Current USB-C multiport chargers work as a current distributor with a microcontroller, where the charging rate decreases as more devices are connected. The project's goal is to provide an alternative to existing products with a more compact, fully analog design charging up to 5 devices with fast charging capabilities.

**System Requirements**

- Use standard 5V 4A power supply to charge all 5 devices overnight
- Follow the standard USB-C power delivery protocol [1]
- Implement Plugable’s patented “Priority Charging” algorithm
- Design with fully analog components (no microcontrollers)

**“Priority Charging” Algorithm**

<table>
<thead>
<tr>
<th>Device Battery Level</th>
<th>Advertised Charging Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 80 %</td>
<td>3.0 A</td>
</tr>
<tr>
<td>80 - 90 %</td>
<td>1.5 A</td>
</tr>
<tr>
<td>90 - 100 %</td>
<td>0.9 A</td>
</tr>
<tr>
<td>100 %</td>
<td>0.0 A</td>
</tr>
</tbody>
</table>

Charges each port up to 15W 3A [2] starting at the highest priority port. Power dynamically shifts to the lower priority ports as each device completes charging in succession.

**AC/DC Adapter:** Provides constant 5V 4A to the system

**Power circuit:** Generates -5V DC power for other components

**Current Sense Circuit:** Measures the current drawn from the device in voltage readings

**Logic Circuit:** Controls the priority charging function that triggers the USB-C interface circuit

**USB-C Interface Circuit:** Chooses the resistance value (R_p) for the USB-C CC line to limit the charging rate of the connected device

- **Port 1:** Device Battery Level 0 %, V_Rd 0.25 - 0.61 V, Advertised Charging Rate 0.9 A
- **Port 2:** Device Battery Level 0 %, V_Rd 0.7 - 1.16 V, Advertised Charging Rate 1.5 A
- **Port 3:** Device Battery Level 0 %, V_Rd 1.31 V or above, Advertised Charging Rate 3.0 A

The voltage drop across resistor R_d (V_Rd) determines the device charging rate. For testing, a 3-port USB-C circuit was built on the breadboard before expanding it to 5 ports for the PCB design. Devices may draw less current than the advertised current.

**Conclusion**

The team successfully designed a fully analog USB-C multiport charger that outputs the desired R_p resistor values according to the Plugable's patented "Priority Charging" algorithm, which charges up to 5 devices using a standard 5V 4A power supply.

**Future Work**

- Optimize circuit components to follow the patented algorithm more efficiently
- Further research to validate the Power Delivery protocol on USB-C connectors
- Integration of AC-DC adapter into the circuit
- Circuit protection and heat sink

**References and Acknowledgments**


**Test Results**

Port # | Device Battery Level | V_Rd | Advertised Charging Rate |
-------|----------------------|------|--------------------------|
Port 1 | 0 %                  | 1.67 V | 3.0 A*                    |
Port 2 | 0 %                  | 1.87 V | 3.0 A*                    |
Port 3 | 0 %                  | 0.42 V | 0.9 A*                    |

*The advertised charging rate is different from the actual charging rate, which depends on how much current the device wants to draw.*