**H🙲M Configuration Dongle**

**EE464 – Senior Design I**

**Senior Design Project Proposal**

**(DRAFT)**

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# **Proposal Summary**

*Title: Daktronics Configuration Dongle*

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*Advisor: Dr. Robert Fourney*

Daktronics manufactures display controllers, and these are accessed over a network. If the network fails or the network settings are incorrectly configured, then the display controller becomes impossible to access. The primary objective of the project is to build a configuration dongle that would plug into the display controller and would be able to reconfigure its network setting. This would require designing the dongle with a user interface and designing a communication protocol that the dongle can use to communicate with the display controller.

The configuration dongle can then be used to get the current system settings of the display controller and then display them on the LCD screen. Using push button installed on the dongle, user can navigate through the settings and will also be able to change the settings too.

The team will collaborate in designing the communication protocol that the dongle will use to communicate with the display controller. After the protocol designing, the team would work on designing the dongle itself using a microcontroller, an LCD screen and five push buttons. After testing and verifying the design and the communication protocol, team will work on designing a PCB board and housing for the dongle.

# **Introduction**

## Definition of Problem

Daktronics is an American company based in Brookings, South Dakota that designs, manufactures, sells, and services video displays, scoreboards, digital billboards, and related products. The display controllers that Daktronics produces are normally accessed over a network using a web browser. If the network fails or the display controller’s network settings are not configured properly, the display controller become inaccessible. This prevents the user from accessing the display controller to implement necessary changes to the display and is time consuming if multiple displays are inaccessible at the same time. A device is needed to physically gain access to the current network settings of those controllers (host device) and to reconfigure those network settings if needed.

## Background

One solution is using a Wi-Fi dongle and have the display controller connect to the network generated by the Wi-Fi dongle. However, if the network setting is messed up then that makes it impossible to connect to the display controller to any kind of network. Another solution is using a Bluetooth dongle to communicate with the display controller. However, in this case, the technician would always have to carry a computer with him/her to the field station. The technician could also use a smartphone and connect to the display controller using a USB cable and have an application software in the smartphone that can be used to change the network settings. However, smartphones are expensive and would have to be charged again and again for power.

Therefore, designing a configuration dongle would be optimal, since it is cheap, compact, easy to carry, doesn’t need a network connection to talk to the host device and can be powered by the host device when connected to it.

## Scope of Proposal

The remainder of the proposal is divided into three major sections. The first section defines the design project by clearly stating a set of objectives, specifications, and design constrains. This section is then followed by the technical solution section which first presents an overview of the design which is comprised of submodules. Then the section presents a detailed description of those submodules and how it achieves to the objectives of the design project. The third subsection of the technical solution section presents a detailed list of the anticipated resources needed and their anticipated cost estimate. Finally, the last section presents the design project schedule and the plan of action which highlights the developed Gantt chart that will be necessary to complete the objectives of the design project.

The scope of this project focuses on the initial development of a system, called the “Configuration Dongle,” to display and configure the network settings of the host device. To avoid scope creep of the project, tasks have been separated into “in scope” and “out of scope” categories and are listed below.

### In Scope

Upon completion, the design project will accomplish the following items:

* The Configuration Dongle will communicate with the host device by enumerating a standard Universal Serial Bus (USB).
* The Configuration Dongle will read the system name and type of the host device.
* The Configuration Dongle will toggle the network mode of the host device.
* The Configuration Dongle will configure the network settings of the host device.

### Out of Scope

These are the concerns that are related to the project that the team is not responsible for, and are thus out of the scope of the project but will be considered as optional objectives:

* ProLink Master control.
* Read link-local Internet Protocol (IP) v6.
* Device component identification.
* Develop a firmware for the host device.

# **Functional Design Requirements**

## Objectives

The primary objective of the project is to develop and build a device (Configuration Dongle) that will communicate with Daktronics’s host device using USB to read and to configure the host device’s network settings. Another objective of the project is to design the communication protocol of the Configuration Dongle so that the beginning and end of a message can unambiguously be detected. Additionally, the device must be able to send and receive data from the host device without dropping data. Finally, the message structure should be designed to detect if the protocol version on the Configuration Dongle and the protocol version on the host device is incompatible and return an error message to the user.

## Specifications

The specifications for the project are listed below:

1. The Configuration Dongle should include a 16x2 LCD display or a matrix OLED display to display the system information and current network settings of the host device.
2. The Configuration Dongle should include at least 3 push buttons on the right-hand side of the PCB.
3. The Configuration Dongle should include one USB port.
4. The Configuration Dongle must be 1.5” by 2.5” in size and no larger than 3” by 6”.
5. The Configuration Dongle must be able to read and write the IPv4 address of the host device under static mode.
6. The Configuration Dongle must be able to read and write IPv4 Netmask in Classless Inter-Domain Routing (CIDR) format.
7. The communication protocol between the Configuration Dongle and the host device must use at least 16-bit Cyclic Redundancy Check (CRC).

## Design Constraints

Daktronics has required that the project adhere to the following constraints:

* The Configuration Dongle must be power by a 0-5V rail.
* Team does not have prior experience with computer networks.
* Team does not have prior experience working with Linux.

# **Proposed Technical Solution**

## Overview

The proposed solution to the problem as defined and in accordance with the Functional Design Requirements is divided into several submodules. The LCD screen will be used to display the host device’s system information along with its network settings. The push buttons will be required for the user to configure the network settings of the host device. A custom communication protocol will be required to receive the required data from and to the host device. The USB port will serve as physical connection between the host device and the Configuration dongle to initiate the communication protocol and to power the Configuration Dongle. The system level block diagram is shown in Fig. 1.

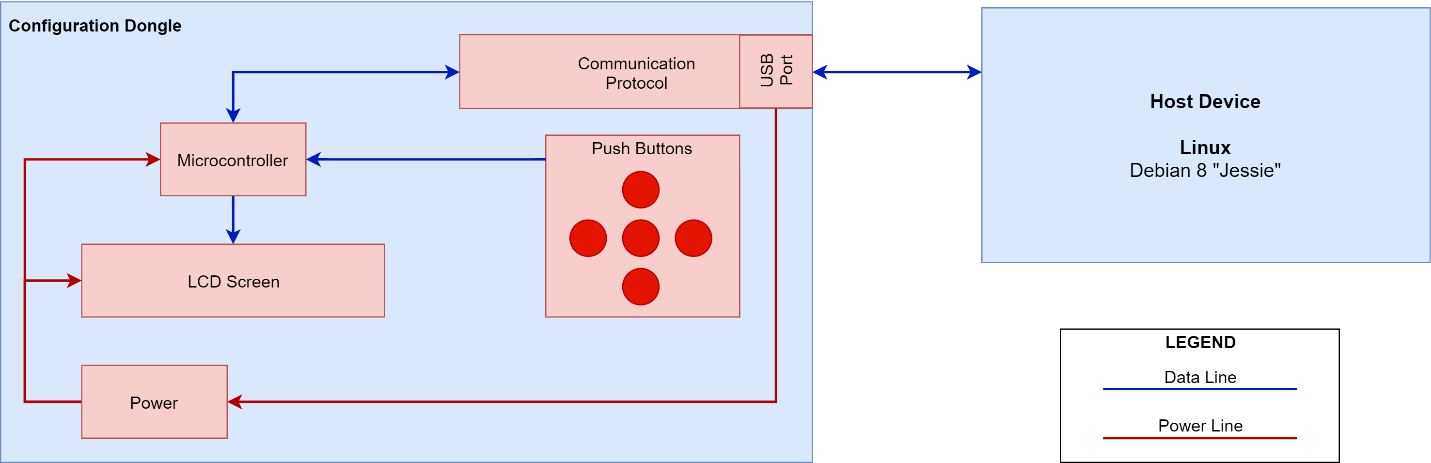


Figure 1. Design Project Block Diagram

## Submodule Description

This section is a detailed description of each submodule in the proposed block diagram, Fig. 1.

### Microcontroller

A microcontroller will be used to initiate the communication protocol between the configuration dongle and the host device, which will accomplish part of the objectives of the project as stated in the Functional Design Requirements section. The microcontroller will also receive data entered by the user. Finally, the microcontroller will be used to send instructions to the LCD screen.

### LCD Screen

The LCD screen will receive instruction from the microcontroller to display data such as the host device’s system information and current network settings, which would achieve the 1st specification of the project.

### Push Buttons

The push buttons are required to achieve the 2nd specification of the project and will be used to send the user’s desired network settings for the host device to the microcontroller. The microcontroller will then communicate with the host device to overwrite the host device’s network settings with the desired network settings provided by the user.

### USB Port & Power

A USB port will be used to power the microcontroller and the LCD screen. Additionally, the USB port will be used by the Configuration Dongle to communicate with the host device. USB ports traditionally have four channels, two differential channels “D+” and “D-” which are used to receive and transmit data, while the other two channels, “Vbus” and “GND” are used to supply 0V-5V power. This will achieve the 3rd specification of the project.

### Communication Protocol with the Host Device The communication protocol will have message framing so that the beginning and end of a message can unambiguously be detected. The protocol will be resistant to dropped bytes and will use a 16-bit CRC in every message. The message structure will be such that future versions of the protocol do not break older implementations. If a future version of the protocol introduces a new message type, the then older version of the system will be able to recognize it and will return an error without losing the message framing.

## Anticipated Required Resources

These are the resources that will be required to build and test the Configuration Dongle:

### System level component list and cost estimate

Table 1: Proposed Budget

|  |  |  |
| --- | --- | --- |
| Item Description | Retail ($) | Anticipated Expense ($) \* |
| Microcontroller |  | $15.86x2 |
| LCD screen |  | $31.76x2 |
| USB Connector |  | $3.84x2 |
| PCB |  | $42 |
| Subtotal |  | $144.92 |
| Total |  | $173.90 |

\* The actual expense may have been after an educational discount.

### Test and Laboratory Equipment

* PC with a Debian 8 “Jessie” operating system.
* Oscilloscope
* 5V Power Supply
* Signal Generator
* Bread Boards
* Microcontroller Development board
* 3D Printer
* PCB Design Software
* Light-emitting diodes (LEDs)
* Voltmeter

## Proposed Performance Verification

The oscilloscope will be used to test the communication between the LCD screen and the microcontroller. The integrated development environment (IDE) will be used to primarily debug the microcontroller code. The LCD screen along with LEDs will also be used to debug the microcontroller code. The user input will be tested by verifying that the input provided by the user is registered in the memory of the microcontroller and will also be tested by displaying the input to the LCD screen. The communication protocol will be tested by sending data to the host device and verifying that the host device has received that data. The LCD screen will also be used to verify that the data being read by the microcontroller from the host device is being displayed to the LCD screen. A voltmeter will then be used to verify that the USB port is supplying 0V-5V to the microcontroller.

# **Proposed Project Schedule**

## Plan of Action

To manage the tasks required to complete the project and to keep track of the objectives, a Gantt chart was created, Fig. 2.

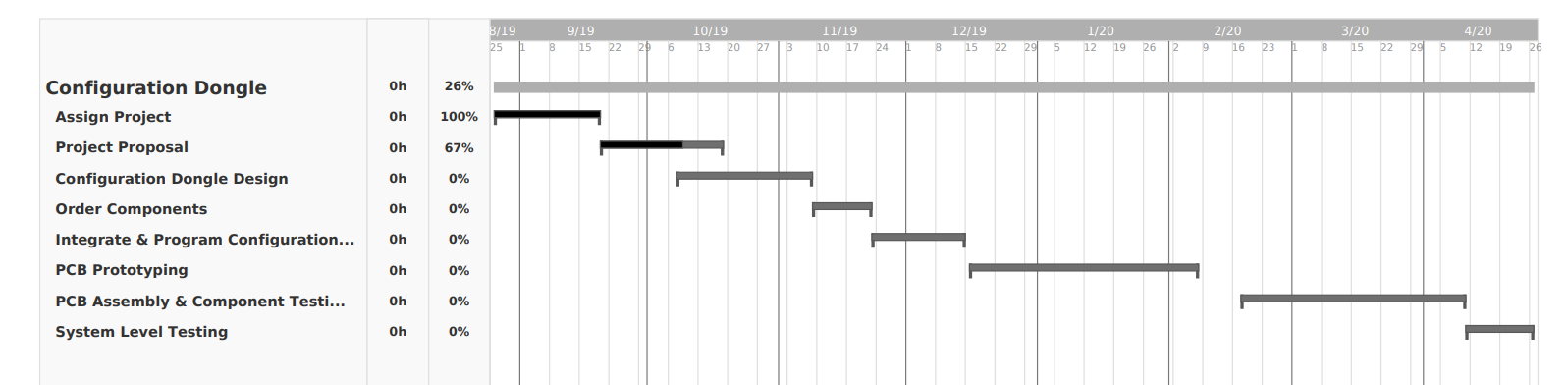


Figure 2. Proposed Project Plan in the form of a Gantt chat

The team will collaborate and work together a minimum of 15 hours each week to accomplish all the objectives of the project. The team will also meet regularly throughout each given week to work on the project and plan tasks for future weeks to accomplish short term goals. Additionally, the team will set milestones for each consecutive month to achieve long term goals and to stay ahead of schedule.

During the “Configuration Dongle Design” phase the team will design primarily the communication protocol between the Configuration Dongle and the host device. At the end of this phase the team will order all the parts necessary for the project. The team will then build and develop each submodule of the project and integrate them together using development boards. The team will then work on designing a prototype PCB. After the prototype PCB have been tested and all the changes have been finalized, the team will order a final version of the PCB. The final version of the PCB will be assembled, and each submodule will be tested to make sure all the submodules accomplish the objectives and the specification of the project. Finally, the team will enter the “System Level Testing”. In this phase a “Performance Verification” document will be created to test and verify that our system level testing achieves the objectives and specifications of the project.

Both members of the team are not experienced with computer networks and Linux. To overcome these concerns, the team plans on researching and learning those topics using South Dakota State University’s available resources along with the resources available on the Internet.

# **References**