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Technical Design (TD)

By: Matronix

Saxion University of applied sciences

MATRONIX

Place, date:	Enschede, 13.10.2022.		
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CONTENTS

ABBREVIATIONS

- LED – Light Emitting Diode
- SDK – Source Development kit
- API – Application Programming Interface
- Li-Ion – Lithium Ion (Battery)
- BMS – Battery Management System

INTRODUCTION

Matronix' technical design document is an overview of the technical details that will be considered during the implementation phase. These details include concept selection, component choice, and software and hardware flowcharts. This document will also help understand the main reasons for this project.

PROBLEM

The task provided to Team Matronix is to develop an RGB LED display sign for users to show their messages on it. The display must be readable from ten meters, have at least 1 hour of battery life, the sign must be mobile and cordless.

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ELABORATION OF CHOSEN PRINCIPLE TO TECHNICAL DESIGN

The concept chosen by Matronix abides to all the requirements requested by the stakeholders:

- Wireless data transmission – Using Raspberry pi's Wi-Fi and SSH or Webserver.
- Clearly readable from ten meters far – The chosen display size provides adequate clarity and readability. In case the desired distance is largely more than ten meters additional modules can be easily attached.
- The display will run for at least an hour as power will be provided by battery modules consisting of two rechargeable 18650 Li-Ion battery cells connected in series with charging, power regulation and safety features. One battery module will be chosen per display to achieve maximum performance and battery life.

The summary or additional features that this product will have are as follow:

- Detachable modular displays
- Hot swappable batteries – Display operation will not be interrupted if at least one battery module is connected
- Automatic Displayed text/graphics Size adjustment based on the amount of displays connected
- Automatic brightness adjustment based on the amount of battery modules connected
- Mounting the displays back-to back will allow displaying the same information from the front and back for people to see from both sides of the display.
- The ports that connect the display modules will also allow for additional modules or sensors to be connected by the I2C BUS and 2 ADC inputs, to add to that any unused IO that would normally be used for additional display modules can be used for additional peripherals instead.

OVERVIEW OF TECHNICAL DESIGN

In this concept, the LED displays will be detachable modules each with its own hot swappable battery. The display size can be increased or decreased by adding or removing LED Matrix modules and the batteries can be removed, replaced, or charged without interrupting the operation of the display. This concept allows for the creation of a very efficient display having minimal power and size problems.

ELABORATION OF TECHNICAL DESIGN

ELECTRICAL & ELECTRONICS CIRCUITS

Show in Appendix A is a schematic of the PCB which will be physically attached to the main display, its purpose is to house the raspberry pi 4b Microcomputer as well as serve as a connection point for the other matrix panel modules to the Microcomputer.

Subcircuits of this schematic are panel detection circuits as well as battery pack detection circuitry.

The other schematics in Appendix A include the power delivery, charging and balancing circuitry.

SOFTWARE

- https://github.com/hzeller/rpi-rgb-led-matrix Library, Resources, Example code
- https://github.com/karolis1115/Matronix Project Repository (GitHub)

TECHNICAL DESIGN INTEGRATION

SAFETY

- Since the Li-Ion battery cells that are used to power the project are potentially dangerous and can lead to unforeseen consequences, care has been taken to implement multiple safety features:
    - Over-charge protection

- Over-discharge protection
- Power delivery to the battery is controlled by a USB-C PD (Power delivery) integrated circuit
- Charging is controlled by a dedicated integrated circuit that charges and balances the two cells in series that will be used for the battery pack
- The Raspberry pi will have the capability to detect how many battery packs are connected to each display, if the amount of battery packs connected is less than the battery backs can handle the brightness will be dimmed to reduce power consumption and extend battery life. (Each pack can run two displays)

COSTS

Due to the sheer amount of engineering that goes into making a modular design of any product excessive costs are to be expected.

The main costs can be divided into these categories:

- Battery power and battery power management
  - Battery cell costs
  - Charging
  - Voltage conversion
  - Battery cell protection (Undervoltage, Overcharging, Automatic sufficient charging supply assertion, …)
- Display and display management
  - Display module costs
  - Display data voltage level shifting
  - Display detection using an ADC
  - Display modularity integration

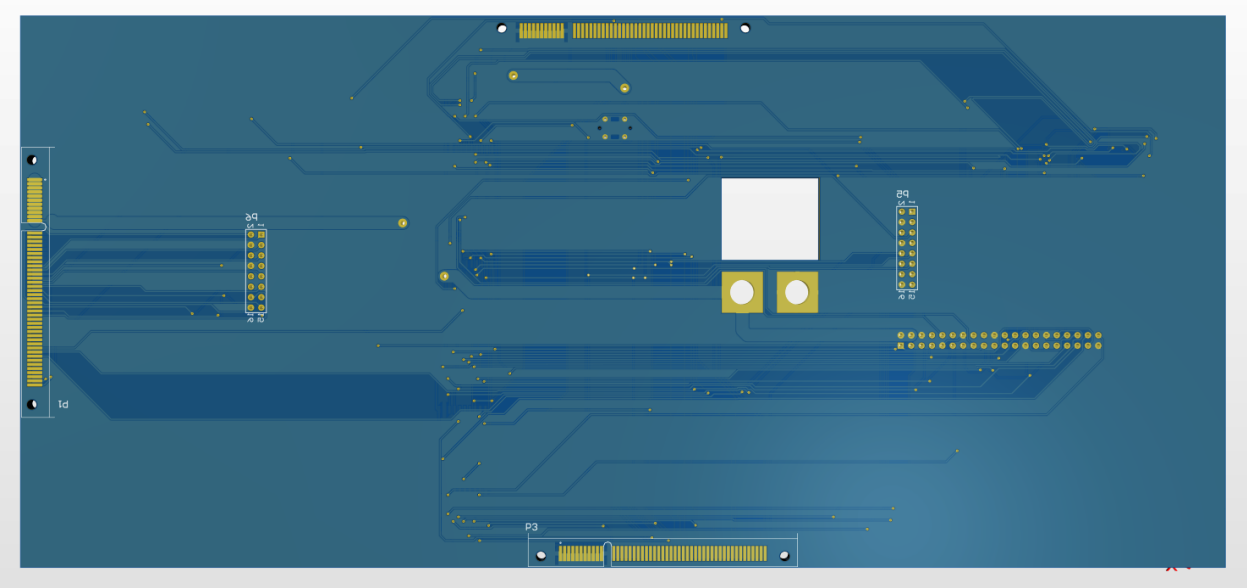
Nr.	Artikelnr.	Omschrijving / Description	Aantal/Quantity	Prijs/stuk (€) Price/unit (€)	Totaal (€)
1		64x32 RGB LED Matrix - 320x160mm	4.00	21.07	84.28
2		LG 18650 Li-ion Battery - 3400mAh - 10A - INR18650	8.00	4.96	39.68
3		Octal Bus Transciever MC74VHCT245ADTRG	4.00	0.94	3.76
4		Card Edge Connector G630H981224BEU	15.00	2.94	44.10
5		Grove - 4 Channel 16-bit ADC (ADS1115) w/	2.00	7.64	15.28
6		USB Connectoren WR-COM USB3.1 Type C	4.00	4.37	17.48
7		DIODE SCHOTTKY 60V 5A SMC	4.00	1.01	4.04
8		MOSFET P-CH 60V 5.1A DPAK	4.00	3.00	12.00
9		Switching Voltage Regulators High-Efficiency, 10A,	4.00	2.56	10.24
10		LDO Voltage Regulators 3.3V 0.8A Positive	4.00	0.67	2.68
11		Battery Terminals 5 Position Male SMD	4.00	2.78	11.12
12		Accuklemmen 4 Position Male SMD	4.00	2.30	9.20
13		Cilindrische accuklemmen, -clips, -houders en -veren	4.00	6.95	27.80
14		Batterijbeheer I2C 2 cell 2A Boost battery charger for	4.00	5.75	23.00
15					
16					
17					
18					
				Totaal Excl. BTW:	**304.66**

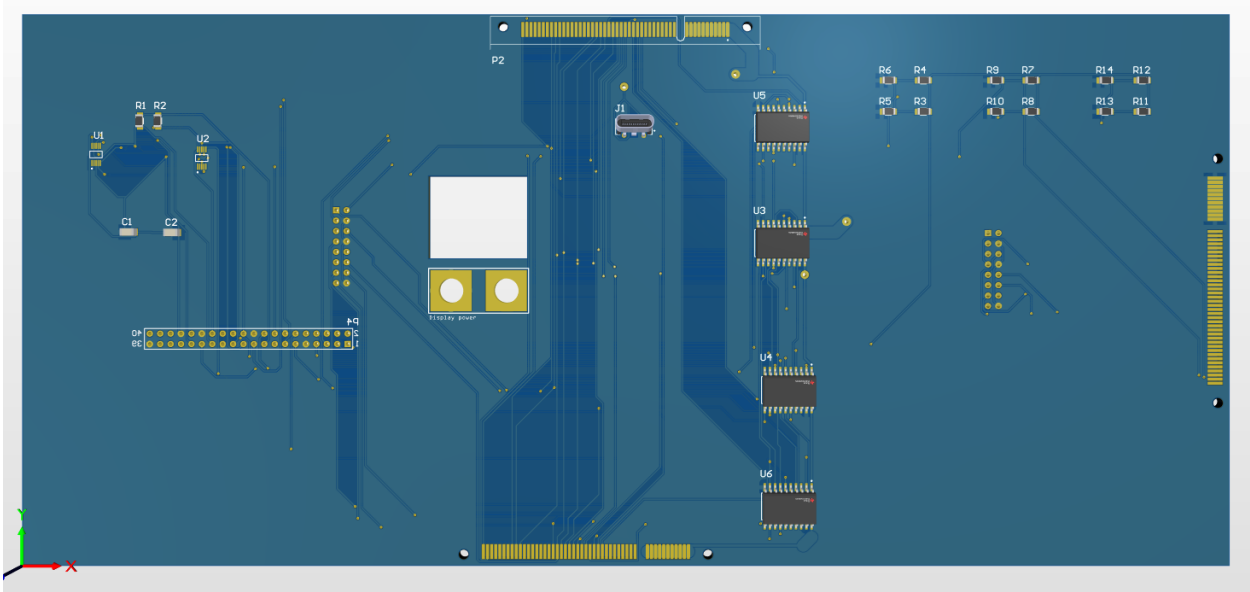
MAINTENANCE

A big part of the concept of this system is that the components are modular, this brings an advantage when a part becomes faulty or reaches its end of life it can be easily swapped out for a new one without soldering.

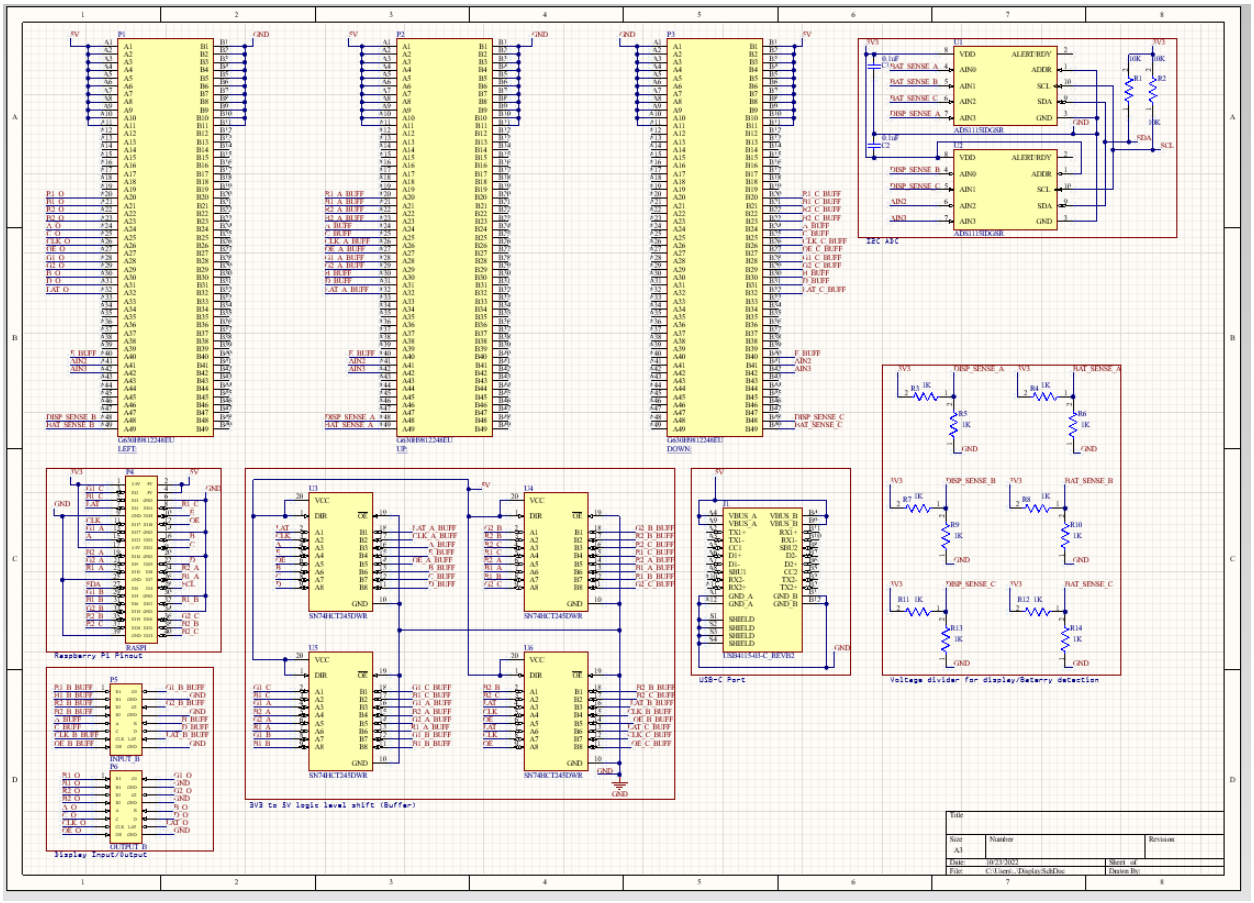
- The battery packs contain holders for the 18650 cells that will be used to power the device, so it is easy to repair the battery module itself.
- The raspberry pi, and display matrix modules will be connected to a PCB using headers so replacing either the Matrix panel or the raspberry pi itself should only require a screwdriver.

APPENDIX A: ELECTRICAL & ELECTRONIC

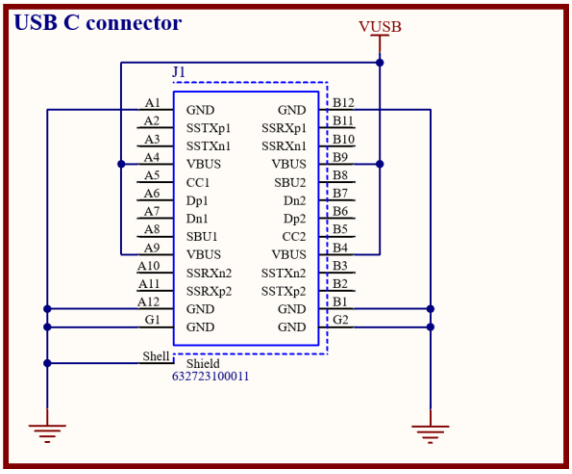


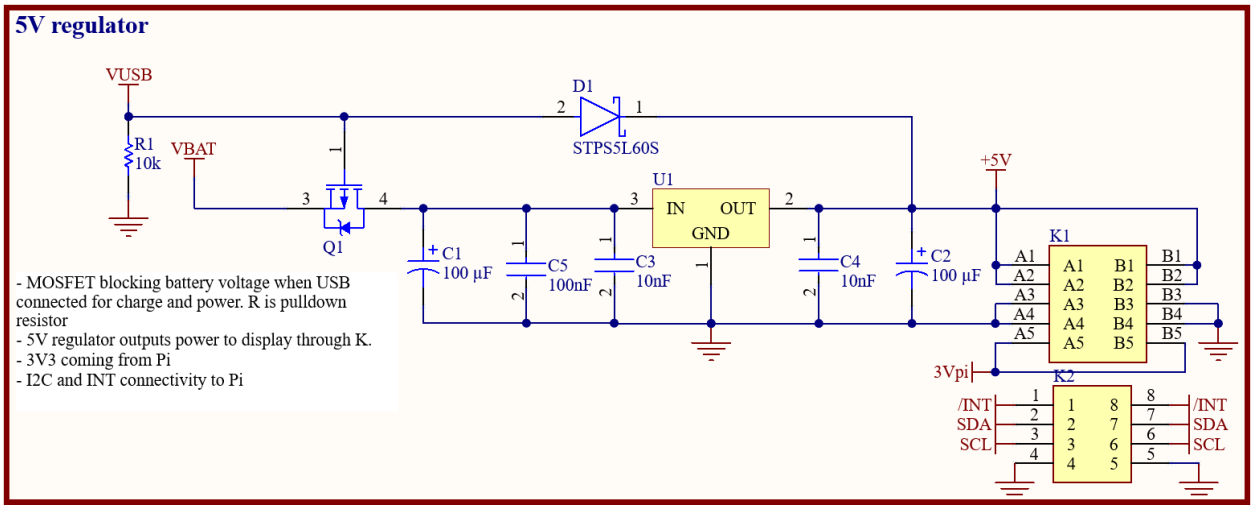


- Main display module printed circuit board (Both sides)

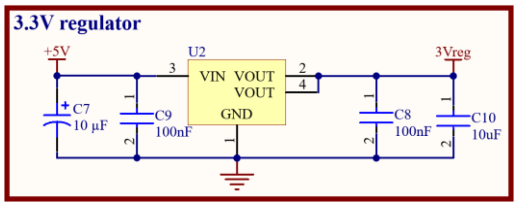


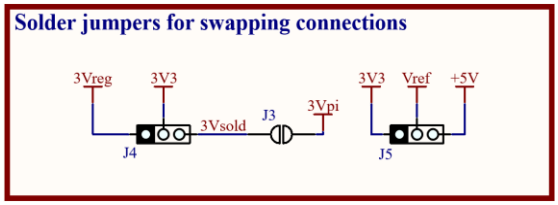
- Main display Circuit schematic (data output, Logic level conversion, battery, display detection, ADC integration)



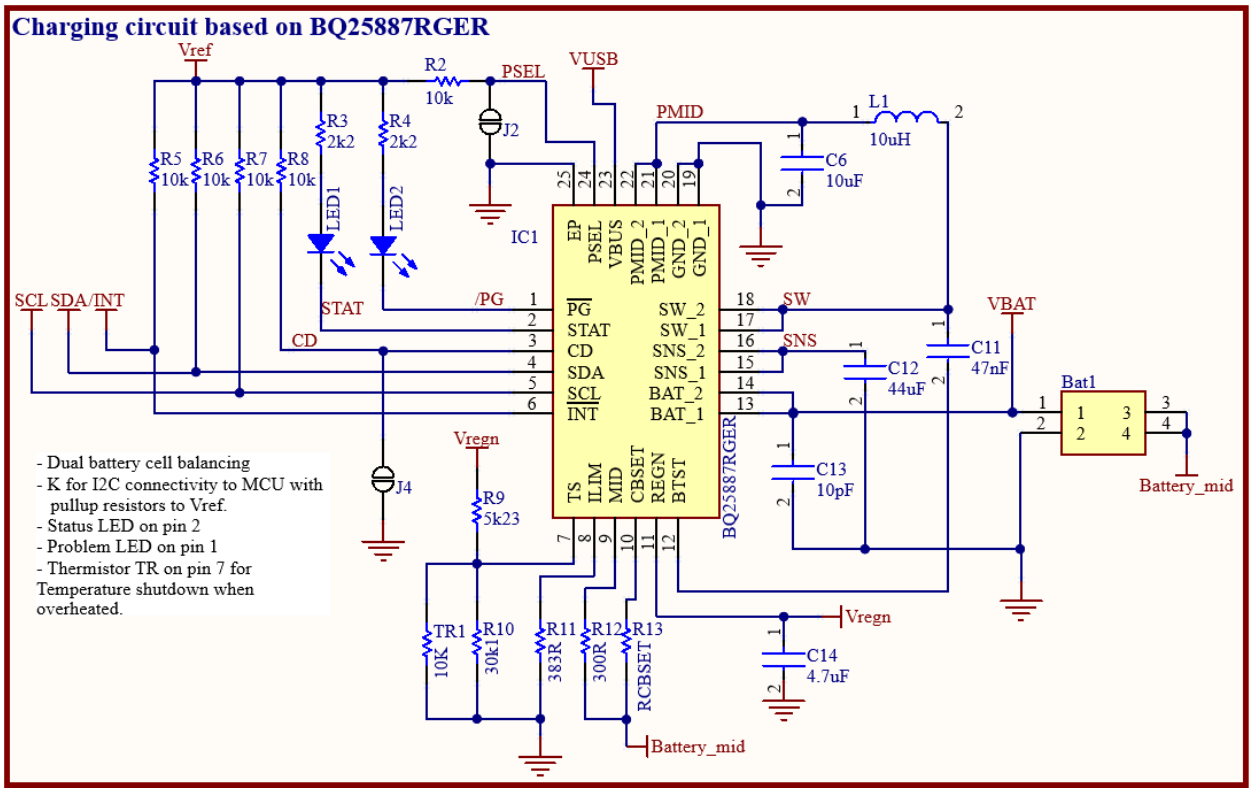


- USB C connection, 5V regulation and power and data outputs





- 3.3V regulation and solder jumpers for configuring data line



- Battery Charging/Protection

DISPLAY DEMONSTRATION

This depicts the displays outputting Patterns using a raspberry pi 4B