INDUSTRIAL AUTOMATION

R2 SERIES OPERATORS MANUAL

Power & Charging Systems

Model R2-X2 eXperimental Model

Cover artwork by John Jongsma

Power makes everything happen and the more power you have the better off you are. Even R2 needs power to make things happen. Most R2 series droids use some type of batteries to run their systems. The most common type of battery used are SLA (Sealed Lead Acid). The SLA technology has been around for decades if not centuries and it is a simple and reliable power source. These batteries are fairly inexpensive and easy to recharge with a simple smart charger and they can be recharged quite a few times before they need to be replaced. The disadvantages of the SLA batteries are that they are HEAVY and the energy density of these batteries are only about 1/3 to1/2 of the newer technology batteries. However, even with these disadvantages the SLA battery is still a very good choice for today's droids.

There are a number of newer technologies on the market today that surpass the capabilities of SLA batteries. Some of these include, NiCd (Nickel Cadmium), NiMH (Nickel Metal Hydride), and Li (Lithium Ion). Of these 3, the Lithium Ion technology offers the greatest potential for battery technology. However, even within the Lithium Ion realm there are several different classes of batteries that offer different capabilities. Some offer a higher energy density but are more difficult to maintain and some offer a lower energy density but maintenance is significantly easier as well as their use. For droids the easy maintenance LiFePo4 batteries seem to be an ideal choice. These batteries weigh much less than SLA batteries, are faster to charge, can be charged many more times than a SLA battery and show very little memory effect after numerous charging cycles. Their only drawback is price, but as the technology improves and gains a wider acceptance price will surely drop.

Here's a list of all the advantages of LiFePo4 batteries:

Source: www.metaefficient.com

1. Safe technology — will not catch fire or explode with overcharge
2. Over 2000 discharge cycles life compared to typically around 300 for lead acid
3. Double the usable capacity of similar amp hour lead acid batteries
4. Virtually flat discharge curve means maximum power available until fully discharged (no "voltage sag" as with lead acid batteries)
5. High discharge rate capability, 10C continuous, 20C pulse discharge
6. Unlike lead acid batteries, can be left in a partially discharged state for extended periods without causing permanent damage
7. Extremely low self discharge rate (unlike lead acid which will go flat quite quickly if left sitting for long periods)
8. Does not suffer from "thermal runaway"
9. Can be used safely in high ambient temperatures of up to 60C without any degradation in performance
10. Maintenance free for the life of the battery
11. Can be operated in any orientation

12. Does not contain any toxic heavy metals such as lead, cadmium, nor any corrosive acids or alkalies thus making LiFePO4 batteries the most environmentally friendly battery chemistry available
13. LiFePO4 cells are of solid construction — there are no fragile/brittle plates made of lead which can be prone to failure over time as a result of vibration
14. Can be safely rapidly recharged — when fully discharged can be brought to a state of over 90% fully charged in 15 minutes

Drive System Power Cells:

The R2-X2 eXperimental Astromech droid has a power source for the drive system that is isolated from other power sources in the droid. The drive system power source consists of four SLA power cells. Each power cell is a 12 Volt unit and has a capacity of 10 Ah. There are two power cells located in the center body just below the dome and one power cell in each battery box next to the foot drives. The four power cells are wired together in a 24 Volt configuration with a total capacity of 40 Ah.

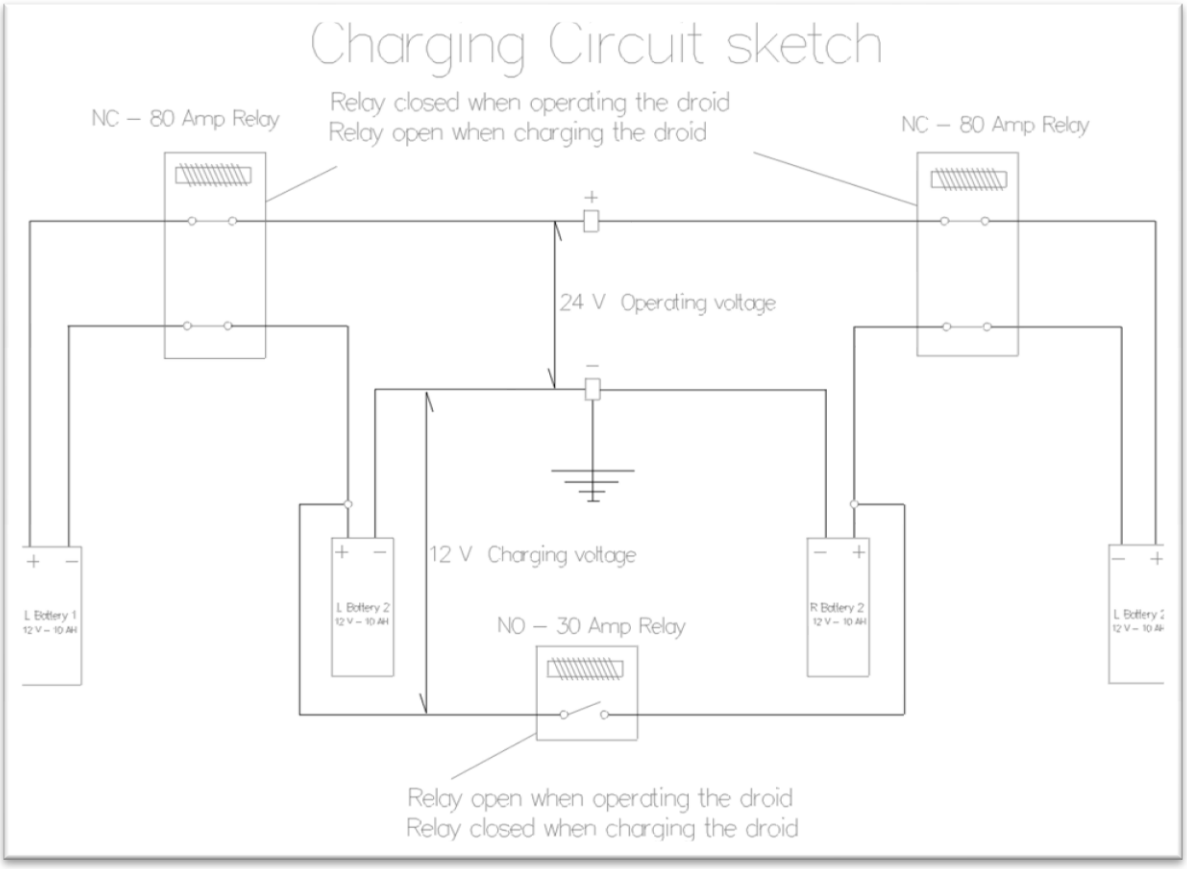

Figure 1: 24 Volt system power cell connections **- Diagram by: Blake Mann**

Accessories Power Cell:

The R2-X2 eXperimental Astromech droid also has a secondary power cell for the accessories that require power in the body. This secondary power cell is also located in the center body just below the dome and is situated between the two other body power cells. The secondary power cell is a 12 Volt unit with a capacity of 12 Ah. This secondary power cell runs the dome drive motor, the center foot lift/lower motor, the 2-3-2 linear actuators, and all of the electronics including the sound system and animatronics panels.

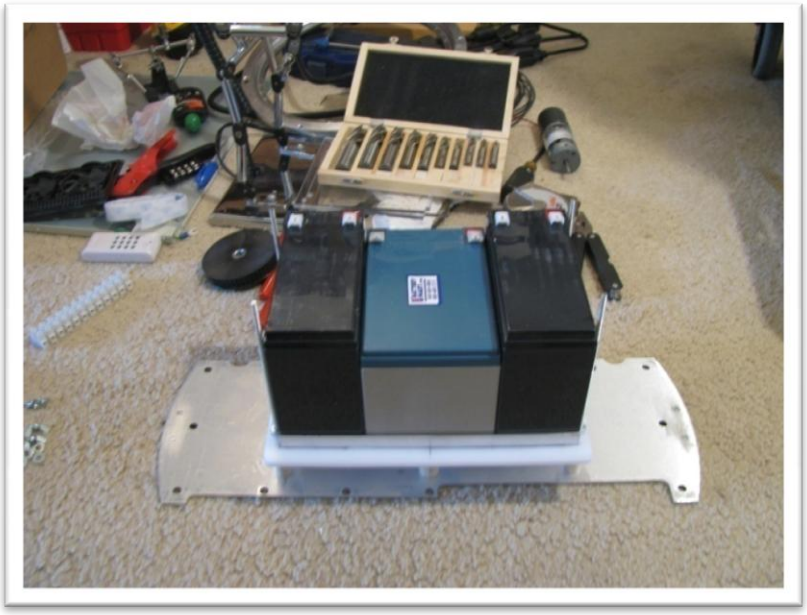

Figure 2: Center body power cells

Dome Power Cells:

The R2-X2 eXperimental Astromech droid has a separate power source contained in the dome. The dome power source consists of 2 NiMH battery packs. Each battery pack is 12 volts and has a capacity or 4 Ah for a total of 8 Ah capacity.

Figure 3: Dome power cells stored inside quad lifter

Figure 4: Dome NiMh power packs

Charging System:

The droid charging system has two modes of operation. The droid can be in operational mode or in charging mode. When in operational mode no charging of the

drive system power cells can take place. However if the droid is stationary the accessories power cell can be charged. While in charging mode the droid cannot be driven as the motors and motor speed controllers are isolated from the system circuits.

The charging system utilizes 5 internal relays to switch from operational mode to charging mode. To charge all of the power cells simultaneously requires a total of five chargers. Four chargers are “smart” chargers which mean they will sense when the batteries are fully charged and will switch to a trickle charge mode just to keep the batteries from losing charge. A single “dumb” charger is use to simply maintain a voltage of 12 volts on the relays to keep them in charging mode and does not actually charge any of the power cells. The chargers must be specifically designed for SLA (Sealed Lead Acid) batteries. It is recommended that the 4 smart chargers should be at least 1 amp chargers.

The purpose of the relays in the charging circuit is to disconnect the batteries in the foot drive battery boxes from their wired 24V configuration and allow them to charge as individual 12 volt power cells. The two center body batteries are also disconnected from their 24V configuration and are re-wired together in parallel so they charge as a single 12 Volt battery. The fifth accessory power cell is a separate unit and can therefore be charged by itself with a “smart” charger. The relays also break the electrical connection to the AX-3500 motor speed controller of the drive system during charging. However, the connection to ground from the motor speed controller is maintained even in charging mode.

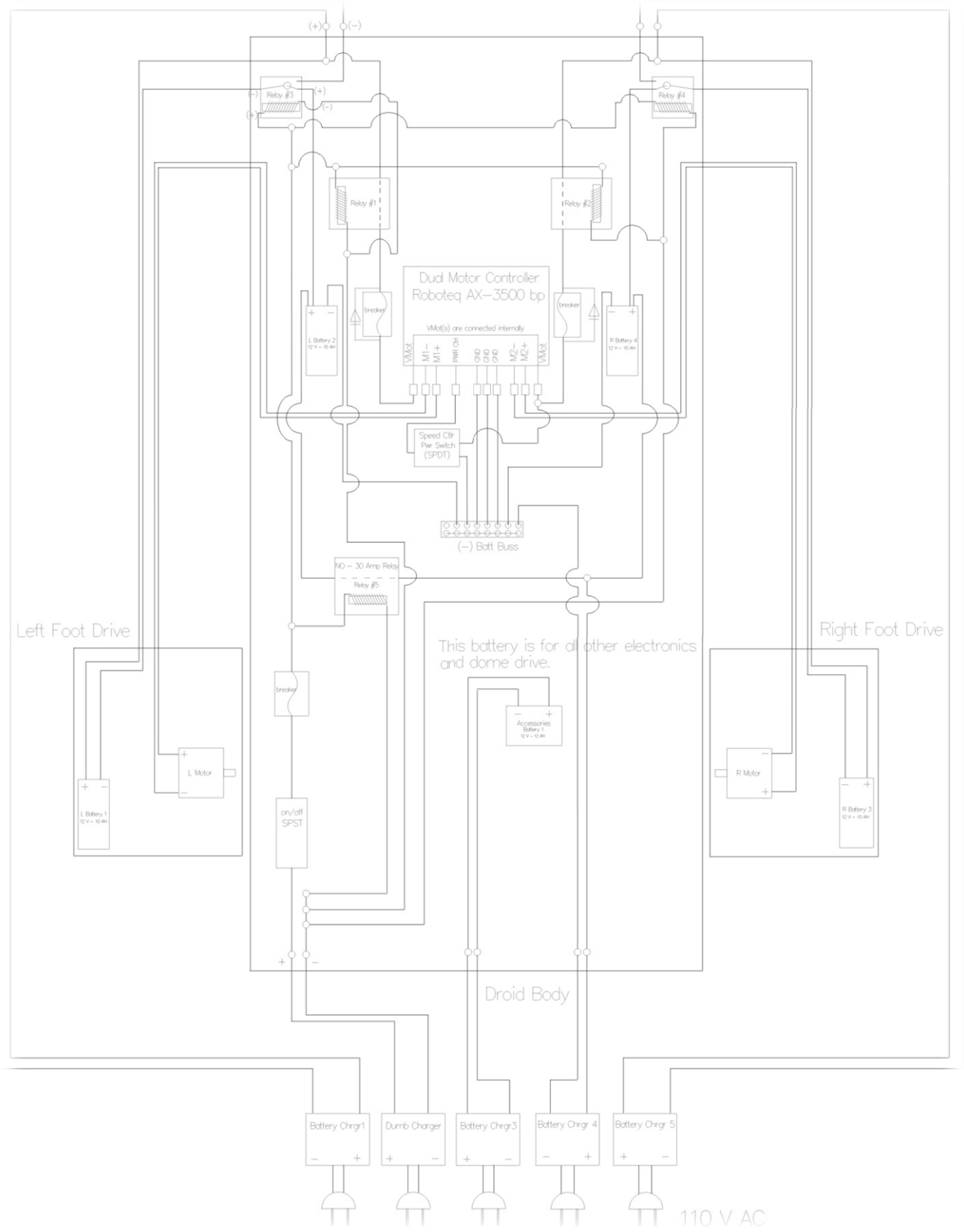

Figure 5: Charging system diagram **- Diagram by: Blake Mann**

Below are images of the two relay panels that are mounted below the side vents of the droid. These are relays from the charging system diagram. These were mounted off of the main drive system panel due to space considerations.

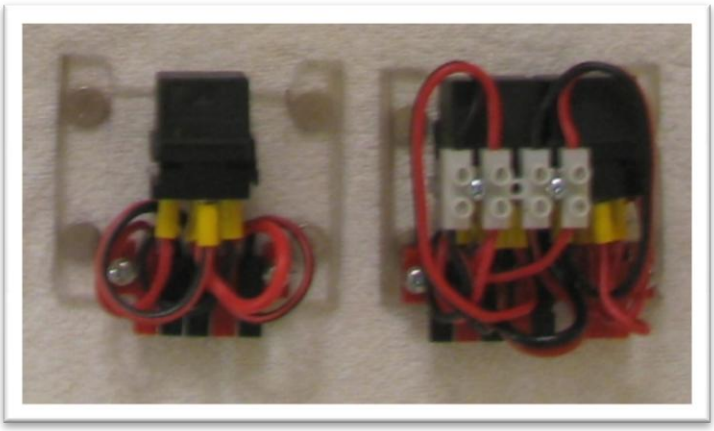

Figure 6: Charging system relay panels

The chargers for the droid connect to the charging system via Anderson Power Pole connectors behind the back side door panels and the single dumb charger for maintaining the voltage on the relays is plugged in to the droid behind the front power port panel.

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