



ELECTRICAL THEORY TECHNICAL CERTIFICATION TRAINING

Field Engineering | 2010

LifeFitness
WHAT WE LIVE FOR

Course Objectives

» **Topics covered in this section:**

- ◆ Basic Electrical Theory
- ◆ Measurements for Life Fitness
- ◆ Electrical Tools and Operation

Electricity - Definition

- » Electricity
 - ◆ is a general term that encompasses a variety of phenomena resulting from the presence and flow of electric charge. Some electricity representations:
 - > Lightning
 - > Static electricity
 - > Electromagnetic field
 - > Electromagnetic induction.
- » Electricity is used to produce light, heat, power, etc.
- » Electricity moving in a stream is called electric current.

Electricity - Terms

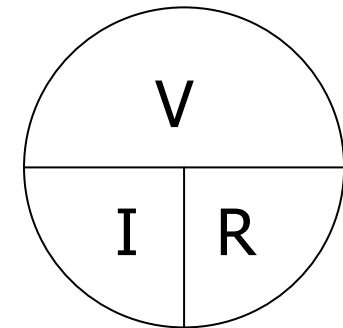
- » **Electric charge** – a property of some subatomic particles, which determines their electromagnetic interactions. Electrically charged matter is influenced by, and produces, electromagnetic fields.
- » **Electric current** – a movement or flow of electrically charged particles, typically measured in amperes.
- » **Electric potential** – the capacity of an electric field to do work on an electric charge, typically measured in volts.
- » **Electric field** – an influence produced by an electric charge on other charges in its vicinity.
- » **Electromagnetism** – a fundamental interaction between the magnetic field and the presence and motion of an electric charge.

Electricity - Practical Terms

- » Voltage (V)
 - ◆ Electrical pressure or force (Unit of Measure: Volt)
- » Current (I)
 - ◆ Number of electrons passing a point in a circuit (Unit of measure: Ampere)
- » Resistance (R)
 - ◆ Resistance to the flow of current (Unit of measure: Ohm [Ω])
- » Power (W)
 - ◆ The work performed by current (Unit of measure: Watt)
- » Continuity
 - ◆ A wire's ability to carry current

Electrical Equations

- » Voltage (V) = Current (I) x Resistance (R)
- » Example: How many ohms of resistance is there in a circuit of 120 volts and 15 amps of current?
- » 120 volts / 15 amps = 8 ohms



Electrical Equations

- » Power (W) = Voltage (V) x Current (I)
- » Example: If the current is measured at 20 amps and the voltage is 120 volts, how many watts of power is generated?
- » 120 volts x 20 amps = 2400 watts

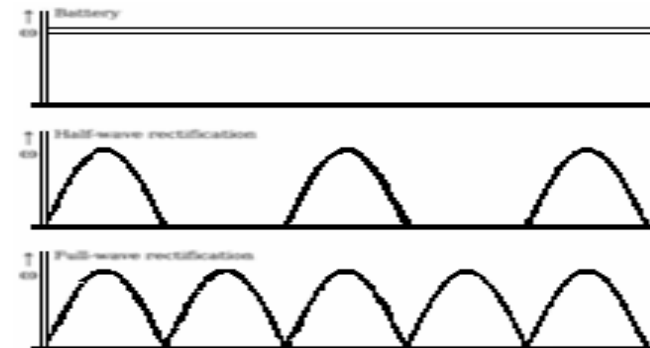
Current

- » **DC or Direct Current** - Direct Current does not change directions, the flow is always from the negative pole to the positive pole such as in a battery.
- » **AC or Alternating Current** - Alternating Current *does* change polarity from a positive to a negative state.

Current

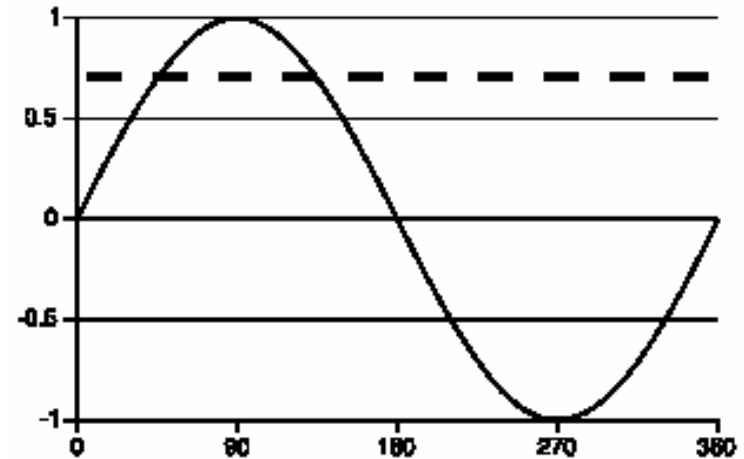
» **DC – Direct Current**

- ◆ Battery current
- ◆ Rectified AC current



AC – Alternating Current

- ◆ Generators



Multimeter

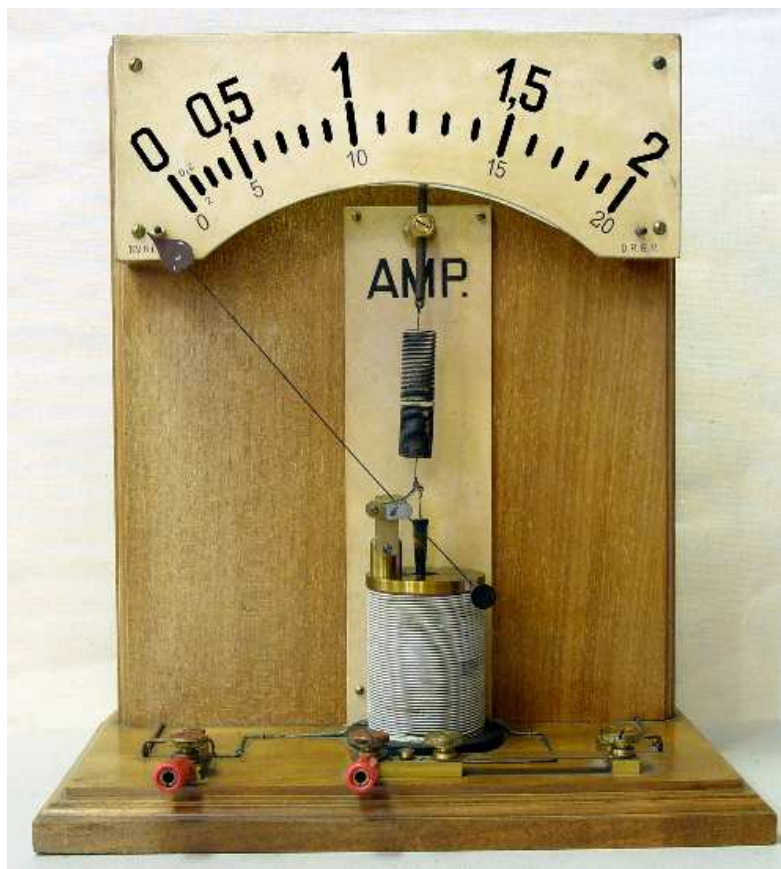
» Use a Multimeter to test ...

- ◆ Wire Continuity/Resistance (Ohms)
 - > Open Circuits
 - > Short to Frame
 - > Short between wires
- ◆ Voltage (Volts)
- ◆ Current (Amps)
- ◆ Transformers/Inductors (Ohms)
- ◆ Note the Units of item measured when in "Auto Range".
 - > **Could be 150mV instead of 150V – very important.**

Is this your Voltmeter?



Modern Ammeter – 1900?



Multimeter

Multimeter - a device used to measure Voltage, Current and Resistance.

- mA (milliamp)
Input terminal
Positive connector
for current
(400mA fuse)

- A (Amp)
Input for current
(10A fuse)



Digital Display

Rotary Key

- COM (common) Input Terminal: **Ground** input connector – (black test lead)

- $V\Omega$ Input terminal
Positive connector for
Volts, Ohms, Diode,
Capacitance &
Frequency (**Red** test
lead)

Multi-meter



Multi-meter with Current Clamp-On



Functions:

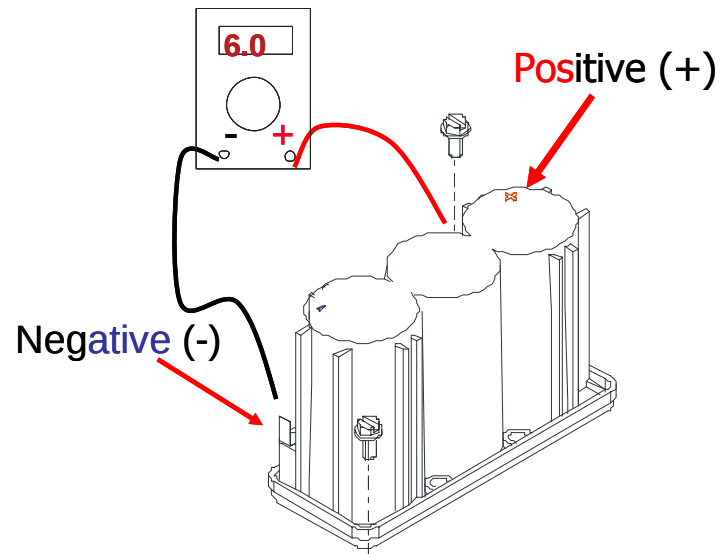
This meter can measure Volts, Ohms, and Amps (Clamp-On).

Additional Feature:

Clamp-On style allows measurement of Current without disconnecting a wire in the circuit.

Multimeter – Voltage measurement

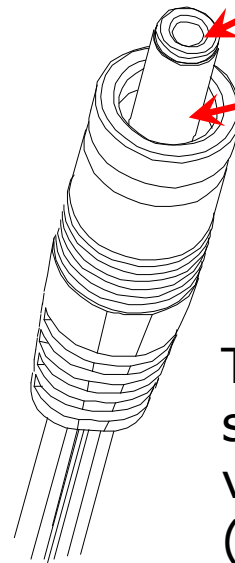
Place the positive lead
(red) inside Plug End.



Positive (+) Red

Negative (-) Black

Place the negative/ground
lead (black) on the outside
of the Plug End.

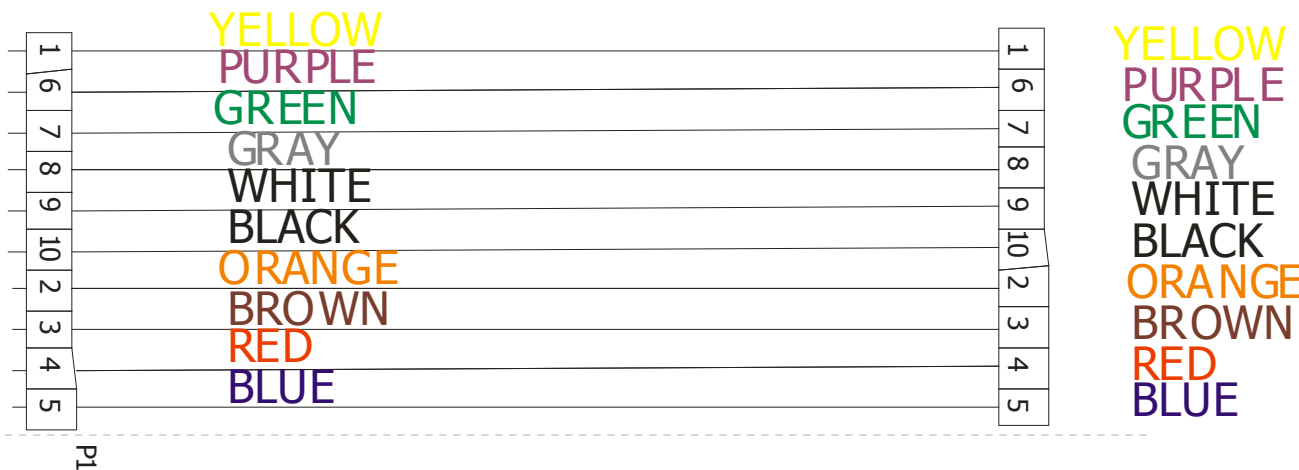


The value on the multimeter
should be the rated output
voltage of the transformer
(although open circuit voltage
might read a higher voltage).

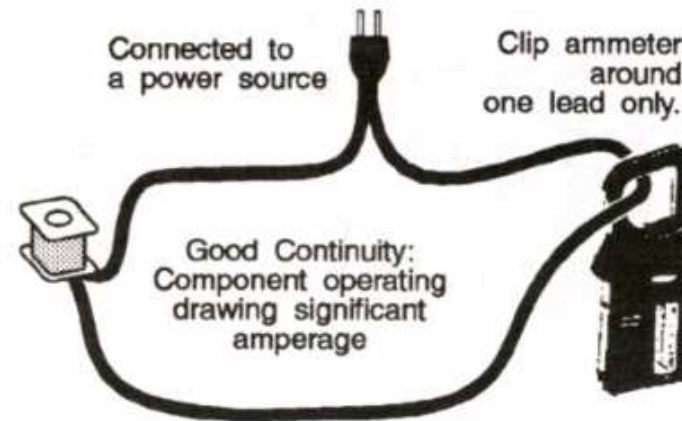
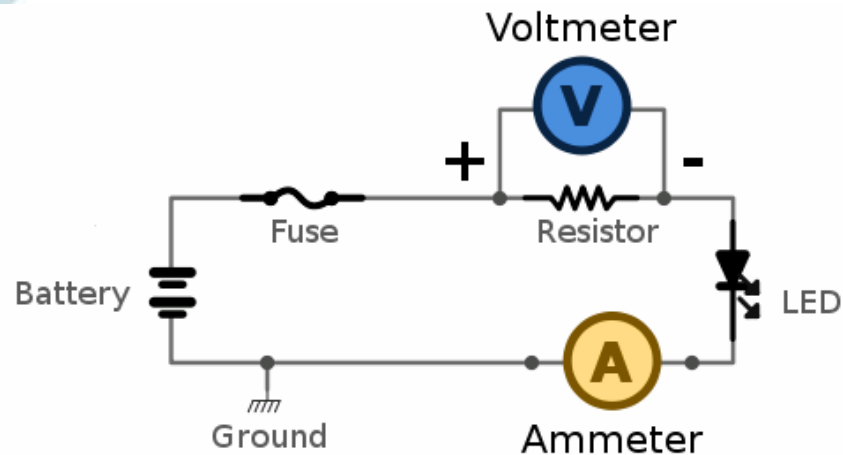
Transformer Plug End for LCD Display Console

Continuity measurement (Ohms)

- » 3 items to measure in a cable. (You will need to disconnect both ends of cable first).
 - ♦ Pin to Pin, yellow to yellow, purple to purple, green to green etc... Should be 0 ohms.
 - ♦ Pin 1 to pins 1, 2, 3, or Yellow to yellow, yellow to purple, yellow to green, etc. and down the line. Then pin 2 to pins 1, 2, 3, etc ... Should be "open".
 - ♦ Using the frame for ground, measure yellow, purple, green and so on, touch each wire color to frame. Should be "open".



Circuit Measurements



Voltage:

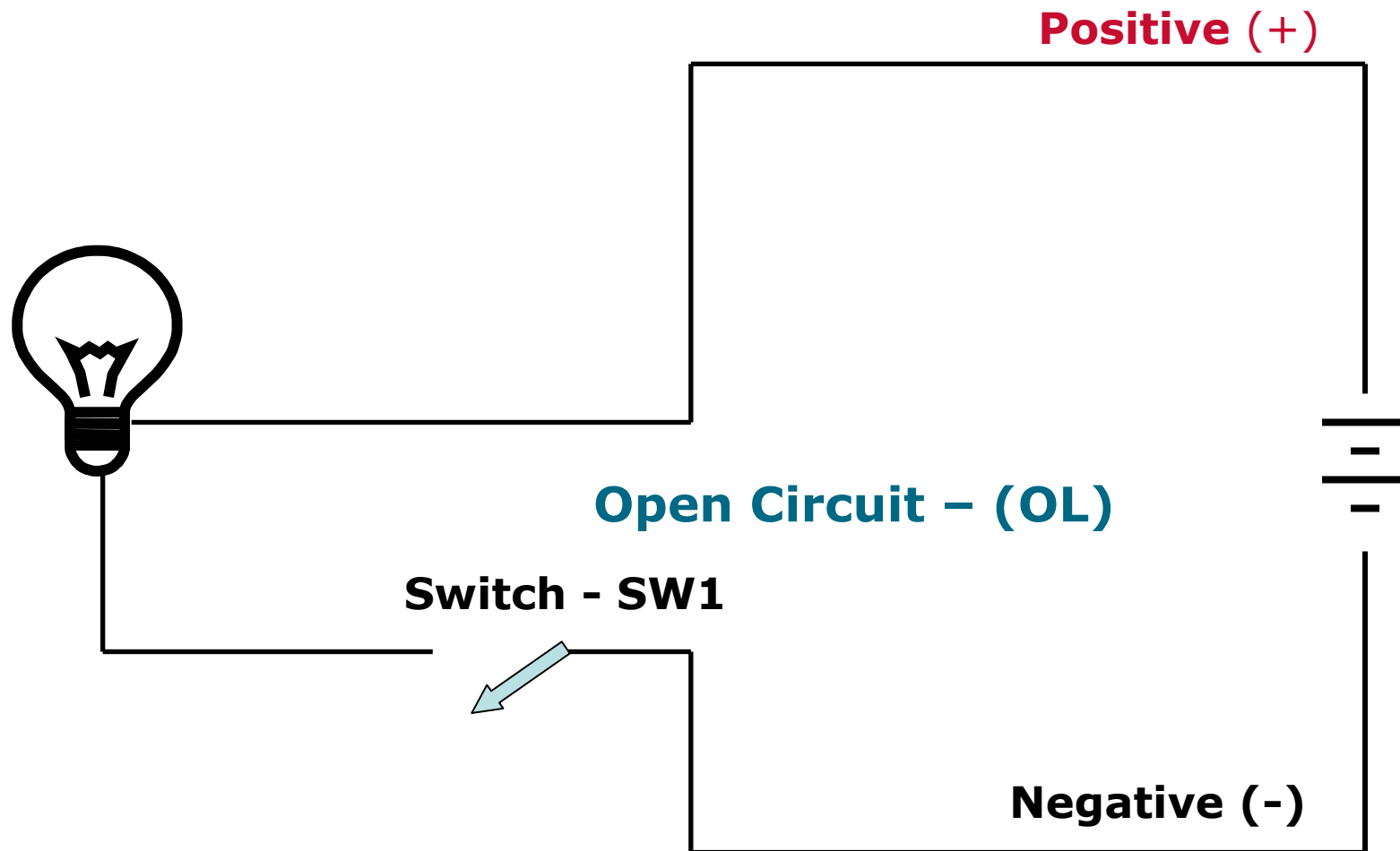
Measured in Parallel – across item to be measured.

Current:

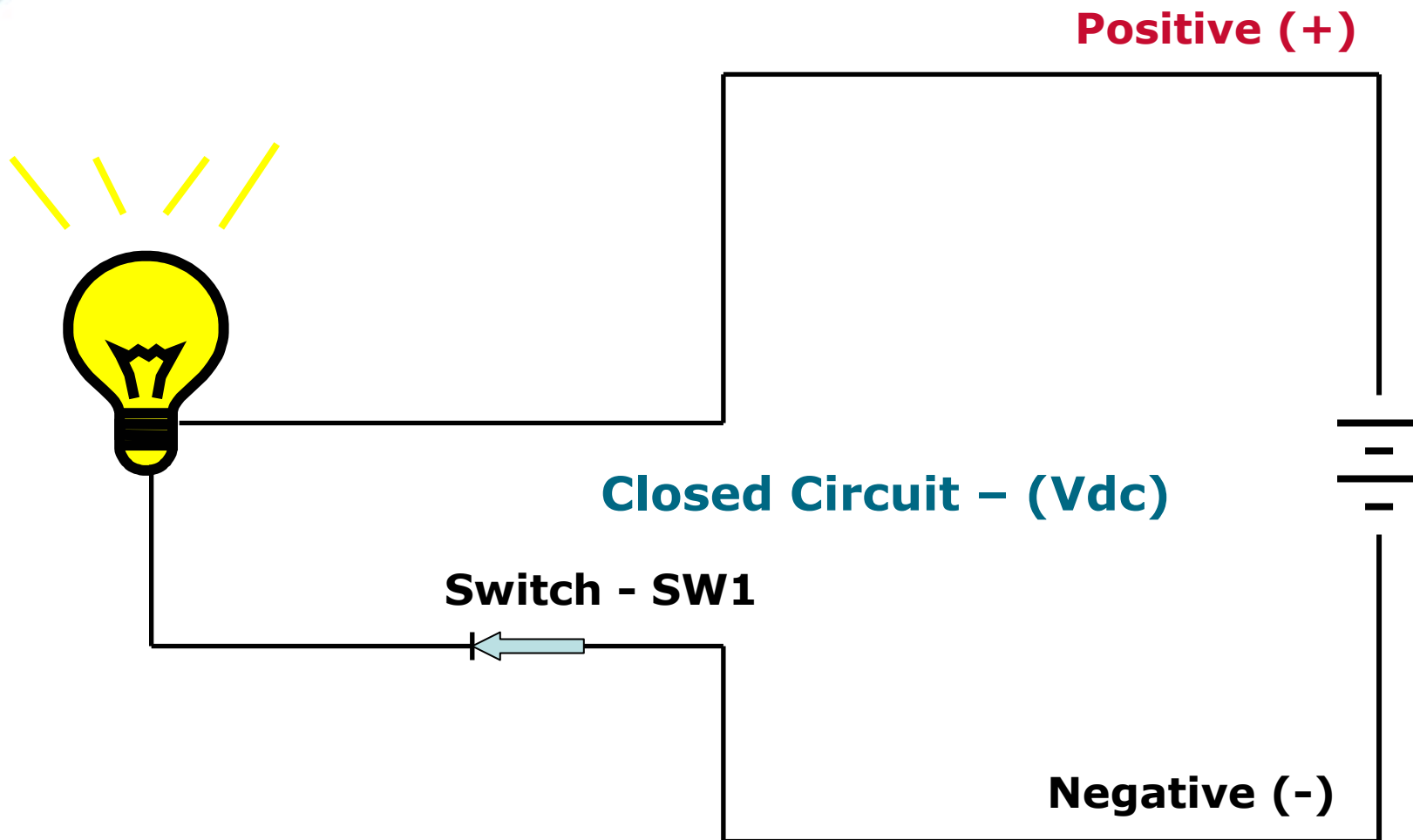
Measured in Series – in line with wire to be measured.

Clamp-on ammeters allow current measurement without disconnecting any wires in the circuit.

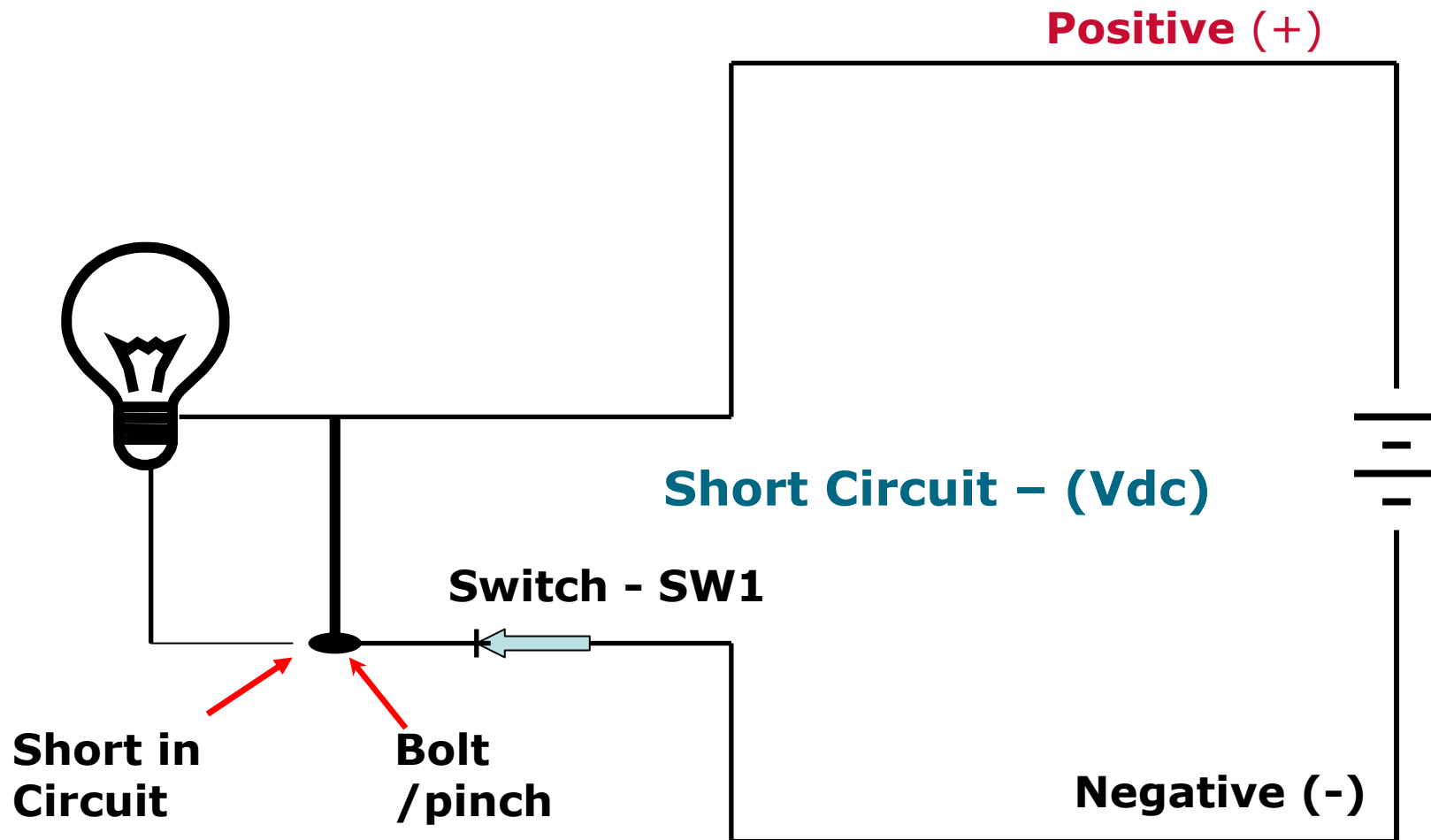
Circuits – Open Circuit



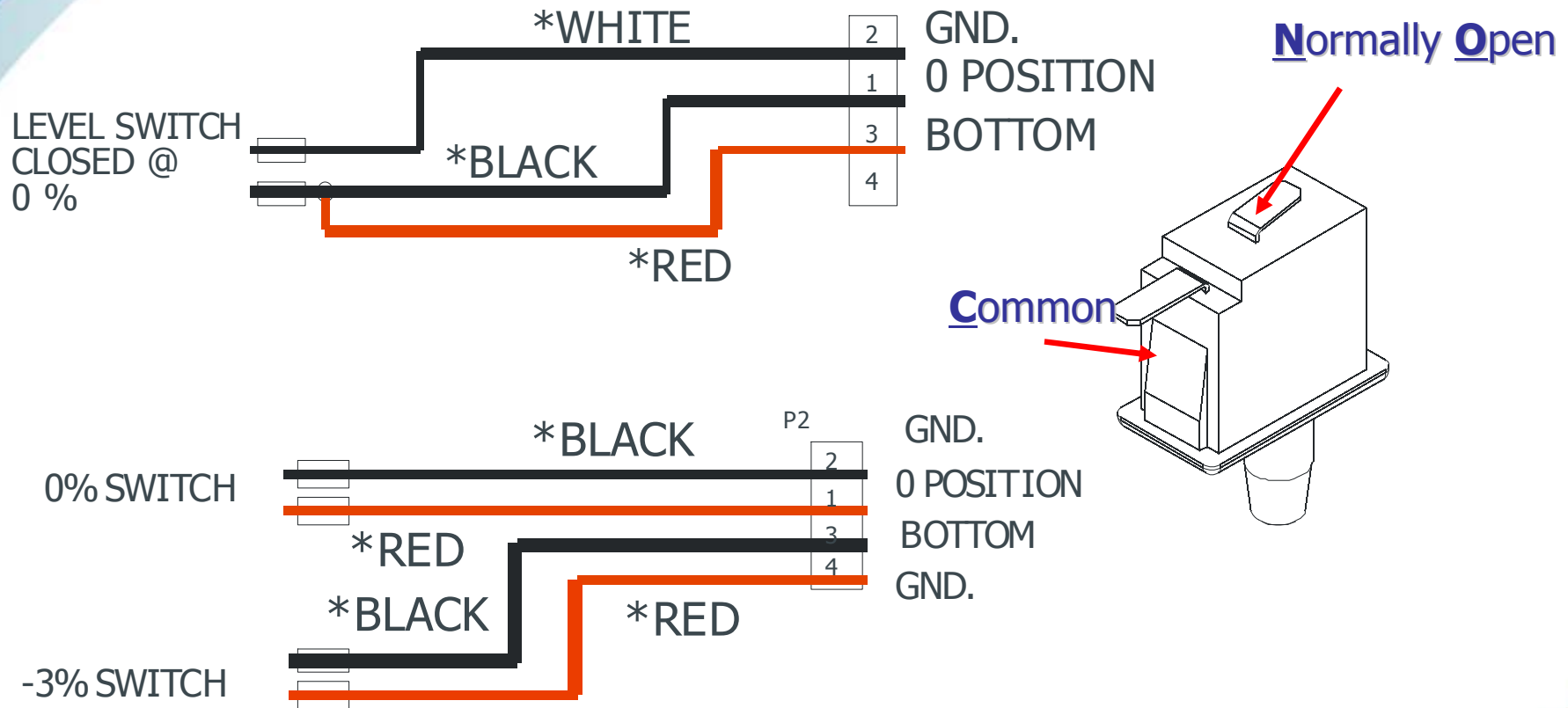
Circuits - Closed Circuit



Circuits - Short Circuit



Treadmill Home Switch



ATTACHED TO LIFT MOTOR (For 97T only)

LED

- » A **Light-Emitting Diode (LED)** is a semiconductor diode that emits light when an electrical current is applied in the forward direction of the device. The effect is a form of electroluminescence where narrow-spectrum light is emitted.
- » LEDs are widely used as indicator lights on electronic devices and increasingly in higher power applications such as flashlights, area lighting, and cars.

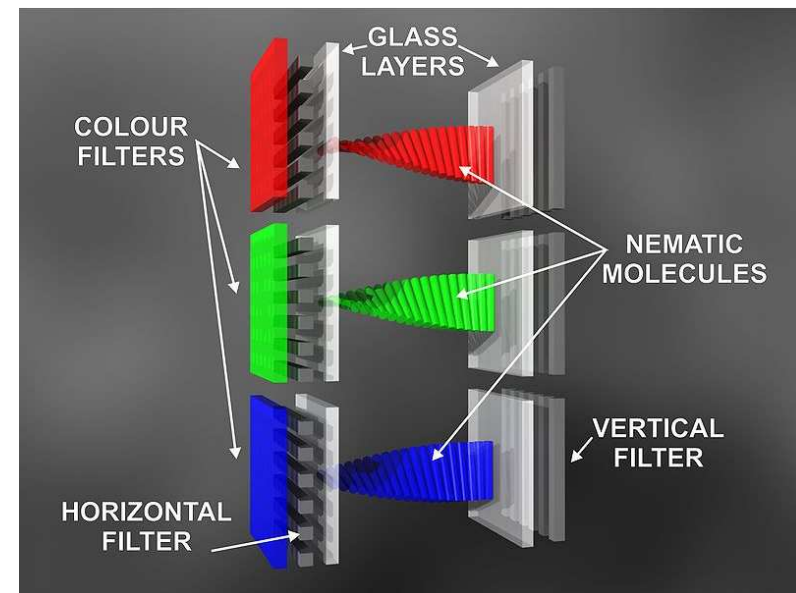
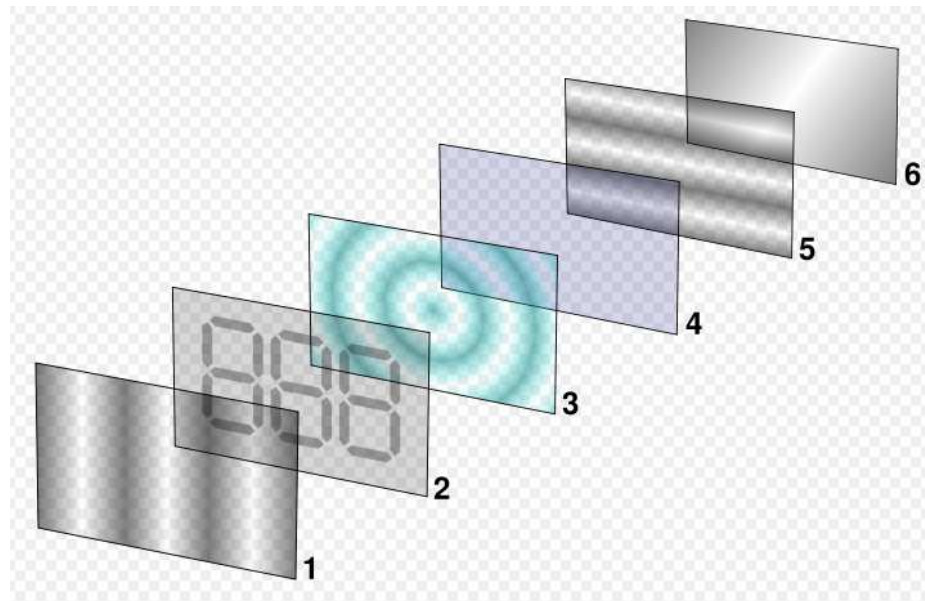
LED's

- » Blue, green, and red LEDs; these can be combined to produce most perceptible colors, including white. Infrared and ultraviolet (UVA) LEDs are also available.



LCD's

- » A **liquid crystal display (LCD)** is a thin, flat electronic visual display that uses the light modulating properties of liquid crystals (LCs). LCs do not emit light directly. LCDs therefore need a light source and are classified as "passive" displays.
- » Some types can use ambient light such as sunlight or room lighting.



Fuse/Circuit Breakers

- » **Fuse** is a device used in electrical systems to protect against excessive current. Fuses are found on some LF Circuit Boards. Fuses can either be fast or slow blow style.
- » **Circuit Breakers** are usually found in the “Fuse Panel” of a building. These are re-settable and are usually a slow blow type that can handle a surge current of 10 times the rated current.
- » Note: Time Delay circuit breakers are commonly used for Treadmill circuits.

Electrostatic Discharge (ESD)

» Definition:

- ♦ The sudden and momentary electric current that flows between two objects at different electrical potentials caused by direct contact or induced by an electrostatic field.

» Example:

- ♦ The most spectacular form of ESD is a spark, which occurs when a strong field creates an ionized conductive channel in air. [Lightning](#) is an example.

» Issue in Electronics:

- ♦ ESD is an unwanted electric current, which can cause damage in electronic components, especially in semiconductor based parts.

Electrostatic Discharge (ESD)

- » To avoid the effect of ESD we need to decrease the potential difference between our body and the ground.

For this, we can use protecting tools, such as...

- ♦ Grounded strap to wrist
- ♦ Special grounded floor surface
- ♦ ESD/Anti-Static bags
- ♦ Etc.



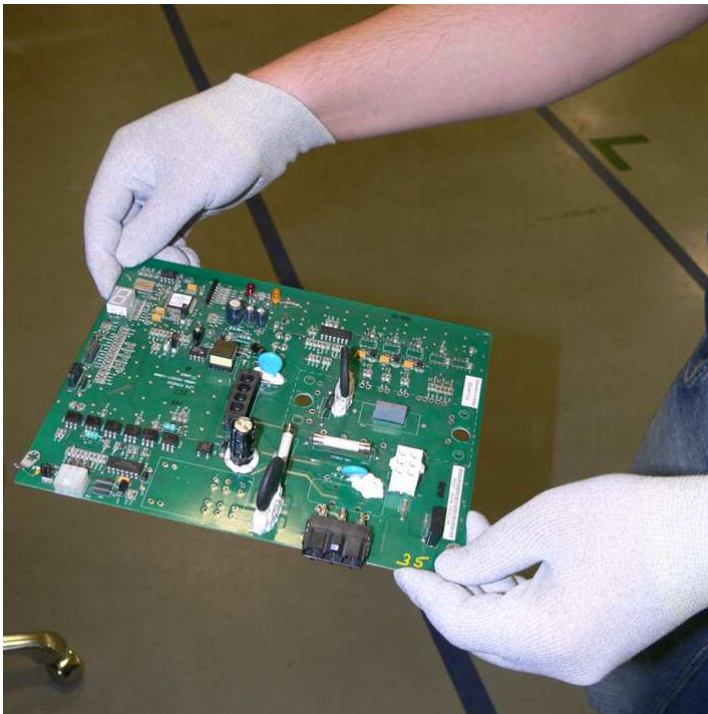
- » There are local and international regulations, standards for ESD protection: (MSZ 16040, 16041, EN 100015)

- » Symbol for ESD protected area:



ESD handling during service

- » Do not touch the electronic components on the PCB directly.



- » Try to hold the PCB at its corners.

ESD Handling/Storage

- » Do not store the boards on a non-ESD protected surface.
- » Do not stack boards on each other.



- » Boards should ALWAYS be stored in a closed ESD protecting bag.



Proper Shipment of Boards

- » Place board into an Antistatic/ESD bag prior to shipping.
- » Always close and stick down the AntiStatic/ESD bag. If the bag is open it then only provides about 70% protection from ESD.
- » If the board is NOT placed in an AntiStatic bag, it is completely susceptible to ESD damage during shipping.



Example of proper packaging of boards

6V LF Batteries – Lead Acid

- » This is the same technology as car batteries.
 - ♦ Lead acid batteries have been around since 1859, and was the world's first rechargeable battery.
 - ♦ They are reliable power source and provide longevity.
- » Must follow guidelines to maintain battery life in LF products.
 - Do not store in high temperature conditions (such as inside a vehicle).
 - Do not use batteries if Open Circuit Voltage is less than 6.0Vdc.
 - Open Circuit Voltage (OCV) is measured after battery has sat without charging or discharging for more than 24 hours.
 - Voltage of 5.7-6.0Vdc might be enough to start up a console, but the battery life has been compromised and might not accept a charge.
 - Make sure that batteries are being properly charged in our applications. This means an average workout (above 50RPM's) time of at least 15 minutes.

Summary – Electrical

- ◆ How do you measure Voltage (Volts)?
- ◆ How can you measure Current (Amps)?
- ◆ How do you check a cable in Life Fitness systems?
- ◆ What conditions damage a 6V Battery in a Life Fitness machine?
- ◆ How do you prevent ESD from damaging boards?
- ◆ Should the DVM be set to AC or DC when measuring voltages in Life Fitness products?

Questions





THANK YOU!

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