

## User Manual

### Introduction



Thank you for choosing the Dataforth Battery Charger and we hope you enjoy what we have developed for you. The Lithium Lumberjacks are glad to support you in your business needs. As requested our team has developed a custom battery charger and battery management system to help you demonstrate the power of Dataforth products for your clientele. Our product features many customized systems to meet the high standards of Dataforth products Including:

- A user display
- Full Integration of the Dataforth MAQ20 modules
- Safety systems to provide safe use of our product
- A portable design for easy travel to tradeshow and demos

This user's manual will walk you through how to not only use our product, but also walk you through maintenance and troubleshooting of our product for continued use. Our goal is for you to have a lasting product that provides benefits and profits for your business.

Your need for a battery charger that integrated Dataforth products to show clients the many uses of your data acquisition and communication devices prompted our team to research and develop a high functioning device that can utilize different Dataforth products. Our team used the Dataforth MAQ20 system as the focal point of our design. This allowed the team to show the many uses of the MAQ20. The team also kept the MAQ20 on the exterior of the design so that at demos and tradeshow clients will be able to fully see the MAQ20 putting Dataforth products at the forefront of the demo, with the overall product being focused on showing off the Dataforth product. Not only did the team recognize the need to show how useful Dataforth products are, but we also designed our product to meet the safety standards set forth by IEEE. Creating a safe functioning product was important for the team. Our team recognized Dataforth's focus on safety and integrated that same high safety standard into our product. The device charges batteries without exceeding high temperatures. This keeps the battery, and all devices inside of our system safe. Our team focused on your needs to develop a safe functional system that complimented your products to allow for you to display your products and their uses to clientele.

Our system is made up of five main subsystems. The first subsystem is the user interface. This subsystem consisted of a high definition LCD screen, five buttons, and an active buzzer. The user interface was made to be simple for anyone to use. Each button has a designated function, the active buzzer allows for an audible alarm if a fault is detected in the system. The large LCD screen allows for easy viewability for the user. The second subsystem is the TI MSP430 microprocessor. This subsystem is the brains of our device. The MSP430 was chosen due to the relationship Dataforth has with Texas Instruments. The third subsystem is the charging circuit. This subsystem is created with step-down converters and relays to allow for the charging of the different battery cells. The fourth subsystem is the discharging circuit. This circuit is also created with relays, but the important part of this subsystem is a high wattage 4 ohm resistor. This resistor being high wattage is important for heat dissipation in the case where all cells discharge at once. The fifth and final subsystem is the MAQ20 system along with the necessary communication modules to use the MAQ20. This subsystem is the main communication between the battery and the MSP430. This subsystem is important because it monitors all the battery cells and communicates with the rest of the subsystems to allow for each subsystem to complete their designated task. This subsystem also displays the functionality of Dataforth

products. Each of our subsystems were designed with both safety and your company needs in mind. Our team included safety details and device protection into all our subsystems. Consistent grounding and electromagnetic interference protection was a focal point in all subsystems where it was important. Attention to all details was important to our team knowing Dataforth also has a focus on precision and detail in their products.

Over the course of the year our team was focused on designing a product that would meet your business needs. We followed the engineering design process and focused on your needs to create a product we felt met your standards and needs. Starting from in depth research of different battery chargers and battery charging algorithms our team developed our system using innovative charging algorithms. Our prototyping was done with a focus on how we could meet your required specifications along with trying to create a device that was complete, and provided functions above those requested. Using a larger, high definition LCD screen was a change made to allow for ease of use. We understood that a goal was to show how Dataforth products can be used so the team not only integrated the MAQ20, but kept it in view of the user so that Dataforth was a focal point when the product was in use. Finally, we developed our product with systems that could withstand being transported long distances, allowing for our device to be taken anywhere to be demonstrated.

The rest of this user's manual will walk through how to use our product to its fullest potential. We again hope you are satisfied with the product we developed for you to use in demonstrating Dataforth product power. We also would like to thank you for your continued support to our team throughout this project.

## **Installation**

This section of the manual will provide you with an in depth understanding of how to correctly set up our product before use. Our product set up was made to be as simple as possible for easy installation and set up at tradeshow and client demonstrations.

To install our product you will need access to 115-125VAC wall power. To install our product you must plug into wall power. After plugging into wall power the user will need to flip the red power switch located on the back of the device next to the power cord. After ensuring the device is plugged in and the switch is in the on position the device is ready for use.

To use the device plug in your four-cell LiPo battery into the yellow XT60 connector located on the front of the device. Once the battery is connected the device has been correctly set up for use.

## Configuration and Use

The Dataforth Battery Charger allows for ease of use through the user interface. Upon startup, the device will check the charging status of your battery by evaluating the voltages of each of the cells. Once the battery charger determines the battery needs to be charged, it begins charging at the slow rate of 1C. This serves as the default charging rate upon startup.

### LCD Screen

The LCD Screen provides all of the information the user needs during charging. Information such as the voltage of each cell, the current the battery is being charged at, and the temperature of each cell. The LCD screen will also alert the user of any faults that occur while charging.

### Interface Buttons

The user interface of the charger features five buttons to actuate multiple functions on the device, such as switching between menus, selecting the charge rate, and performing a system reset.

*Switching Between Menus* - Utilize the two black buttons on the right side of the device to switch between menus of the display screen. The order is as follows

- Main Menu - Displays charging percentage, current charging rate, and overall battery temperature
- Secondary Menu - Displays the voltage and temperature information for each of the individual LiPo cells.

*Selecting the Charging Rate* - There are two buttons for setting the charge rate. The central black button is used to select the slow charging rate of 1C. This charging rate is automatically applied upon system startup and after system reset. The red button selects the fast charging rate of 3C.

*System Reset* - The button on the very right of the interface is for a user initiated system reset. The reset procedure will deactivate the device from charging or discharging by opening the relay circuits of the charging and discharging circuits, thus disconnecting the battery. The system

will then be able to reconnect to the charging and discharging circuits by choosing a charging rate of 1C or 3C.

### **Fault Conditions**

*Cell Fault* is most likely to happen due to plugging the battery in the wrong direction, as the battery connector itself has no discernable directional plug for the cell balance bus. It may also occur due to a reverse charged cell, which would be a cause for battery disposal.

*Battery Overtemp* can happen due to battery overcharge and failure of the charging circuitry within the system. It may also be caused by an imbalance in the chemistry such that charging or discharging the cells causes thermal runoff.

*System Overtemp* may happen due to a passive component burning. While unlikely, it may also be caused by overheated discharge or charge wires as they may carry up to 10A of current.

### **Maintenance**

The Dataforth Battery Charger is meant to provide reliable charging over many charging cycles. However, to ensure users are able to properly maintain their device properly, links to charger components have been provided below.

Charging Circuit Relays: Minimum of 100,000 cycles before needing replacement

<https://www.mouser.com/ProductDetail/Panasonic-Industrial-Devices/JW1AFSN-DC5V-F?qs=bpFJJ1fyfoDGhqtQ7d1JMw%3D%3D>

3.5" LCD Screen:

<https://www.amazon.com/gp/product/B08QYNMSZM/>

### **Troubleshooting Operations**

While no product is flawless, the team has built this system to be exceptionally robust. In this section we will cover issues that may occur and how to correctly troubleshoot them.

#### **Code Not Loading**

One issue that could occur is the device code not staying loaded on the MSP430 on shutdown. While the code should stay on the MSP430, if it ever does not reload on startup simply open the

face of the chassis by removing the four screws on the chassis face. Once removed the chassis should be able to open. Inside you will find the MSP430. Using a USB to Micro-USB cable connect a computer or laptop to the MSP430 and reload the device code. Once done, put the chassis back together and the device should be functioning properly again.

### **No Power to a Subsystem**

If any portion of the product stops receiving power follow these steps to troubleshoot. First step would be to check the fuse located next to the power switch on the back of the device. If the fuse is not blown then the chassis will need to be opened. To open the chassis remove the four screws on the chassis face and the chassis should now open. Once opened, locate all seven step down converters. A reference step down converter is shown in Figure 1. Each step down converter has three LEDs located on the right of the device. Find the output indicator LED labeled "OK". If that LED is solid red then that step down converter is no longer working. If this occurs refer to the maintenance section of the manual to order a new step down converter. If all step down converters are functioning the next step would be to test for any loose connections within the device with a continuity test. If a loose connection is found, reconnect and put the device back together. If no loose connection is found the device that is not receiving power may no longer be working. Refer to the maintenance section to order a replacement part.

### **Conclusion**

The Lithium Lumberjacks would like to thank you for your decision to work with us on the development of this product. Our team is happy to have worked with your company and hope our product continues to be of use to you for years to come. While our team will be moving forward into our professional careers in the coming months feel free to reach out to us at our team email [lithium.lumberjacks@nau.edu](mailto:lithium.lumberjacks@nau.edu). Thank you again for your time and business.