Component Testing Using Your Multi-Meter

For Matrix Fitness Commercial & Vision Fitness Commercial Equipment

Matrix Onyx Collection excluded from this instruction

Created: Jan 2019 / Revised: **March 2026**

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 cables 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.

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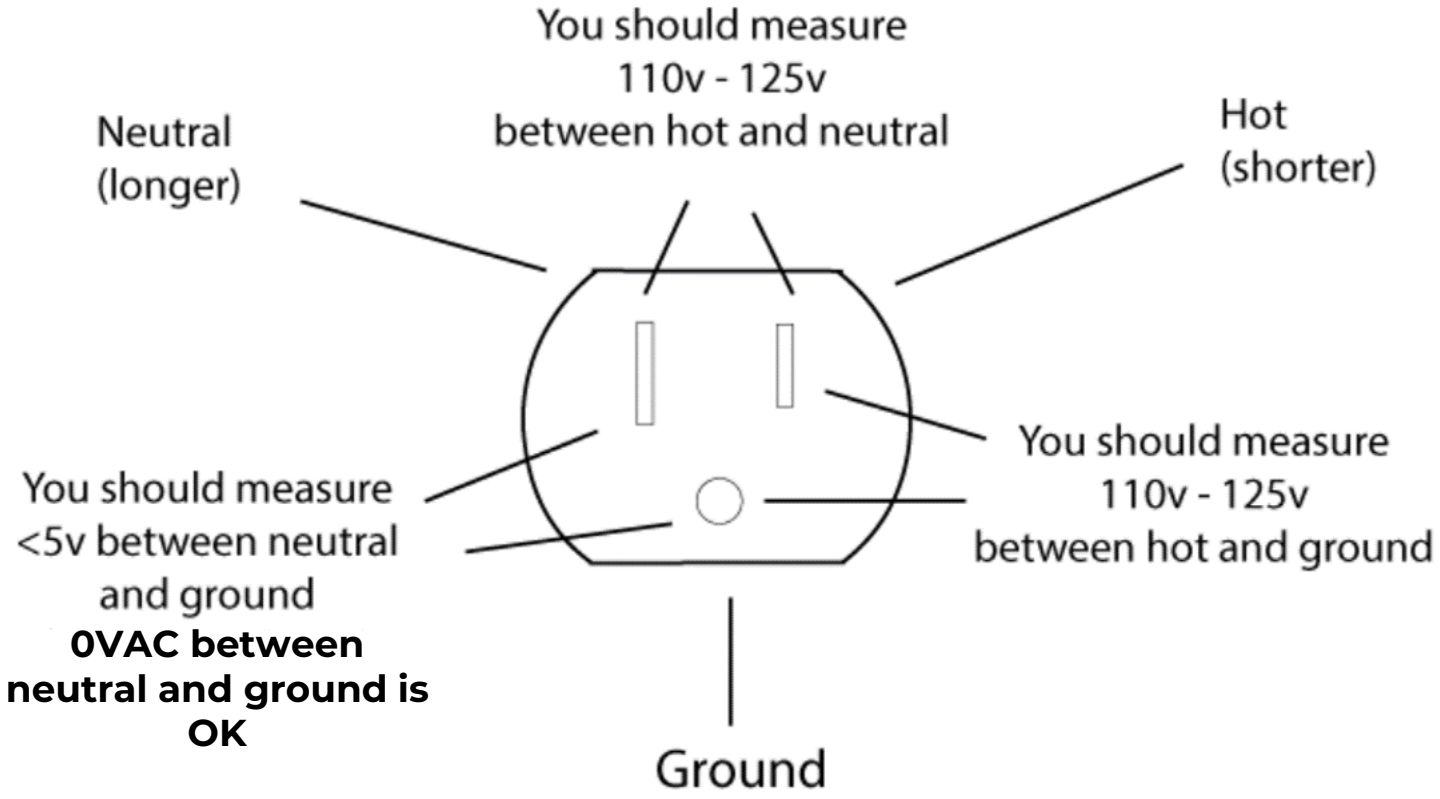
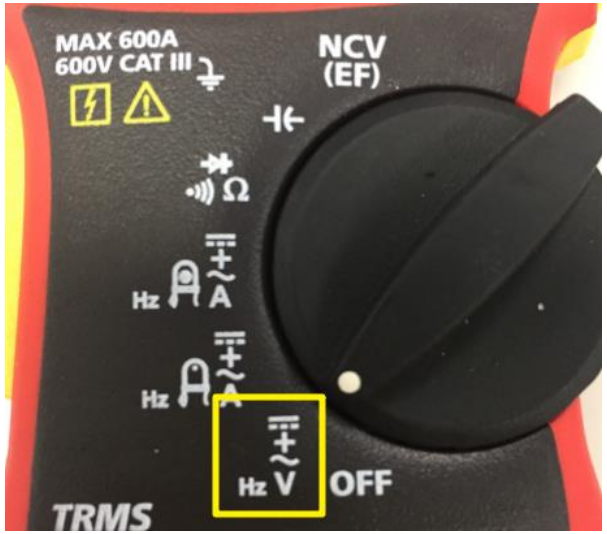
Understanding Outlets

AC Voltage





Assuming your country uses 120VAC

ToC

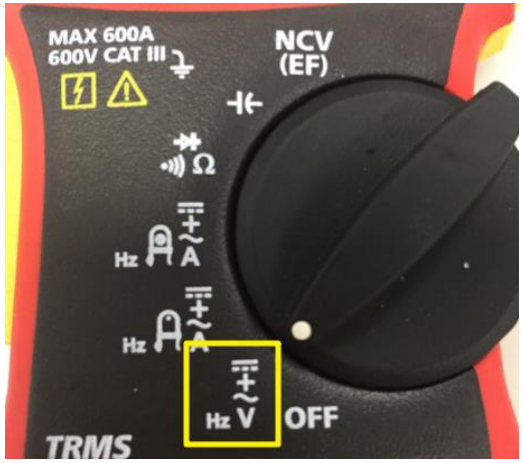
Receptacle and Power Cord

AC Power

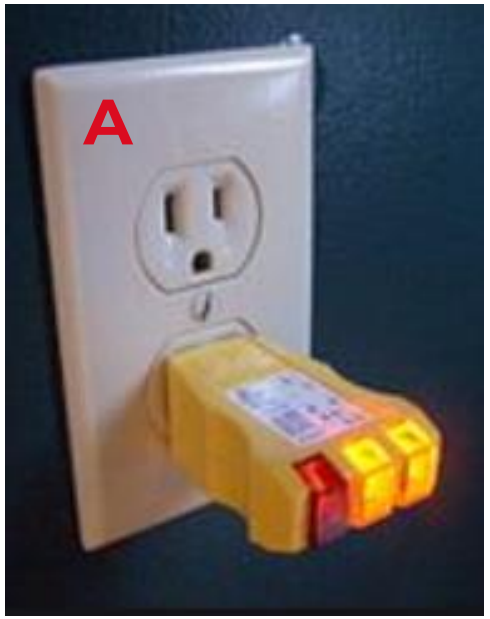
If a receptacle is damaged or suspect, it is the responsibility of the customer to repair or replace.

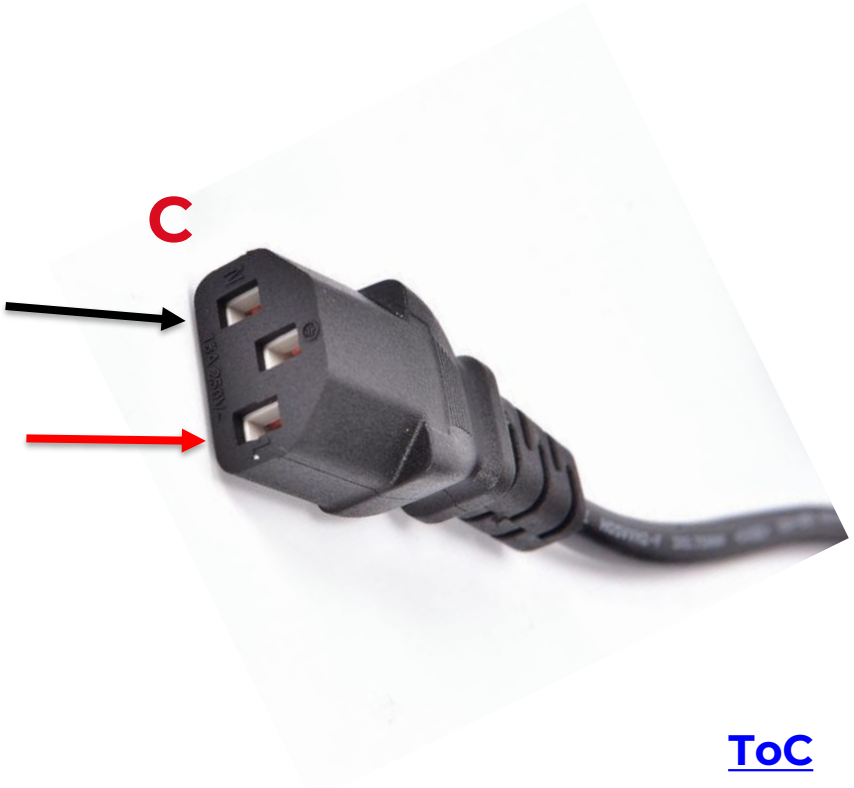
There maybe some instances where you need to verify that the correct voltage is being delivered to a piece of equipment. The safest way to do this is to use a receptacle tester plugged into the outlet (A). You can also use a multi-meter and touch the hot and neutral with your meter probes (B).

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



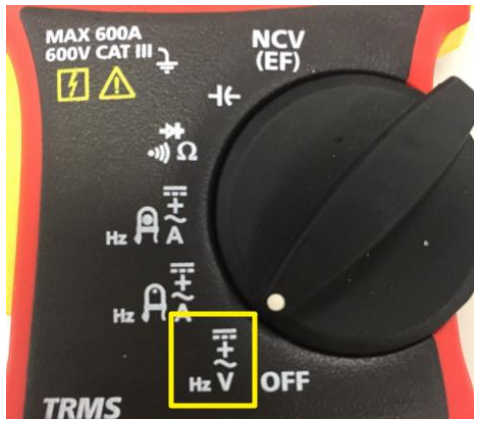


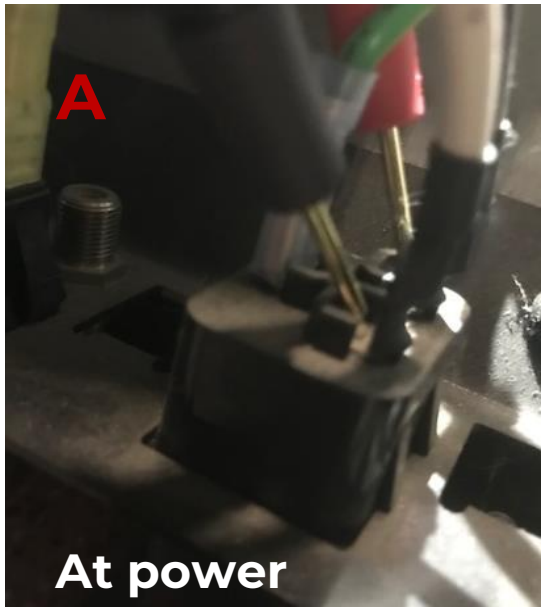
ToC

Tracing Power to the MCB/LCB

AC Power

Set the meter to **AC or VAC** 



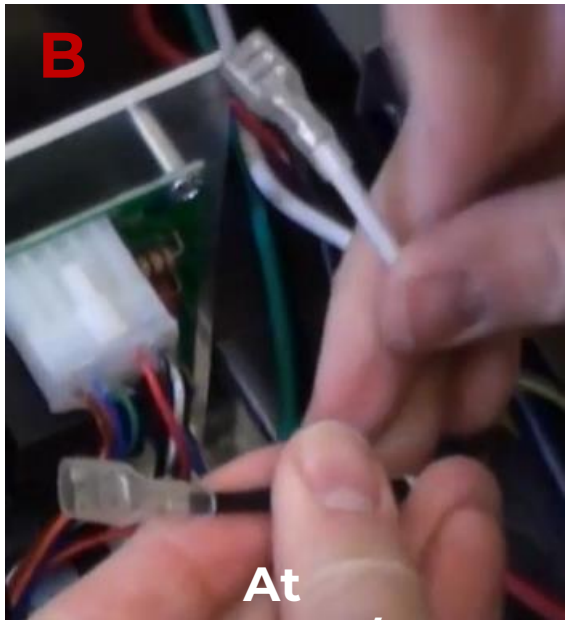


A – With the power cord plugged in and the power switch on, check the voltage at the power inlet & going into the power filter or MCB/LCB. The meter will display the voltage. To test good, you should get **120VAC (+/- 5%)**

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



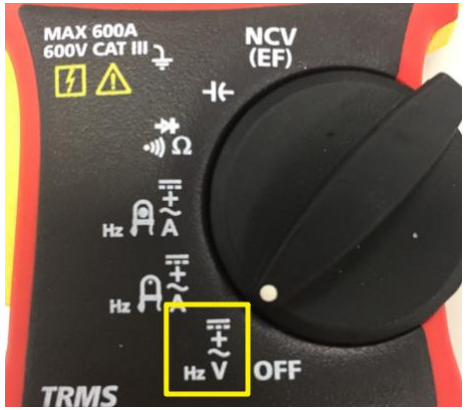
ToC

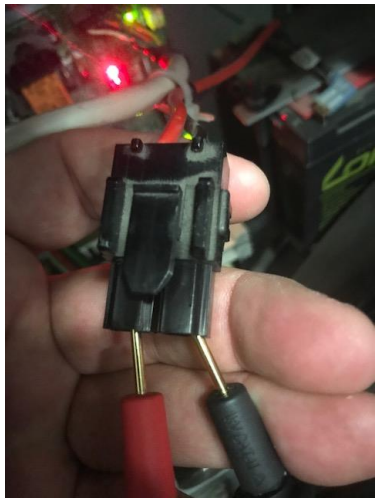
Frame Battery
DC Voltage

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

Console Cable

The console cable goes by several names; console cable, communication cable, data cable

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.

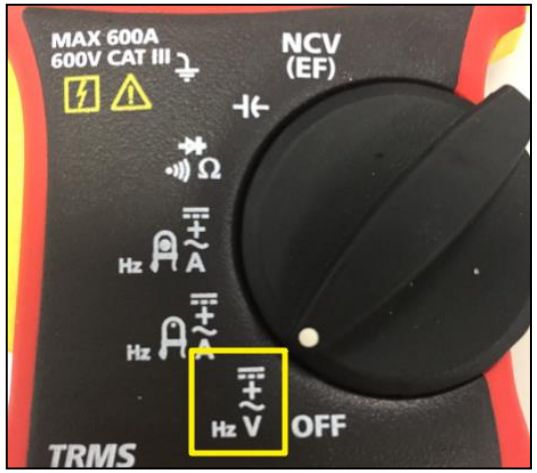
ToC

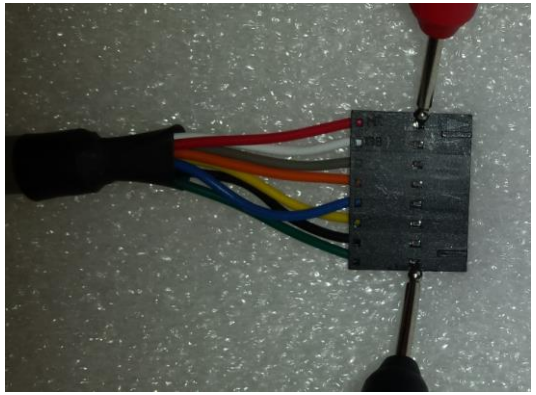
Console Cable

DC Voltage

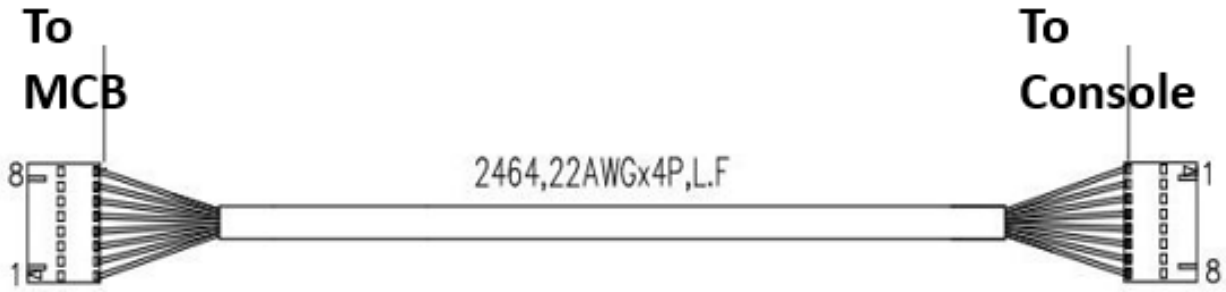
Check the voltage <u>at the console end</u> of the cable

1. Set the meter to **DC or VDC**
2. At the console end of the cable, use a multi-meter and touch the Pin1 and Pin 8. Your reading should be read a minimum of **12VDC.**





All Matrix equipment uses the same 8 Pin Console Cable

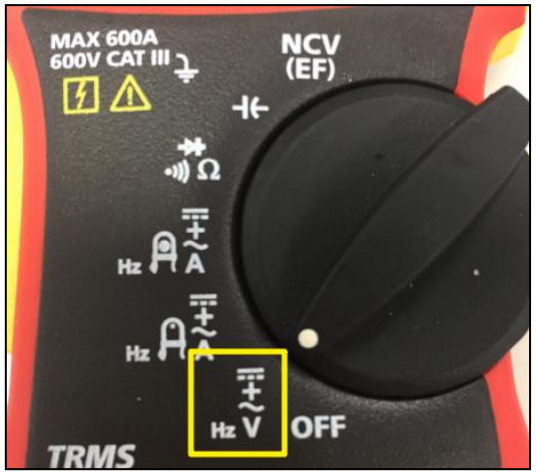


Pin#	Function	Voltage (VDC)
1	DC power input	+12
2	DC power input	+12
3	Communication (MCB and console)	-5 ~ +5.0
4	Safety key signal	Open drain, +5.0 based on system design
5	Safety key signal	Open drain, +5.0 based on system design
6	Communication (MCB and console)	-5 ~ +5.0
7	Ground	0.0
8	Ground	0.0

ToC

Console Cable
DC Voltage

Some Vision commercial equipment uses the same 7 Pin Console Cable.



Check the voltage at the console end of the cable

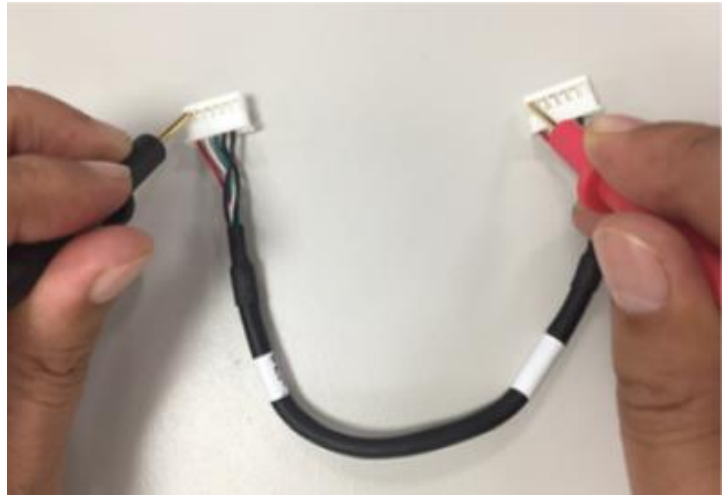
Pin #	Function	Voltage (VDC)
1	DC power input	5.5V
2	D/A	
3	RPM	0 ~ +5.0
4	Ground	
5	DC power input	14V
6	n/a	
7	Ground	

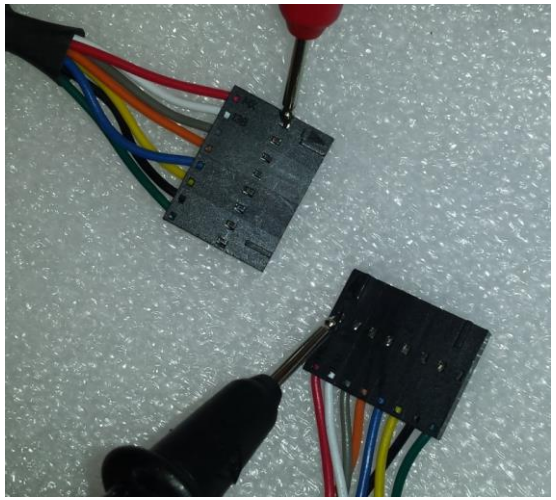
ToC

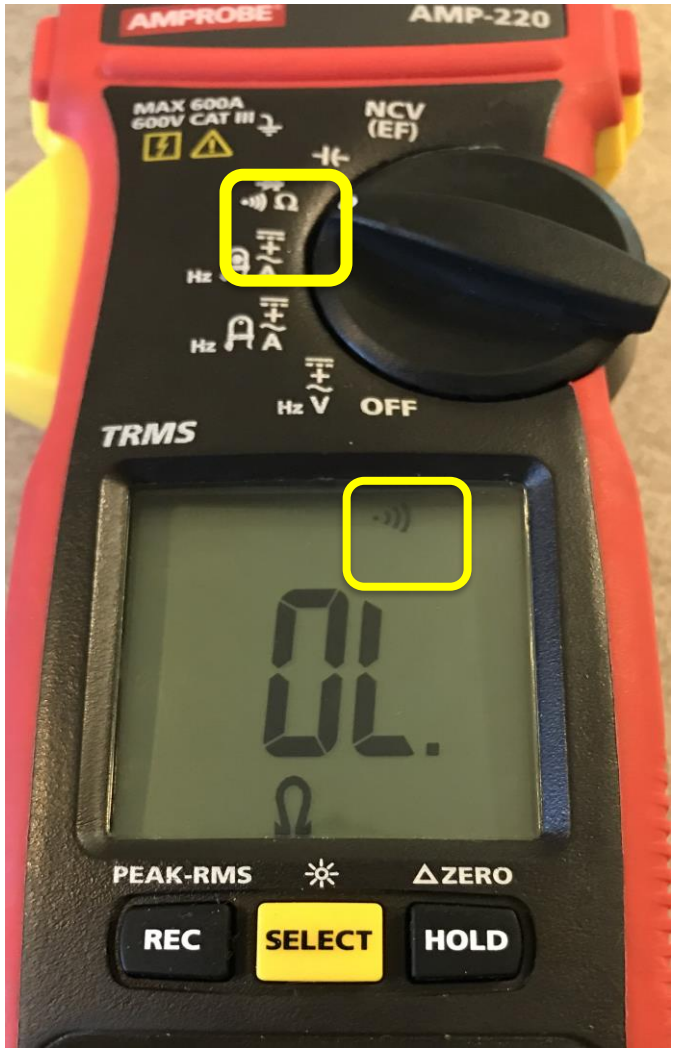
Continuity Test
Testing each wire in a cable

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.







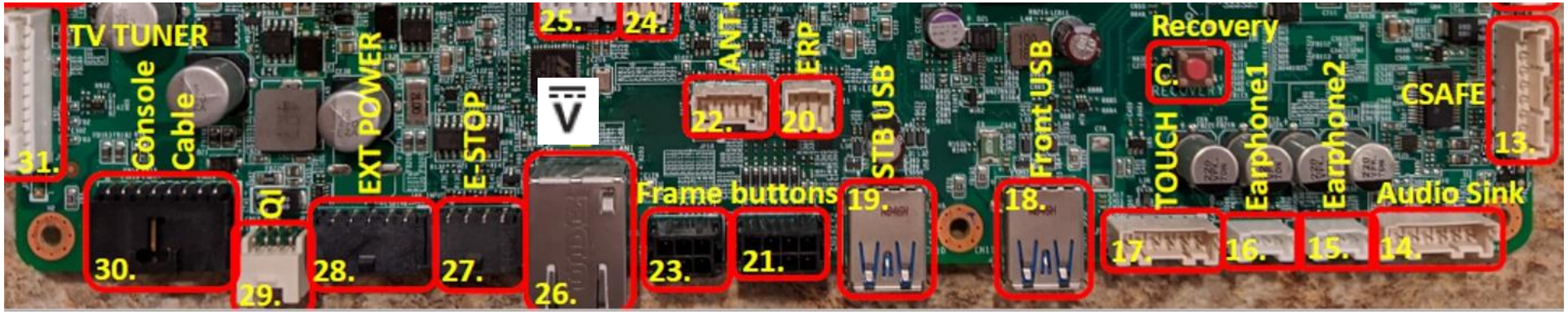
ToC

Power Adapter Board

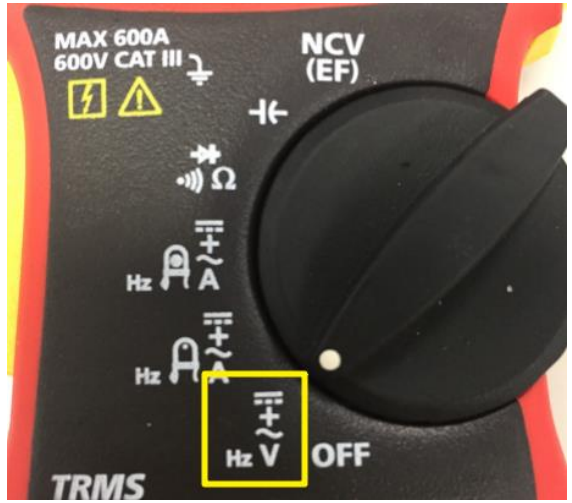
DC Voltage

Required for Matrix Touch and Touch XL consoles

Check the voltage at the console end of the power adapter wire that plugs into #28 on the UCB



1. Set the meter to **DC or VDC**
2. Disconnect the power adapter cable from the UCB. When you unplug this cable from the UCB, power will begin to dissipate after about 30 seconds. Perform this test within 30 seconds of unplugging the cable.
3. Use a multi-meter and touch the 2 outside pins (Pin 1 and Pin 5)
4. You should get **12.6VDC**.



Test Pin 1 & Pin 5

To C

Power Adapter Board

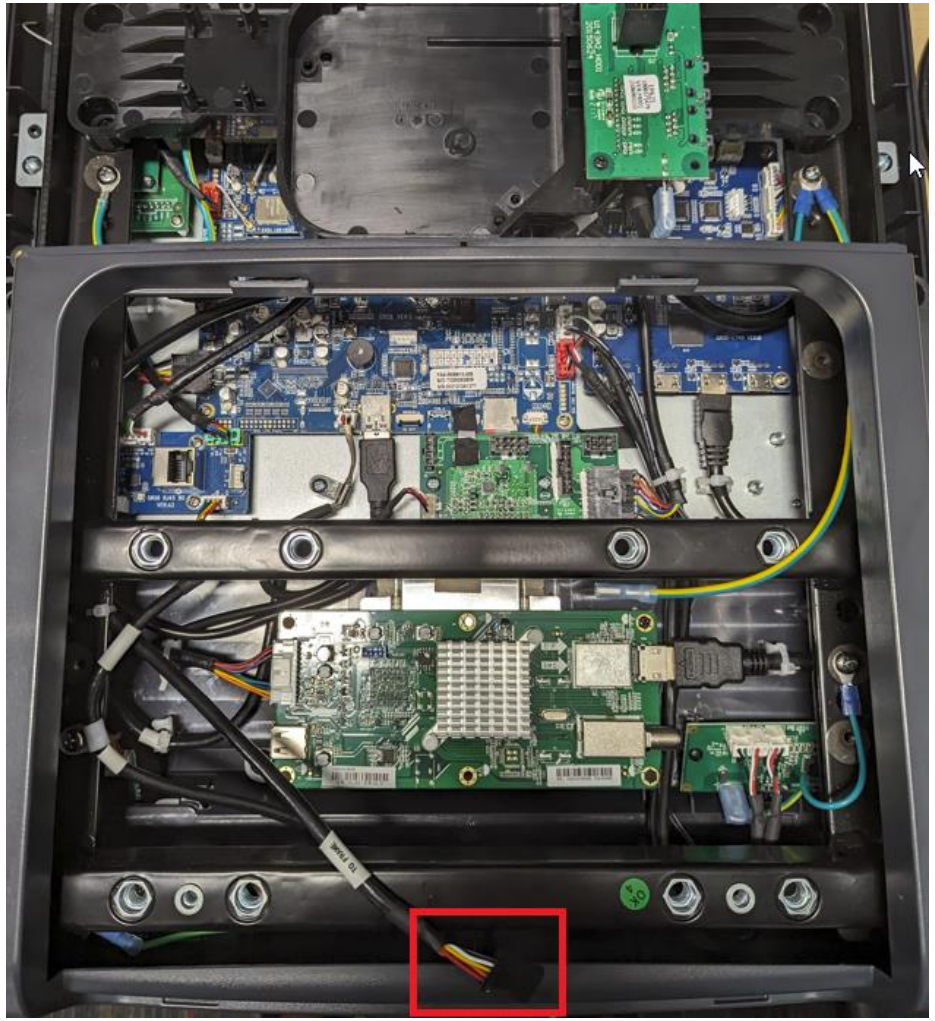
DC Voltage

Required for Matrix Touch Base and Touch XL Base consoles

Check the voltage at the console end of the power adapter wire that plugs into the 5-pin female cable labeled “to frame”.

1. Set the meter to **DC or VDC**
2. Disconnect the power adapter cable from the UCB. When you unplug this cable from the UCB, power will begin to dissipate after about 30 seconds. Perform this test within 30 seconds of unplugging the cable.
3. Use a multi-meter and touch the 2 outside pins (Pin 1 and Pin 5)
4. You should get **12.6VDC**.

Test Pin 1 & Pin 5



ToC

Power Adapter Board

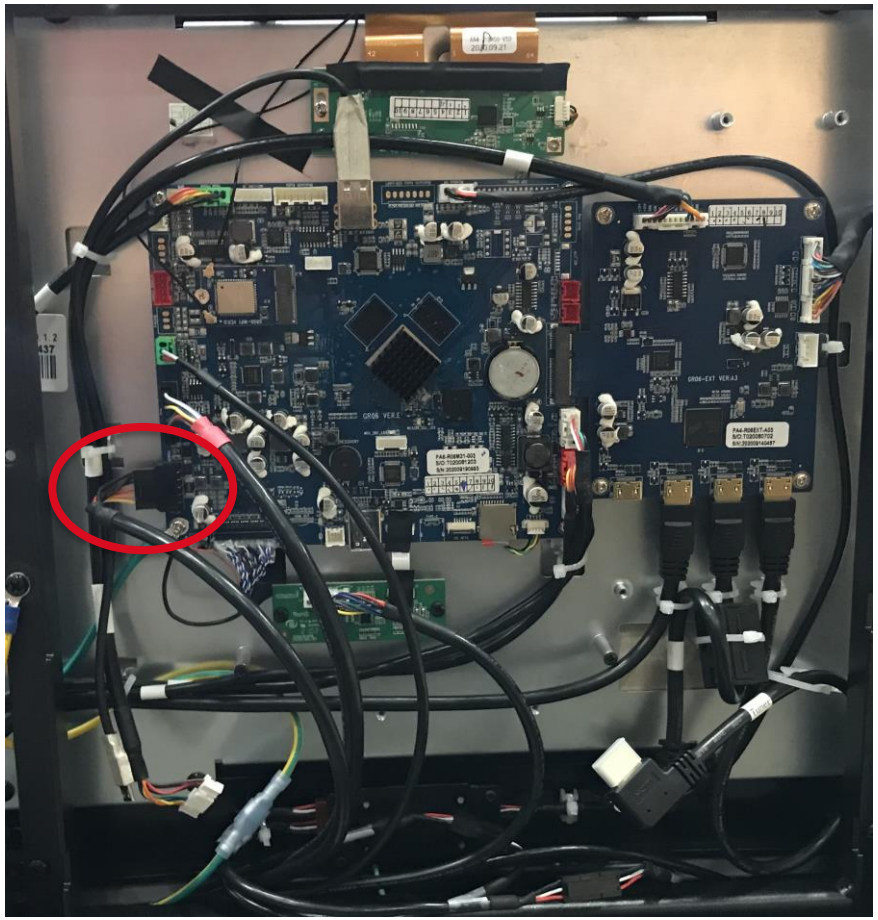
DC Voltage

Required for Vision Entertainment Touchscreen Treadmill consoles

Check the voltage at the console end of the power adapter wire that plugs into the 5-pin female cable labeled “to frame”.

1. Set the meter to **DC or VDC**
2. Disconnect the power adapter cable from the UCB. When you unplug this cable from the UCB, power will begin to dissipate after about 30 seconds. Perform this test within 30 seconds of unplugging the cable.
3. Use a multi-meter and touch the 2 outside pins (Pin 1 and Pin 5)
4. You should get **12.6VDC**.

Test Pin 1 & Pin 5



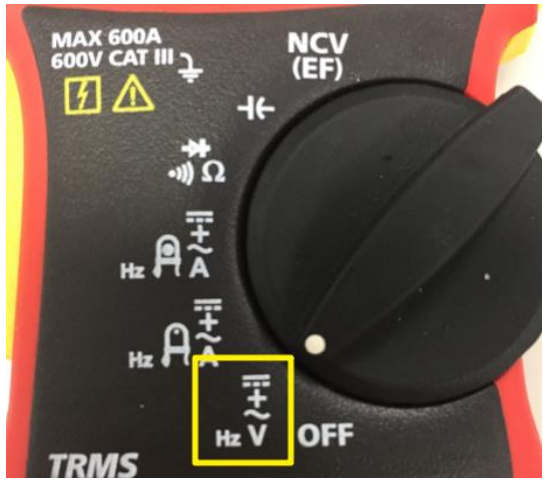
ToC

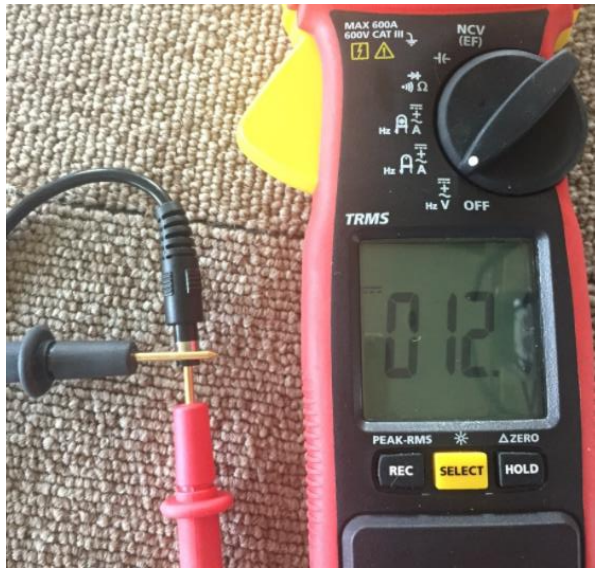
DC Transformer (Power Supply)

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.





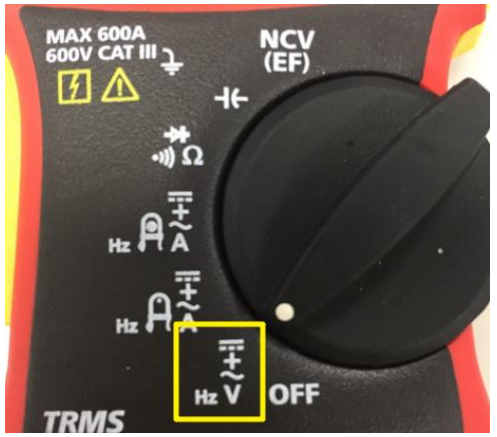
A reading between 11-13VDC is okay. It may mean your meter hasn't been calibrated or is out of calibration.

ToC

Heart Rate Grips

Not getting a heart rate reading?

- Is user making contact with 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



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.

Showing ClimbMill heart rate contacts

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

ToC

Heart Rate Board

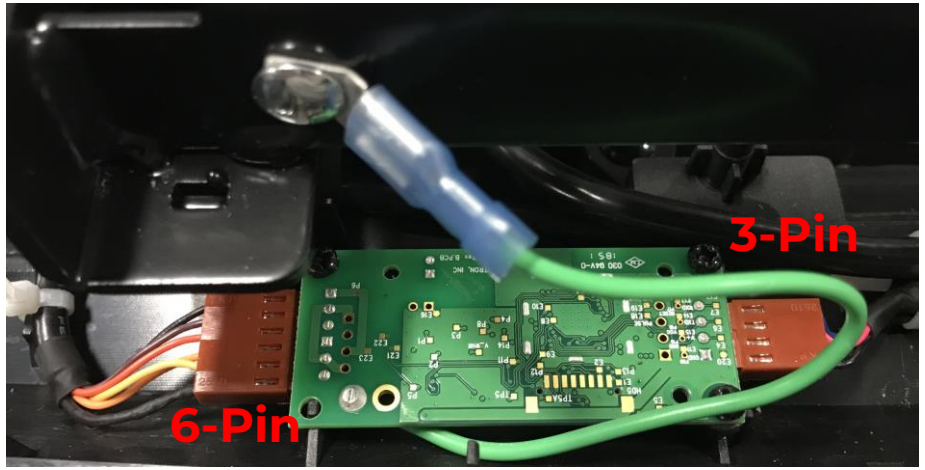
Turn the dial on your meter to “**Resistance, Continuity & Diode**”

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

E-Stop

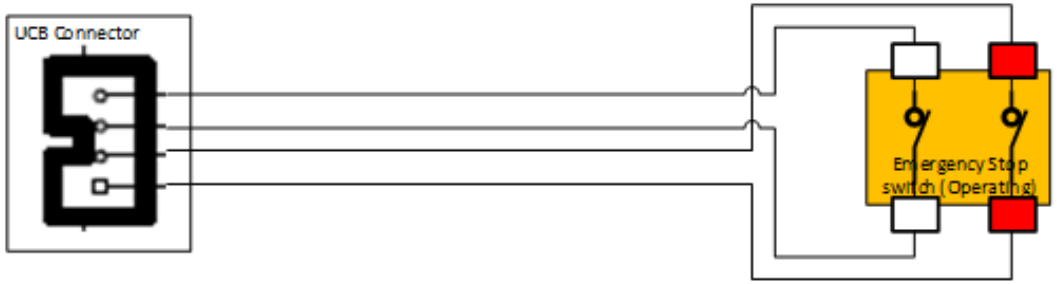
MX Performance, Endurance and Lifestyle Treadmills

There are 2 sets of wires (4 in total) that plug into the e-stop switch. It's important not to switch them. **RED** wires should be on one side and **WHITE** should be on the other. **Note: Endurance Series Treadmills have different colored wires. Refer to the images on the next page.**

Both sets of wires connect to the UCB however, through circuitry on the UCB (not software) the UCB sends a signal through the console cable to the MCB that the e-stop switch was activated and MCB will stop the drive motor.

With a multimeter set to measure "**continuity**" :

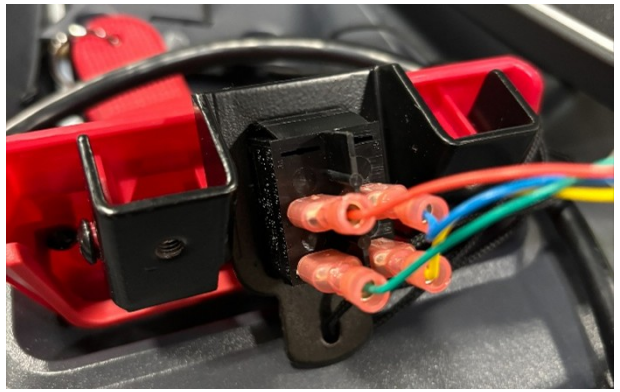
- Leads 1 and 2 should measure continuity with Emergency Stop in normal operating position
- Leads 1 and 2 should measure open circuit with Emergency Stop triggered/engaged
- Leads 3 and 4 should measure continuity with Emergency Stop in normal operating position
- Leads 3 and 4 should measure open circuit with Emergency Stop triggered/engaged
- There should be no continuity between either leads 1 & 2 to either leads 3 & 4 for any position of the Emergency Stop switch.

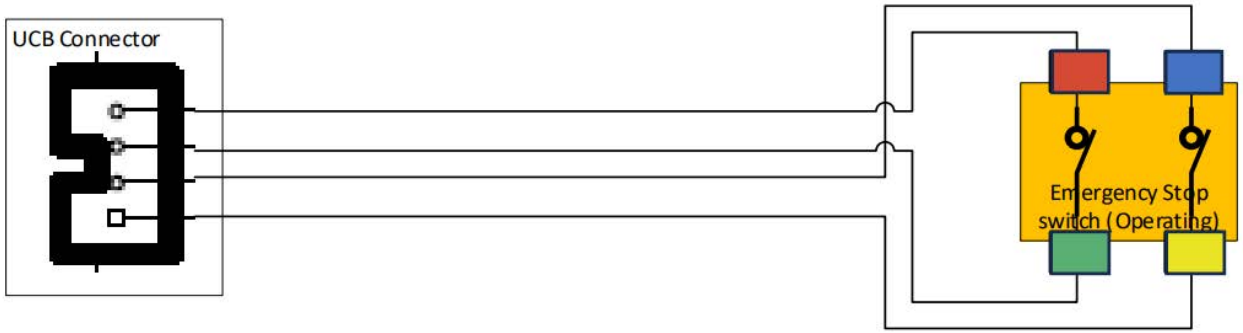


ToC

E-Stop

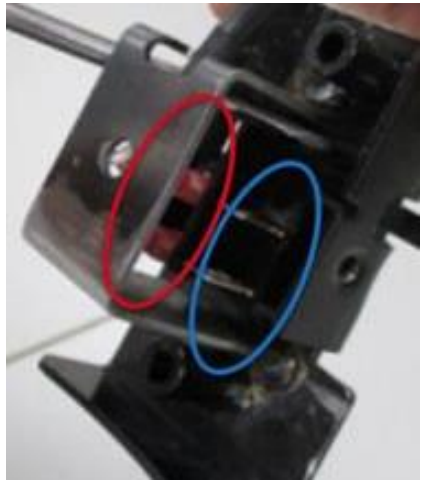
The images below show the Endurance Series Treadmill emergency stop wire configuration:





Older Matrix treadmills, Matrix ClimbMill console masts, and the Vision commercial treadmill use a power switch under the e-stop button. There are 2 wires that must be plugged into the same side of the switch. Touch the spade with the wires connected, engage and disengage the e-stop. If always open or always closed replace the switch.

Treadmill

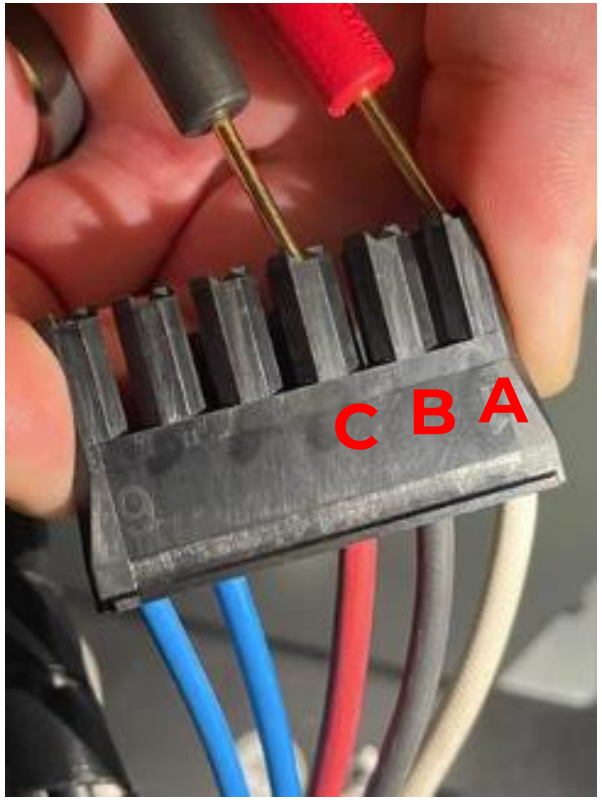


ClimbMill

ToC

AC Drive Motor
Resistance

1. Power off the machine and unplug from the power source
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 **2.5Ω (+/- 10%)**
    - If significantly higher readings or OL is displayed, a coil may be bad



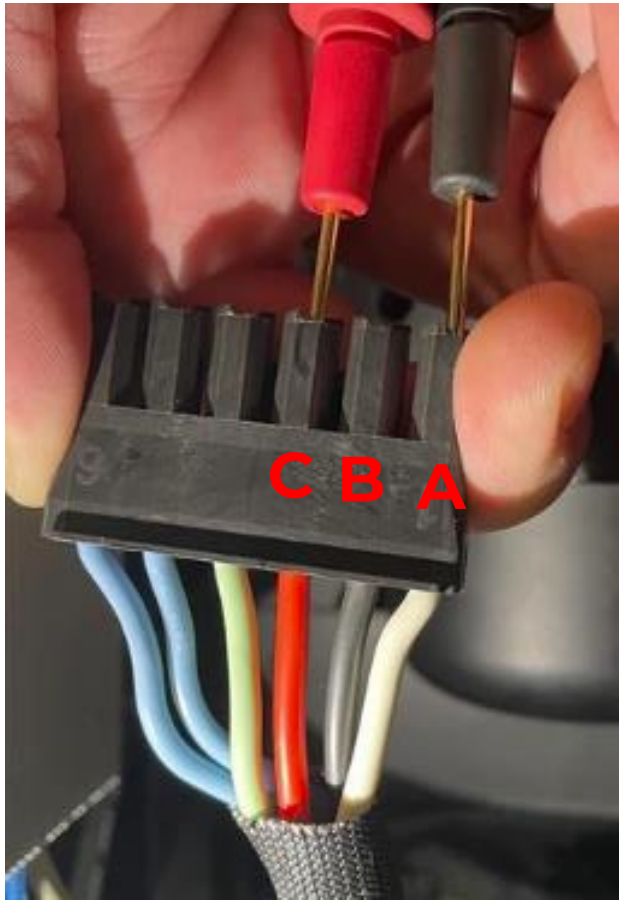
ToC

PMS Motor

MX Performance Plus TM543 Treadmills

Resistance

1. Power off the machine and unplug from the power source
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 **approximately 0.9Ω**
    - If significantly higher readings or OL is displayed, a coil may be bad



ToC

AC Motor & PMS Motor

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.

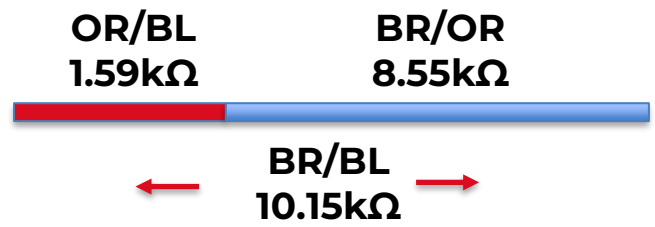
1. Power down the unit and unplug from the power source
2. Disconnect the motor cable from the MCB
3. Turn the dial on your meter to "**Resistance, Continuity & Diode**"
4. Connect the Red & Black probes to meter
5. Place both probes on the blue wires on the motor cable
6. There should be an Ohm reading **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.

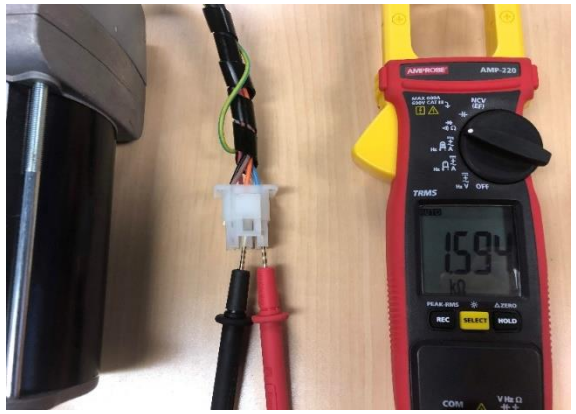
Note: Unless you have good contact with the meter probes and each blue wire, you may get a false reading. Ensure you have good contact before deciding on what to do next.

ToC

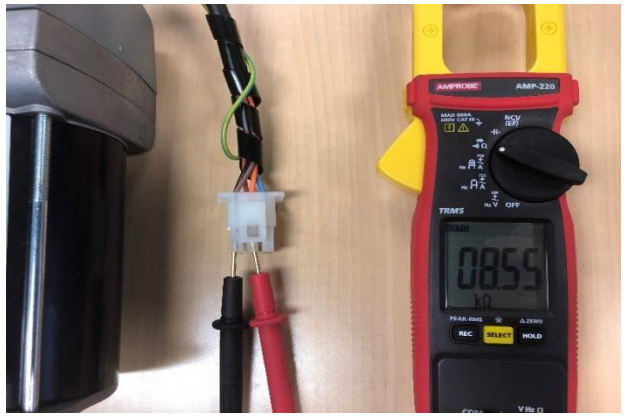
Incline Motor
Variable Resistance (VR)

1. Power off the machine and unplug from the outlet
2. Disconnect the Incline 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 pairs of VR Wires – BRown, ORange & BLue
6. BR/BL will give your total range – In this case 10.15kΩ (total range should be between 9-11kΩ)
7. Orange/Blue & Brown/Orange will give you the current position – BR/OR plus OR/BL should be equal to BR/BL (+- 5%)
8. If any of the combinations give a very high or OL reading (greater than 15Ω), then the incline motor could be defective
    - If the motor was set to a low incline (0-3%) when measured, OR/BL should measure much less than BR/OR. If the motor was set to a high incline (12-15%) when measured, OR/BL should measure much greater than BR/OR.





OR/BL – 1.59kΩ



BR/OR – 8.55kΩ

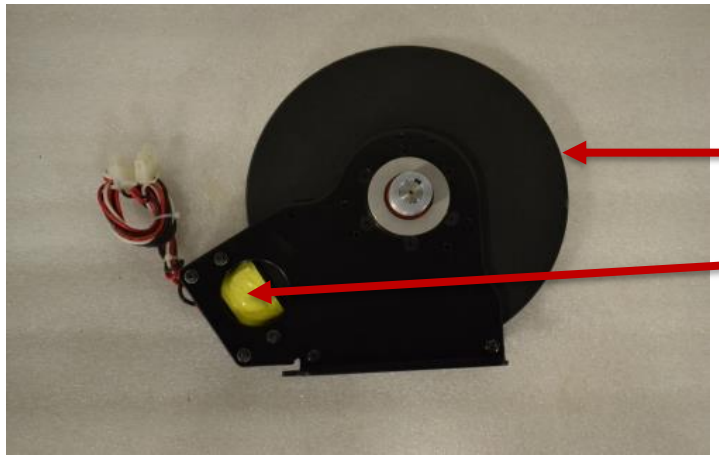
BR/BL – 10.15kΩ

ToC

Resistance Systems

Commercial product uses 1 of 2 types of resistance systems.

Induction Brake

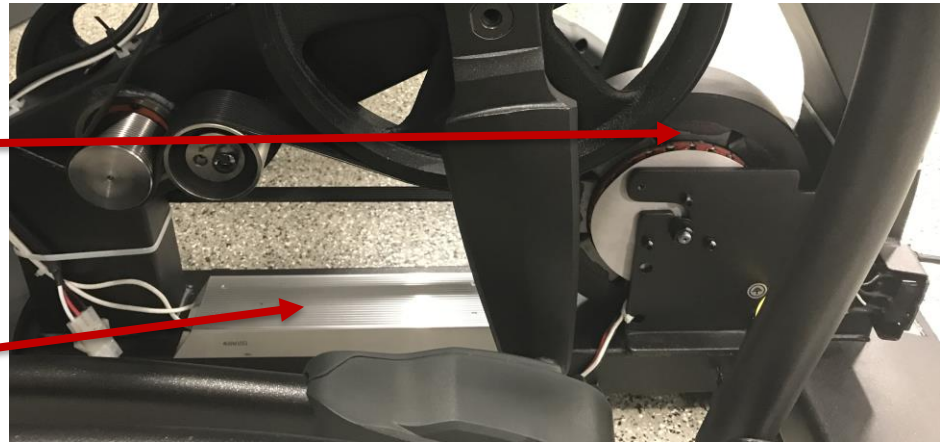


Generator

ECB

Resistor

Generator & Resistor



The following slides will show you how to test the components in each system.

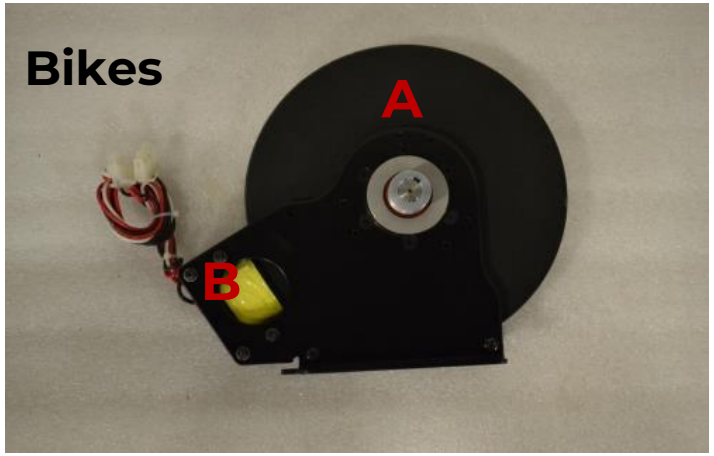
ToC

Induction Brake (ECB)

MX Bikes and ClimbMills

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

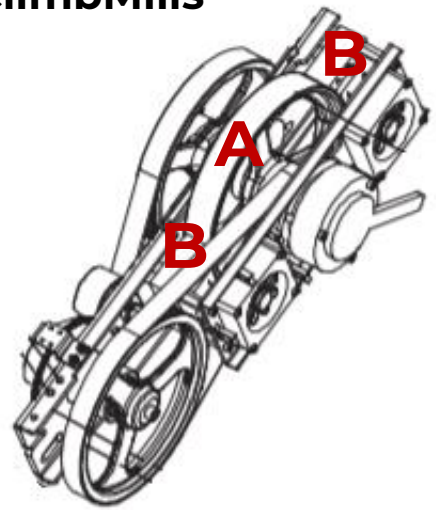
Bikes



A - 3 Phase Generator

B - ECB Coil

ClimbMills



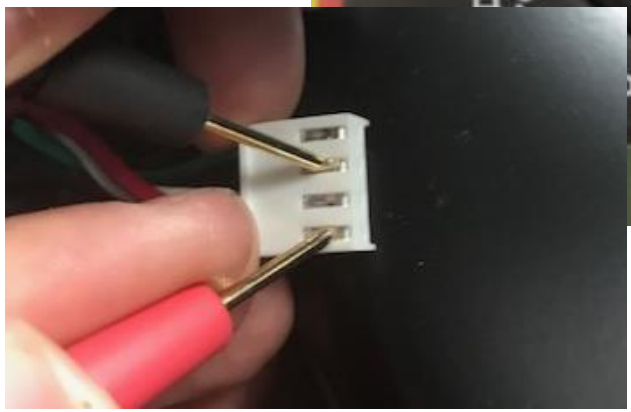
A - Flywheel

B - ECB Coil (qty 2)

ECB Testing

- Test from the ECB wire connector.
- Turn the dial on your meter to "**Resistance, Continuity & Diode**"
- Measure across the black and red wires. There should be between **12.8 – 14.2 ohms**.
- If out of range, replace the ECB.
- If in range, replace the LCB.

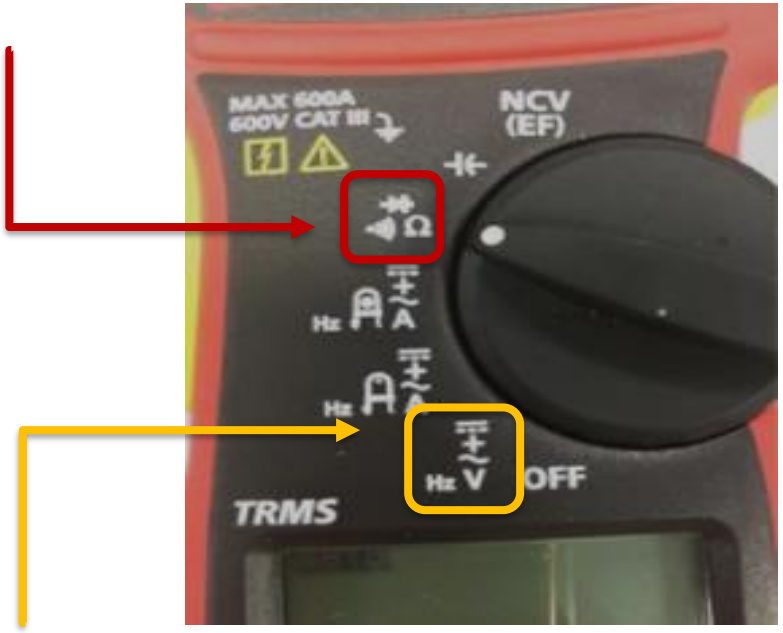
If the ECB tests good on the bike induction brake, test the generator (see next slide).



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**
- If **voltage is variable** (voltage should change based on how fast the generator is spinning), then the generator is good. If the voltage is not variable when changing speed, 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.*

ToC

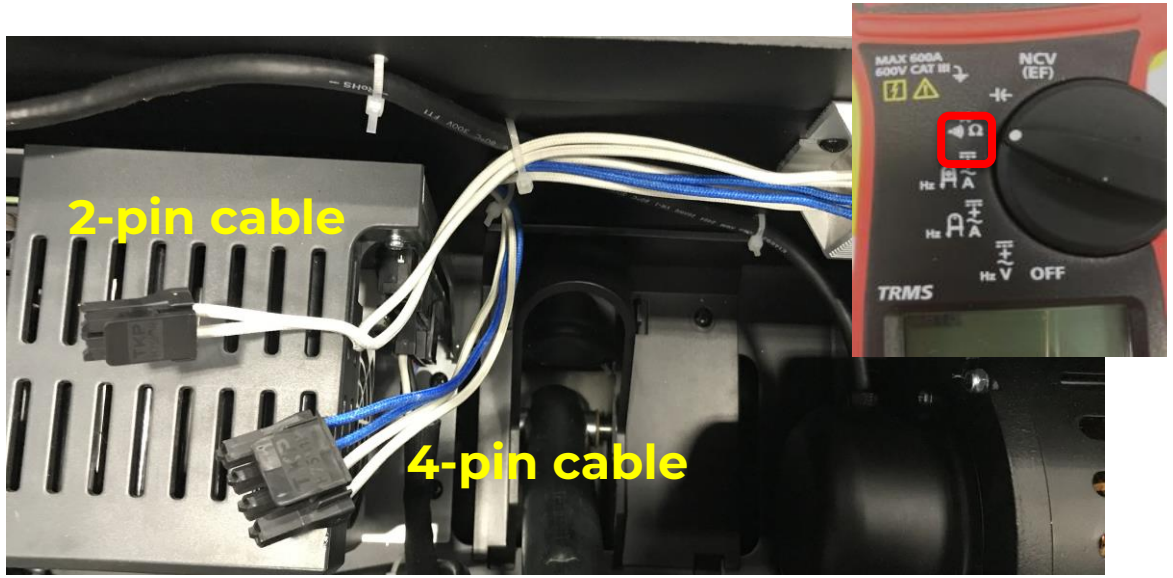
100ohm Resistor
MX Performance Plus Treadmill

There are 2 sets of cables (1, 2-pin and 1, 4-pin) coming from the resistor to the MCB however there are three pairs of terminals from the resistor, one pair for the 100ohm resistor, one pair for the 1.25ohm resistor, one pair for the thermal switch (blue wires).

- The 2-pin connector is the breaking impedance of the resistor. To check the function, measure the ohms across the 2 pins and for a properly functioning resistor you should get **100 ohms +/- 5%** (95 ohms - 105 ohms).

- The 4-pin cable, measure across pin 1&2 to check the impedance of the thermal switch If the thermal switch is functioning properly, it will read **1.25 ohms +/- 5%** (1.1875 ohms - 1.3125 ohms).

IMPORTANT:
Since the resistor is putting a load to the MCB so the slat belt doesn't move freely and has some resistance when a user steps on it, a humming noise may be noticeable when the unit is powered on but not in use. This is normal.



ToC

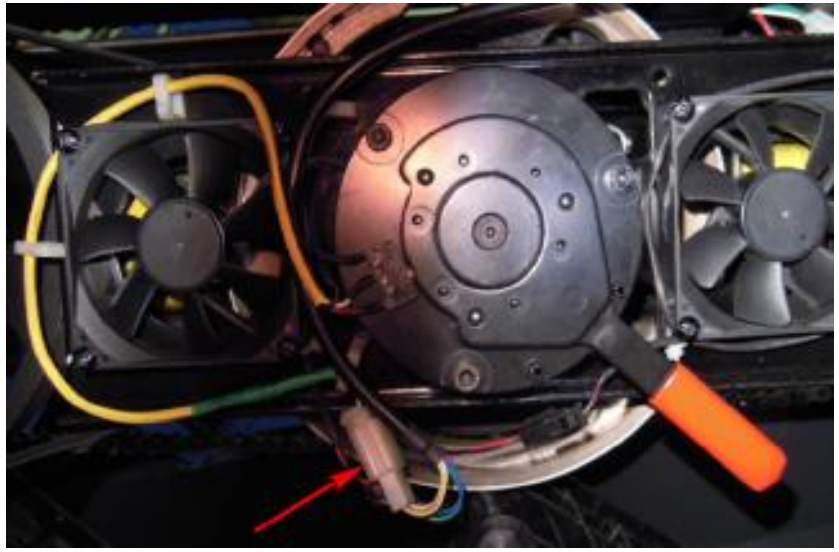
DC Brake

SN Prefix: CS29, CS30, CS34, CS35

This DC brake is found in the EN ClimbMill along with the Matrix Performance, Endurance and Lifestyle models.

DC brake not functioning?

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



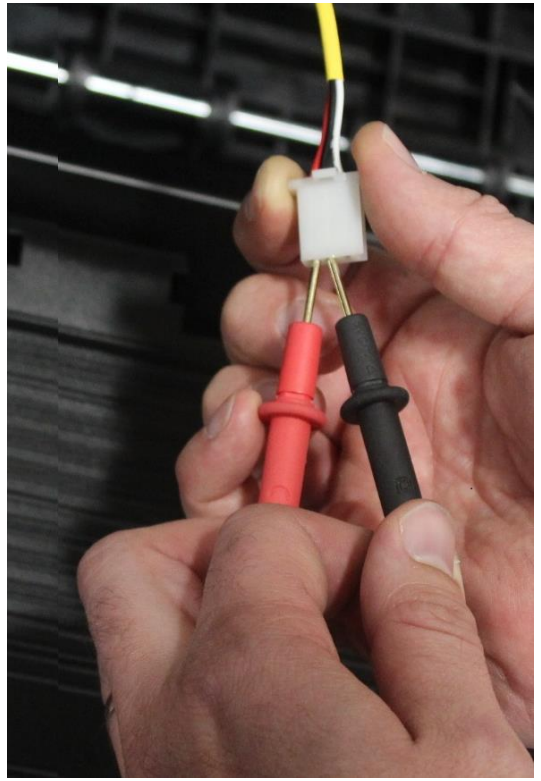
ToC

DC Brake

SN Prefix: CS17, CS21, CS22, CS23, CS24

DC brake not functioning?

- Unplug the DC brake wire (usually the yellow wire)
- Turn the dial on your meter to "**Resistance, Continuity & Diode**"
- Test using the Red and Black wires on the DC brake
- Tests good at **37 ohms**



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.

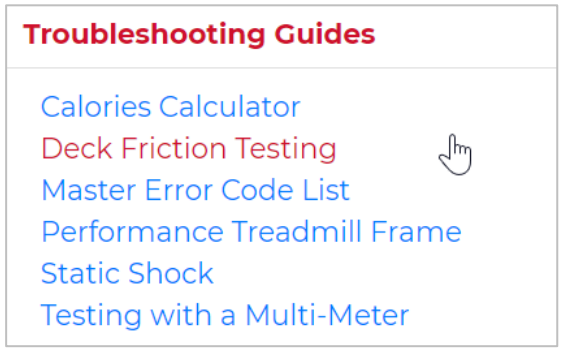
A friction test is required to be performed to determine if any parts are needed under the product warranty period.

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.

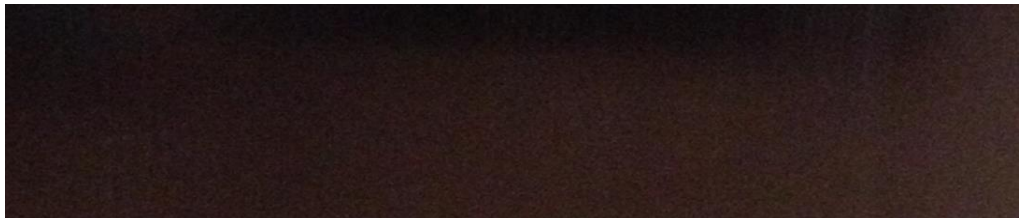


ToC

Running Deck and Belt Condition

Use this as a reference to compare your deck and belt against. If any signs of wear appears, perform a friction test to see if any action should be taken.

Surface of the running deck



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

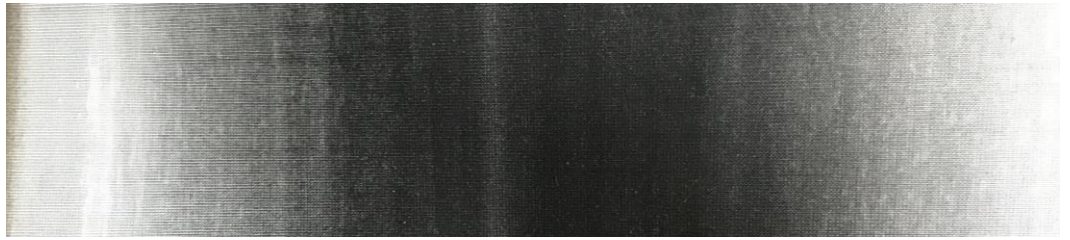
Bad – showing grooves you can see and feel

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

Bad – burn marks/lines are starting to appear



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

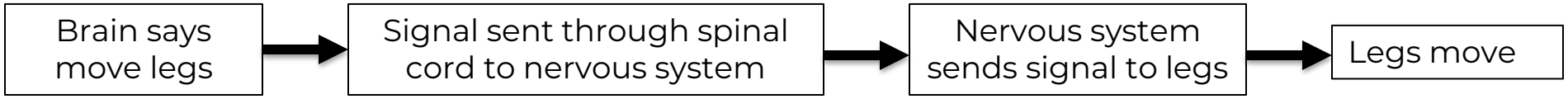
ToC

Fitness Equipment 101

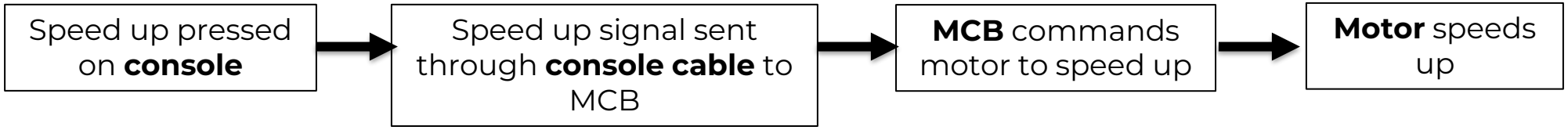
Using the human anatomy, I will describe an easy way to understand how fitness equipment works. Once you understand this, it may make make power and component testing easier to understand. No matter what a piece of fitness equipment looks like, the basic functions are all the same. Always start troubleshooting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



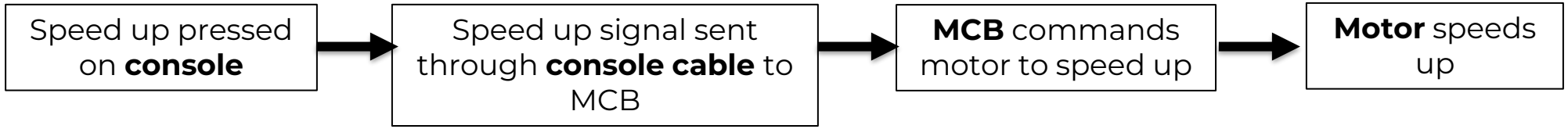
Treadmill



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

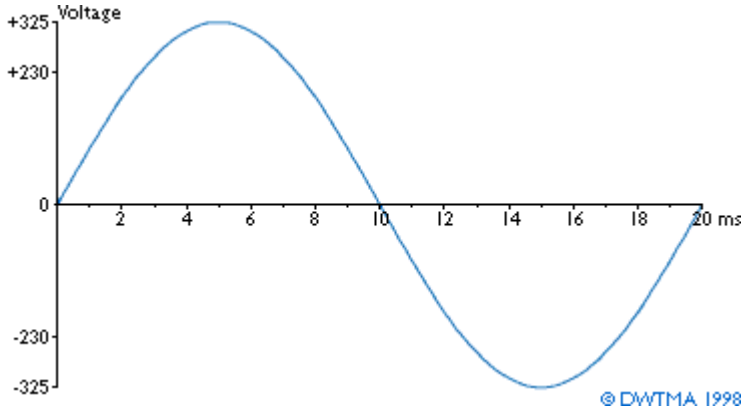
Understanding Voltage

AC & DC

DC voltage is found in commercial cardio 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).

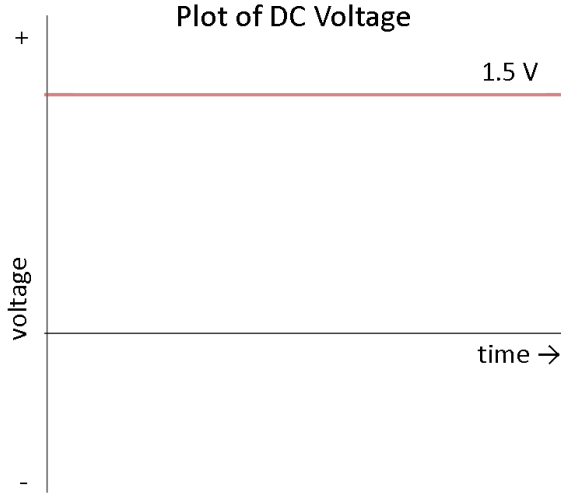


This AC sine wave shows 1 cycle – see how the voltage increase to its peak **positive** charge and then decreases until it reaches zero. At this point the flow of current (polarity) changes and the **negative** charge increases and then decreases to zero.
In most parts of the world, this **cycle** happens 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/floor 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 non-treadmill equipment. Treadmills however require a 20A NEMA outlet that is wired separately from other circuits. *Refer to the Power and Technology Requirements document found in Online Remedy for more detail.*

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

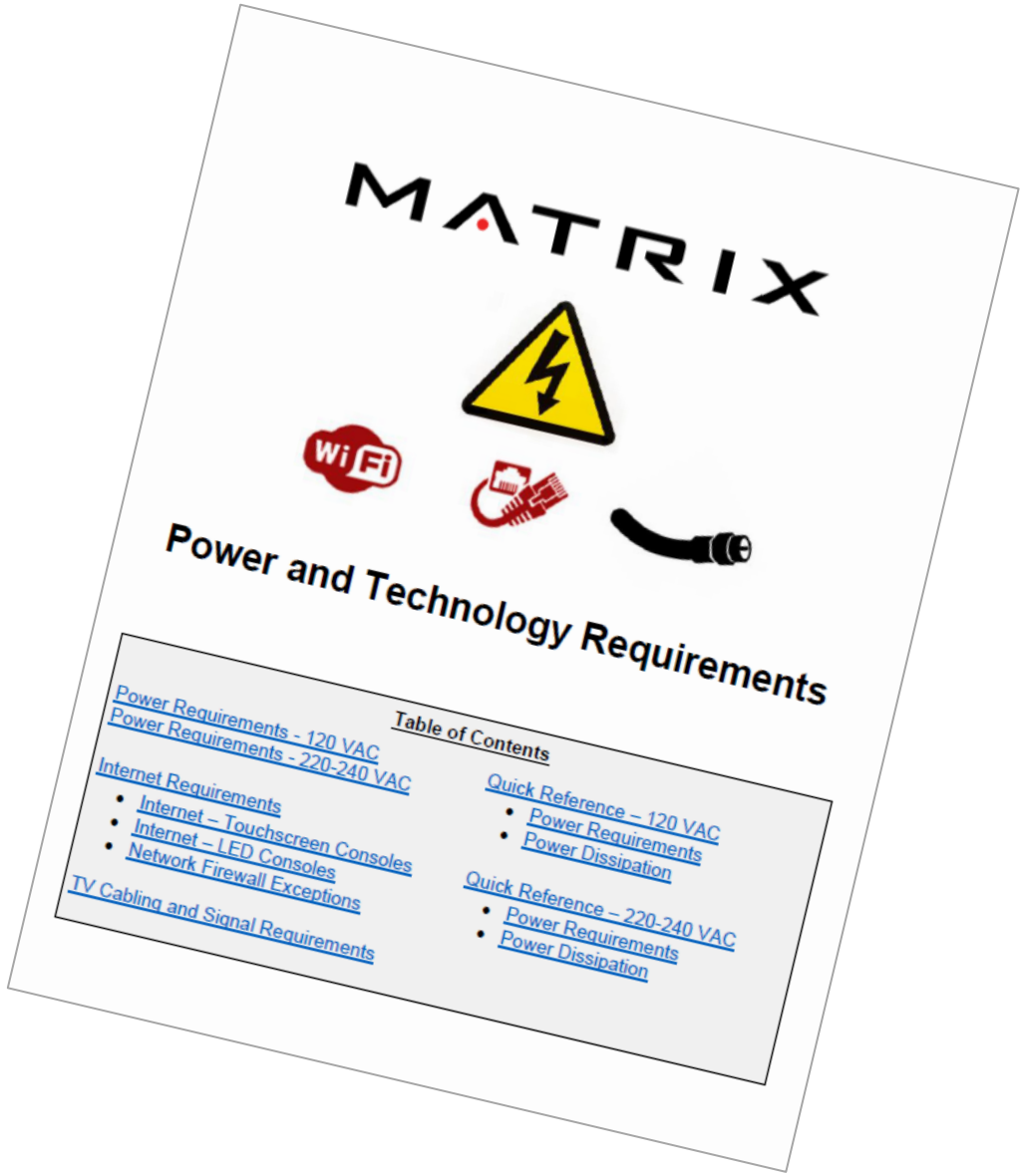
OK

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

ToC

Power and Technology Requirements

Refer to your regions/country's Power and Technology Requirements document for more information.



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