is entirely depending on the screw drive type or recess type.

### I. Types of screwdriver

There are many types of screwdrivers according to the design of the screw head drive or recess type, but in this article we are going to discuss some common types of screwdriver which are mostly used in every project.

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figure 2.5 different types of screwdrivers

❖ **Flat Head (or Slotted Head) Screwdriver**



figure 2.6 flat head screwdriver

It is one of the oldest types of screwdriver. It was invented in the 15th

century in Europe and one of the most common types of screwdrivers. As the name suggest it has a flat shape shaft tip with a single slot which engages with the slotted screw head only. It can be manual driven or power driven, but not often power driven because slotted head has 'cam- out effect'. Now what does it mean? Well 'cam-out effect' is a process by which the screwdriver tends to slips off from the surface of the screw head, when the torque applied on the surface of the screw exceeds a certain limit or sometimes due to lack of centering, which usually causes the damage to the screw head or screwdriver tip.

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❖ **Phillips Screwdriver**



figure 2.7 Phillips head screw driver

As today's world is moving from a manual driven to power or motor driven,

❖ **Pozidriv Screwdriver**



figure 2.8 pozidriv screwdriver

❖ **Robertson or Square Screwdriver**

these were the first step towards power driven screwdrivers to save time and do things more precisely and accurately. These were invented in 19th century by Henry Phillips with an aim to introduce the power driven screwdrivers in most of the industries. When you see these screwdrivers from the front, the tip looks like a cross sign. These types of screwdrivers also shows cam- out effect but it does purposely when the torque exceeds a limit while tightening up of screw which resist the damage of screwdriver profile and screw and clearly extends the life of the tool.

The pozidriv screwdriver, unlike Phillips screwdriver, has two cross sign which are offset at 45 degree angles. These are designed and widely used in Europe. This shape doesn't completely overcome the cam-out effect but provide better resistance to slipping and offer more stability than Phillip profile, therefore used for the applications which require high torque for tightening of screw.

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figure 2.9 Robertson or square screwdriver

The square screwdriver also known as Robertson screwdriver, named after a Canadian inventor. The engagement of

quite tapered square shape opening screw with the square protrusion, with no angle involved, neglects the cam-out effect, thus improve centering. Slight Taper shape at the front of the tool provides a good locking with the screw and thus makes it more comfortable for use. These screwdrivers types were first used for industrial purpose by ford motor company, because these drivers speed up the production, reduce damages, and highly reliable.

#### ❖ Torx Screwdriver



figure 2.10 trox screwdriver

Torx screwdriver is becoming very common and often used by automotive technicians. Many times they are called as star tips by technician. This driver has a star shape tip with 6 rounded lobes. Because of the circular geometry of the lobes there is low radial force in a torx screwdriver, which increases the life of the screw and the screwdriver bit. Unlike Phillips or pozidriv screwdrivers, much higher torque can be transferred with the same amount of force with no chance of tool slipping, even at high driving speed power tools, which makes its more reliable to use.

#### ❖ Hex Screwdriver or Hexagon Screwdriver

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figure 2.11 Hexagon Screwdriver



It has six straight lobes, like hexagon. These are used to fasten often bolts rather than screws. You must have seen these bits in your ratchet box for tightening up or loosening hex bolts, nuts and screws. No slipping or cam-out effect takes place while driving this hence most of the power driver tools can be fitted with hex arrangement bits and thus makes the production fast and with less error.

### 2.1.3 wrenches

Wrenches are available in a variety of styles for a variety of applications. Some are designed to work with standard (SAE) fasteners and some are for metric applications. Look for color coding on some wrenches to help you quickly identify standard or metric.

#### I. types of wrenches

Here are some of the more common wrench types and their uses.

| Type                        | Uses / Features  | Example  |
|-----------------------------|--|--|
| ❖ <b>Adjustable Wrench</b>  | <ul style="list-style-type: none"> <li>• Tightens / loosens nuts and bolts</li> <li>• Moveable lower jaw to adjust wrench size</li> <li>• Works with both standard and metric fasteners</li> </ul> |  <p>figure 2.12 Adjustable Wrenches</p>  |
| ❖ <b>Combination Wrench</b> | <ul style="list-style-type: none"> <li>• Tightens / loosens nuts and bolts</li> <li>• Metric and standard sizes</li> <li>• One open end and one box end (usually the same size)</li> </ul>         |  <p>figure 2.13 Combination Wrenches</p> |



❖ **Open-End Wrench**

- Tightens / loosens nuts and bolts
- Metric and standard sizes
- Two open ends (usually different sizes)
- Jointed or flex-head models let you work at different angles



figure 2.14 Open-End Wrenches

❖ **Ratchet Wrench**

- Tightens / loosens nuts and bolts
- Metric and standard sizes
- Ratchet action on one end moves freely in one direction and engages the fastener in the other direction to tighten or loosen without removing the tool
- Some have pivoting ratchet ends for use in tight spaces



figure 2.15 Ratchet Wrenches & Sets

❖ **Short-Body or Stubby Wrench**

- Tightens / loosens nuts and bolts in tight spaces
- Metric and standard sizes



figure 2.16 Short-Body Wrenches

❖ **Crowfoot Wrench**

- Tightens / loosens bolts
- Standard and metric sizes
- Has no handle
- Operates with a ratchet handle / socket extension combination
- Designed to work in tight spaces



figure 2.17 Crowfoot Wrenches

- ❖ **Pipe Wrench**
  - Turns metal pipes and fittings
  - Moveable upper jaw to adjust wrench size



figure 2.18 Pipe Wrenches

- ❖ **Hex Key / Allen Wrench**
  - Tightens / loosens hex-head screws and bolts
  - Standard and metric sizes
  - Available as separate wrenches or in sets where the wrenches fold up into a handle
  - Available with T-handles for improved leverage



figure 2.19 Hex Keys/Allen wrench set

- ❖ **Strap Wrench**

Tightens, loosens and turns a variety of different size items, such as plumbing fittings, container lids, etc., that don't have flat faces for a standard wrench to grip



figure 2.20 Strap Wrenches

❖ **Wrench and Mechanic's Tool Sets**

- **Wrench sets** collect a variety of sizes in one handy collection
- **Mechanic's tool sets** (image to the right) often provide a variety of wrenches as well as other tools such as pliers and socket / ratchet sets
- Options range from smaller 3-piece wrench sets to mechanic's tool collections with 300+ pieces



figure 2.21 Mechanic's Tool Sets

**2.1.4 Utility Knife**



figure 2.22 utility knife

A utility knife, or box cutter, is handy for cutting sheathing from non-metallic (Romex) power and pump cable, to cut off electrical tape, electric wire and to open cardboard boxes.

**2.1.5 wire stripper**



figure 2.23 wire stripper

Wire strippers are used to cut and strip insulation from electrical wire. They have a variety of holes for stripping different standard sizes of wire and include cutting teeth for trimming the wire ends.

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## 2.2 Testing Devices for installation work

Installation testing may look for errors that occur in the installation process that affect the user's perception and capability to use the installed software. There are many events that may affect the software installation and installation testing may test for proper installation whilst checking for a number of associated activities and events. there are different testing devices for any machine installation works.

### 2.2.1 Multi meter

A **multi meter** is a test tool used to measure two or more electrical values—principally voltage (volts), current (amps) and resistance (ohms). It is a standard diagnostic tool for technicians in the electrical/electronic industries. Multi meters combine the testing capabilities of single-task meters—the voltmeter (for measuring volts), ammeter (amps) and ohmmeter (ohms). Often they include a number of additional specialized features or advanced options. Technicians with specific needs, therefore, can seek out a model targeted for particular tasks.

#### I. Parts of Multi meter



The face of a multi meter typically includes four components:

- Display: Where measurement readouts can be viewed.
- Buttons: For selecting various functions; the options vary by model.
- Dial (or rotary switch): For selecting primary measurement values (volts, amps, ohms).
- Input jacks: Where test leads are inserted.

figure 2.24 components of multi meter

#### II. Safety

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Each application with a digital multi meter presents potential safety hazards that must be considered when taking electrical measurements. Before using any electrical test equipment, people should always first refer to the user's manual for proper operating procedures, safety precautions, and limits.

## 2.2.2 Mega-Ohmmeter

Mega ohmmeter or megger is a special type of ohmmeter used to measure the electrical resistance of insulators. Insulating components, for example cable jackets, must be tested for their insulation strength at the time of commissioning and as part of maintenance of high voltage electrical equipment and installations. For this purpose meg ohmmeters, which can provide high DC voltages (typically in ranges from 500 V to 5 kV, some are up to 15 kV) at specified current capacity, are used. Acceptable insulator resistance values are typically 1 to 10 megaohms, depending on the standards referenced.



figure 2.26 mega ohmmeter or megger

### HOW IT WORKS

The megger sends voltage through the cable to calculate the amount of current flowing through the circuit, for an accurate indication of insulation integrity. Higher resistance means good insulation.

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## 2.2.3 Clamp Ammeter

A clamp meter is an electrical test tool that combines a basic digital multi meter with a current sensor. Clamps measure current. Probes measure voltage. Having a hinged jaw integrated into an electrical meter allows technicians to clamp the jaws around a wire, cable or other conductor at any point in an electrical system, then measure current in that circuit without disconnecting it.

Below their plastic moldings, hard jaws consist of ferrite iron and are engineered to detect, concentrate and measure the magnetic field being generated by current as it flows through a conductor.

### I. Parts of Clamp Ammeter



figure 2.27 clamp ammeter parts

1. Current-sensing jaw.
2. Tactile barrier (to protect fingers from shocks).
3. Hold button: Freezes the display reading. Reading is released when button is pushed a second time.
4. Dial (aka rotary switch).

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- 5. Display.
- 6. Backlight button.
- 7. Min Max button: On first push, display shows maximum input. On subsequent pushes, minimum and average inputs are shown. Works in current, voltage and frequency modes.
- 8. Inrush current button.
- 9. Zero button (yellow): Removes dc offset from dc current measurements. Also serves as dial's shift button to select yellow functions scattered around the dial.
- 10. Jaw release lever.
- 11. Alignment marks: To meet accuracy specifications, a conductor must be aligned with these marks.
- 12. Common input jack.
- 13. Volts/ohm input jack.
- 14. Input for flexible current probe.

**Note:** watch video for more understanding  
<https://www.youtube.com/watch?v=HfAz9iVQoiY>

### 2.2.4 Pressure Gage

Pressure measurement is the analysis of an applied force by a fluid (liquid or gas) on a surface. Pressure is typically measured in units of force per unit of surface area. Many techniques have been developed for the measurement of pressure and vacuum. Instruments used to measure and display pressure in an integral unit are called pressure gauges or vacuum gauges. A manometer (not to be confused with nanometer) is a good example, as it uses a column of liquid to both measure and indicate pressure. Likewise the widely used Bourdon gauge is a mechanical device, which both measures and indicates and is probably the best known type of gauge.

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figure 2.28(a) Bourdon pressure gauge      figure 2.28(b) reading **psi**(red scale) and **kPa** (black scale)

Most gauges measure pressure relative to atmospheric pressure as the zero point, so this form of reading is simply referred to as "gauge pressure". However, anything greater than total vacuum is technically a form of pressure. For very accurate readings, especially at very low pressures, a gauge that uses total vacuum as the zero point may be used, giving pressure readings in an absolute scale.

Pressure is measured in three ways—absolute, gauge and vacuum.

- **Absolute pressure** is a measure of actual pressure including ambient air, which is zero-referenced with a perfect vacuum, but can be as high as 14.7 psi at sea level. Absolute pressure readings are considered in applications interacting with ambient air, such as the compression ratio calculation for flow (cfm) requirements.
- **Gauge pressure** is zero-referenced against ambient pressure and is used in most applications operating in, but not with, ambient air, such as in fluid power systems. Disconnected from equipment, gauge pressure will read zero.

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- **vacuum “pressure”** is referenced against ambient pressure, as with “in.-Hg” (inches of mercury) units, which measures pressure below ambient. A vacuum gauge is a pressure gauge used to measure pressures lower than the ambient atmospheric pressure, which is set as the zero point, in negative values (e.g.: –15 psig or –760 mmHg equals total vacuum).

### 2.2.5 Industrial Thermometer

Industrial Thermometers is designed for installation in pipes, vessels, plant and machinery. Sheath and case are made of stainless steel. To allow fitting to the process, different installation lengths and process connections are available. Through the high protection class of the industrial thermometer (IP65) and its liquid damping, operation under high vibration conditions is possible. The imperial nominal sizes are commonly used.



figure 2.29(a) Threaded thermo well (b) Screw-in thermo well (c)weld-in or with flange

### 2.2.6 Frequency Meter

A **frequency meter** is an instrument that displays the frequency of a periodic electrical signals. Various types of frequency meters are used. Many are instruments of the deflection type, ordinarily used for measuring low frequencies but capable of being used for frequencies as high as 900 Hz. These operate by balancing two opposing forces. Changes in the frequency to be measured cause a change in this balance that can be

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measured by the deflection of a pointer on a scale. Deflection-type meters are of two types, electrically resonant circuits and ratio meters.



figure 2.30 frequency meter

An example of a simple electrically resonant circuit is a moving coil meter. In one version, this device has two coils tuned to different frequencies and connected at right angles to one another in such a way that the whole element, with attached pointer, can move. Frequencies in the middle of the meter’s range cause the currents in the two coils to be approximately equal and the pointer to indicate the midpoint of a scale. Changes in frequency cause an imbalance in the currents in the two coils, causing them, and the pointer, to move.

### 2.2.7 Flow Meter

A **flow meter** is an instrument used to measure linear, nonlinear, mass or volumetric flow rate of a liquid or a gas. When choosing flow meters, one should consider such intangible factors as familiarity of plant personnel, their experience with calibration and maintenance, spare parts availability, and mean time between failure history, etc., at the particular plant site. It is also recommended that the cost of the installation be computed only after taking these steps. One of the most common flow measurement mistakes is

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the reversal of this sequence: instead of selecting a sensor which will perform properly, an attempt is made to justify the use of a device because it is less expensive. Those "inexpensive" purchases can be the most costly installations.

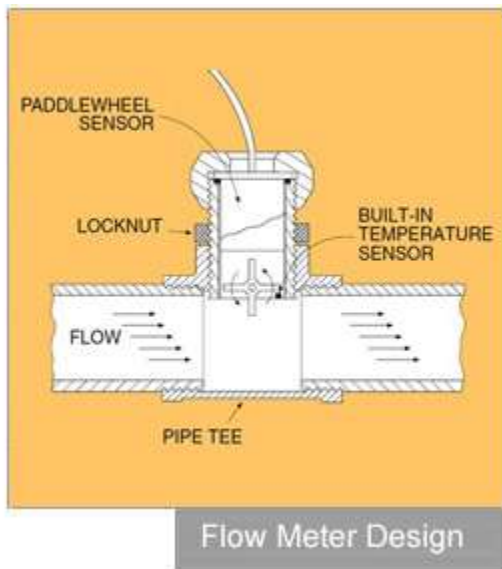


figure 2.31 flow meter design

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|                     |                     |
|---------------------|---------------------|
| <b>Self-Check 2</b> | <b>Written Test</b> |
|---------------------|---------------------|

Name: \_\_\_\_\_

Date: \_\_\_\_\_

Direction I: Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.

1. what are the most important things to do installation work?
2. what are the tasks perform with pliers? list down some types of plier.
3. write the most important tools for installation work.
4. what is the use of screwdriver? list down some types of screwdriver.
5. what are the devices that use to check the installed process?
6. write down some types of wrenches and their use.
7. which testing device is use to measure volt, current, resistance and continuity?

Direction II: match column A to B

A

1. measure pressure
2. measure volt, current and other
3. display, buttons, dial & input jacks
4. collect variety of size in one box
5. multipurpose tools

B

- A. tool box
- B. combination pliers
- C. pressure gages
- D. multi meter
- E. components of multi meter

**Note: Satisfactory rating - 10 points**

**Unsatisfactory - below 10 points**

**Answer Sheet**

Score = \_\_\_\_\_

Rating: \_\_\_\_\_

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Name: \_\_\_\_\_

Date: \_\_\_\_\_

### Short Answer Questions

1. \_\_\_\_\_  
\_\_\_\_\_
2. \_\_\_\_\_  
\_\_\_\_\_
3. \_\_\_\_\_  
\_\_\_\_\_
4. \_\_\_\_\_  
\_\_\_\_\_
5. \_\_\_\_\_  
\_\_\_\_\_
6. \_\_\_\_\_  
\_\_\_\_\_
7. \_\_\_\_\_  
\_\_\_\_\_

### Matching Questions

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_

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**Introduction**

Installation is the process of making hardware and/or software ready for use. Obviously, different systems require different types of installations and installation materials. While certain installations are simple and straightforward and can be performed by non-professionals, others are more complex and time-consuming and may require the involvement of specialists.

Machine installation is a key parts if putting the machine in to service if the installation is carried out carefully using the correct materials and procedures, it is an investment in the machine serviceability and reliability for its entire service life. installing a new machine or equipment whether is a new site or an existing workplace can be challenging. to make the installation process as easy as possible and save time, money and decreasing the downtime use the appropriate installation materials described or recommended on the manufacturer manuals or instructions.

**3.1 wires and cables**

Wire and cable are used to describe the same thing, but they are actually quite different. Wire is a single electrical conductor, whereas a cable is a group of wires swathed in sheathing. The term cable originally referred to a nautical line of multiple ropes used to anchor ships, and in an electrical context, cables (like wires) are used to carry electrical currents. Whether indoors or outdoors, proper wire and cable installation is of paramount importance - ensuring a smooth electricity supply, as well as passing electrical inspections. Each wire and cable needs to be installed carefully, from the fuse box to the outlets, fixtures and appliances.

**3.1.1 wires**

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A wire is a single conductor(material most commonly being copper or aluminium) while cable is two or more insulated wires wrapped in one jacket. Multiple conductors that have no insulation around would be classified as a single conductor. Some factors that will affect your choice of electrical wiring include color, label information and applications. The information printed on the wire covering is all that you need to choose the correct wire for your home. Here’s some detailed information on the various features of electrical wire, which will help you choose the correct composition:



figure 3.1 example of wire

**1. Size of Wires** – Each application requires a certain wire size for installation, and the right size for a specific application is determined by the wire gauge. Sizing of wire is done by the American wire gauge system. Common wire sizes are 10, 12 and 14 – a higher number means a smaller wire size, and affects the amount of power it can carry. For example, a low-voltage lamp cord with 10 Amps will require 18-gauge wire, while service panels or subpanels with 100 Amps will require 2-gauge wire..

**2. Wire Lettering** – The letters THHN, THWN, THW and XHHN represent the main insulation types of individual wires. These letters depict the following NEC requirements:.

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- T – Thermoplastic insulation
- H – Heat resistance
- HH – High heat resistance (up to 194°F)
- W – Suitable for wet locations
- N – Nylon coating, resistant to damage by oil or gas
- X – Synthetic polymer that is flame-resistant

### 3. Types of Wires – There are mainly 5 types of wire: .

- **Triplex Wires** : Triplex wires are usually used in single-phase service drop conductors, between the power pole and weather heads. They are composed of two insulated aluminum wires wrapped with a third bare wire which is used as a common neutral. The neutral is usually of a smaller gauge and grounded at both the electric meter and the transformer.
- **Main Feeder Wires** : Main power feeder wires are the wires that connect the service weather head to the house. They're made with stranded or solid THHN wire and the cable installed is 25% more than the load required.
- **Panel Feed Wires** : Panel feed cables are generally black insulated THHN wire. These are used to power the main junction box and the circuit breaker panels. Just like main power feeder wires, the cables should be rated for 25% more than the actual load.
- **Non-Metallic Sheathed Wires** : Non-metallic sheath wire, or Romex, is used in most homes and has 2-3 conductors, each with plastic insulation, and a bare ground wire. The individual wires are covered with another layer of non-metallic sheathing. Since it's relatively cheaper and available in ratings for 15, 20 and 20 amps, this type is preferred for in-house wiring.

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- **Single Strand Wires** : Single strand wire also uses THHN wire, though there are other variants. Each wire is separate and multiple wires can be drawn together through a pipe easily. Single strand wires are the most popular choice for layouts that use pipes to contain wires.

#### 4. Color Codes – Different color wires serve different purposes, like:.

- **Black** : Hot wire, for switches or outlets.
- **Red** : Hot wire, for switch legs. Also for connecting wire between 2 hardwired smoke detectors.
- **Blue and Yellow** : Hot wires, pulled in conduit. Blue for 3-4 way switch application, and yellow for switch legs to control fan, lights etc.
- **White** : Always neutral.
- **Green and Bare Copper** : Only for grounding.

**5. Wire Gauge, Ampacity and Wattage Load** – To determine the correct wire, it is important to understand what ampacity and wattage a wire can carry per gauge. Wire gauge is the size of the wire, ampacity is how much electricity can flow through the wire and wattage is the load a wire can take, which is always mentioned on the appliances..

#### 3.1.2 Cables

An electrical cable also has different types, color and application as its determining factors. Here's a brief about cables that you need to understand to determine the correct cable for your home.

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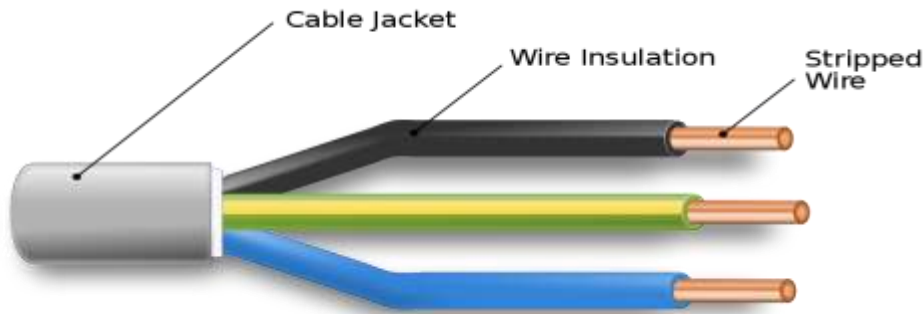


figure 3.2 Example of cable

**1. Types of Electrical Cables** – There are more than 20 different types of cables available today, designed for applications ranging from transmission to heavy industrial use. Some of the most commonly-used ones include:.

- **Non-Metallic Sheathed Cable** : These cables are also known as non-metallic building wire or NM cables. They feature a flexible plastic jacket with two to four wires (TECK cables are covered with thermoplastic insulation) and a bare wire for grounding. Special varieties of this cable are used for underground or outdoor use, but NM-B and NM-C non-metallic sheathed cables are the most common form of indoor residential cabling.
- **Underground Feeder Cable** : These cables are quite similar to NM cables, but instead of each wire being individually wrapped in thermoplastic, wires are grouped together and embedded in the flexible material. Available in a variety of gauge sizes, UF cables are often used for outdoor lighting and in-ground applications. Their high water-resistance makes them ideal for damp areas like gardens as well as open-to-air lamps, pumps, etc.

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- **Metallic Sheathed Cable** : Also known as armored or BX cables, metal-sheathed cables are often used to supply mains electricity or for large appliances. They feature three plain stranded copper wires (one wire for the current, one grounding wire and one neutral wire) that are insulated with cross-linked polyethylene, PVC bedding and a black PVC sheathing. BX cables with steel wire sheathing are often used for outdoor applications and high-stress installations.
- **Multi-Conductor Cable** : This is a cable type that is commonly used in homes, since it is simple to use and well-insulated. Multi-conductor or multi-core (MC) cables feature more than one conductor, each of which is insulated individually. In addition, an outer insulation layer is added for extra security. Different varieties are used in industries, like the audio multicore ‘snake cable’ used in the music industry.
- **Coaxial Cable** : A coaxial (sometimes heliax) cable features a tubular insulating layer that protects an inner conductor which is further surrounded by a tubular conducting shield, and might also feature an outer sheath for extra insulation. Called ‘coaxial’ since the two inner shields share the same geometric axis, these cables are normally used for carrying television signals and connecting video equipment.
- **Unshielded Twisted Pair Cable** : Like the name suggests, this type consists of two wires that are twisted together. The individual wires are not insulated, which makes this cable perfect for signal transmission and video applications. Since they are more affordable than coaxial or optical fiber cables, UTP cables are often used in telephones, security cameras and data networks. For indoor use, UTP cables with copper wires or solid copper cores are a popular choice, since they are flexible and can be easily bent for in-wall installation.

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- **Ribbon Cable** : Ribbon cables are often used in computers and peripherals, with various conducting wires that run parallel to each other on a flat plane, leading to a visual resemblance to flat ribbons. These cables are quite flexible and can only handle low voltage applications.
- **Direct-Buried Cable** : Also known as DBCs, these cables are specially-designed coaxial or bundled fiber-optic cables, which do not require any added sheathing, insulation or piping before being buried underground. They feature a heavy metal core with many layers of banded metal sheathing, heavy rubber coverings, shock-absorbing gel and waterproof wrapped thread-fortified tape. High tolerance to temperature changes, moisture and other environmental factors makes them a popular choice for transmission or communication requirements.
- **Twin-Lead Cable** : These are flat two-wire cables that are used for transmission between an antenna and receiver, like TV and radio.
- **Twin axial Cable** : This is a variant of coaxial cables, which features two inner conductors instead of one and is used for very-short-range high-speed signals.
- **Paired Cable** : With two individually insulated conductors, this cable is normally used in DC or low-frequency AC applications.
- **Twisted Pair** : This cable is similar to paired cables, but the inner insulated wires are twisted or intertwined.

**2. Cable Color Code** – Color coding of cable insulation is done to determine active, neutral and earth conductors. The NEC has not prescribed any color for phase/active conductors. Different countries/regions have different cable color coding, and it is essential to know what is applicable in your region. However, active conductors cannot be green/yellow, green, yellow, light blue or black..

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**Cable Size** – Cable size is the gauge of individual wires within the cable, such as 14, 12, 10 etc. – again, the bigger the number, the smaller the size. The number of wires follows the wire-gauge on a cable. So, 10/3 would indicate the presence of 3 wires of 10-gauge within the cable. Ground wire, if present, is not indicated by this number, and is represented by the letter ‘G’.

Safety is very important, and if your installation of wires and cables is not proper, it could lead to accidents. Before you start any electrical project that includes wiring and cabling, you need to obtain permission from your local building inspector. Once the job is done, get the installation inspected for compliance with local codes and regulations.

### 3.2 Coils

Coil, in an electric circuit, one or more turns, usually roughly circular or cylindrical, of current-carrying wire designed to produce a magnetic field or to provide electrical resistance or inductance; in the latter case, a coil is also called a choke coil. A soft iron core placed within a coil produces an electromagnet. A cylindrical coil that moves a plunger within it by variations in the current through the coil is known as a solenoid.



figure 3.3 example of coil

Solenoid, a uniformly wound coil of wire in the form of a cylinder having a length much greater than its diameter. Passage of direct electric current through the wire creates

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a magnetic field that draws a core or plunger, usually of iron, into the solenoid; the motion of the plunger often is used to actuate switches, relays, or other devices.

### 3.2.1 Types of Coil

- Coil spring, used to store energy, absorb shock, or maintain a force between two surfaces
- Electromagnetic coil, formed when a conductor is wound around a core or form to create an inductor or electromagnet
- Ignition coil, an electromagnetic induction coil used in internal combustion engines to create a pulse of high voltage for a spark plug
- Coil is a popular name of an inductor
- Intrauterine device or coil, a contraceptive device

### 3.3 Teflon sealant (thread seal tape)

Thread seal tape (also known as Teflon tape, or plumber's tape) is a film tape commonly used in plumbing for sealing pipe threads. The tape is sold cut to specific widths and wound on a spool, making it easy to wind around pipe threads. Thread seal tape lubricates allowing for a deeper seating of the threads, and it helps prevent the threads from seizing when being unscrewed.<sup>[1]</sup> The tape also works as a deformable filler and thread lubricant, helping to seal the joint without hardening or making it more difficult to tighten,<sup>[2]</sup> and instead making it easier to tighten. Typically the tape is wrapped around a pipe's thread three times before it is screwed into place. It is commonly used commercially in applications including pressurized water systems, central heating systems, and air compression equipment. Thread seal tape used in plumbing applications is most commonly white, but it is also available in various colors..

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figure 3.4(a) example of teflon    figure 3.4(b) example in the direction of implementation

- White: used on threads up to 3/8 inch
- Yellow: used on threads 1/2 inch to 2 inch, often labeled "gas tape"
- Pink: used on threads 1/2 inch to 2 inch, safe for potable water
- Green: oil-free Teflon used on oxygen lines and some specific medical gasses
- Gray: contains nickel, anti-seizing, anti-galling and anti-corrosion, used for stainless pipes
- Copper: contains copper granules and is certified as a thread lubricant but not a sealer

### 3.4 Terminal Lugs

Terminal Lug is a device attached to a conductor to permit connection to a terminal. A terminal designed to be affixed, usually at one end, to a post, stud, chassis, or the like for mounting. It has provisions for attachment of wires or similar electrical conductors in order to establish an electrical connection and could require the use of tools for attachment of wire.

A terminal may be attached to a wire by a number of methods including screw-on, press-on or crimp-on. Selection is based on two main criteria ; the wire size the barrel is designed to accept and the tongue with will fit a particular stud size. The barrel may be insulated or non-insulated. Normally both insulated or non-insulated should have the wire crimped on, but in some cases the non-insulated lugs may be soldered. There are a number of styles including three and four way. The eyelet may be Ring, Block Spade, Spring Spade, Flanged Spade, or Hook. Some terminal lugs also have two eyelets.

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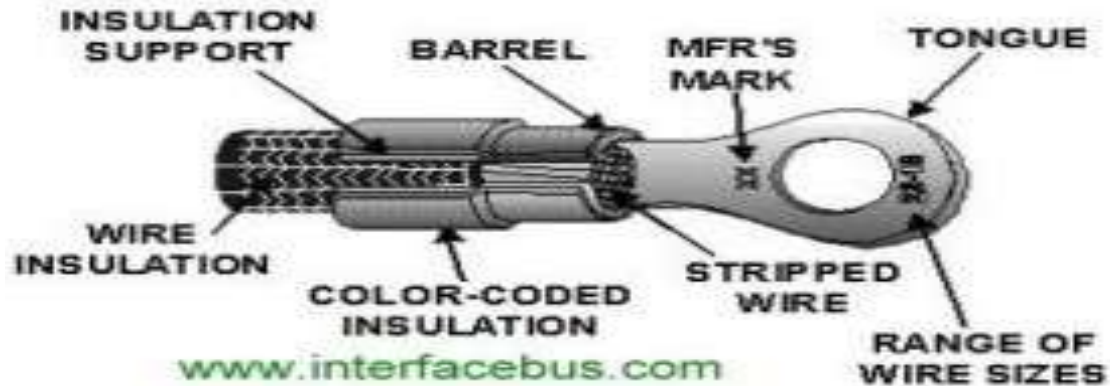


figure 3.5(a)pre insulated Terminal Lug

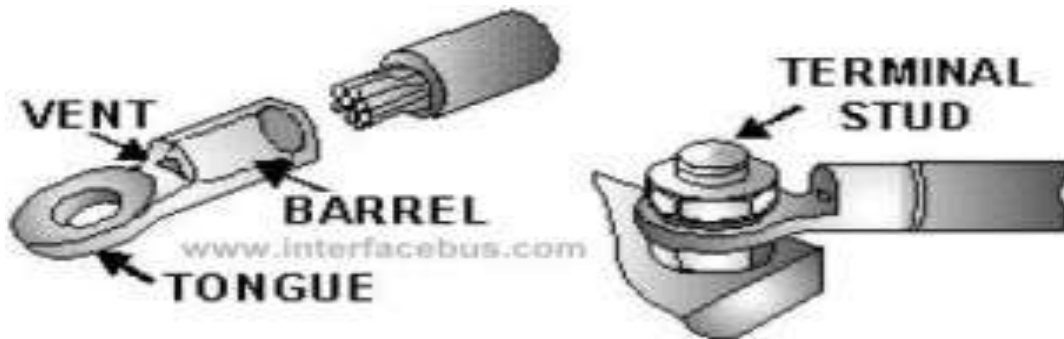


figure 3.5(b)Terminal Lug attached to a Terminal Stud

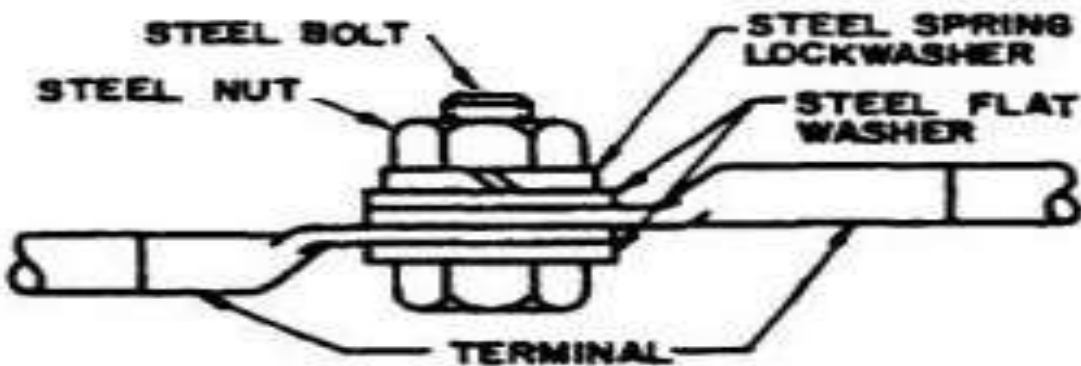


figure3.5(c) Terminal Lug Assembly

There are four main types of terminal lugs;

- Basic Terminal with insulated nylon support sleeve.

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- Basic terminal with permanently attached insulating sleeve.
- Basic terminal bonded with silver brazing alloy.
- Basic terminal with butted seam

### 3.5 Terminal blocks

A terminal block (also called as connection terminal **or** terminal connector) is a modular block with an insulated frame that secures two or more wires together. It consists of a clamping component and a conducting strip. A typical simplest terminal block is as shown in the image below.

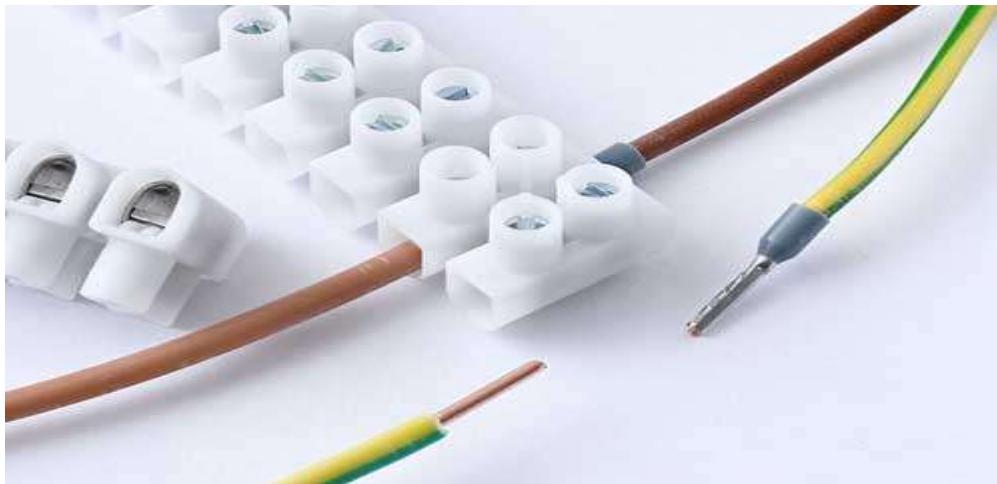


figure 3.7 terminal block

The insulating body of a terminal block houses a current carrying element (a metal strip or terminal bar). It also provides a base for clamping element. The body has a mounting arrangement so that the block can be easily mounted on or unmounted from a PCB or a mounting rail. Most terminal blocks are usually modular and mounted on DIN rail. That allows us to increase the number of terminals according to the requirements. Terminal blocks keep connections much more secure and wires well organized.

#### 3.5.1 Types Of Terminal Blocks

Electrical terminal blocks can be classified on the basis of structure, device type, termination options etc.

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## 1. structure type

- Single level pass-through terminal blocks These are simply used to connect two wires together, i.e. wire-to-wire connection. These are also called as single feed terminal blocks. Single level terminal blocks are of the most simple type having one input contact and one output contact.
- Dual level terminal blocks These blocks have another level of connection terminal stacked on the first one. This arrangement is generally used to save space.
- Three level terminal blocks Just like dual level blocks, these have an extra level at the top. An advantage of using multilevel blocks is that multiple connections can be made in the same block.

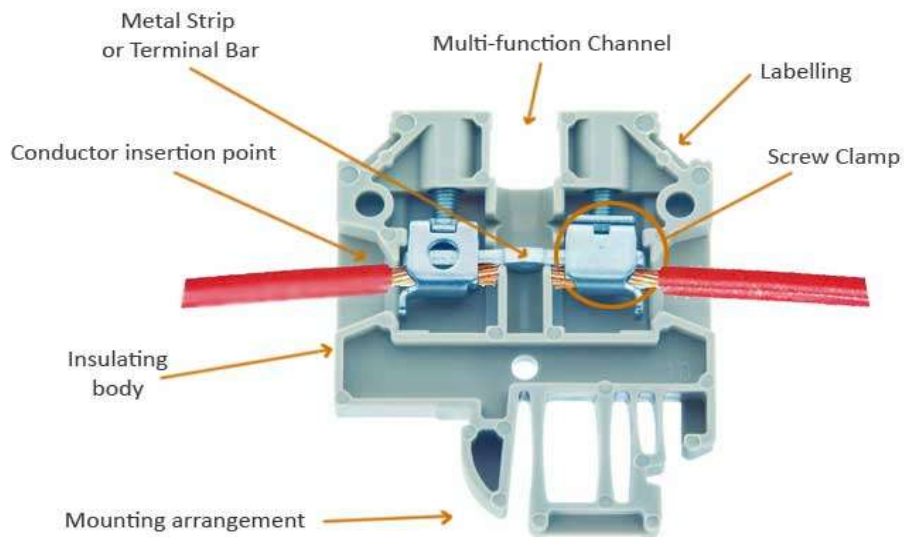


Figure 3.8(a) Single level pass through terminal block

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Dual level terminal block

figure 3.8(b) dual terminal block



Three level terminal block

figure 3.8(c) three level terminal block

## 2. Device Type

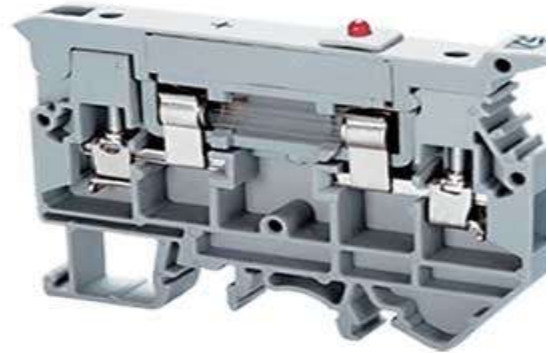
- Ground Terminal Blocks

These blocks often look like a single level feed through terminals. The exception is that these blocks and the metal connection where the wire is terminated are grounded to the panel or DIN rail on which the block is mounted.

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Ground terminal block



Fuse terminal block

figure 3.9(a) ground terminal block

figure 3.9(b) Fuse connection terminal block

- Fused Connection Terminals

These are similar to the pass-through blocks with an exception of the metal connection strip is replaced with a fuse. Therefore, the wires will be connected through a fuse providing an added protection.

### 3. Clamping Options In Terminal Blocks

- Screw terminal:- are the most common type of connection method. The wire or conductor is simply pressed against the conductor strip in the block by tightening the screw. Screw terminals accommodate a very wide range of wire or conductor sizes.
- Spring clamp:- These type of terminals use spring pressure to retain the wire clamped. Spring clamps are a newer alternative to screw clamps and are generally used for relatively small wires.

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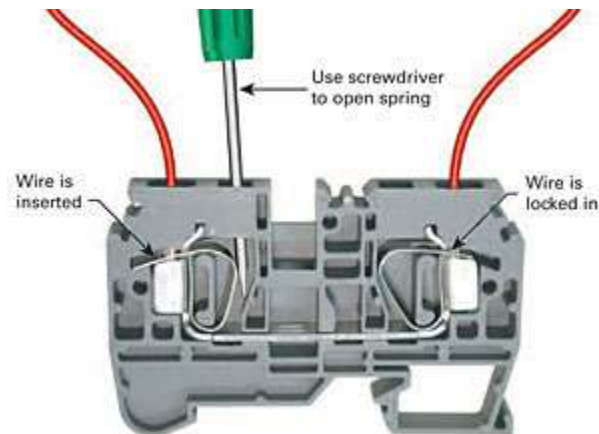


Figure 3.10 spring clamp terminal block

- Push-in terminal blocks:- these allow you to connect a wire simply by inserting it. Most push-in terminals require the use of a ferrule. A ferrule strengthens the end of the wire/conductor. However, some push-in terminal blocks allow to insert a solid conductor directly or a stranded conductor by inserting a screwdriver into the release hole.
- Insulation Displacement Connector (IDC):- These connectors do not require us to strip the insulation for contact. We simply need to insert the wire without stripping the insulation, and the two sharp metal blades inside the terminal will cut through it to the conductor making proper contact.
- Barrier terminal block:- These are used where vibration is an issue. A spade or ring terminal is attached to the wire and then inserted into a bolt and tightened with a nut on the terminal block. This prevents loosening of the wire due to vibrations.

### 3.6 Terminal Wire Marker

Wire markers and cable markers are used to label wires and cables. Wire marking can be done before or after termination. There is a large variety of markers available, including an array of sizes, colors, and lengths. When selecting individual products,

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specifications to consider include materials of construction and certifications or approvals.



figure 3.11.examples of wier marker

### 3.6.1 Types of wire marker and Cable marker

Selecting wire markers and cable markers requires an understanding of product types. Product categories include dot matrix labels and dot matrix ribbons, laser labels and laser sheets, pre-printed markers, and self-laminating labels. Wire markers and cable markers also include thermal transfer labels, thermal transfer ribbons, tags, and wire wraps.

**Dot matrix** labels and dot matrix ribbons are designed specifically for use with dot matrix printers. Similarly, laser labels and label sheets are designed for laser printers.

**Self-laminating** labels include a clear portion that will wrap around and laminate the legend. This protects the printed area of a label from exposure to solvents, oil, water, or other contaminants.

**Thermal printers** require thermal transfer labels or thermal transfer ribbons. Wire markers and cable markers also include tags and wraps.

**Heat shrink tubing** is available in a wide range of sizes, colors, and materials to suit many different applications.

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**Wire wraps** are labels with a printable side and an adhesive side used to wrap and stick the label to the tube or wire. Specialty wire markers and cable markers are also available. When the marker wraps around the wire the legend is visible from all sides.

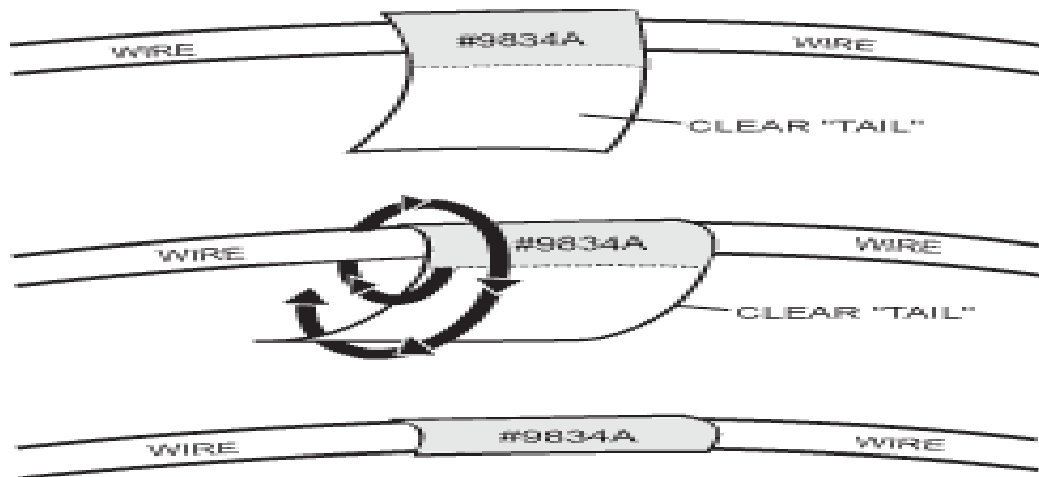


figure 3.12 Wire wrap labels

**Sleeve markers** should only be used before a termination because they must be slipped over the open end of the wire. They provide a degree of flexibility before they are heat-shrunk around the wires or cables. They are non-adhesive and once they are shrunk, sleeve markers provide permanent identification that can withstand harsh environments.

**Pre-printed markers** can be purchased in a variety of stock legends. Generally, custom legends can also be selected. They are ideal for many applications.

**Printable markers** offer the flexibility of labeling as needed, and may provide a better option when a long legend with multiple characters is required.

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figure 3.13 Printable wire marker

**Wire ties-** Ties are used to bundle wires, cables, and tubing together. Wire tie markers have space available for placing an identifying mark.

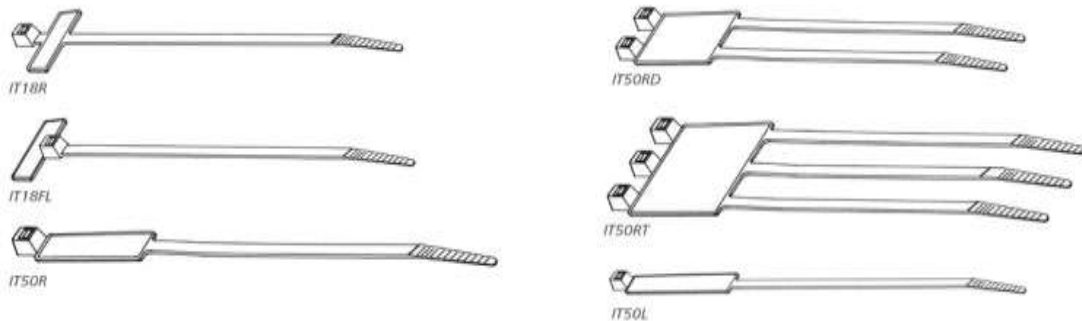


figure 3.14 wire or cable ties

### 3.6.2 Specifications of wire marker

Typically, wire markers and cable markers are made of cloth, nylon, polyester, metalized polyester, steel.

**Diameter-** The size of the wires and cables determines the diameter of the marker. Similarly, the length of the label should be five times the outer diameter of the wire to be marked.

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**Environmental conditions-** The environmental conditions, such as operating temperature, should be considered when selecting a wire marker and the material it's made from.

### 3.7 Tubing and Tube Fitting

#### 3.7.1 Tubing

Tubing (also known as inner tubing, "bumper tubing") is a recreational activity where an individual rides on top of an inner tube, either on water, snow, or through the air. Tubing on water generally consists of two forms: towed and free-floating, also known as river tubing.

Towed tubing:- usually takes place on a large body of water such as a lake or river. One or more tube riders (often called "tubers") tether their tubes to a powered watercraft such as a motor boat or a personal watercraft. The riders are then towed through the water by the watercraft.

In free-floating tubing, the tube riders are often conveyed by the current of a waterway. Tubers paddle with their hands and often used webbed gloves to steer. Tubes can be outfitted with tube covers or 'skins'. These covers are fabric, and cover the bottom of the tube, the sides, and have a skirt that covers the inner diameter, while leaving room for the tuber to sit. Covers can be altered with pockets, can holders and have handles for the tuber to hold on to. It is strongly discouraged to tie anything to the tube or use ropes of any kind as a tuber can get bound or wrapped in them and potentially drown.

#### 3.7.2 Fittings

All types of fittings for instrumentation and industrial applications. Like tube, pipe, weld and adapter fittings are manufactured to the different type, size, and shape.

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## General Fittings Specifications

- Working Pressure
- Temperature Range
- Sizes such as diameter of the pipe or tube to fit
- Materials such as carbon steel, brass, plastic, PVC, PPR and other materials are available
- Connection Types such as elbow, tee, union, nipple

## Tube Fittings

SSP offers nine tube fitting designs for instrumentation and industrial applications.

- Duolok two-ferrule, Unilok single-ferrule and Griplok dual-ferrule compression tube fittings
- SAE, Nav-Sea and HP Series O-ring face seal fittings
- SAE and Ultraflare 37° flared fittings
- SAE flareless tube fittings

## Pipe Fittings

SSP designs and manufactures three series of instrumentation and Industrial pipe fittings with weld end connections in sizes from 1/16 to 2 in.

- TruFit instrumentation pipe fittings and adapters
- TruFit10K pipe fittings are rated at a minimum of 10,000 psig.
- Industrial threaded pipe fittings and adapters

## Weld Fittings

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Weld fittings provide permanent, reliable connections in almost any environment. Tube socket, pipe socket and butt weld fittings are available in sizes from 1/8 to 2 in. in 316 stainless steel and Alloy 400. Other materials are available.

### Hose Fittings

SSP offers hose fittings with a wide range of end connection types for hydraulic, PTFE-lined, and push-on hose. Hose connections are available in 316 SS and Alloy 400. Other materials are available.

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|                     |                     |
|---------------------|---------------------|
| <b>Self-Check 2</b> | <b>Written Test</b> |
|---------------------|---------------------|

Name: \_\_\_\_\_

Date: \_\_\_\_\_

Direction : Answer all the questions listed below by choosing from the given alternative.

1. or more turns, usually roughly circular or cylindrical, of current-carrying wire designed to produce a magnetic field is called  
A. coil      B. cable      C. relay      D. contactor
2. The material that use to transmit electric current  
A. motor      B. Pump      C. wire and cable      D. A and B
3. the wire color that use for grounding only.  
A. black      B. red      C. white      D. green & bare copper
4. The modular block with an insulated frame that secures two or more wires together  
A. terminal lug      B. terminal block      C. wire marker      D. All
5. Electrical terminal blocks can be classified on the basis of  
A. structure type      B. device type      C. termination options      D. All

**Note: Satisfactory rating - 10 points**

**Unsatisfactory - below 10 points**

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## Answer Sheet

Score = \_\_\_\_\_

Rating: \_\_\_\_\_

Name: \_\_\_\_\_

Date: \_\_\_\_\_

### Choose Questions

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_



|                          |                            |
|--------------------------|----------------------------|
| <b>Operation Sheet 1</b> | <b>Measure with megger</b> |
|--------------------------|----------------------------|

**Procedure to use it**

1. Make sure no power is running to the system you are testing.
2. Insert the test probes into the V and COM input terminals.
3. Turn the dial to the 500V setting (if testing 240V system) or 250V (if testing a 120V system).
4. Clip the black probe to the black wire coming from the source..
5. Hold or clip the red probe to the ground wire.
6. The display should show “- - -” until the TEST button is pressed.
7. If the high voltage symbol appears along with >30 V, disconnect probes and disconnect power before proceeding further
- . 8. If the high voltage symbol does not appear, push and hold the TEST button to begin the test.

Please note: The number in the bottom right of the display screen shows the voltage being applied to the circuit. The resistance will show in the middle of the screen in MΩ or GΩ. The TEST icon will appear in the bottom right corner until the test is complete. If the resistance is higher than the maximum display range, the megger will display the > symbol on the left side of the screen. Higher resistance means good insulation. The minimum and maximum IR (Insulation Resistance) values can be found in the megger manual.

9. Keep the probes connected and release the TEST button.
10. Remove both probes and repeat test by clipping the black probe to the red (if testing a 240V system) or solid yellow (if testing 120V system) and repeat steps 5-9.



|          |                         |
|----------|-------------------------|
| LAP Test | Practical Demonstration |
|----------|-------------------------|

Name: \_\_\_\_\_ Date: \_\_\_\_\_

Time started: \_\_\_\_\_ Time finished: \_\_\_\_\_

Instructions: use megger to perform the following tasks within 1 hours.

### Procedure to perform the task

1. Make sure no power is running to the system you are testing.
2. Insert the test probes into the V and COM input terminals.
3. Turn the dial to the 500V setting (if testing 240V system) or 250V (if testing a 120V system).
4. Clip the black probe to the black wire coming from the source..
5. Hold or clip the red probe to the ground wire.
6. The display should show “- - -” until the TEST button is pressed.
7. If the high voltage symbol appears along with  $>30$  V, disconnect probes and disconnect power before proceeding further
- . 8. If the high voltage symbol does not appear, push and hold the TEST button to begin the test.

Please note: The number in the bottom right of the display screen shows the voltage being applied to the circuit. The resistance will show in the middle of the screen in M $\Omega$  or G $\Omega$ . The TEST icon will appear in the bottom right corner until the test is complete. If the resistance is higher than the maximum display range, the megger will display the  $>$  symbol on the left side of the screen. Higher resistance means good insulation. The minimum and maximum IR (Insulation Resistance) values can be found in the megger manual.

9. Keep the probes connected and release the TEST button.
10. Remove both probes and repeat test by clipping the black probe to the red (if testing a 240V system) or solid yellow (if testing 120V system) and repeat steps 5-9.

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