

Introduction

The AX2550 is assembled in an aluminum case which is usually bolted to the metal chassis of the equipment being controlled. Provisions need to be made for earthing the chassis and the controllers to avoid electrical shock to the operator of the equipment.

Rules applicable to battery powered appliances

Any electric appliance built inside or over a metal chassis has to conform to electrical standards and regulations so to be safe for the operator to use.

A good part robotic appliances are battery operated and are mounted on a metallic chassis.

Even if an appliance is battery operated, it may still have to conform to the rules for AC appliances, if the appliance is intended to be connected to an AC battery charger and/or to an AC diagnostic monitor. In this case the regulations that apply to AC appliances apply to the battery appliance as well.

Typical example is the laptop computer; although a laptop PC is battery energized, it is sold with an AC battery charger, so it is regularly connected to the AC. For this reason all regulations applicable to AC appliances apply to the laptop computer as well.

In particular laptops have various exposed metallic parts (example: the shell of the USB connector). They are interconnected and are connected to the Earth prong of the AC plug.

Fig 1 shows the connection to a battery charger; note that Vcc and GND outputs of the battery charger are insulated from its phase and neutral AC wires.

As long as the laptop is energized only by the battery, the USB shell is floating.

As soon as it is connected to the battery charger, the USB shell becomes connected to Earth preventing any chance of electrical shock to the user.

Laptop USB connector

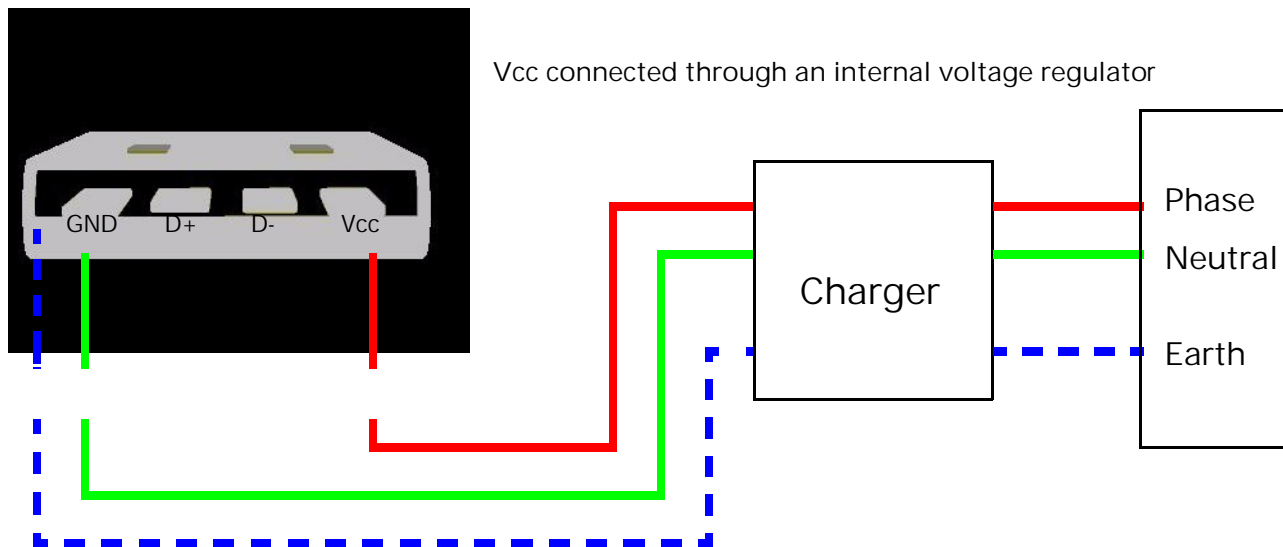


FIGURE 1. Laptop USB connector; shell goes to Earth

Conclusion: battery operated robotic appliances built on a metal chassis and intended to be connected to battery chargers or other AC equipment are subject to the regulations concerning appliances which have a metal enclosure or a metal chassis.

The rule is that if the appliance has various metal components, including a metal chassis, accessible to the operator then:

- all exposed metallic parts must be interconnected
- they must be insulated from the internal power
- they must be connected to Earth any time an AC equipment (battery charger etc.) is connected to the appliance.

The fact that the battery charger terminals may be fully insulated from AC is irrelevant. The rule assumes that all kinds of failures, malfunctions, mis-connections may happen and the operator must be protected from shock at all times. A solid connection to Earth will prevent any metal part from becoming hot.

We are not concerned at this point on how the system is built; we are concerned with the fact that the AX2550 is equipped with an easily visible strap for connection to the Earth directly or via the chassis; it is the customer's responsibility to design the system in such a way that the chassis is earthed any time the appliance is connected to an AC equipment.

Earth versus Ground

There is some confusion in the terms "Earth" and "Ground" so first let's establish the reference nomenclature.

An appliance has three critical busses:

- The internal power positive buss (the positive pole of the battery).
- The internal power negative buss also known as Ground (the negative pole).
- The chassis, normally insulated from the internal power.

The AC distribution system inside a house or a commercial building has three critical busses as well:

- Phase
- Neutral
- Earth (sometimes called Ground; we will not use the term Ground to avoid confusion with the "Ground" as defined above).

Domestic Electrical distribution

Let's review briefly how the AC is distributed to houses or commercial buildings:

The AC line coming in into the Main Switch box is usually comprised of three wires:

- Phase 1
- Phase 2
- Neutral (connected to the Neutral Buss)

The voltage between the two phases is 208 Volt AC while the voltage between any of the two phases and Neutral is 120 Volt AC.

The two phases (208 Volt AC) are routed inside the house for heavy duty appliances like an electric kitchen range or a hot air laundry dryer.

Light duty appliances are operated by Phase and Neutral (120 Volt AC).

Phase 1, Phase 2 and Neutral are routed inside the house.

In addition a fourth wire routed in the house, called Earth.

The Earth wire:

- does not come from the external distribution system

- does not normally carry any current
- it goes to ALL the metallic enclosures of the various appliances which are therefore all interconnected.
- is connected to a metal pipe or a metal plate buried underground, therefore all metallic enclosures are forced at Earth potential, making impossible for them to become electrically hot.
- the connection to the pipe is normally done at the Main Switch Box outside of the house by a heavy copper cord connecting the Neutral Buss to the pipe.
- The Neutral wire is also connected to the Neutral Bus and therefore goes to Earth as well.

The difference between the Neutral and the Earth wires is that:

- the Neutral wire is part of the AC power distribution. It carries the return current back to the Power Generation Station.
- the Earth wire is local to the house, it is not part of the AC power distribution coming into the house and does not go outside of the house.

The long distance high voltage electrical distribution lines are implemented in a Delta configuration (three wires/phases) to save the cost of a fourth conductor. At the local sub-station that they are scaled down to a Wye (Star) configuration (three phases plus neutral).

A house is served with two phases (out of the three available) and neutral.

The missing phase is rotated among blocks of houses to balance the three phases with respect to Neutral.

Two phases provide 208 Volt and Phase -Neutral provides 120 Volt.

Fig 2 illustrate how the AC lines are wired coming to a house, at the Main Switch Box where all breakers and the Neutral Buss are located, and at to the three holes wall electric outlet.

The three wires come of which:

- the two phases and the neutral are internally routed
- the neutral is connected to the Neutral Buss and from here it is buried in the ground.
- the Earth is originated at the same place where the neutral is buried and distributed as a fourth wire.

Fig 3 illustrates how a battery operated appliance with a metal case is to be connected.

Phase and Neutral feed the internal power system while the case is insulated and goes to the Earth wire. As long the phase does not accidentally touch the case, the Earth wire carries no current.

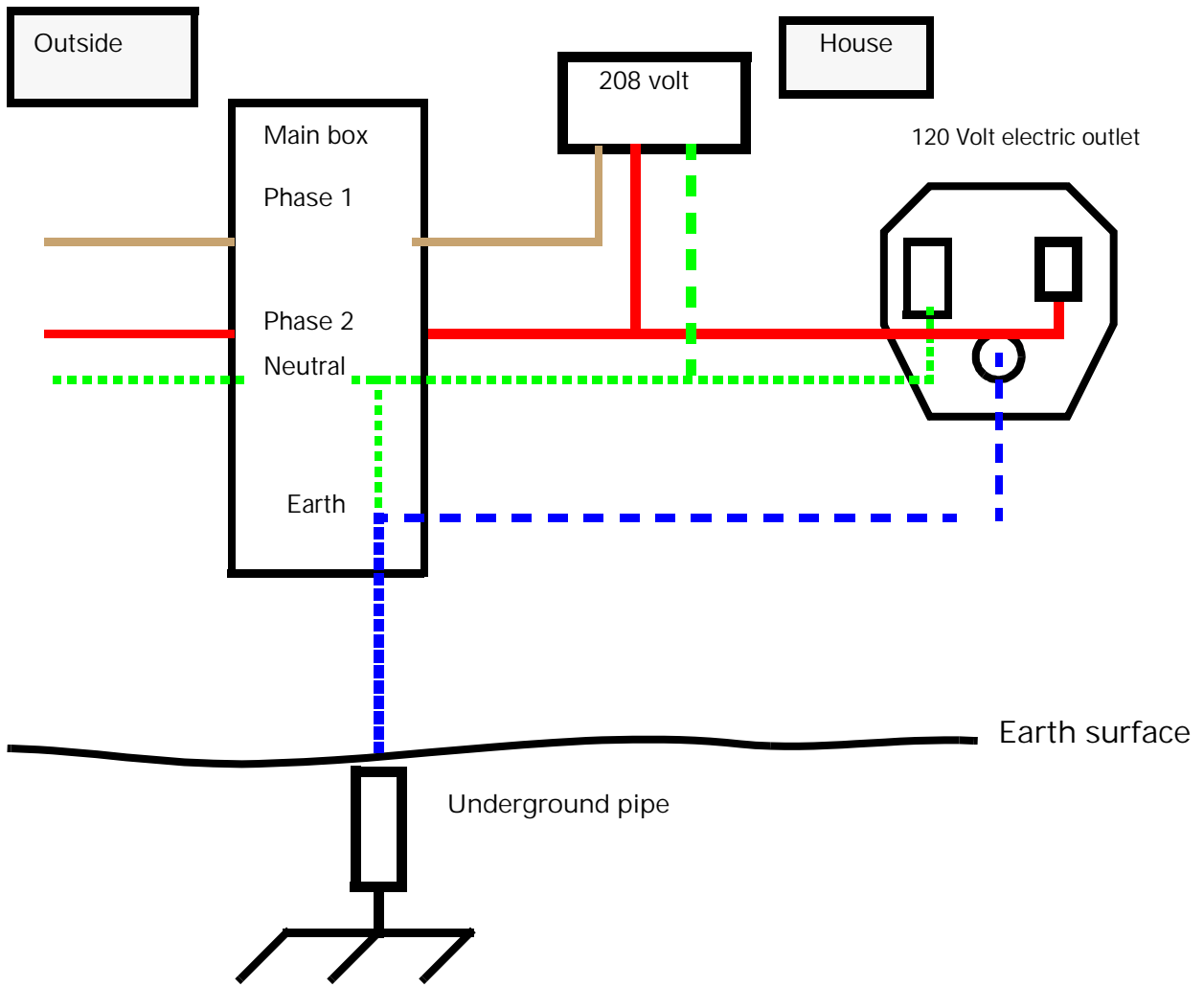


FIGURE 2. Domestic wiring

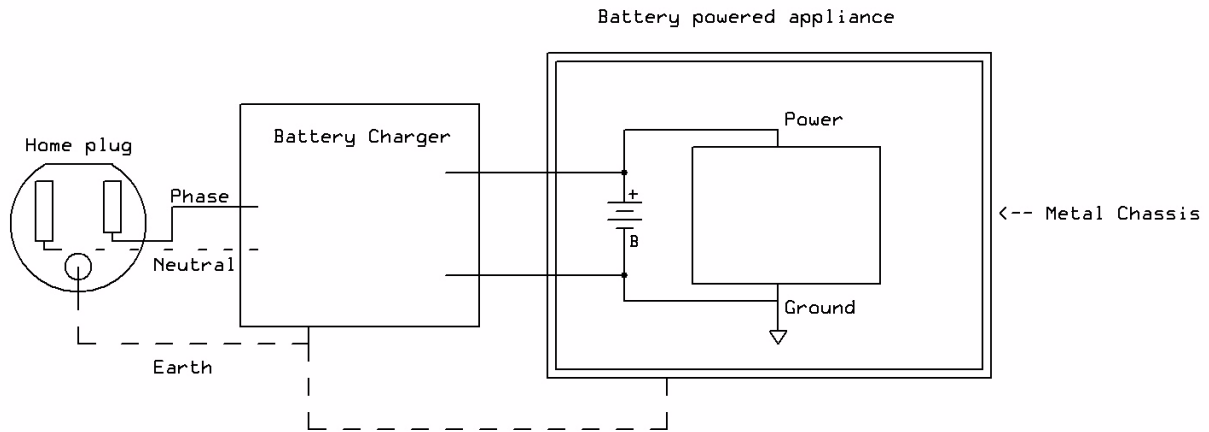


FIGURE 3. Rechargeable battery operated appliance

Connecting to Earth

With reference to Fig 4, a battery powered appliance mounted on a metal chassis has to fulfill the following conditions:

- All metallic components accessible by the user including the chassis must be interconnected.
- Any time an AC equipment (battery charger, diagnostic monitor, AC power supply, oscilloscope, personal computer,...) is connected to the appliance, the chassis must be earthed.

The AX2550 Roboteq controller is enclosed in a metal case; it is isolated from the internal circuitry and it has a strap marked for connection to Earth. The strap allows connecting the controller to the chassis.

Responsibility of the system designer

The designer of the system has to ensure that the design fulfills the safety requirements.

Failure to interconnect all metallic components to the chassis and/or failure to anchor the chassis to Earth when an AC equipment is connected may potentially raise the chassis to a dangerous voltage in case of defective, malfunctioning or erroneously connected AC equipment.

The designer needs to take all necessary steps to avoid such an eventuality.