

Safety

Battery Safety Regulations

Lithium-ion batteries are widely used as a power source in portable electrical and electronic products. We will be using an AC adapter to power our product but it will also include batteries as a secondary power source. Because of this there are some standards we must follow, they include UL 2054 Standard for Household and Commercial Batteries, UN/DOT 38.3: Lithium Battery Transportation and IEC 62133-1:2017 which specifies requirements and tests for the safe operation of portable batteries.

The UL 2054 standard has many test that must be passed, which can be seen below. These requirements are for the purpose of reducing the dangers that can be caused when using batteries that are not properly test. The electrical test are one of the most challenging. The abusive overcharge presents the most difficulties given the overvoltage conditions applied to the pack. Major challenges in performance and safety still exist, including the thermal stability of active materials within the battery at high temperatures, and the occurrence of internal short circuits that may lead to thermal runaway. These are just some of the reason why so many test must be performed, it is all to reduce the risk in usage and failure.

ELECTRICAL TESTS

- 9 Short-Circuit Test
- 10 Abnormal Charging Test
- 11 Abusive Overcharge Test
- 12 Forced-Discharge Test
- 13 Limited Power Source Test
- 13A Battery Pack Component Temperature Test
- 13B Battery Pack Surface Temperature Test

MECHANICAL TESTS

- 14 Crush Test
- 15 Impact Test
- 16 Shock Test
- 17 Vibration Test

BATTERY ENCLOSURE TESTS

- 18 General

- 19 250 N Steady Force Test
- 20 Mold Stress Relief Test
- 21 Drop Impact Test

FIRE EXPOSURE TESTS

- 22 Projectile Test

ENVIRONMENTAL TESTS

- 23 Heating Test
- 24 Temperature Cycling Test

The IEC 62133 is another standard for lithium-ion batteries, the International Electrotechnical Commission (IEC), is a nonprofit standards organization. The IEC writes international standards for all electrical, electronics and related technologies, including batteries and the IEC 62133 is that standard. It tests for the safe operation of portable sealed secondary(rechargeable) lithium cells and batteries containing non-acid electrolyte, under the conditions of their intended use and if they were used a bit improperly but still within reason. The list below contains some test done to verify that they meet the standards.

- 7.3.1 External short-circuit (cell)
- 7.3.2 External short-circuit (battery)
- 7.3.3 Free fall
- 7.3.4 Thermal abuse (cells)
- 7.3.5 Crush (cells)
- 7.3.6 Over-charging of battery
- 7.3.7 Forced discharge (cells)
- 7.3.8 Mechanical tests (batteries)
- 7.3.9 Design evaluation – Forced internal short-circuit (cells)

If we want to ship our product anywhere by truck, boat, or plane or any form of transportation we will need to certify that the batteries we are using have passed UN/DOT 38.3 to ensure the safety of lithium batteries during shipping. The list below contains the test done to verify that they meet the standards.

- T1 – Altitude Simulation
- T2 – Thermal Test
- T3 – Vibration
- T4 – Shock
- T5 – External Short Circuit

- T6 – Impact
- T7 – Overcharge
- T8 – Forced Discharge

MET Laboratories is the nation's first Nationally Recognized Testing Laboratory (NRTL) a responsive and recognized leader for manufacturers seeking North American product safety certification. MET Labs can be used to certify our product because it is recognized by OSHA and approved to test and certify 180 standards by OSHA.

OSHA standards focus on the design and use of electrical equipment and systems. The standards cover only the exposed or operating elements of an electrical installation such as lighting, equipment, motors, machines, appliances, switches, controls, and enclosures, requiring that they be constructed and installed to minimize workplace electrical dangers. Also, the standards require that certain approved testing organizations test and certify electrical equipment before use in the workplace to ensure it is safe.

Protection Against Electrical Hazards

Most electrical accidents result from one of the following three factors:

- unsafe equipment or installation,
- unsafe environment, or
- unsafe work practices.

Some ways to prevent these accidents are through the use of insulation, guarding, grounding, electrical protective devices, and safe work practices. Insulators such as glass, mica, rubber, or plastic used to coat metals and other conductors help stop or reduce the flow of electrical current. This helps prevent shock, fires, and short circuits. To be effective, the insulation must be suitable for the voltage used and conditions such as temperature and other environmental factors like moisture, oil, gasoline, corrosive fumes, or other substances that could cause the insulator to fail. To make sure our product is as safe as possible we will properly insulate our product. We will also build our product in a controlled and safe environment so that no problems occur during production.

Safe Battery Battery Disposal

It's illegal to discard auto batteries, backup batteries, and rechargeable batteries in the regular garbage. Other batteries, like alkaline batteries, may be discarded in the regular trash, but it is more environmentally friendly to bring to a SAFE Disposal Event or to DSNY Household Special Waste Drop-Off Site. So properly disposing of the batteries is very important, there are multiple ways to properly dispose of batteries. One way would be to individually package

non-alkaline or to put clear tape on the terminals and take the batteries to a Safe Disposal Event or Household Special Waste Drop Off Site. Another way is to take the batteries to where they are sold, you are able to return 10 of the same type of batteries to them for free. And lastly you can go online to call2recycle.org and find a drop off site. For our customers we could provide a service in which if they have an issue with the batteries they can send them to us properly packaged and we would send them a replacement. That way we could handle non functioning batteries and properly recycle them.

Environmental

There are many environmental issues associated with the bot that can arise depending on the condition it is situated at. Therefore, to address these issues carefully, we have divided the issues into two distinct categories. The first category is environmental issue that affect our product such oxidation, liquid, temperature and airborne contaminants. The second category is about how our product may affect the environment.

Affecting The Product:

Oxidation

The product's inner and outer materials such as the conducting wires that are exposed to the air molecules, can be oxidized by oxygen, creating rusts. This isn't a big issue as it is a naturally occurring thing in almost all devices/machines. Though, we will choose the bot's materials wisely to limit the use of materials that can be oxidized over time if it gradually comes in contact with oxygen. After thorough inspection of the bot, if we need, we have the budget to insulate the the bot's greater parts. This will not only greatly reduce the amount of rust accumulation but it has many other benefits such as the reduction potential short circuiting areas.

Conductive Liquids (e.g. water)

As with all electronic devices, there is always a danger of damaging the device or having it catch fire due to conductive liquids short circuiting the device. Since we will be using DC power source, any sort of liquid coming in contact with the power source can not only damage the source and device but it may also create explosions depending on the way the power source is built inside. This is extremely dangerous because it can create electrical fire which cannot be extinguished by simply putting more water. In fact the fireman putting water can get deadly shocks because water is highly conductive and can give of high current shocks. Thus, we need to carefully address this issue because if our solution is not appropriate for this particular device, it can damage the device permanently. After doing research and inspection on the bot's parts, we have decided to create multi level protection against conductive liquids for the bot. The first level is to insulate the bot as much as possible to liquid-proof the device. The second layer is to add a DC Voltage Regulator between our DC power source and the bot. The third layer of protections is to have embedded power regulators on the main components, especially the Raspberry Pi, which comes built-in from the trusted manufacturer.

Temperature:

The temperature of an electrical component is affected by the ambient temperature of the environment, the heat produced by the component, and the efficiency of heat removal provided

by the thermal system. It has proven by data that in semiconductor and electronic parts, failure rate hugely increases depending upon heat and life shortens. Managing heat is a critical factor in the design of power electronics. There are many ways of cooling electronics, free convection cooling is the form, and it works by allowing heat to dissipate directly to the air surrounding it. Forced air and Liquid cooling are two other methods used to dissipate heat. Forced air cooling uses fans to blow air across the surface of an electronic component. Liquid cooling works by a liquid coolant circulating through a system reducing the heat. So the temperature of the environment can also contribute to a component or the device itself failing. So deciding that what type cooling system we will use in our product is something that must be put under great consideration.

Affecting The Environment:

Solid waste pollution

Solid waste is any garbage, refuse, sludge, and it usually arises from various human activities such as the discarding of useless or unwanted items. It consists of the discarded materials from the urban community as well as industrial waste. In a city like New York City with such a dense population it is known to produce a lot of garbage which harms the environment. So to reduce the negative environmental impact our device could have when it is disposed of we will contact our customers to let them know that we will pay for the return shipping of a broken or non-functioning product so that we could properly recycle it.

Air pollution

Air pollution consists of chemicals or particles in the atmosphere that pose serious health and environmental threats. Smog hanging over cities is the most familiar and obvious form of air pollution. Carbon dioxide, a greenhouse gas, is the main pollutant that is warming Earth. While people also emit carbon dioxide when they breathe, the burning of fossil fuels such as gasoline and natural gas which are used to power things like cars, planes. The emissions from power plants also produce a great deal of carbon dioxide, and these things are the major contributors to greenhouse gases. Our product will avoid these types of pollution because it is not powered by the burning of fossil fuels but instead it uses electricity.

Auditory pollution

Also known as noise pollution is the impact that disruptive noise can have on other human beings and on animal life. Living in a city like New York City it can be sometimes overlooked how loud the city actually is because of the traffic, trains and the construction that is constantly going on. But to those who come to visit it can be overwhelming. Noise pollution has negative effects on the health of humans and animals. For humans it can cause hypertension, high

stress levels, tinnitus, noise induced hearing loss, sleep disturbances, and other harmful effects. Because our users are seniors we must make sure that our product does them any auditory harm, of disturbs others if it used in a nursing home.