Today's Date:_____

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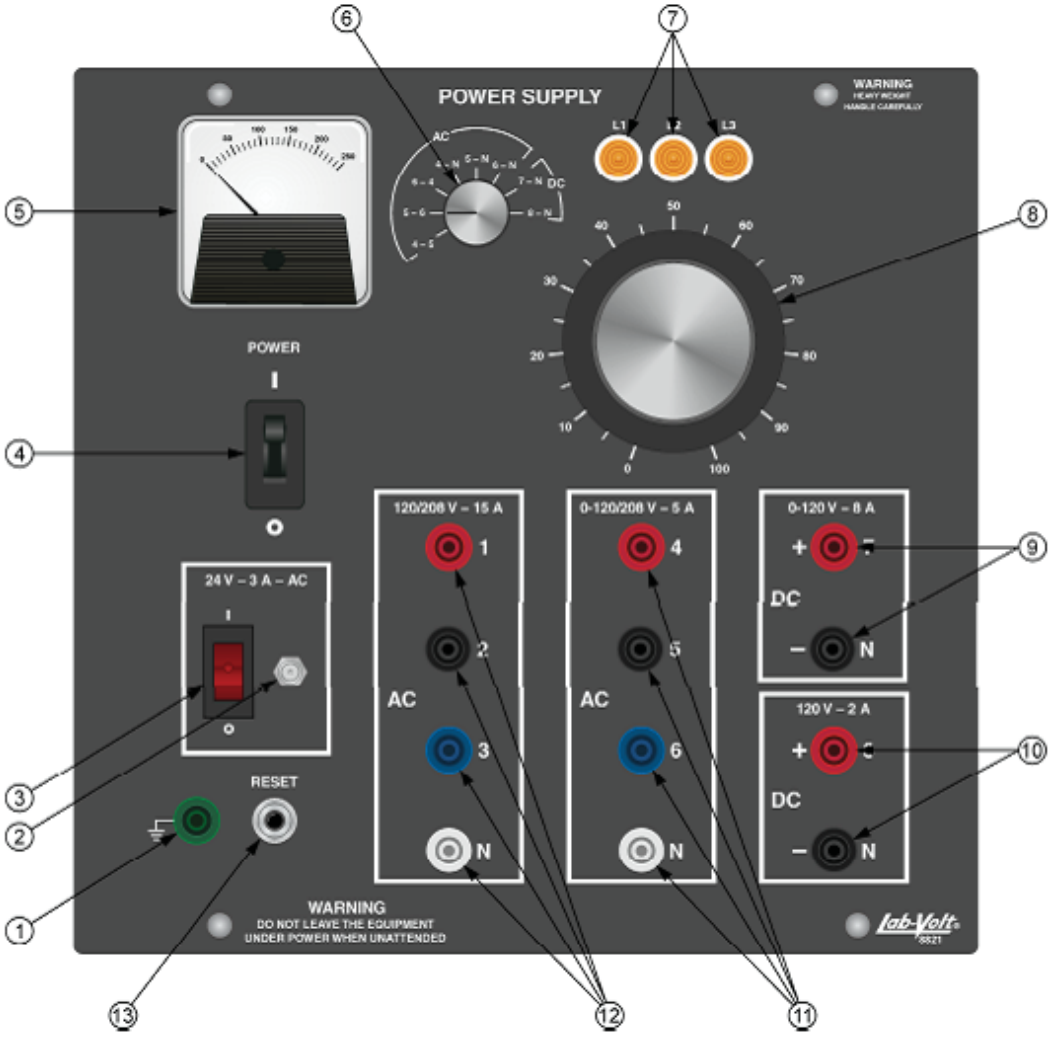
LABORATORY EXPERIMENT NO. 1

SAFETY AND THE POWER SUPPLY



OBJECT

1. To learn the simple rules of safety.
2. To learn how to use the ac/dc power supply.

DISCUSSION

TO ALL STUDENTS AND TEACHERS:

Know the location of the FIRST AID supply in your shop or lab. Insist that every cut or bruise receives immediate attention, regardless of how minor it seems to be. Notify your instructor about every accident. He will know what to do.

If the student follows the instructions with a degree of accuracy, there are no serious hazards or dangers in the Electro Mechanical Systems of learning. Many people receive fatal shocks every year from the ordinary *120 volt* electricity found in the home.

A thorough safety program is a "must" for anyone working with electricity. Electricity can be dangerous and even fatal to those who do not understand and practice the simple rules of SAFETY. There are many fatal accidents involving electricity by well-trained technicians who either through over-confidence or carelessness, violate the basic rules of personal SAFETY. The first rule of personal safety is always,

"THINK FIRST"

This rule applies to all industrial work as well as electrical workers. Develop good habits of workmanship. Learn to use tools correctly and safely. Always study the job at hand and think through your procedures, your methods, and the applications of tools, instruments and machines before acting. Never permit yourself to be distracted from your work and never distract another worker engaged in hazardous work. Don't be a clown! Jokes are fun and so is "horsing around", but not near moving machinery or electricity. There are generally three kinds of accidents which appear all too frequently among electrical students and technicians. Your knowing and studying about them and observing simple rules will make you a safe person to work with. You could personally be saved from painful and expensive experiences—you might be saved to live to a rewarding retirement age.

ELECTRIC SHOCK

What about electric shocks? Are they fatal? The physiological effects of electric currents can generally be predicted by the chart shown in *Fig. 1-1.*

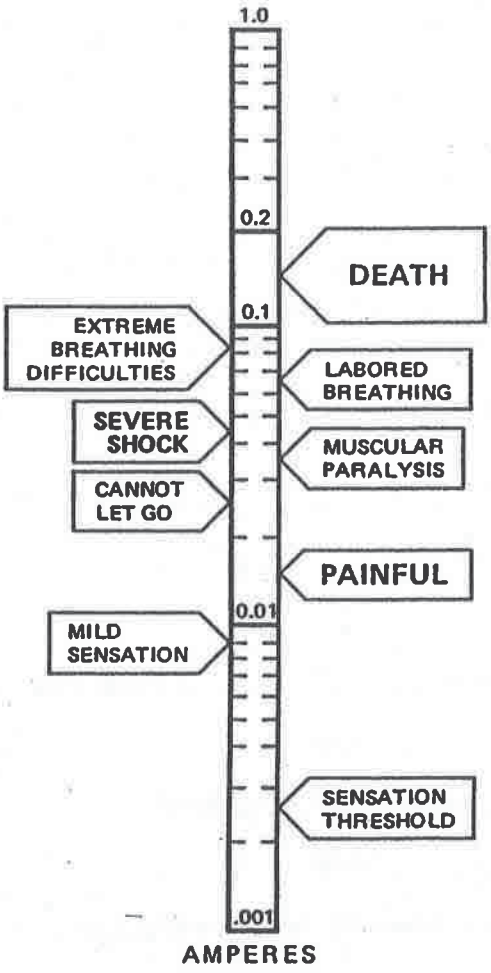


Fig. 1-1

Notice that it is the current that does the damage. Currents above *100 milliamperes* or only one tenth of an ampere are fatal. A workman who has contacted currents above *200 milliamperes* may live to see another day if given rapid treatment. Currents below *100 milliamperes* can be serious and painful. A safe rule: Do not place yourself in a position to get any kind of a shock.

What about VOLTAGE?

Current depends upon voltage and resistance. Let's measure your resistance. Using your ohmmeter, measure your body resistance between these points:

From right to left hand .....*ohms (resistance)*

Now wet your fingers and repeat the measurements:

From right to left hand .....*ohms (resistance)*

The actual resistance varies, of course, depending upon the points of contact and, as you have discovered, the condition of your skin, and the contact area. Notice how your resistance varies as you squeeze the probes more or less tightly. Skin resistance may vary between *250 ohms* for wet skin and large contact area, to *500,000 ohms* for dry skin. Considering the resistance of your body previously measured, and *100 milliamperes* as a fatal current, what voltages might prove fatal for you to contact.

Use the formula: *Volts = .1 × ohms.*

Contact between two hands (dry):

.....*volts*

Contact between two hands (wet):

.....*volts*

DO NOT ATTEMPT TO PROVE THIS!

Nine rules for safe practice and to avoid electric shocks:

1. Be sure of the conditions of the equipment and the dangers present BEFORE working on a piece of equipment. Many sportsmen are killed by supposedly unloaded guns; many technicians are killed by supposedly "dead" circuits.

2. NEVER rely on safety devices such as fuses, relays and interlock systems to protect you. They may not be working and may fail to protect when most needed.

3. NEVER remove the grounding prong of a three wire input plug. This eliminates the grounding feature of the equipment making it a potential shock hazard.

4. DO NOT WORK ON A CLUTTERED BENCH. A disorganized mess of connecting leads, components and tools only leads to careless thinking, short circuits, shocks and accidents. Develop habits of systemized and organized procedures of work.

5. DO NOT WORK ON WET FLOORS. Your contact resistance to ground is substantially reduced. Work on a rubber mat or an insulated floor.

6. DON'T WORK ALONE. It's just good sense to have someone around to shut off the power, to give artificial respiration and to call a doctor.

7. WORK WITH ONE HAND BEHIND YOU OR IN YOUR POCKET. A current between two hands crosses your heart and can be more lethal than a current from hand to foot. A wise technician always works with one hand. Watch your TV serviceman.

8. NEVER TALK TO ANYONE WHILE WORKING. Don't let yourself be distracted. Also, *don't talk to anyone,* if he is working on dangerous equipment. Don't be the cause of an accident.

9. ALWAYS MOVE SLOWLY when working around electrical circuits. Violent and rapid movements lead to accidental shocks and short circuits.

BURNS

Accidents caused by burns, although usually not fatal, can be painfully serious. The dissipation of electrical energy produces heat.

Four rules for safe practice and to avoid burns:

1. *Resistors get very hot,* especially those that carry high currents. Watch those five and ten watt resistors. They will burn the skin off your fingers. Stay away from them until they cool off.
2. *Be on guard for all capacitors which may still retain a charge.* Not only can you get a dangerous and sometimes fatal shock, you may also get a burn from an electrical discharge. If the rated voltage of electrolytic capacitors is exceeded or their polarities reversed they may get very hot and may actually burst.
3. *Watch that hot soldering iron or gun.* Don't place it on the bench where your arm might accidentally hit it. Never store it away while still hot. Some innocent unsuspecting student may pick it up.

4. HOT SOLDER *can be particularly uncomfortable in contact with your skin.* Wait for soldered joints to cool. When de-soldering joints, don't shake hot solder off so that you or your neighbor might get hit in the eyes or on his clothes or body.

MECHANICAL INJURIES

This third class of safety rules applies to all students who work with tools and machinery. It is a major concern of the technician and the safety lessons are found in the correct use of tools. Five rules for safe practice and to avoid mechanical injury:

1. Metal corners and sharp edges on chassis and panels can cut and scratch. File them smooth.
2. Improper selection of the tool for the job can result in equipment damage and personal injury.
3. Use proper eye protection when grinding, chipping or working with hot metals which might splatter.
4. Protect your hands and clothes when working with battery acids, etchants, and finishing fluids. They are destructive!
5. If you don't know-ASK YOUR INSTRUCTOR.

THE POWER SUPPLY

The Power Supply Module EMS 8821 provides all of the necessary ac/dc power, both fixed and variable, single phase and three-phase, to perform all of the Laboratory Experiments presented in this manual.

The module must be connected to a *three-phase, 120/208 volt, four wire (with fifth wire ground) system.* Power is brought in through a five prong, twist-lock connector located at the rear of the module. An input power cable with mating connector is provided for this purpose.

The power supply furnishes the following outputs:

1. *Fixed 120Vac* is made available for the use of accessory equipments such as oscilloscopes and TVM's. This power is brought out to a standard grounding type receptacle rated at *15A.*
2. *Fixed 120/208 volts, 3ϕ* power is brought out to four terminals, labeled 1, 2, 3 and N. *Fixed 208 volts 3ϕ* may be obtained from terminals 1, 2 and 3. *Fixed 208 volts ac* may be obtained between terminals 1 and 2, 2 and 3 or 1 and 3. *Fixed 120 volts ac* may be obtained between any one of the 1, 2 or 3 terminals and the N terminal. The current rating of this supply is *15A per phase.*
3. *Variable 120/208 volts, 3ϕ* power is brought out to four terminals, labeled 4, 5, 6 and N. *Variable 3ϕ 0-208 volts* may be obtained from terminals 4, 5 and 6. *Variable 0-208 volts ac* may be obtained between terminals 4 and 5, 5 and 6 or 4 and 6. *Variable 0-120 volts ac* may be obtained between any one of the 4, 5 or 6 terminals and the N terminal. The current rating of this supply is *5A per phase.*
4. *Fixed 120Vdc* is brought out to terminals labeled 8 and N. The current rating of this supply is *2A.*
5. *Variable 0-120Vdc* is brought out to terminals labeled 7 and N. The current rating of this supply is *8A.*

The full current rating of the various outputs cannot be used simultaneously. If more than one output is used at a time, reduced current must be drawn. The neutral N terminals are all connected together and joined to the neutral wire of the ac power line. All power is removed from the outputs when the on-off breaker is in the off position (breaker handle down).

CAUTION: Power is still available behind the module face with the breaker off! Never remove the power supply from the console without first removing the input power cable from the rear of the module.

The variable ac and dc outputs are controlled by the single control knob on the front of the module. The built-in voltmeter will indicate all the variable ac and the variable and fixed dc output voltages according to the position of the voltmeter selector switch. The power supply is fully protected against overload or short circuit. Besides the main *15A 3ϕ* on-off circuit breaker on the front panel, all of the outputs have their own circuit breakers. They can be reset by a common button located on the front panel.

The rated current output may be exceeded considerably for short periods of time without harming the supply or tripping the breakers. This feature is particularly useful in the study of dc motors under overload or starting conditions where currents of up to *200A* may be drawn.

All of the power sources may be used simultaneously providing that the total current drawn does not exceed the *15A per phase* input breaker rating. Your power supply, if handled properly, will provide years of reliable operation and will present no danger to you.

INSTRUMENTS AND COMPONENTS

Power Supply Module	*EMS 8821*
AC Metering Module *(250V)*	*EMS 8426*
Connection Leads	*EMS 9128*

EXPERIMENTS

Caution: High voltages are present in this Laboratory Experiment! Do not make any connections with the power on! The power should be turned off after completing each individual measurement.

☐ 1. Examine the construction of the Power Supply Module EMS 8821. On the front panel of the module, identify the following:

☐ a) The three-pole circuit breaker on-off switch.

☐ b) The three lamps indicating the operation of each phase.

☐ c) The ac/dc voltmeter.

☐ d) The ac/dc voltmeter selector switch.

☐ e) The variable output control knob.

☐ f) The *fixed 120Vac* receptacle.

☐ g) The *fixed 120/208 volt* output terminals (labeled 1, 2, 3 and N).

☐ h) The *variable 0-120/208 volt* output terminals (labeled 4, 5, 6 and N).

☐ i) The *fixed dc* output terminals (labeled 8 and N).

☐ j) The *variable dc* output terminals (labeled 7 and N).

☐ k) The common reset button.

☐ 2. State the ac or dc voltage and the rated current available from each of the following terminals:

a) Terminals 1 and N =

.....*V* .....*A* .....

b) Terminals 2 and N =

.....*V* .....*A* .....

c) Terminals 3 and N =

.....*V* .....*A* .....

d) Terminals 4 and N =

.....*V* .....*A* .....

e) Terminals 5 and N =

.....*V* .....*A* .....

f) Terminals 6 and N =

.....*V* .....*A* .....

g) Terminals 7 and N =

.....*V* .....*A* .....

h) Terminals 8 and N =

.....*V* .....*A* .....

i) Terminals 1, 2 & 3 =

.....*V* .....*A* .....

j) Terminals 4, 5 & 6 =

.....*V* .....*A* .....

k) The receptacle =

.....*V* .....*A* .....

☐ 3. Examine the interior construction of the module. Identify the following items:

☐ a) The *3ϕ* variable autotransformer.

☐ b) The filter capacitors.

☐ c) The thermal-magnetic circuit breakers.

☐ d) The solid state rectifier diodes.

☐ e) The diode heat sinks.

☐ f) The five prong twist lock connector.

☐ 4. Insert the Power Supply Module into the console. Make sure that the on-off switch is in the off position and that the output control knob is turned fully counterclockwise for minimum output. Insert the power cable, through the clearance hole in the rear of the console, into the twist-lock module connector. Connect the other end of the power cable into a source of *3ϕ 120/208 volts.*

☐ 6. a) Place the voltmeter selector switch into its 4-N position.

☐ b) Turn the control knob and note that the ac voltage increases. Measure and record the minimum and maximum ac output voltage as indicated by the built-in voltmeter.

$Vac_{minimum}$ = ... $Vac_{maximum}$ = ...

☐ c) Return the voltage to zero and turn off the power supply by placing the on-off breaker switch in its "*down*" position.

☐ 8. For each of the following conditions:
☐ a) Connect the *250Vac* meter across the terminals specified.
☐ b) Turn on the power supply.
☐ c) Measure and record the voltage.
☐ d) Turn off the power supply.

Terminals 1 and 2 = ...*Vac*

Terminals 2 and 3 = ...*Vac*

Terminals 3 and 1 = ...*Vac*

Terminals 1 and N = ...*Vac*

Terminals 2 and N = ...*Vac*

Terminals 3 and N = ...*Vac*

☐ e) Are any of these voltages affected by the turning of the control knob? .....

☐ 10. For each of the following positions of the voltmeter selector switch:
☐ a) Turn on the power supply and rotate the control knob to its full *cw* position.
☐ b) Measure and record the voltage.
☐ c) Return the voltage to zero and turn off the power supply.

Terminals 4 and 5 = ...*Vac*

Terminals 5 and 6 = ...*Vac*

Terminals 6 and 4 = ...*Vac*

Terminals 4 and N = ...*Vac*

Terminals 5 and N = ...*Vac*

Terminals 6 and N = ...*Vac*

* Discussion Point: Read the "Controlling Electrical Hazards" of the OSHA (Occupational Safety & Health Administration) 3075 2002, which is available online at https://www.osha.gov/Publications//3075.html, and focus on the section of "Effects of Electric Current in the Human Body", then compare it with the Fig 1.1 of this lab manual.

Note