Component Testing Using Your Multi-Meter

Residential Equipment for the following brands:

Matrix Retail
Vision Fitness
Horizon Fitness

Multi-Meter

The course introduces the use of a clamp style meter for the testing of equipment

AMPROBE Model - AMP-220 AC/DC Electrical Clamp Meter is:

Required for AC Motor Treadmill Deck Friction Testing (AMP-210 will work as well)
and
Recommended for AC/DC voltage testing and ohms testing

IMPORTANT: If a test requires unplugging wires from the LCB/MCB, ensure the machine is **powered down and disconnect the power cord** from the wall outlet. Please wait for LEDs on the LCB/MCB to completely turn off before performing tests.

Note: *Using a Multi-meter improperly can result in damage to equipment or personal injury. If you are not sure, please seek local guidance before working with a multi-meter.*

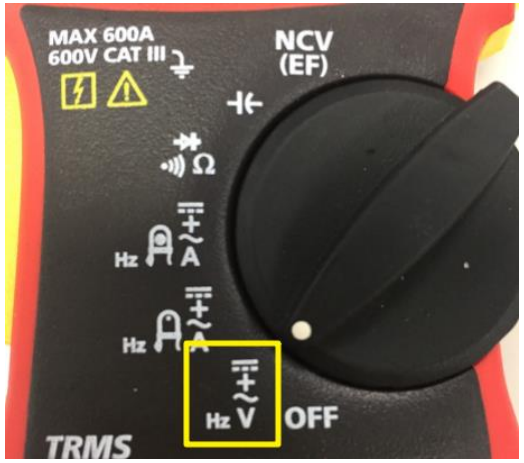
Table of Contents

Receptacle and Power Cord
AC Power

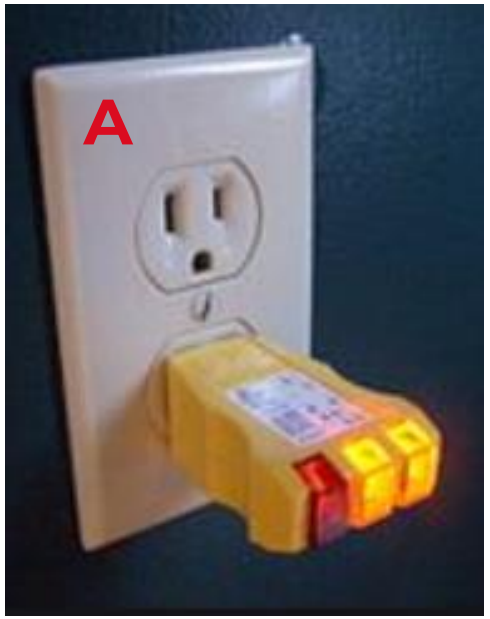
If a receptacle is damaged or suspect, it is the responsibility of the customer to repair or replace.

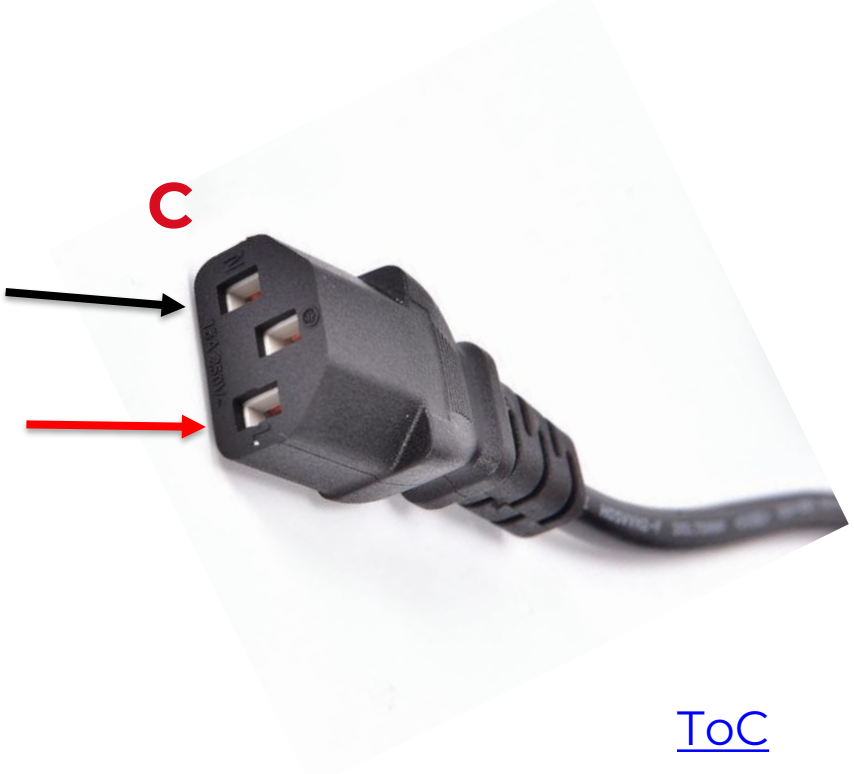
There maybe some instances where you need to verify that the correct voltage is being delivered to a piece of equipment. The safest way to do this is to use a receptacle tester plugged into the outlet (A). You can also use a multi-meter and touch the hot and neutral with your meter probes (B).

With the power cord plugged into the receptable, you can then use your multi-meter to verify the voltage coming through the power cord (C).



Set the meter to AC or VAC V



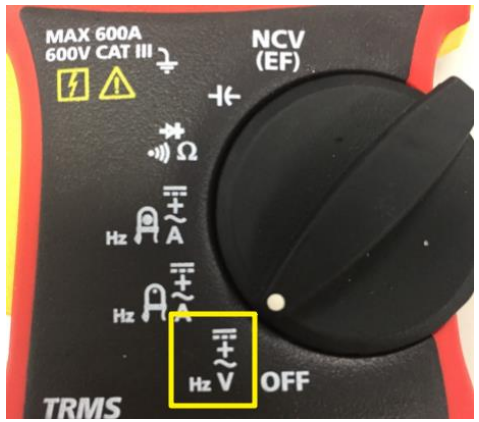


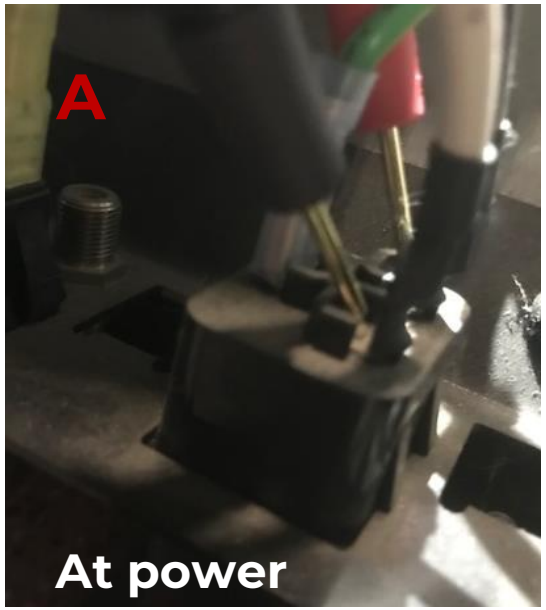
ToC

Tracing Power to the MCB/LCB

AC Power

Set the meter to **AC or VAC**





A – With the power cord plugged in and the power switch on, check the voltage at the power inlet & going into the power filter or MCB/LCB. The meter will display the voltage. To test good, you should get **120VAC (+/- 5%)**

WARNING: Be careful that your probes do not slip off the leads when testing at the power socket as this could cause sparks and cause damage.

B - Connect the Red probe to White wire (AC1) and the Black probe to the black (AC2) wire. *Depending on the unit you are testing the wire harness may look different.*
The meter will display the voltage. To test good, you should get **120VAC (+/- 5%)**

OR

ToC

Console Cable

The console cable goes by several names; console cable, communication cable, data cable. Every machine has a console cable that connects the UCB and LCB/MCB. This cable supplies power to the console and relays communication between the console and LCB/MCB.

This cable has 2 primary functions:

1. Supplies the console with voltage for power
    - Perform a Voltage Test on the cable but also know you need to test the wall outlet, power cord and power to the LCB/MCB to ensure the cable is getting voltage to send through the cable to the console.

2. Supplies communication from the console to the LCB/MCB when buttons are pressed; speed increase/decrease (drive motor), resistance increase/decrease (resistance motor, induction brake, ECB), and safety key is enabled (treadmills)
    - Perform a Continuity Test on the wires within the cable to check for breaks in the wires.

ToC

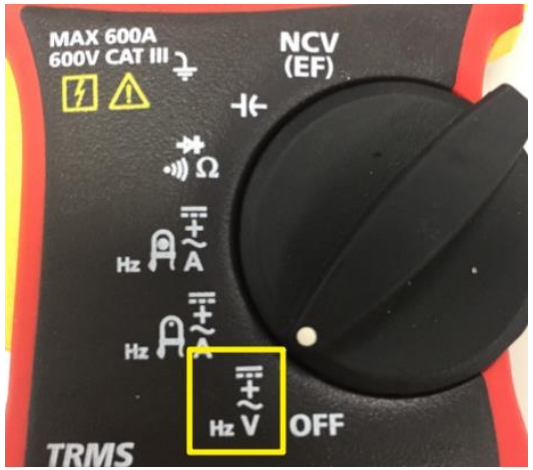
Console Cable Voltage Test

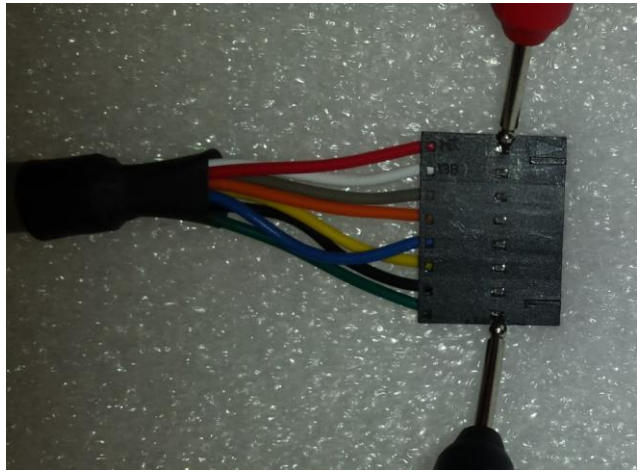
DC Voltage

Check the voltage <u>at the console end</u> of the cable

1. Set the meter to **DC or VDC** ⎓
2. At the console end of the cable, use a multi-meter and touch the Ground and Voltage Pin. Your reading should be read a minimum of **12VDC.**

A reading between 11-13VDC is okay. It may mean your meter hasn't been calibrated or is out of calibration.





Refer to the pin reference on the following slide for the console cable you want to test.

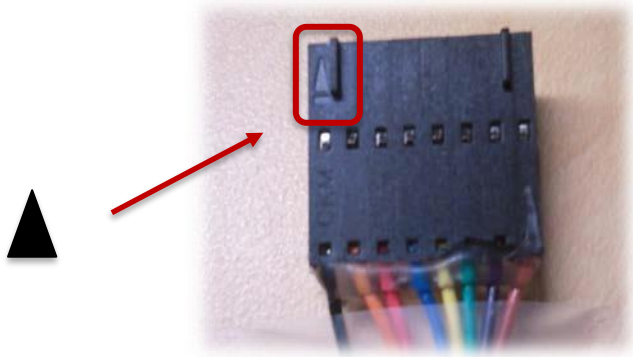
ToC

Console Cable Specs

8-Pin Digital Console Cable

Pin#	Description	Voltage (VDC)
1	DC power input	+12
2	DC power input	+12
3	Communication (MCB and console)	-5 ~ +5.0
4	Safety key signal	Open drain, +5.0 based on system design
5	Safety key signal	Open drain, +5.0 based on system design
6	Communication (MCB and console)	-5 ~ +5.0
7	Ground	0.0
8	Ground	0.0

Important: Pin 1 is always indicated with a triangle next to it.



9-Pin Digital Console Cable

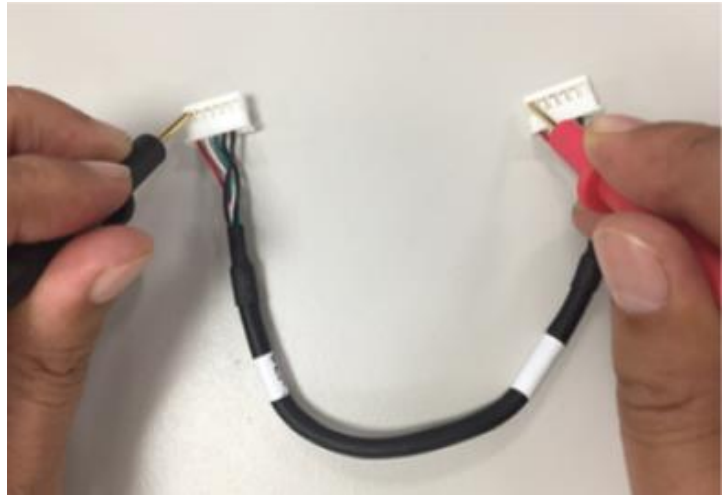
Pin#	Description	Voltage (VDC)
1	DC power input	+12
2	Ground	0.0
3	Incline motor position counter	0 ~ +5.0
4	Incline up signal	0 ~ +5.0
5	Incline motor 0 position	0 ~ +5.0
6	Incline down signal	0 ~ +5.0
7	Front roller RPM	0 ~ +5.0
8	Safety key signal	0 ~ +5.0
9	Drive motor speed	0 ~ +5.0 at 225Hz

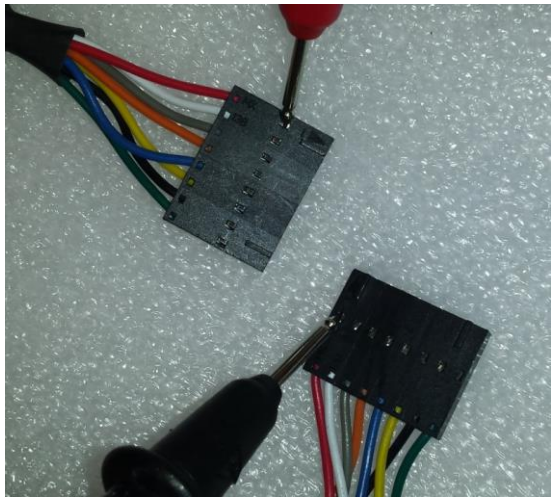
ToC

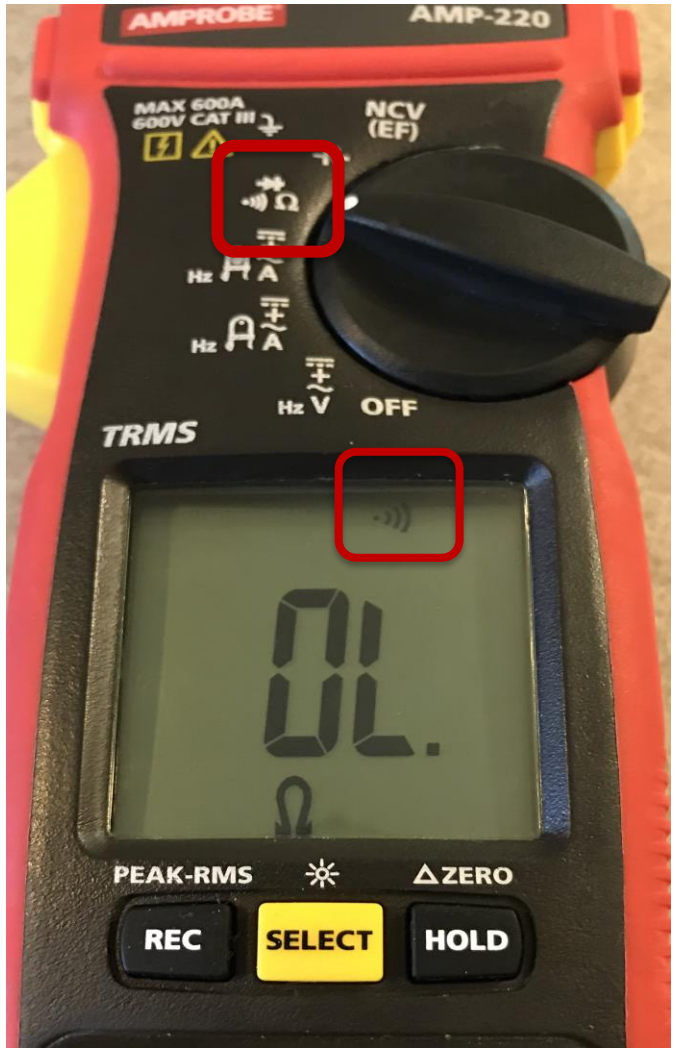
Continuity Test
Testing each wire in a cable

A simple continuity test can easily help to diagnose a break or short in any cable.

1. Power off the machine.
2. Turn the dial on your meter to “**Resistance, Continuity & Diode**”
3. Press select on the meter until the sound icon is shown
4. Disconnect the cable you want to test at both ends
5. Connect the Red & Black probes to meter.
6. Touch both ends of each wire within the cable with the probes.
7. The meter will beep if the wire is good (no breaks in the wire).
8. Repeat for each wire in the cable.
9. If you do not get a beep and have made good contact with your probes, replace the cable.







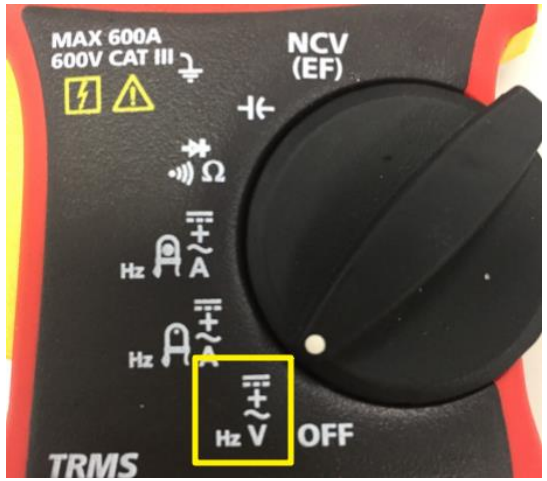
ToC

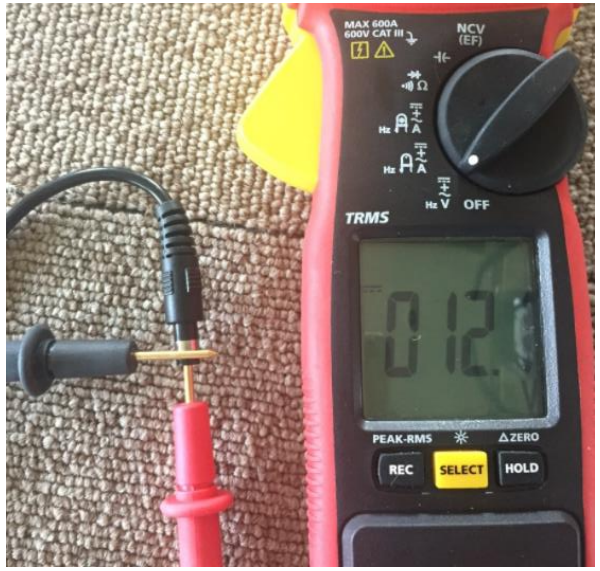
DC Transformer (Power Supply)

DC Voltage

Some bikes and ellipticals will have a power adapter as part of the power cord. Each adapter will be labeled with the voltage output. Use your meter to test the function.

1. Set the meter to **DC or VDC**
2. Insert the Red probe into the barrel.
3. Touch the Black Probe to the outside of the barrel
4. The voltage will be displayed and should match the rating on the transformer.





A reading between 11-13VDC is okay. It may mean your meter hasn't been calibrated or is out of calibration.

ToC

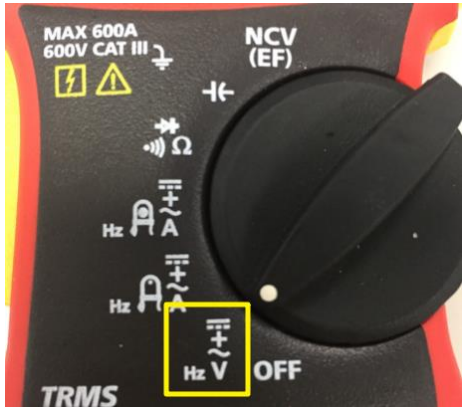
Frame Battery
DC Voltage

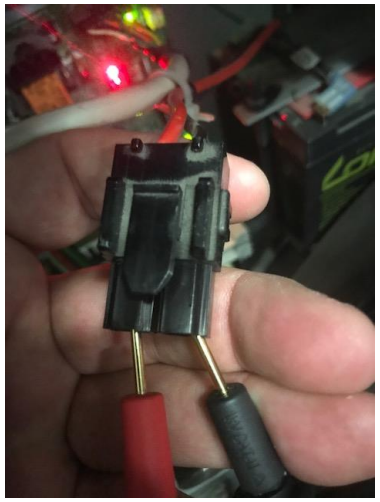
Frame batteries are only found in product that can be used in self-power mode and not plugged into a receptible.

Symptom of a low battery: The console powers up but shuts off as soon as the user stops pedaling (or reverses direction)

- If the battery is rechargeable and half the voltage it is capable of, plug the unit into a wall/floor outlet over night to recharge
- If the battery is not rechargeable, replace it if the voltage is less than half the total output
- If battery tests good, this means the LCB is not regulating the power correctly and the LCB should be replaced

1. Set the meter to **DC or VDC**
2. Connect the Red & Black probes to meter.
3. At the battery, touch the Red probe to the Positive terminal and the Black to the Negative terminal.
4. The battery wire at the LCB, touch Red probe to red and Black probe to black
5. The meter will display the voltage.



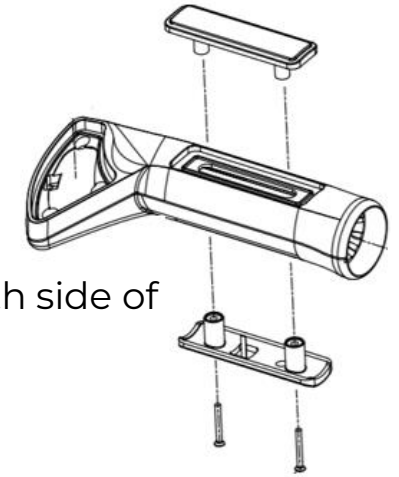


ToC

Heart Rate Grips
Identifying

Heart rate contacts on the grips have 2 plates. When there are 2 plates, sometimes they are both on the same side of the grip and some have 1 plate on each side. Each plate is part of a circuit. If both plates are not being touched by the user, no HR will be displayed. If both plates are being touched by the user, use a multi-meter to test the circuit. If test passes, then the issue most likely is from the heart rate board.

HR plates on both side of grip



HR plates on 1 side of grip

Not getting a heart rate reading?

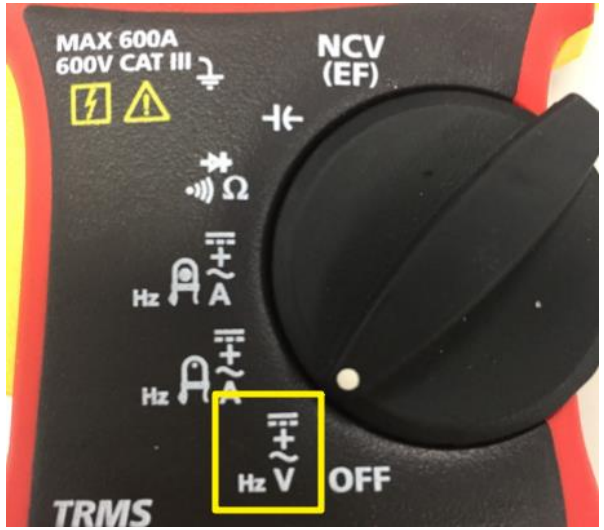
- Is user contacting the top and bottom HR plates?
- Cold and/or sweaty/wet hands can cause no HR reading
- Lotion on hands can cause no HR reading
- Poor circulation in the hands can cause no HR reading
- Fluorescent lighting can cause “ghost readings” meaning no one will be touching the grip plates but the console will show as it is trying to read HR

ToC

Heart Rate Plates
Testing

1. Set the meter to **DC or VDC**
2. Connect the Red & Black probes to meter.
3. Touch the Red probe to the Positive terminal and the Black to the Negative terminal.
4. If the meter displays the voltage between **0.5 – 2 VDC**, the grips are good. If you get a negative reading, reverse the plates your probes are touching.
    - If you get a reading below 0.5, remove the plates from the grip but leave connected to the wires and measure again. Dried sweat around the plates may cause a short which would give you no reading.

If HR plates test good, next test the heart rate board (see next slide)



ToC

Heart Rate Board

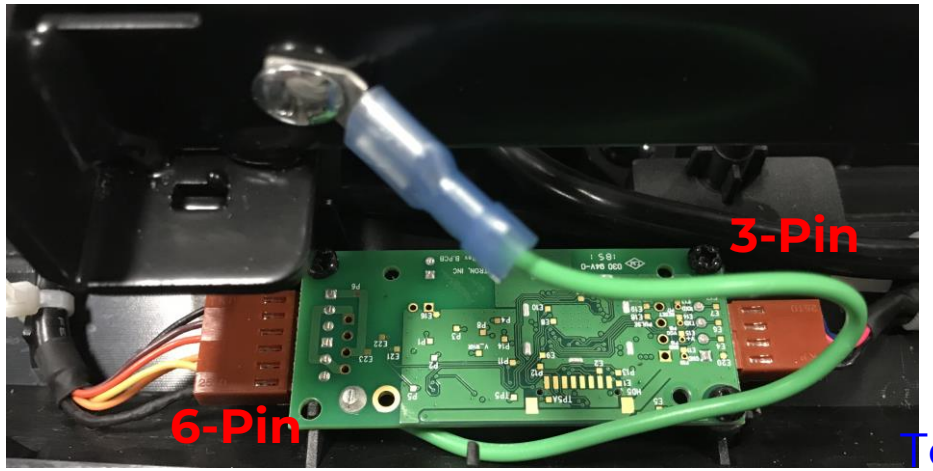
Turn the dial on your meter to “**Resistance, Continuity & Diode**”

Verify the HR board ground wire

1. With a multi-meter set for ohms, place one prong on the HR board ground wire, and the other on the console ground screw.
2. You should get a resistance reading of 1 or less ohm.
3. If you get a reading over 1 ohm or no reading at all, replace the HR board.

Check the continuity of the wire that goes from the HR board to the console

1. With a multi-meter set for ohms, place one prong on the 3-pin wire connecting to the HR board and the other on where this wire connects to the console.
2. If you get a reading of over 1 or no reading at all, replace this wire.



ToC

Speed Sensor
ICR50 Cycle

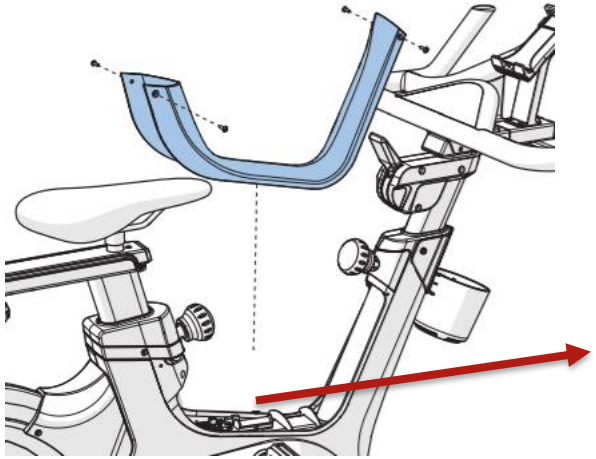
You can use your multi-meter to check the speed sensor if no RPM registers on the console.

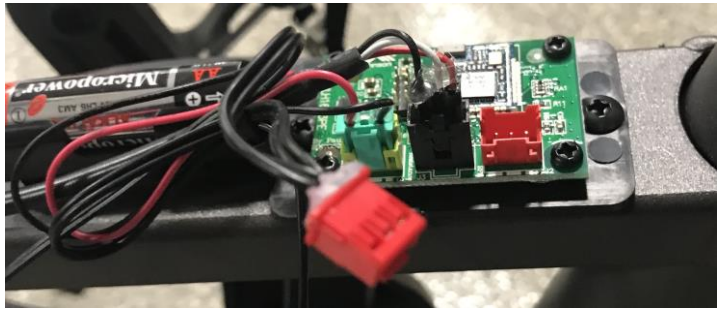
Turn the dial on your meter to "**Resistance, Continuity & Diode**"

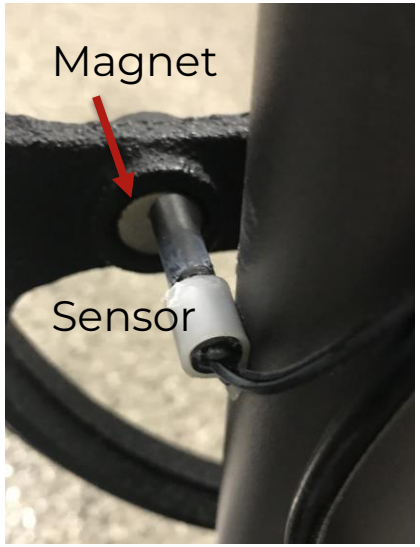
Console

Select the sound option on your meter.

1. Disconnect the red connection from the board
2. Touch your meter probes to the cable wires
3. Turn the pedal so the magnet passes the sensor
4. If the cable is good, the meter will beep as the magnet passes the sensor
    - If RPM is still not showing on console, check battery voltage.
    - If battery voltage is good, replace board.







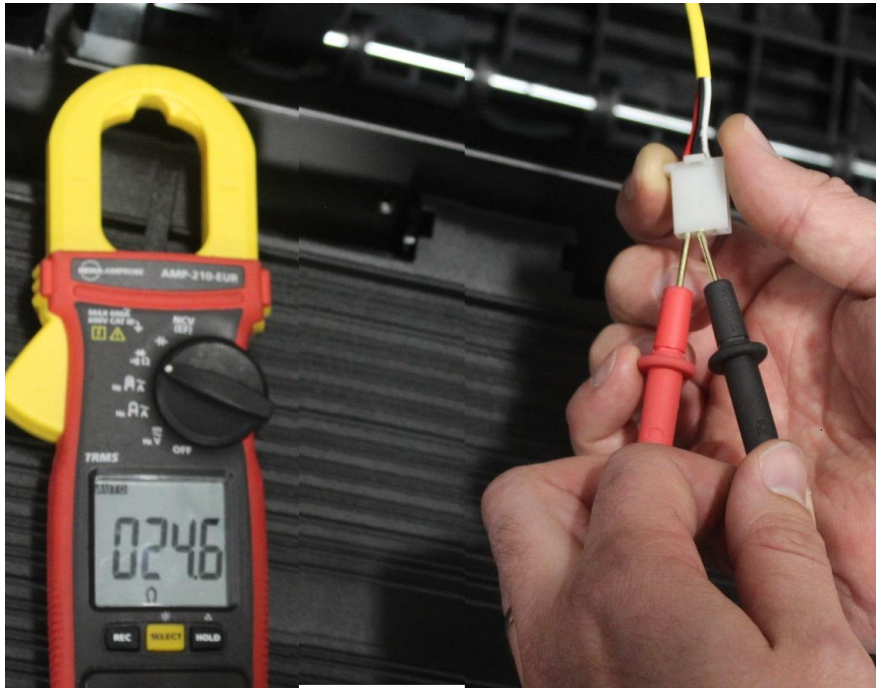
ToC

DC Brake

SN Prefix: CS38

This DC brake is found in the Matrix Retail ClimbMill attached to the Induction Brake. This holds the induction brake axle in place so the user can climb onto the stairs without having them move. Once the user presses go, the brake releases and the Induction Brake takes over keeping the stairs steady.

1. Unplug the DC brake wire (usually the yellow wire)
2. Turn the dial on your meter to "**Resistance, Continuity & Diode**"
3. Test using the Red and Black wires on the DC brake
4. Tests good at **24.6 ohms (+- 10%).**



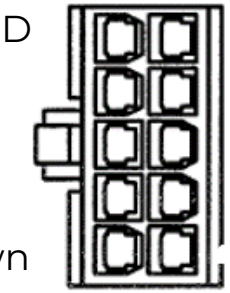
ToC

Incline Motor – Limit Switch

If any tests fail, you will need to replace the incline motor.

Testing the incline motor windings
Power off the machine and disconnect the incline motor wire. Red/White and Black/White should be **36ohms (+/- 10%).**

Testing the limit switch
Power off the machine and disconnect the incline motor wire. Measuring continuity, Red probed to Blue & Black probed to Brown, should be **open (OL)** normally. Depress the limit switch, should read continuity.

Brown / GND		VCC / Orange
Blue / Zero		Count / Green
NA		NA
Red / Up		NA
Black / Down		AC / White

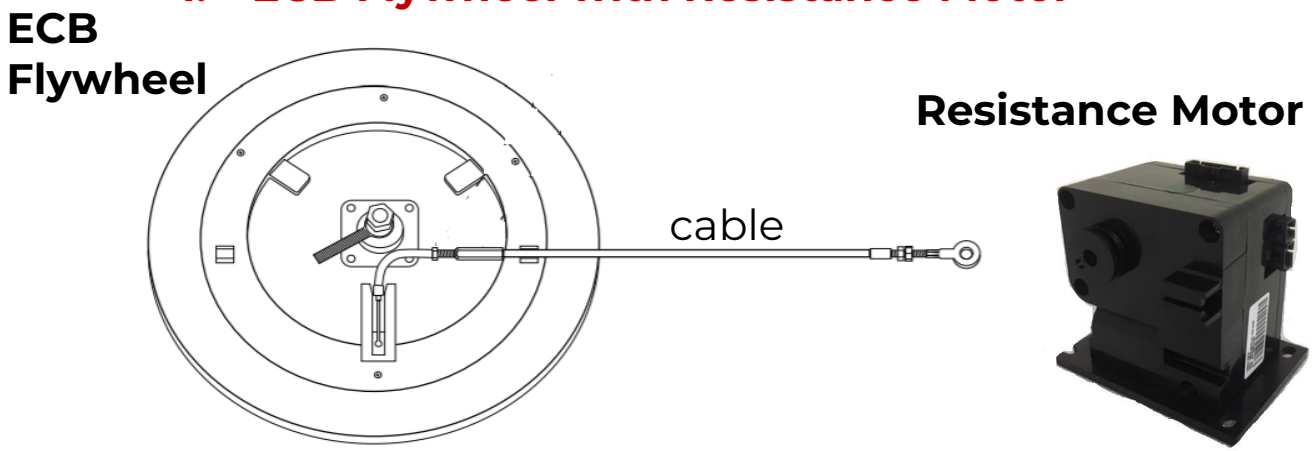
Incline Motor Part #:
This is not an exclusive list. Other part numbers may apply:
1000101465
1000391680
1000400744
1000400147

ToC

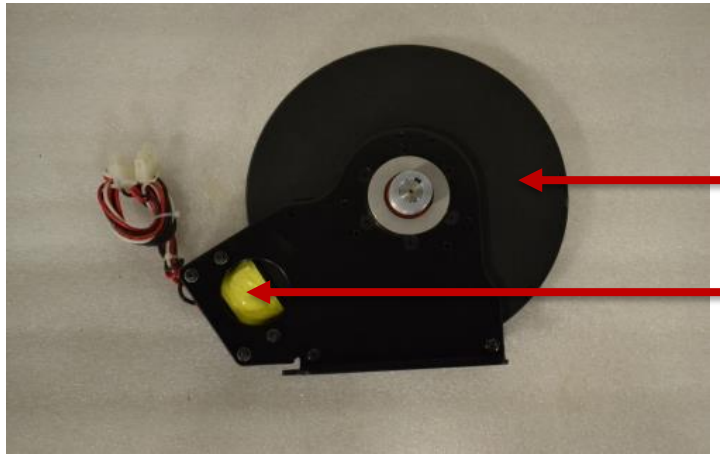
Resistance Systems

Residential product uses 1 of 3 types of resistance systems.

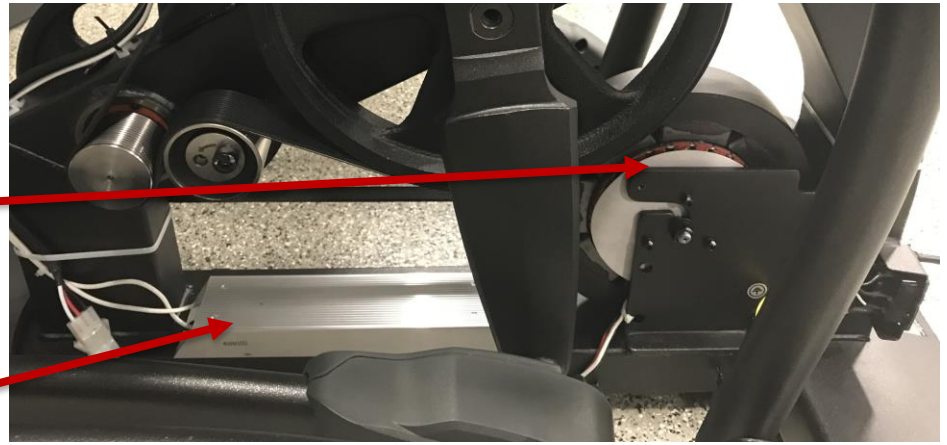
1. ECB Flywheel with Resistance Motor



2. Induction Brake



3. Generator & Resistor

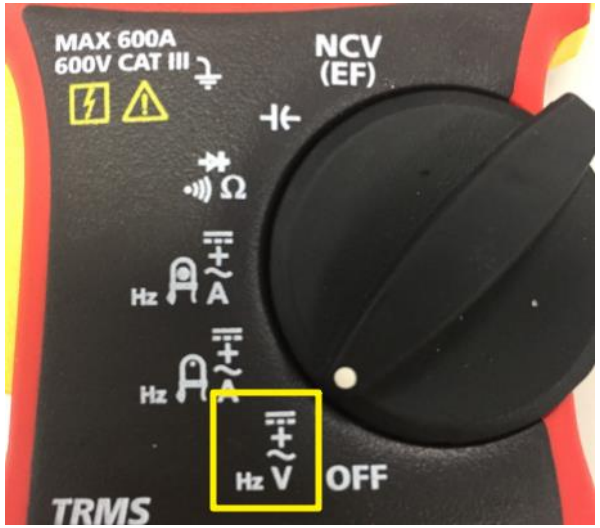


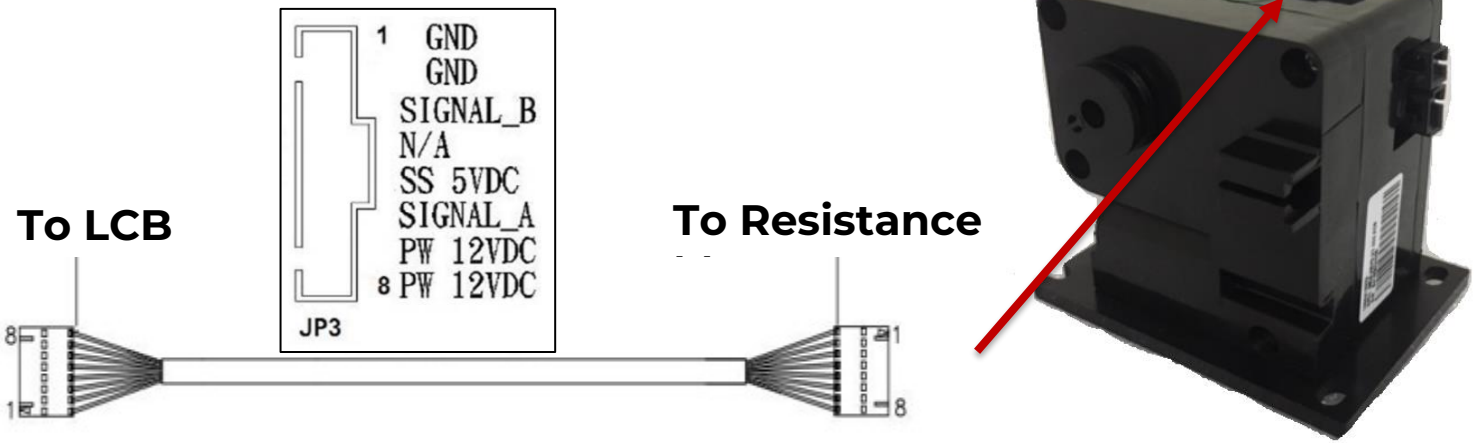
ToC

ECB Flywheel with Resistance Motor

There is a steel cable that connects the resistance motor and the ECB. When resistance is pressed by the user, the resistance motor wheel the cable attaches to turns which moves the magnets in the ECB closer to the flywheel.

1. Set the meter to **DC or VDC**
2. Connect the Red & Black probes to meter.
3. Touch the probes to pin 1 & 8 (2 outside pins)
4. If the meter displays the voltage between **12VDC**, resistance motor is getting enough power
5. If the meter does not display 12VDC, perform a continuity test on the wires within the cable.
    - If tests good, replace the LCB
    - If test fails, replace the resistance motor





ToC

Resistance Motor
Speed Sensor Cable

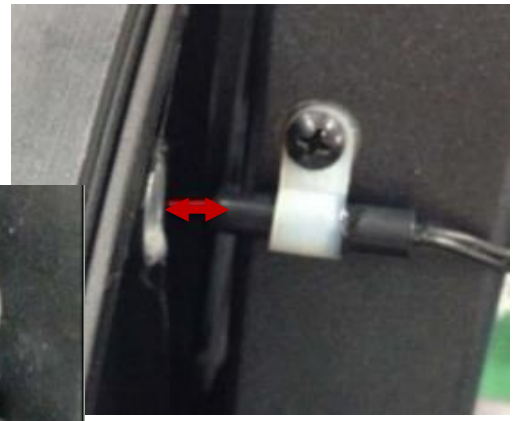
Other wires plugged into the resistance motor are a speed sensor cable and power cable. Follow the instruction below to test the speed sensor cable and position.

Speed Sensor Cable (RPM issues)

1. Turn your multi-meter setting to Ohms.
2. Disconnect the black speed sensor wire from the front of the resistance motor.
3. Put one lead into the Pin 1 and the other on Pin 2. Turn the crank so the speed sensor crosses the magnet on the flywheel, and you should get a variable resistance to test good. If not, check the distance of the speed sensor from the magnet and test again.

Ref #	Connection
1	Speed sensor
2	Power adapter
3	Console cable

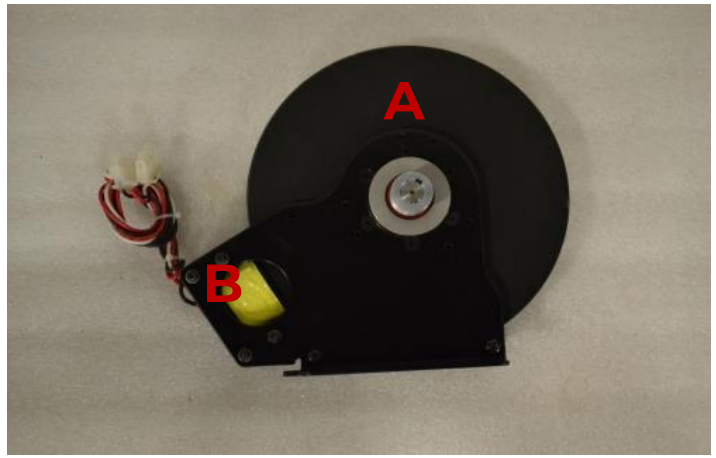
< 5mm distance



ToC

Induction Brake (ECB)

An Induction Brake is made up of 2 components. A generator and an ECB coil (magnet).



A - 3 Phase Generator

B - ECB Coil

ECB Testing

- Find the ECB plug at the LCB.
- Turn the dial on your meter to "**Resistance, Continuity & Diode**"
- Measure pins 1&2. There should be between **12.8 – 14.2 ohms**.
- If out of range, replace the ECB.
- If in range, replace the LCB.

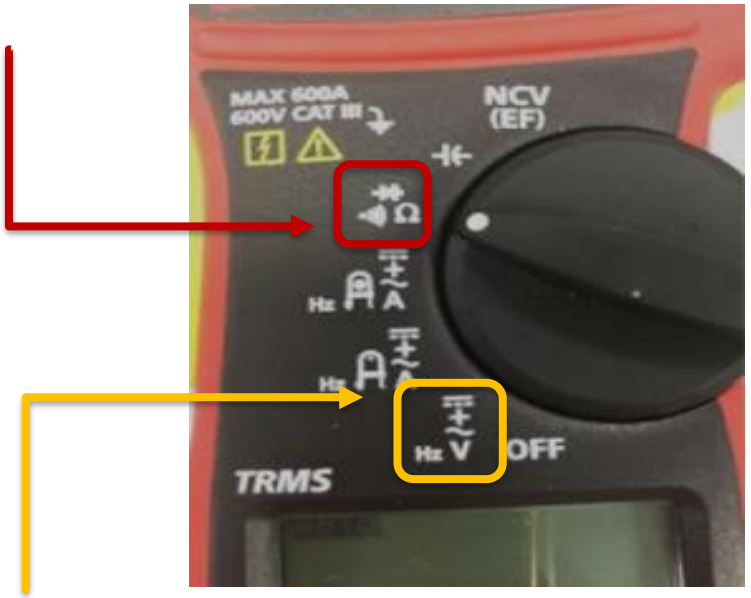
If the ECB tests good, test the generator (see next slide).

ToC

Generator

Resistance & Voltage

1. Set the meter to "**Resistance, Continuity & Diode**"
2. Power down and unplug from the power source
3. Connect the Red & Black probes to meter.
4. Touch the probes to pins 1&2, 1&3 and 2&3.
5. The meter will display the ohms. The generator tests good when **values are equal** between any combination of 2 wires.



No RPM readout? The LCB reads the voltage output from the generator to determine speed.

- Set the meter to **AC Voltage** and touch the probes to pins 1&2, 1&3 and 2&3 in sequence while spinning the generator.
- If **voltage is variable** (voltage should change based on how fast the generator is spinning), then the generator is good. If any of the three pairs shows no voltage, then the generator is bad.

ToC

10ohm Resistor

1. Turn the dial on your meter to "**Resistance, Continuity & Diode**"
2. Power down and unplug from the power source
3. Connect the Red & Black probes to meter
4. Touch the 2 wires at the connector
5. The resistor tests good when ohms value is between **8-10ohms**

Assuming resistance is off or non-existent:

- If reading is less than 8 ohms, replace the resistor
- If reading is over 10 ohms, replace the LCB

Note: *An open circuit or infinite ohms would be a case to replace the resistor.*

Resistor

ToC

Treadmill Motors

Residential treadmills will either have an DC or AC drive motor. It’s important to know what you are working with so you can properly test the motor.

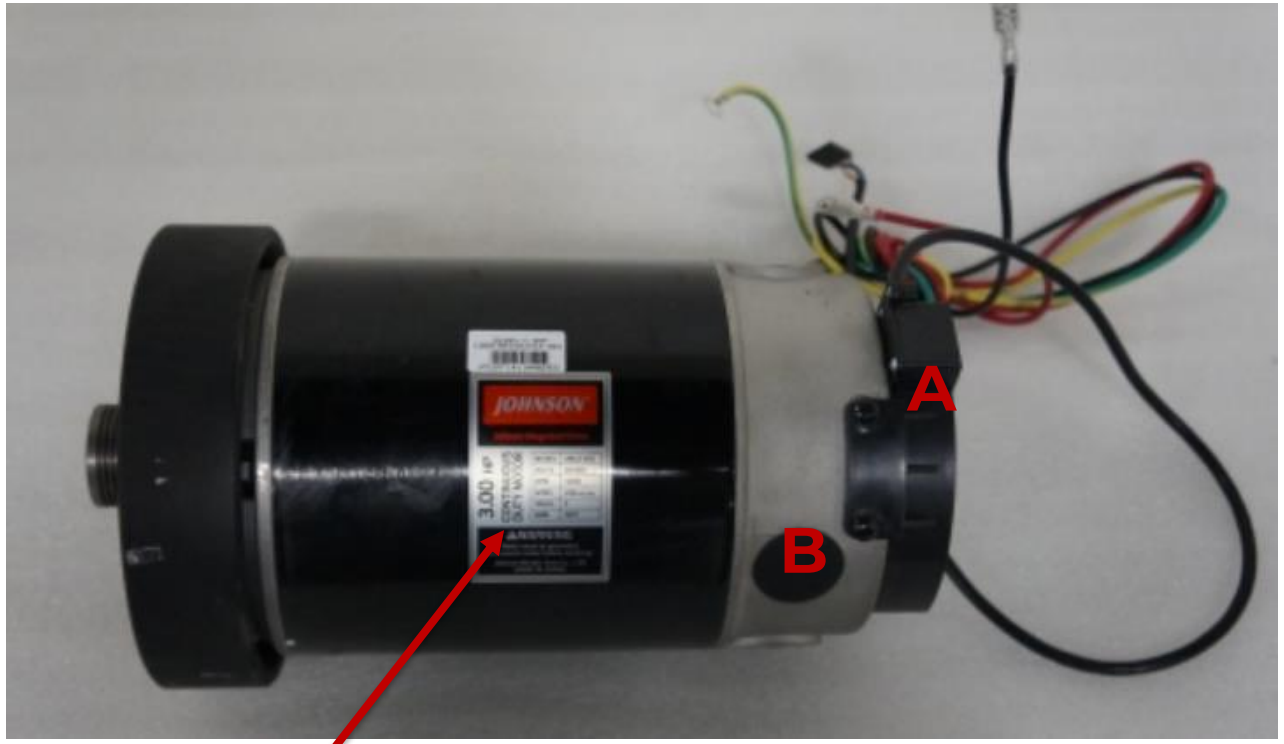
DC Motor

AC Motor

ToC

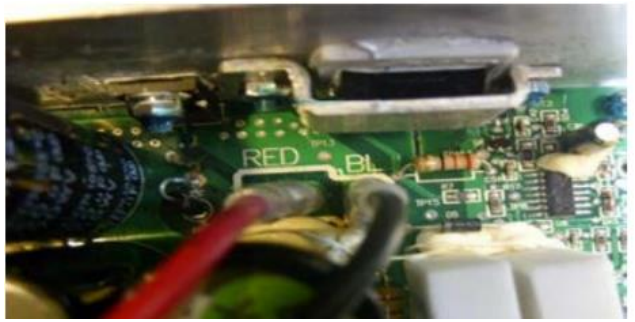
DC Treadmill Motors
Identifying

DC motors have a few unique features an AC motor will not have
A - Speed sensor – communicates RPM (speed) back to the MCB
B - Commutator brush/spring – if this brush/spring is burnt and or the commutator is dirty, it can cause the motor to not work properly. Refer to Cleaning a DC Drive Motor instruction in Online Remedy for more details.



The label on the motor will also indicate if the motor is AC or DC

The wire harness on DC motors consists of a black and a red wire with spade connectors. These wires connect directly to the MCB.

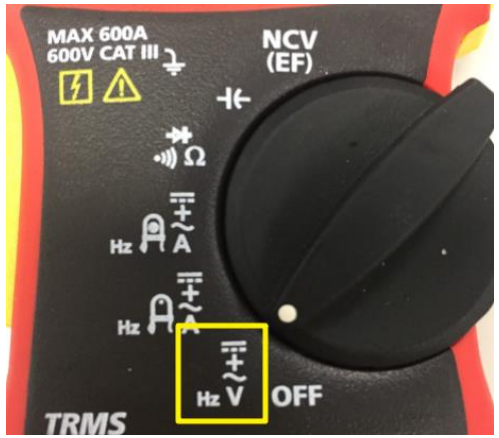


ToC

DC Treadmill Motors
Testing

Voltage Test

1. Power off the treadmill and disconnect the power cord.
2. Unplug the motor from the lower board.
3. Attach meter leads directly into the motor leads (red to red and black to black) and manually spin the running belt or motor flywheel.
4. The motor should generate **variable DC voltage** depending on the speed it is turned.



Resistance Test

1. Power off the treadmill and disconnect the power cord.
2. Unplug the motor from the lower board.
3. Using an ohm meter, attach meter leads directly into the motor leads (red to red and black to black)
4. Any reading **below 10 ohms** means the motor tests good.

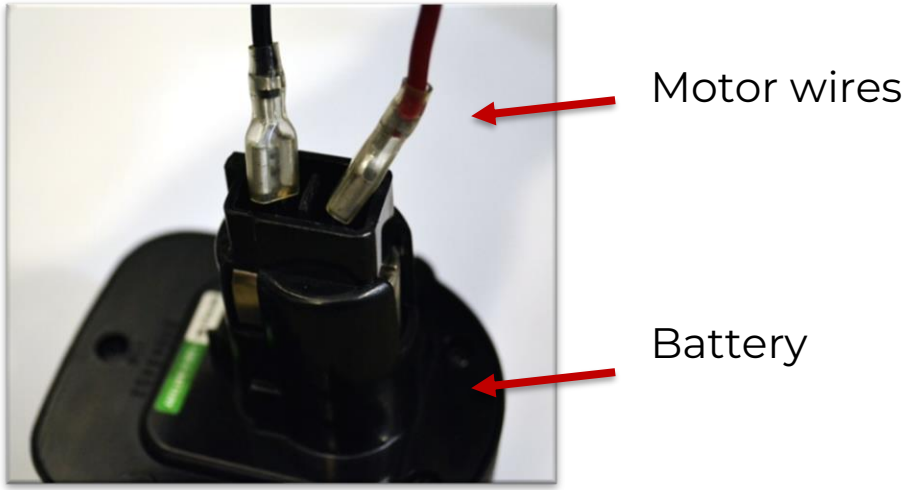
ToC

DC Treadmill Motors

Testing Without a Multi-meter

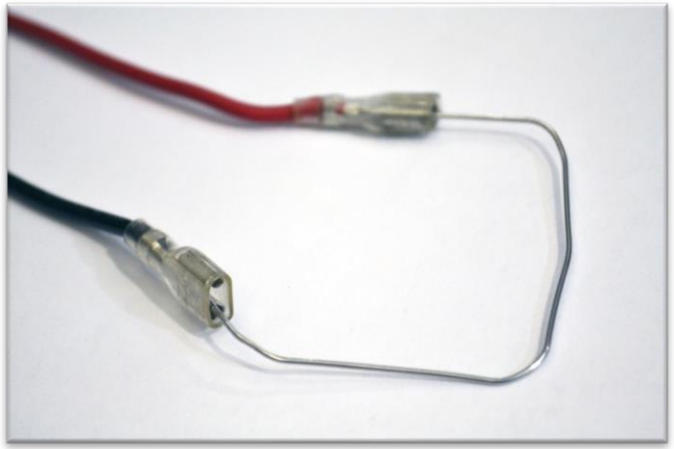
Voltage Test using a battery

1. Power off the treadmill and disconnect the power cord.
2. Unplug the motor from the lower board.
3. Touch the motor wires to a charged 12-24V battery.
4. The motor should start, and the running belt should begin to move.
    - If it doesn't move, replace the motor



Resistance Test using a paperclip

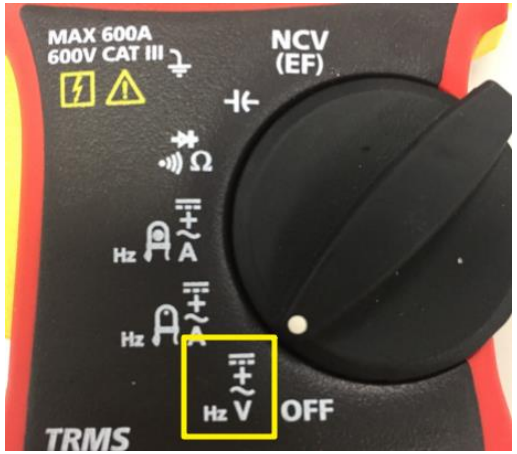
1. Power off the treadmill and disconnect the power cord.
2. Unplug the motor from the lower board.
3. Connect the motor wires using a paperclip
4. Turn the motor flywheel with your hand, you should feel some resistance.
    - Test without the paperclip between the wires to feel the difference.



ToC

DC Treadmill Motors

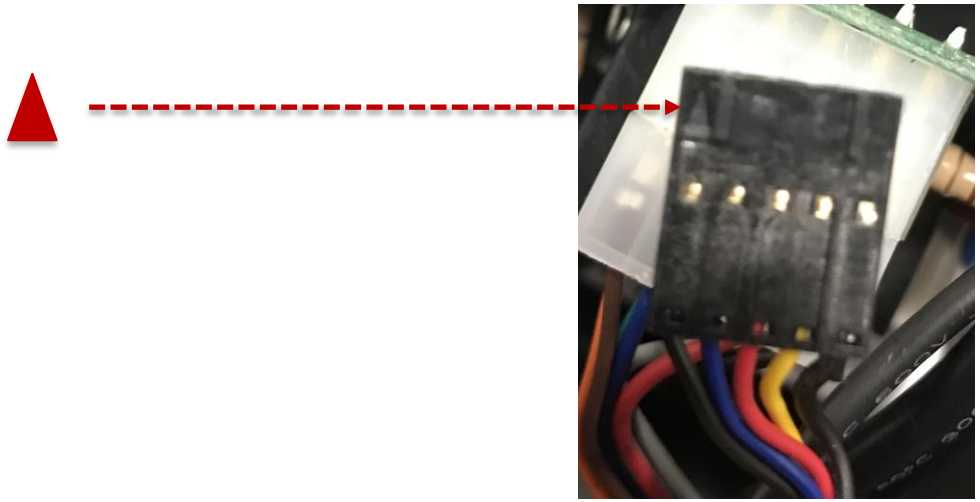
Speed Sensor Wire Testing

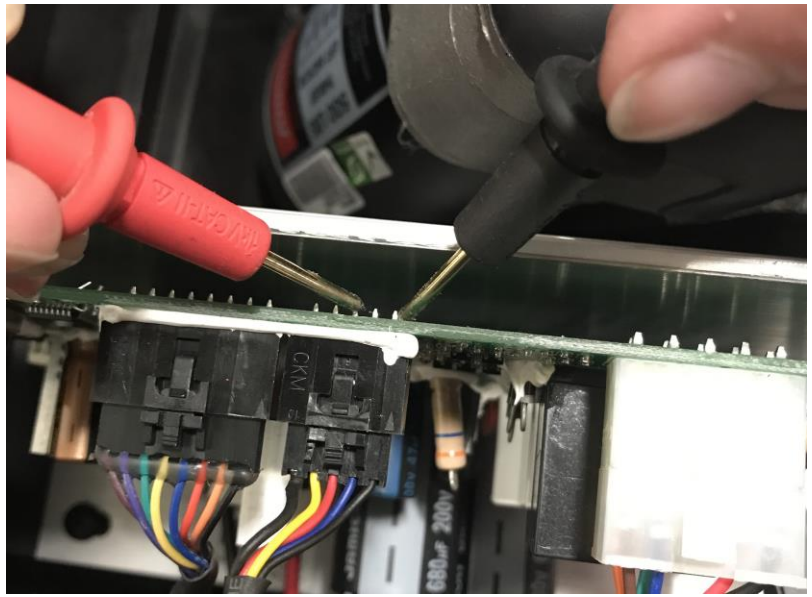


Voltage Test

1. Power off unit and disconnect the power cord.
2. Unplug the speed sensor to identify Pin 1 then plug it back into the MCB.
3. Power on the treadmill
4. Attach meter leads directly to Pin 1 and 3 from the back of the MCB
5. You should receive **5VDC (+/- 10%)**

Important: Pin 1 is always indicated with a triangle next to it.

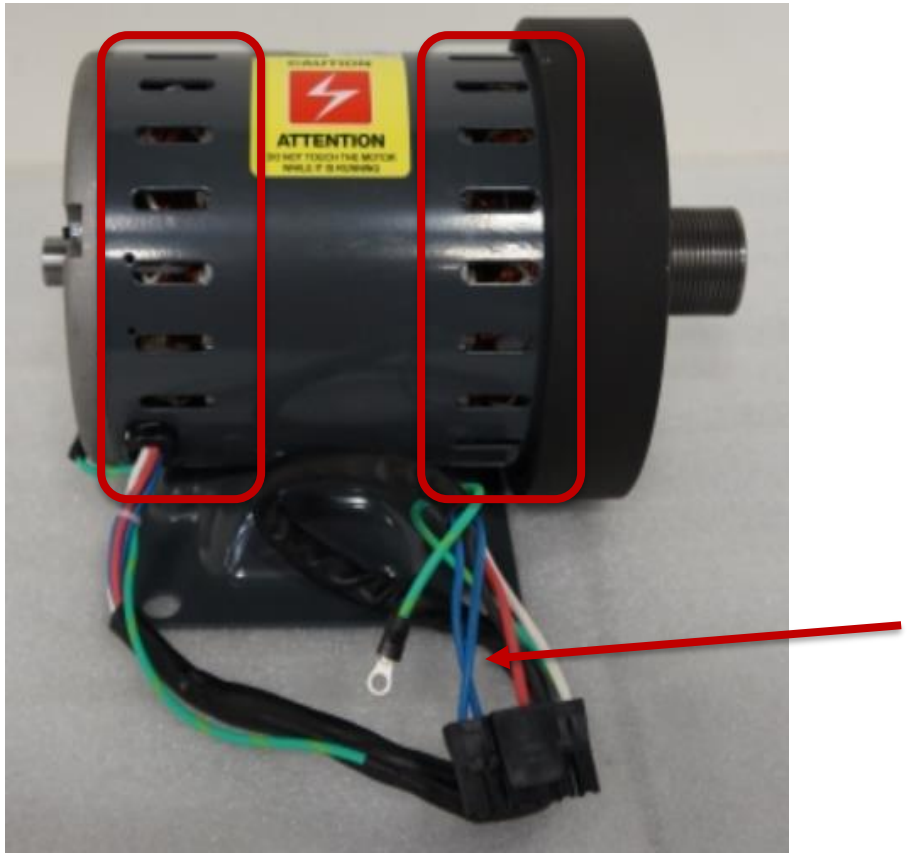




ToC

AC Treadmill Motors
Identifying

AC motors are easily identified by having slots around the motor housing. AC motors will not a speed sensor or commutator.

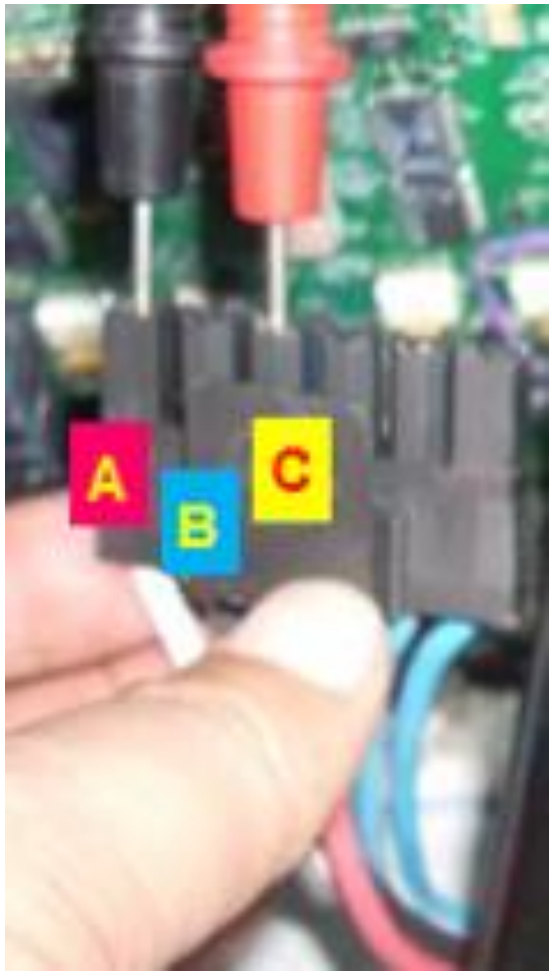


The AC motor (alternating current) can overheat if the air movement slots on the motor are not cleaned out or if the power coming into the treadmill is bad or being shared. Because of this, the motor has a thermal switch in it which turns it off if this should occur. The blue wires on the wire harness are for this switch. If you see these blue wires, you can be certain you are working with an AC motor.

ToC

AC Treadmill Motors
Testing

1. Power off the machine and unplug from the wall
2. Disconnect the motor cable from the MCB.
3. Turn the dial on your meter to "**Resistance, Continuity & Diode**"
4. Connect the Red & Black probes to meter.
5. Use the probes to test each of the 3 motor coils –A,B & C
6. Test A-B, A-C & B-C. Each result should be **under 2.5Ω**
    - If significantly higher readings or OL is displayed, a coil may be bad



ToC

AC Treadmill Motors

Testing - Temperature

If the motor gets too hot, the thermal switch will open. At that time, the console will display an error code. This could happen from over-use/hard-use or because there is an issue with the power feeding the treadmill.
If this happens, test power at receptacle & power cord and trace power to MCB then perform a friction test for belted treadmills If all test good, allow the motor to cool, the thermal switch will close meaning a reading of 2 or less Ohms should be measured on the blue wires which will allow the motor to work normally - see steps below.

1. Disconnect the motor cable from the MCB
2. Turn the dial on your meter to "**Resistance, Continuity & Diode**"
3. Connect the Red & Black probes to meter
4. Place both probes on the blue wires on the motor cable
5. There should be an Ohm reading **2 or less**
    - If there is an Ohm reading above 2, replace the motor.
    - If the Ohm reading is less than 2 and the unit is receiving the over temperature error code, replace the MCB.

Note: Unless you have good contact with the meter probes and each blue wire, you may get a false reading. Ensure you have good contact before deciding on what to do next.

ToC

Friction Test

Treadmills using AC Motors & Waxed Running Surfaces

The friction test was developed to help determine running deck and belt wear and if it is causing electrical breakers to trip. Friction Testing is only set up for treadmills utilizing AC drive motors and a waxed running belt/deck.

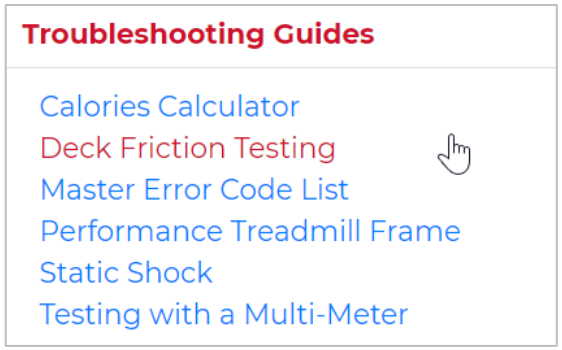
A friction test is required to be performed to determine if any parts are needed under the product warranty period.

When should a friction test be performed?

- If lumps appear on the rear roller
  - This is caused by dust mixing with the heated wax then sticking to the rollers reducing the life of the deck/belt
- If the treadmill or wall panel breaker trips
- When the treadmill mileage accumulates approximately 18,000 miles
- If the console throws a “motor over current” error code
- If the appearance if the deck or belt show wear
  - See Deck and Belt Condition page

Go to Online Remedy > Videos to watch a friction test being performed.

Please refer to the Deck Friction Testing instruction found in Online Remedy.



ToC

Running Deck and Belt

Treadmills using DC Motors & Silicone Running Surfaces

The friction test used on treadmills with AC motors and waxed running surface can not be performed on treadmills with DC motors and a silicone running surface. Determining replacement for the deck and belt will be determined by look and feel. Without maintaining the lubrication schedule for the treadmill, the deck/belt may wear out more quickly than if properly maintained. There are several ways that will show when it's time to replace a running belt, a running deck or BOTH.

- The most common issue is to see white dust or nylon fabric at the rear of the machine, underneath the deck, and around the rollers – replace belt
- Excess heat from friction could cause the running belt to rip and split in half – replace belt
- Excess heat from friction can cause the underside of the running belt to discolor (dark brownish in color) – replace belt
- Excess heat from friction can cause the top layer of the deck to wear through exposing the wood (brown). This most likely will cause belt damage as well – replace deck and belt

The next page will show you images of good and bad decks and belts.

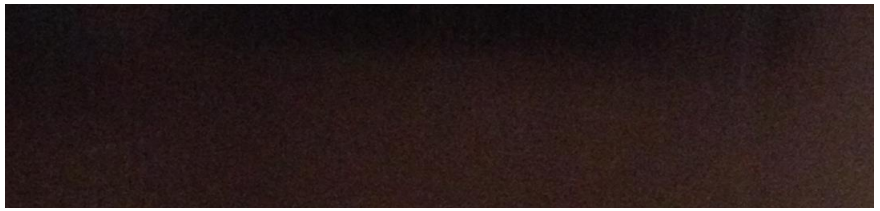
Refer to Online Remedy for instruction on when and how to apply silicone for the model of treadmill you have.

ToC

Running Deck and Belt Condition

Use this as a reference to compare your deck and belt against. If any signs of wear appears, apply silicone oil as directed or contact Customer Technical Support to place an order.

Surface of the running deck



Good – black in color, surface is shiny and smooth to the look and touch

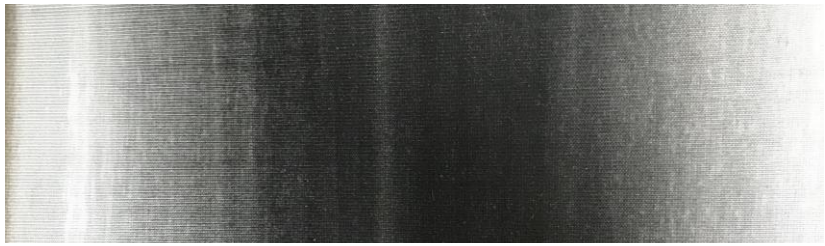
Bad – showing grooves you can see and feel

Bad – showing dull marks you can see and feel.

Underside of the running belt

Good – white in color and no material peals or burn marks. Slight discoloration is normal

Bad – burn marks/lines are starting to appear



Bad – majority of material is black/dark brown in color

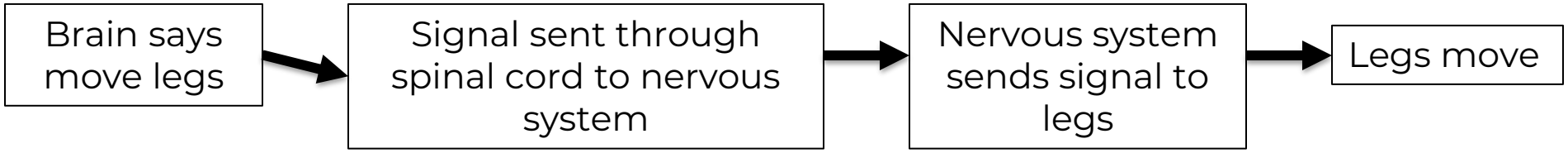
ToC

Fitness Equipment 101

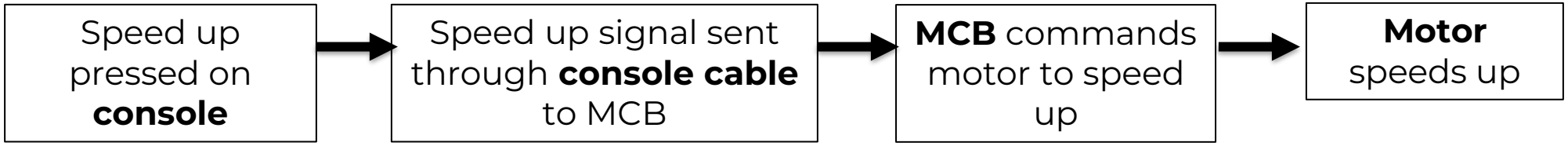
Using the human anatomy, I will describe an easy way to understand how fitness equipment works. Once you understand this, it may make make power and component testing easier to understand. No matter what a piece of fitness equipment looks like, the basic functions are all the same. Always start troubleshooting where the command comes from (console) and go downstream from there.

UCB (upper control board) / Console = brain
Console cable = spinal cord
LCB (lower control board) / MCB (motor control board) = nervous system
Components (drive motor, incline motor, resistance systems) = arms and legs

Human body



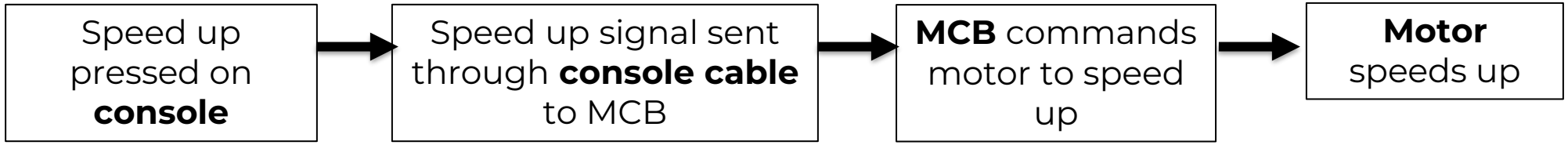
Treadmill



ToC

Fitness Equipment 101

Treadmill



Using the example above:

Console
- Does it have enough power (perform voltage test on the console cable)
  - No – check power from wall through power cord to MCB
- Are keys/buttons working (perform a keypad test through the console)

Console Cable
- Are you getting proper voltage at the console (perform voltage test on the console cable)
- Is communication getting to MCB (perform continuity test on console cable)

MCB
- Check frame troubleshooting guide/service guide for MCB LED light responses

Motor
- Test motor (voltage, ohms and resistance tests)

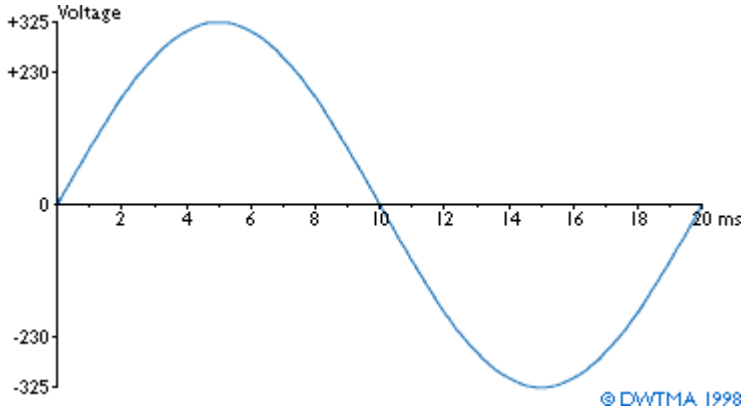
ToC

Understanding Voltage - AC & DC

DC voltage is found in cardio product anywhere past the LCB/MCB. Everything leading up to that point is AC voltage.

It is important to understand the difference between AC current and DC current.

AC = Voltage that changes polarity (direction) several times per second (cycle).

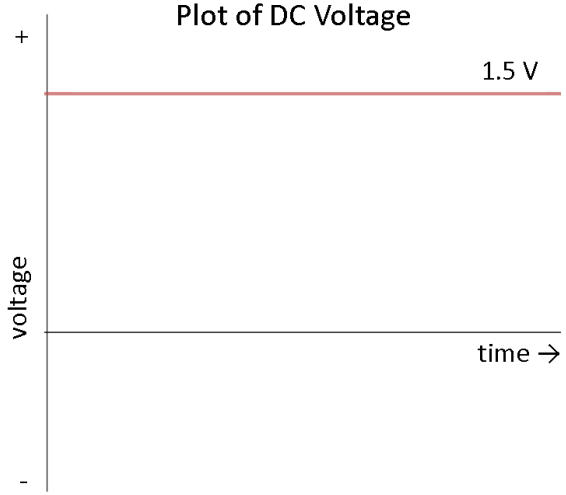


This AC sine wave shows 1 cycle – see how the voltage increase to its peak **positive** charge and then decreases until it reaches zero. At this point the flow of current (polarity) changes and the **negative** charge increases and then decreases to zero.
In most parts of the world, this **cycle** happens 50 or 60 times per seconds and is known as the **frequency.** The frequency is measured using the unit **Hertz (Hz).**

=AC

DC = Voltage that has a steady polarity.

This DC sine wave shows that the direction of current does not change.
The voltage may drop over time as the power source depletes but the path of the current will remain unchanged.



=DC

ToC

Electrical DO NOTS

Always plug fitness equipment directly into the power source (wall outlet).

DO NOT plug fitness equipment in using an extension cord, surge protector or GFCI outlet.

ToC

Acceptable Electrical Outlets

Standard 15A outlets can be used for most fitness equipment. Some retail treadmills however may require a 20A NEMA outlet. See product Owners Manual for specific requirements.

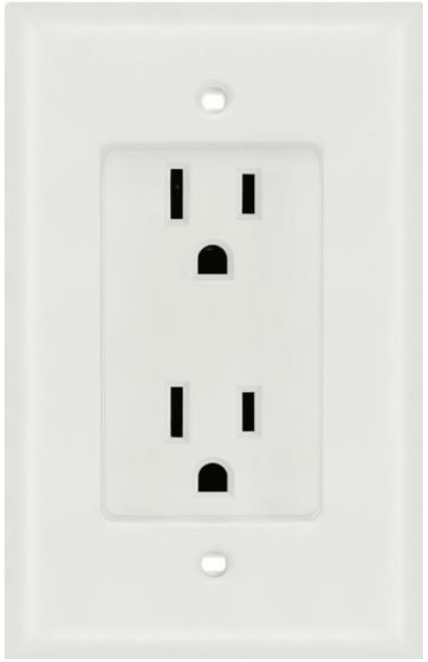
GFCI (Ground Fault Circuit Interrupter) outlets – GFCI outlets prevent serious electric shock and reduce the risk of electrical fire by monitoring electrical current, cutting power or 'tripping' when the outlets detect an imbalance or excess current flow down an unintended path. **GFCI outlets CAN NOT be used for fitness equipment as power fluctuates and will cause the outlet to "trip" the receptacle breaker.**

GFCI outlets are easy to identify featuring two buttons on its face: a "TEST" button and a "RESET" button.

Do not use

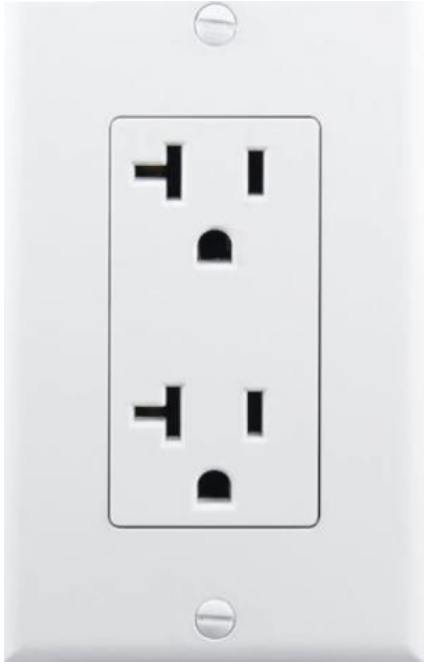
GFCI 15A Outlet

OK



Standard 15A Outlet

OK

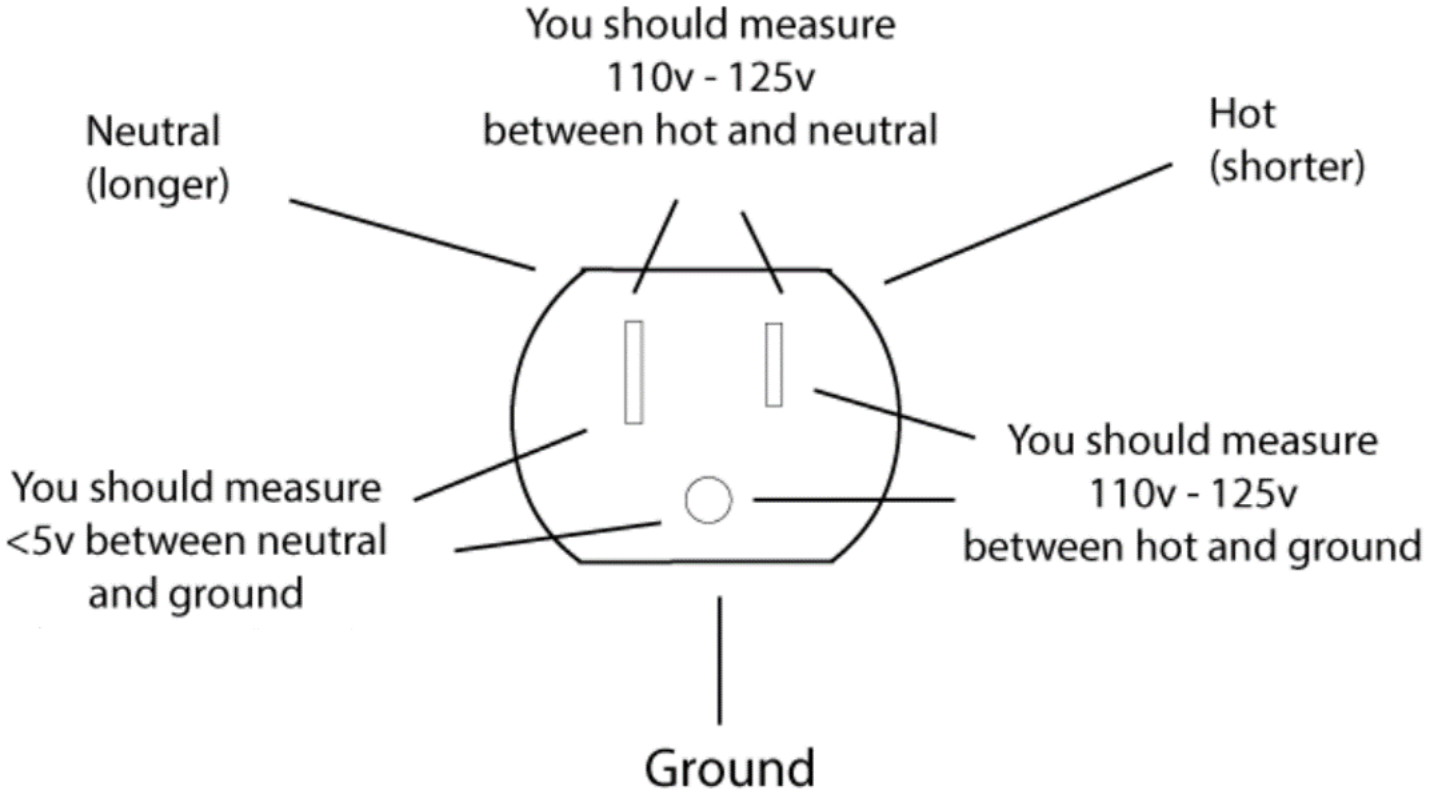


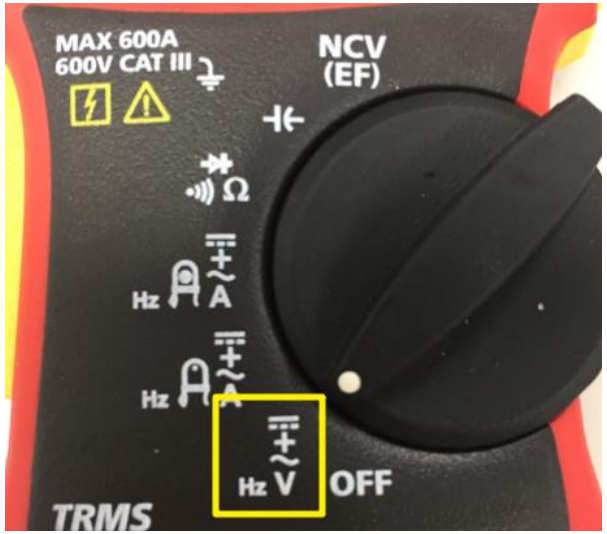
NEMA 5-20R 20A Outlet
(120V North America)

ToC

Understanding Receptacles

AC Voltage





Assuming your country uses 120VAC

ToC