

TL25: KEY DOCUMENT REQUIREMENT SPECIFICATIONS

Changelog

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2018-10-14T14:54:06Z	Rowan 11986156	Added change log
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EXECUTIVE SUMMARY

Our product is a display made of reconfigurable “Tiles”. Each Tile has a Light Emitting Diode (LED) and Infrared (IR) sensor matrix that is sensitive to gestures directly above it. For instance, when an object moves within three inches of the display, the LEDs light up creating a reflection-like effect. The display can display text, and in the future, could be configured to show time, weather, bus information, etc. The Tiles can be rearranged at the user’s discretion to create larger displays and/or displays different shapes. Each Tile connects seamlessly with its neighbors via a magnetic pogo pin connector to avoid cables. The display is internet enabled and can be controlled through an app. Furthermore, the Tile is a visual work of art that you can show off to your friends and family, turning an otherwise mundane surface into a visually stimulating display. [Fig 1] depicts a two-Tile display with a third Tile being added to the display.

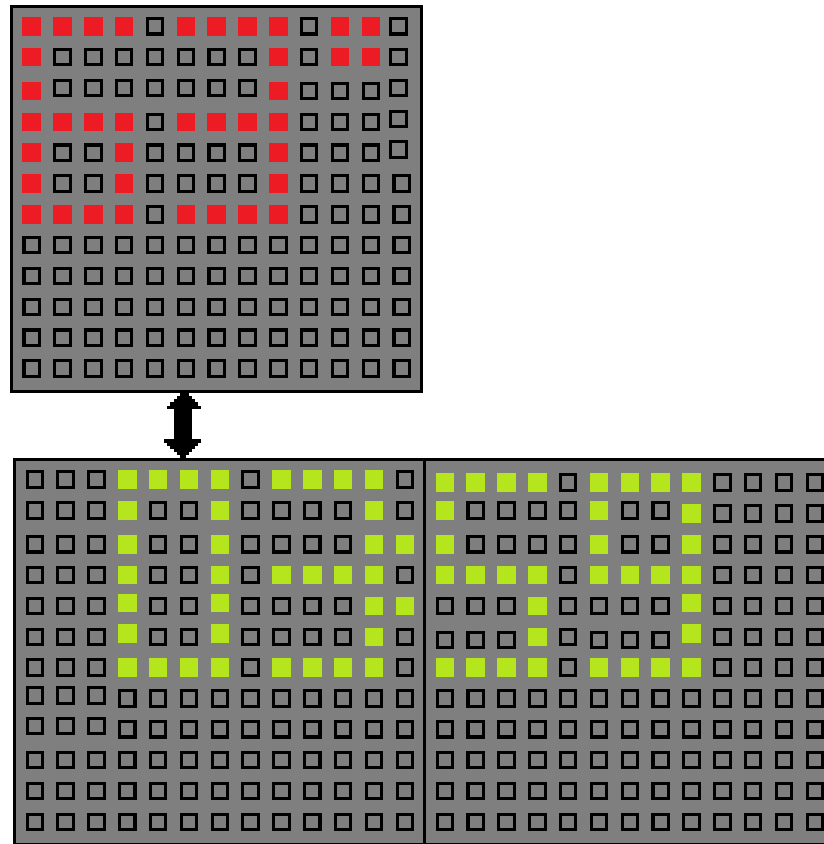


Figure 1: Artistic Depiction of a Three Tile Display

1 - CONTEXT AND BACKGROUND

With the advent of Internet of Things (IoT), the idea of smart homes is picking up traction with consumers. There is a demand for internet enabled entertainment lighting solutions, with the current market leaders being the [NanoLeaf](#) and the [LIFX Tile](#) [1]. The NanoLeaf Canvas has touch enabled panels but is only capable of displaying a single color per panel, while the LIFX Tile can display multiple colors per LIFX Tile but uses a cumbersome cable management system. Neither of these products are responsive to movement or capable of displaying text, though some avid engineers have attempted to hack their LIFX Tiles to do just that [2].

Our Client is Lab498, a local tech startup company that is hardware oriented and wants to change the way we interact with power at home. Their flagship product, [VoltSafe](#), aims to magnetically connect wall plugs and control them wirelessly. Our product is an extension of their vision for smarter homes. They have asked our team to create a proof of concept modular display capable of gesture responsiveness, text display, on the fly reconfigurability, and internet connectivity.

2 - DOMAIN

Our project, the responsive modular LED display, falls under the smart home technology domain, an emerging market that is currently valued at \$31 billion in the United States and is projected to reach an excess of \$50 billion by 2022 [3]. The main competing products to our project are the NanoLeaf Canvas and the LIFX Tile.

3 - GOALS

3.1 - Cost

The product is intended to be competitive on the consumer market, so the cost must be comparable to the NanoLeaf Canvas retailing at 9 panels for \$299.99 [4] and the LIFX Tile retailing at 5 Tiles for \$249.99 [5].

3.2 - Wireless Connectivity

To be a smart home device, the product must incorporate wireless communication to allow users to connect a mobile phone. Users will be able to change the colour, brightness, and text displayed on the Tile over Wi-Fi. In the future, incorporating wireless connectivity as an open source Application Programming Interface (API) will allow integration with smart home controllers like Google Home and Alexa and let users create their own applications to control the responsive modular display.

4 - Functional Specification

4.1 - Real Time Feedback

The Tiles must mirror movements directly in front of them in real-time. They must also be able to interpret and change operating modes based on gestures. These features will provide a level of interactivity not present in comparable products such as the NanoLeaf Canvas.

4.2 - Modularity

4.2.1 - Dynamic Addition and Removal of Devices

One of the key features of this product must be the ability to add and remove devices dynamically. The devices must have a fast “plug-and-play” setup to allow users to adjust the size and shape of their display as needed. Additionally, this would add flexibility in powering up the whole display from any of the Tiles.

4.2.2 - Unified Display

Tiles must connect to each other to form a larger unified seamless display. For example, if four Tiles are connected in series, then a message must scroll across all 4 Tiles as if it was one long display.

5 - Non-Functional Specifications

5.1 - Reliability

5.1.1 - Electrical Components

Electrical components, if handled correctly, have a long operating life expectancy. Key factors for reliable preservation of the main components on the test Printed Circuit Board (PCB) are outlined below according to the manufacturer datasheets.

IR Phototransistor (VEMT2020x01)

Recommended operating temperature is (-40 - 100°C) [6].

LED (COM-14608)

Recommended operating temperature is (-40 – 70°C) [7]. We need to take caution against electrostatic discharge and heat generated from the LEDs when making the system design.

Furthermore, since the product uses IR Sensors for reliable operation, a robust heat dissipation system must be designed within our PCB to ensure that the heat generated from the LEDs does not affect the IR Sensor readings.

5.1.2 - Mechanical Components

The Tiles must connect using pogo pins and magnets like the Apple magsafe connectors. Pogo pins are typically rated for a minimum of 10,000 cycles, which must be enough for a multi-year lifetime expectancy. We may face reliability issues in the following areas:

- Pogo pins are not designed to transfer high speed data'.
- The female mating pad can get corroded and contaminated increasing the contact resistance through the connection making it more difficult for low voltage, high speed signals to be transmitted.
- The internal spring must make good contact with the pogo pins plunger and base. But this can get worn over time and lead to improper contact between the pin and the pad. A solution to this is mentioned in (section 5.2.1 - Connection, Key Documents Design).

5.2 - Aesthetics

The Tiles must be visually appealing on a wall or table during operation and when powered off. This means that connected Tiles must appear as one seamless display. LEDs must not be uncomfortably bright (< 10000 Lux) and the packaging must be slim and sleek.

6 - CONSTRAINTS

6.1 - Regulations and Safety

All components, especially the power distribution system, must be compliant with current regulations set by the Institute of Electrical and Electronics Engineers (IEEE) and other relevant regulatory bodies. Although creating our own AC/DC power converter will reduce costs, it will pose regulatory and safety constraints in the product design timeline [8].

6.2 - Power Management

In North America, 1800W is the typical maximum power an outlet can provide. Products must ideally not consume more than 600W. Thus, the total modular display must consume less than 600W.

6.3 - Size

Each module must be smaller than 20 cm by 20 cm as per client specification.

6.4 - Display Resolution

The Tiles must have a minimum display resolution to outline moving objects as well as display text. Text requires a minimum of 5x7 pixels per character.

6.5 - Object Detection

6.5.1 - Detection Resolution

The sensors must have a minimum resolution of 1.7 cm by 1.7 cm.

6.5.2 - Detection Distance

The Tiles must be able to detect an object up to 10 cm away.

GLOSSARY OF TERMS

API	An Application Programming Interface is a set of functions and procedures allowing the creation of applications that access the features or data of an operating system, application, or other service.
IR	Infrared is a spectrum of non-visible light spanning in wavelength from Red (700 nm) to Microwaves (1 mm)
PCB	A Printed Circuit Board is a sheet of layered copper and non-conductive substrate that mechanically supports and electrically connects electronic components via embedded copper tracks.
Phototransistor	A semiconductor junction that alters the level current flowing through it depending on the level of light the junction is exposed to.
Pogo Pin	A spring-loaded conducting device used to connect two PCBs
LED	A Light Emitting Diode is a semiconductor junction that emits light when current flows through it
Lux	The lux is a derived SI unit for measuring the luminous flux per unit area. It is equivalent to 1 lumen per square meter.

CITATIONS

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- [7] iPixel LED Light Co., Ltd, "SUPER LED", COM-14608 datasheet.
- [8] "The AC-DC Power Supply: Make It or Buy It?", *Electronic Design*, 2018. [Online]. Available: <https://www.electronicdesign.com/boards/ac-dc-power-supply-make-it-or-buy-it>. [Accessed: 14- Oct- 2018].

