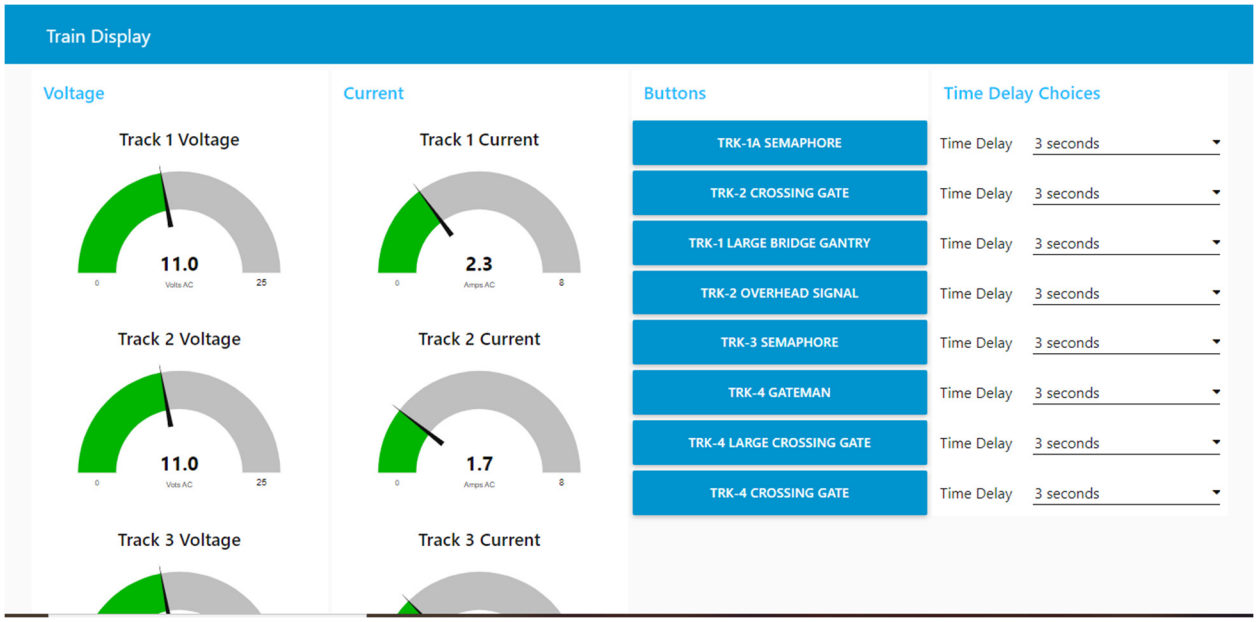
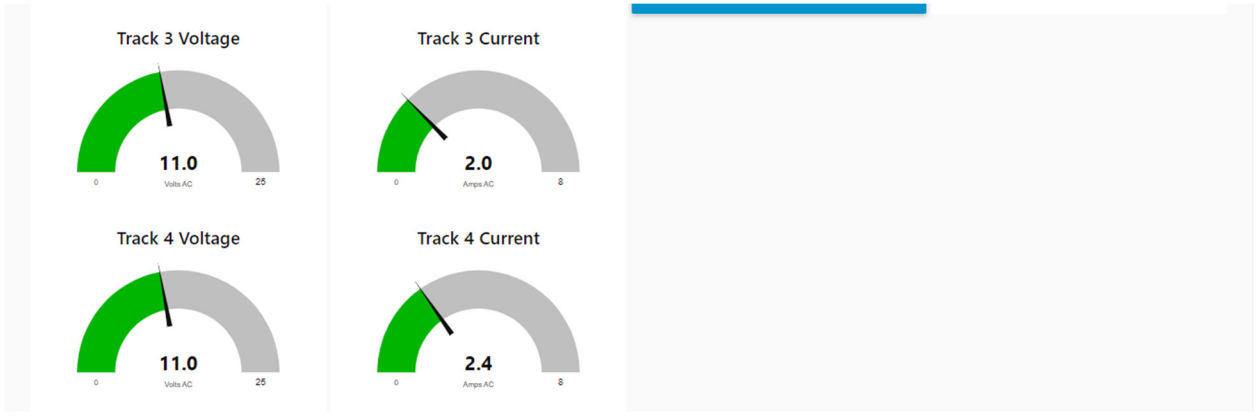
Train Controller Features

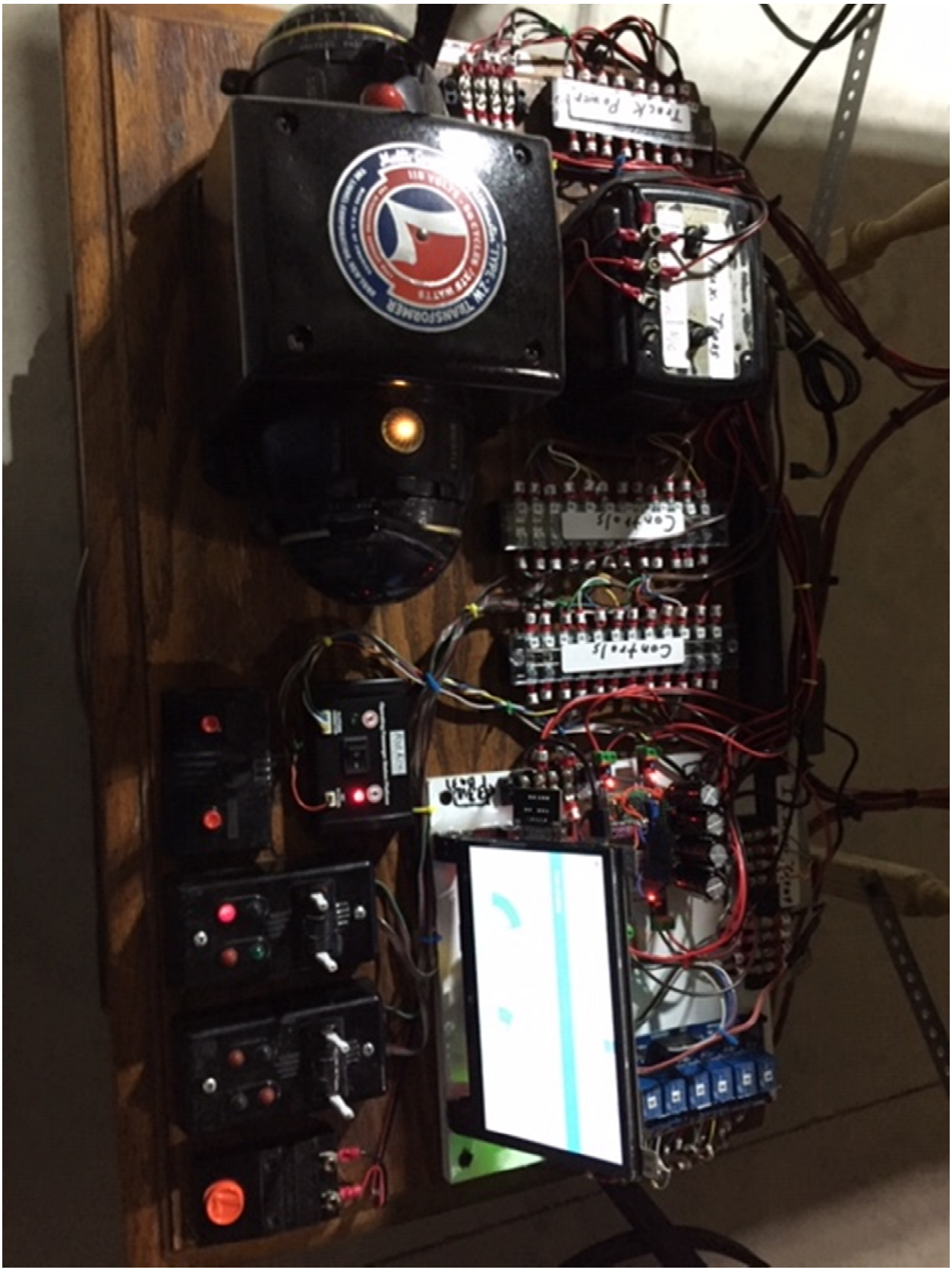
The following features are available utilizing the code embedded within the Train Controller:

1) The ability to pull up a “Touch Screen” dashboard locally on the display or any phone, tablet, or PC connected within the WiFi router firewall by typing in the following on a WEB Browser http://<IP address of your Pi>:1880/ui
2) Ability to monitor up to “4” Track Voltages utilizing 16 bit A/D conversion through the Raspberry Pi “IIC” interface using the “SDA” & “SDL” Lines.
3) Ability to monitor up to “4” Track Currents utilizing 16 bit A/D conversion through the Raspberry Pi “IIC” interface using the “SDA” & “SDL” Lines.
4) Ability to manually control “8” accessories via the touch screen
5) Ability to automatically control up to “8” accessories with variable time delays that can be set via a custom menu that control the Infra-Red Sensor inputs.
6) The ability to randomly play of to “13” train sounds downloaded as wav files from the web site on the instructions page. All sounds have an adjustable volume control on the console.
7) Track Voltage and Current “gauges” are human factored to change colors (green scale = normal, yellow scale = caution, red scale = danger).
8) Variable screen brightness via PWM through the control on the console.
9) Storage of variables (such as time delays) upon startup / power on.
10) Auto start-up of web “dashboard” server upon power on.


Train Display
Voltage
Track 1 Voltage
11.0
Volts AC
0
25
Track 2 Voltage
11.0
Volts AC
0
25
Track 3 Voltage
Current
Track 1 Current
2.3
Amps AC
0
8
Track 2 Current
1.7
Amps AC
0
8
Track 3 Current
Buttons
TRK-1A SEMAPHORE
TRK-2 CROSSING GATE
TRK-1 LARGE BRIDGE GANTRY
TRK-2 OVERHEAD SIGNAL
TRK-3 SEMAPHORE
TRK-4 GATEMAN
TRK-4 LARGE CROSSING GATE
TRK-4 CROSSING GATE
Time Delay Choices
Time Delay 3 seconds
Time Delay 3 seconds
Time Delay 3 seconds
Time Delay 3 seconds
Time Delay 3 seconds
Time Delay 3 seconds
Time Delay 3 seconds


Track 3 Voltage
11.0
Volts AC
0
25
Track 4 Voltage
11.0
Volts AC
0
25
Track 3 Current
2.0
Amps AC
0
8
Track 4 Current
2.4
Amps AC
0
8

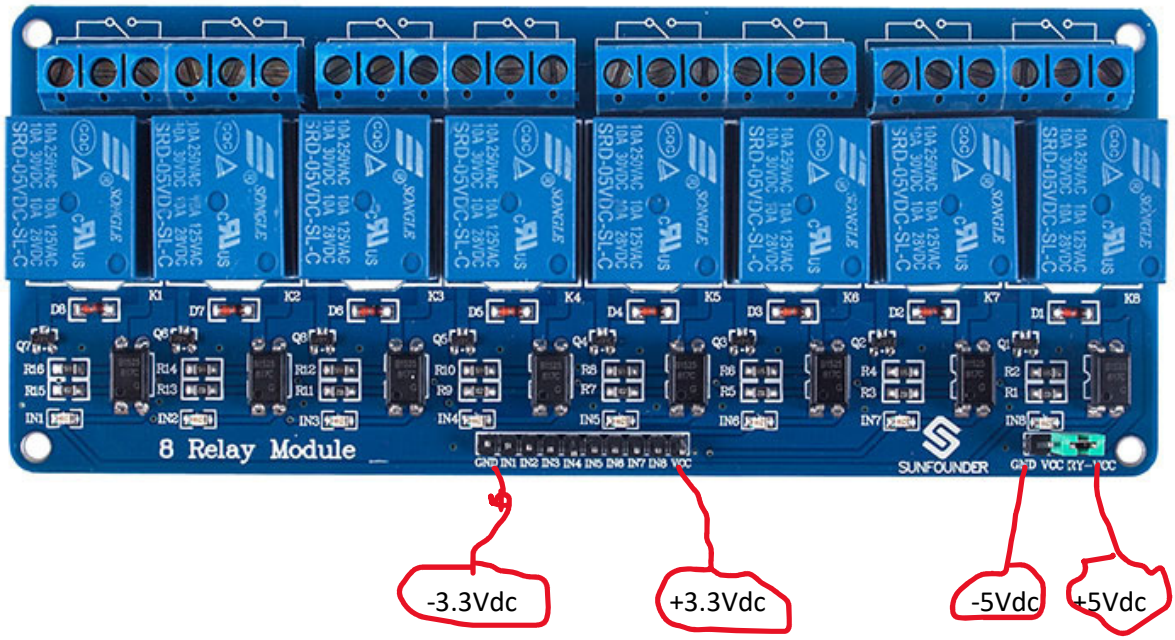

Node-RED Dashboar...
Saturday 03/26/202
Node-RED Dashboard - Chromium
Node-RED Dashboard
Not secure | 192.168.50.7
Train Display
Voltage
Track 1 Voltage
11.3
Current
Track 1 Current
1.4
RAIL KING
Passenger Station Platform
A/C
13-14 Volts


Track Power
Controls
Controls

Setup and Instructions (New Build) Intermediate Level

1) Order parts from the enclosed “Bill of Materials” that you do not have.

2) Pull Jumper on relay board, and wire up one of the 5Vdc adaptors and the 3.3 Vdc as follows:



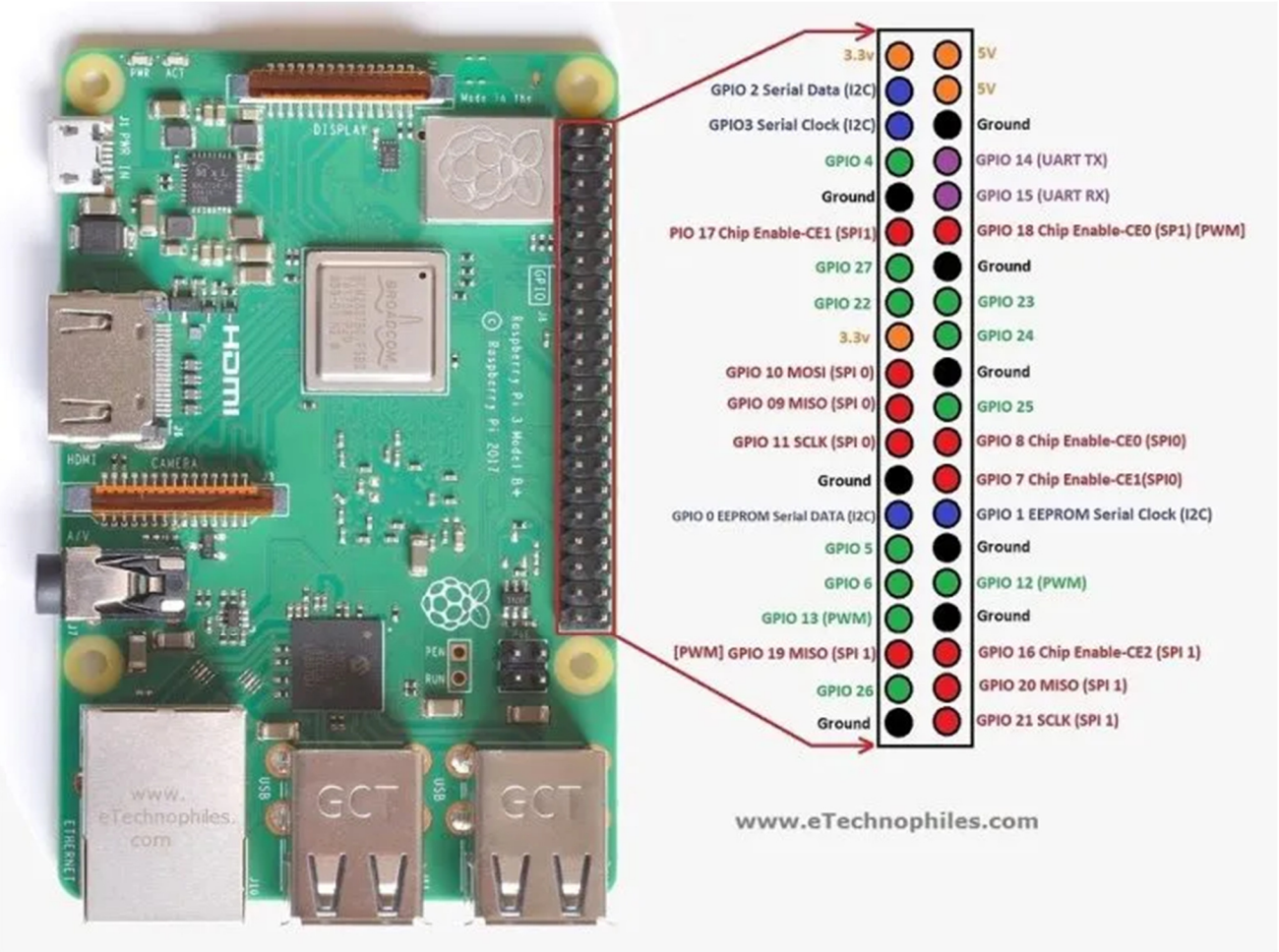
- + 5Vdc to relay board terminal “JD-VCC”
- - 5Vdc to relay board terminal “Gnd”
- +3.3VDC from Raspberry Pi breakout connector to relay Board “terminal-1”
- -3.3VDC from Raspberry Pi breakout connector to relay Board “terminal-9”

Note – The rest of the relay board gets wired according to the I/O Map in Step #5.

3) Assemble Elecrow 7" Touch Screen Display with Stand and speakers and volume control.

4) Mount Raspberry Pi 3B+ or 4 to Elecrow 7" Touch Screen Display (follow instructions from Elecrow).

5) Wire HCDC RPi GPIO Status LED & Terminal Breakout Board according to the following I/O Map for GPIO (input) and GPIO (output):



Accessary #	Accessory Name	GPIO (input) From IR Sensor Board "out pin"	GPIO (output) to relay Board	Relay Board Pin
1	Track #1A Semaphore	GPIO6	GPIO17	IN1
2	Track #2 Crossing Gate	GPIO13	GPIO18	IN2
3	Track #1 Large Bridge Gantry	GPIO19	GPIO27	IN3
4	Track #2 Overhead Signal	GPIO26	GPIO22	IN4
5	Track #3 Semaphore	GPIO12	GPIO23	IN5
6	Track #4 Gateman	GPIO16	GPIO24	IN6

Accessary #	Accessory Name	GPIO (input) From IR Sensor Board "out pin"	GPIO (output) to relay Board	Relay Board Pin
7	Track #4 Large Crossing Gate	GPIO20	GPIO25	IN7
8	Track #4 Crossing Gate	GPI21	GPIO5	IN8

Notes:

1) All GPIO Inputs are to digital inputs using "pullup" high resistors in node red
2) All GPIO outputs are set to digital outputs (high level = off, low level = on) in node red

6) Build A/D converter board according to the schematic included with these instructions and wire the 3.3VDC power lines and the A/D conversion through the Raspberry Pi "IIC" interface using the "SDA" & "SDL" Lines in accordance to the Pi pinout diagram shown above. In addition, the A/D voltage board needs to be set to hex address 0X48, and the A/D Current Board set to hex address 0X48 by soldering a jumper wire on each board as follows to the following pins:
   - 0x48 (ADR -> GND)
   - 0x49 (ADR -> VDD)

   Note – Before utilizing the program, the supporting library must be installed by going to the Raspberry Pi terminal and typing the following command "sudo pip install adafruit-ads1x15". And of course the voltage inputs need to be calibrated by applying an AC source, running the program in a python shell (can also unquote print commands) and adjusting each channel potentiometer (refer to schematic) when comparing the program value to a calibrated multimeter.

7) Set up Raspberry Pi Linux system files by performing the following:
   Set Up Raspberry Pi (3B+ or 4) by performing the following:
   Using NOOBS is the easiest way to install Raspbian on your SD card. To get hold of a copy of NOOBS:
   Visit www.raspberrypi.org/downloads/
   - The simplest option is to download the zip archive of the files.
   - Formatting the SD Card
   - If the SD card on which you wish to install Raspbian currently has an older version of Raspbian on it, you may wish to back up the files from the card first, as they will be overwritten during this process.
   - Visit the SD Association's website and download SD Formatter 4.0 for Windows or Mac if not already on your laptop.
   - Follow the instructions to install the software.
   - Insert your SD card into the computer or laptop's SD card reader and make a note of the drive letter allocated to it, e.g. F:/.

- In SD Formatter, select the drive letter for your SD card, and format it.
- Extracting NOOBS from the zip archive. Next, you will need to extract the files from the NOOBS zip archive you downloaded from the Raspberry Pi website.
- Go to your Downloads folder and find the zip file you downloaded.
- Extract the files and keep the resulting Explorer/Finder window open.
- Copying the files. Now open another Explorer/Finder window and navigate to the SD card. It's best to position the two windows side by side.
- Select all the files from the NOOBS folder and drag them onto the SD card.
- Once the files have been copied over, insert the micro SD Card into your Raspberry Pi, and plug the Pi into a power source.
- You will be offered a choice when the installer has loaded. You should check the box for Raspbian, and then click Install.
- Click Yes at the warning dialog, and then sit back and relax. It will take a while, but Raspbian will install.
- In a Linux terminal window on the Raspberry Pi type "sudo raspi-config" and enable "VNC", "GPIO" and all other I/O options.

Note – As an alternative to the above, you can download an image file from the raspberry pi website above, install "balena etcher" available at https://www.balena.io/etcher/ on your laptop or computer and burn the image directly.

Note- After complete, insert the SD card into the Raspberry Pi slot (Be careful to insert the correct way). A Google search can help if you are not familiar.

8) Note- Node red should already be installed, but if it is not, Set up Node Red by performing the following:
   - Running the following command will download and run the Node Red script.
     bash <(curl -sL https://raw.githubusercontent.com/node-red/raspbian-deb-package/master/resources/update-nodejs-and-nodered)
   - Note - This script will work on any Debian-based operating system, including Ubuntu and Diet-Pi. You may need to run sudo apt-get install build-essential first to ensure npm is able to build any binary modules it needs to install.

9) Node Ned should already be installed on you raspberry pi. To enable Node-RED to run each time the Pi is turned on, which you want in this case, you can enable the service server to autostart by running the command on the terminal line on the raspberry pi:
   sudo systemctl enable nodered.service

10) Once Node-RED is running you can access the editor code in a browser. If you are using the browser on the Pi desktop, you can open the address: http://localhost:1880

11) Recommend Chromium or Firefox-ESR on the Pi and not Epiphany
    - Otherwise, you should use the IP address of the Pi: http://<ip-address>:1880 You can find the IP address by running **hostname -I** in the terminal window on the raspberry Pi. This is where you will import the code "flow" or make program changes.
    - Once The Node-RED application is ready. The dashboard is available at http://<IP address of your Pi>:1880/ui This is the screen where you can vies the track voltages, currents, change accessory time delays, and manually activate accessories.

12) Install Python the following code files on the Raspberry Pi file Location "home/pI" (If you do not have them, copy each one of them from these instructions, paste them into a python interpreter and re-name them as indicated below when you save them to "home/pi" directory. Note – Python is space indent sensitive, be sure to keep indents in correct position, otherwise you will get an error when the program runs :
    - datasort1.py
    - datasort2.py
    - datasort3.py
    - datasort4.py
    - datasort5.py
    - datasort6.py
    - datasort7.py
    - datasort8.py
    - Track Voltage AtoD.py
    - Track Current AtoD.py

13) Download a total of "13" of your own selected version of train "wave files" from the following website https://www.krafttrains.com/sound_fx.htm

14) Rename the downloaded files to the following extensions "Sound_1.wav", Sound_2.wav", etc. until you get to "13" inclusive.

15) Create a folder called "Sounds_1" at the following location on the Raspberry Pi "home/pI" and move the "wav" files to that location. Note – Can perform this through VNC Server if activated on Raspberry Pi and downloaded as a program on a windows computer. Note – This is a terminal server program, otherwise you will have to SSH into the raspberry pi directly.

16) Add the following Libraries into Node Red by going back to step #5 (first bullet) and going to the "Palette Manager" under the main menu and typing the following under install (may want to use the search window to find)
    - node-red-contrib-pythonshell

17) Import the Node Red Program "Nodes & Code" by going back to the main menu and selecting:

Import; then clipboard, and copy the "Node Red flows (Train).json" file enclosed in these directions into the box, and the nodes will appear. Be sure to hit "deploy" when completed. After completed, to view the Node Red Dashboard, go back to step #5 (second bullet)

18) Make Node Red store "context" settings on Raspberry Pi by adding performing the following. Node Red version 0.19 and later it is possible to store the context data in the file system. In order to do this you will need to modify the settings file and add the following entry:

    Note – Since this is a hidden file, you will need to pull up a terminal window and type the following:
    pi@raspberrypi:~ $ cd .node-red/
    pi@raspberrypi:~/.node-red $ nano settings.js

    Depending on the version of Node-Red that you have uncomment the following line or add it.

```
contextStorage: {
        default: {
            module:"localfilesystem"
        },
    },
```

When complete with the line above, press "CNTR + X" then "Y" then "Enter"

19) Turn power on and calibrate optical sensors by turning potentiometers fully CCW (no sensor obstruction) and rotating CW until the "trigger" on board LED just illuminates, then back off CCW just slightly until the LED goes off (but not flashing). Test by placing a piece of white paper near the sensor and the trip LED should now illuminate. See manufacturer spec sheet for min / max distances, and ensure IR-LED's are geometrically parallel, even, and not skewed from one another.

20) Be sure to power down and turn off correctly (when not in use). This can be accomplished by going to the Raspberry Pi icon in the upper left corner and tapping. Then scroll down to "shutdown" and wait a few minutes before turning the power off. Failure to do so, will damage the SD card.

Future Improvements:

- Change Track Voltage A/D inputs to “differential”. This would require another A/D module, but would eliminate the “common mode” voltage gauge response so each channel would be individually monitored vs. all channels averaging and reading the same.
- Or could try to add a digital filter to the Track Voltage A/D inputs to see if that clears up the “common mode” issue before adding another A/D board in “differential mode”?

Python Files Table of Contents

```python
#Program to Read and sort data

import sys, re
from time import sleep

while True:
    data = sys.stdin.readline() # read the input
    x = re.findall("^CH1:", data)
    if x:
        z = re.split("\s", data)
        z = z[1].strip(",")
        print(z)
    sleep(.2)
```

```
#Program to Read and sort data

import sys, re
from time import sleep

while True:
    data = sys.stdin.readline() # read the input
    x = re.findall("^CH2:", data)
    if x:
        z = re.split("\s", data)
        z = z[1].strip(",")
        print(z)
    sleep(.2)

```

```
#Program to Read and sort data

import sys, re
from time import sleep

while True:
    data = sys.stdin.readline() # read the input
    x = re.findall("^CH3:", data)
    if x:
        z = re.split("\s", data)
        z = z[1].strip(",")
        print(z)
    sleep(.2

```

```
#Program to Read and sort data

import sys, re
from time import sleep

while True:
    data = sys.stdin.readline() # read the input
    x = re.findall("^CH4:", data)
    if x:
        z = re.split("\s", data)
        z = z[1].strip(",")
        print(z)
    sleep(.2)

```

```
#Program to Read and sort data

import sys, re
from time import sleep

while True:
    data = sys.stdin.readline() # read the input
    x = re.findall("^CH1:", data)
    if x:
        z = re.split("\s", data)
        z = z[1].strip(",")
        print(z)
    sleep(.2)

```

```
#Program to Read and sort data

import sys, re
from time import sleep

while True:
    data = sys.stdin.readline() # read the input
    x = re.findall("^CH2:", data)
    if x:
        z = re.split("\s", data)
        z = z[1].strip(",")
        print(z)
    sleep(.2)
```

```
#Program to Read and sort data

import sys, re
from time import sleep

while True:
    data = sys.stdin.readline() # read the input
    x = re.findall("^CH3:", data)
    if x:
        z = re.split("\s", data)
        z = z[1].strip(",")
        print(z)
    sleep(.2)
```

```
#Program to Read and sort data

import sys, re
from time import sleep

while True:
    data = sys.stdin.readline() # read the input
    x = re.findall("^CH4:", data)
    if x:
        z = re.split("\s", data)
        z = z[1].strip(",")
        print(z)
    sleep(.2)
```

```
"""
1) Create a folder called "Sounds"
2) Load wav files that are 8 bit unsigned or 16 bit signed / 24 bit signed little endian PCM
   into that folder
To play it in a terminal use:
-----------------------------
aplay /home/pi/Sounds/Sound_1.wav
(if it does not work type:
  sudo raspi-cong
  Then force audio to 3.5mm jack or HDMI, auto does not always work)
"""


# Import Libraries
# ----------------
from time import sleep
import time,os,random

# Random Quote Function
# ---------------------
def voice():
    options = ["Sound_1.wav",
               "Sound_2.wav",
               "Sound_3.wav",
               "Sound_4.wav",
               "Sound_5.wav",
               "Sound_6.wav",
               "Sound_7.wav",
               "Sound_8.wav",
               "Sound_9.wav",
               "Sound_10.wav",
               "Sound_11.wav",
               "Sound_12.wav",
               "Sound_13.wav",
               ]
    return random.choice(options)

while True:
    try:
        os.system('aplay /home/pi/Sounds/' + voice())
        print(voice())
        sleep(5)

    except (KeyboardInterrupt, SystemExit):
        print("Keyboard Stop") #Used for debug
        exit()
```

```
"""
Program to read "4" Lionel Train Track Currents with ASC712 20amp Sensor

To install A/D Library, use the following:
sudo pip3 install adafruit-ads1x15

Or alternatively to install with examples:
do apt-get update
sudo apt-get install build-essential python-dev python-smbus python-pip
sudo pip install adafruit-ads1x15

To check I2C addresses:
sudo i2cdetect -y 1

Notes for setting up A/D Module:
--------------------------------
1) For 16 bit A/D the scaling is as follows:
digital = [(2^16)-1 / 2] = 26,399

2) Scaled Value = [((A/D_value/digital) * (Gain)) * FS]
Where Vcc = voltage input, and FS is the Full Scale value to read (ie 100.0 = 100.0%)

"""

# Import Libraries:
# -----------------
from time import sleep
import Adafruit_ADS1x15
import sys, re, os

# Uncomment One of the following:
# -------------------------------
# Create an ADS1115 ADC (16-bit) instance.
adc = Adafruit_ADS1x15.ADS1115(address=0x49)
# Or create an ADS1015 ADC (12-bit) instance.
#adc = Adafruit_ADS1x15.ADS1015()

# Note you can change the I2C address from its default (0x48), and/or the I2C
# bus by passing in these optional parameters:
#adc = Adafruit_ADS1x15.ADS1015(address=0x49, busnum=1)

# Choose a gain of 1 for reading voltages from 0 to 4.09V.
# Or pick a different gain to change the range of voltages that are read:
#  - 2/3 = +/-6.144V
#  -   1 = +/-4.096V
#  -   2 = +/-2.048V
#  -   4 = +/-1.024V
#  -   8 = +/-0.512V
#  -  16 = +/-0.256V
# See table 3 in the ADS1015/ADS1115 datasheet for more info on gain.

#print('Reading ADS1x15 values, or press Ctrl-C to quit...')

# Global Variables:
# -----------------
CH = [0]*4 # Create a List for all the "4" ADC channel values (0-3).
FS = 3.3 # Full Scale  with Vcc @ 3.30 volts
CH0_V = 0.0   # New Votage Channel Adjustments (float)
CH1_V = 0.0
CH2_V = 0.0
CH3_V = 0.0
mVperamp = 100.0 # Sensor constant; for 20 amp sensor it is 0.1.  See datasheet
GAIN = 1.0 # Choose for 3.3 volts
digital =  26399 # [(2^16)-1 / 2]
CF = 2.38 # Calibration Factor

# Function to Read A to D Converter:
```

```
# ---------------------------------
def Read_AD():
    global FS, GAIN, digital
    for i in range(4): # Read All Channels
        # Read the specified ADC channel using the previously set gain value.
        CH[i] = adc.read_adc(i, gain=GAIN)
            # Note you can also pass in an optional data_rate parameter that controls
            # the ADC conversion time (in samples/second). Each chip has a different
            # set of allowed data rate values, see datasheet Table 9 config register
            # DR bit values.
            #values[i] = adc.read_adc(i, gain=GAIN, data_rate=128)
            # Each value will be a 12 or 16 bit signed integer value depending on the
            # ADC (ADS1015 = 12-bit, ADS1115 = 16-bit).
        # Print the ADC values.
        #print('| {0:>6} | {1:>6} | {2:>6} | {3:>6} |'.format(*CH)) # Debug print
        string values
    CH0 = float("{0:.2f}".format(((CH[0]*GAIN)/digital) * FS))
    CH1 = float("{0:.2f}".format(((CH[1]*GAIN)/digital) * FS))
    CH2 = float("{0:.2f}".format(((CH[2]*GAIN)/digital) * FS))
    CH3 = float("{0:.2f}".format(((CH[3]*GAIN)/digital) * FS))
    return (CH0, CH1, CH2, CH3)

# Create a table for troubleshooring (comment out when complete)
#print('| {0:>6} | {1:>6} | {2:>6} | {3:>6} |'.format(*range(4))) # Create 4 table colums
#print('-' * 37) # Print 37 dashes


CH0_list = []
CH1_list = []
CH2_list = []
CH3_list = []
for j in range(151): #150 samples
    (CH0_V, CH1_V, CH2_V, CH3_V) = Read_AD() # Goto Function and get results
    CH0_list.append(CH0_V)
    CH1_list.append(CH1_V)
    CH2_list.append(CH2_V)
    CH3_list.append(CH3_V)
    sleep(0.00001) # 10uS delay for sample time of points
#print(str(CH2_list)) # Test Channel
maxvalue0 = max(CH0_list) # Get Max Value from list
minvalue0 = min(CH0_list) # Get Min Value from list
maxvalue1 = max(CH1_list) # Get Max Value from list
minvalue1 = min(CH1_list) # Get Min Value from list
maxvalue2 = max(CH2_list) # Get Max Value from list
minvalue2 = min(CH2_list) # Get Min Value from list
maxvalue3 = max(CH3_list) # Get Max Value from list
minvalue3 = min(CH3_list) # Get Min Value from list
CH0_I = float("{0:.2f}".format((((maxvalue0-minvalue0)/2)*0.707*1000*CF)/mVperamp))
CH1_I = float("{0:.2f}".format((((maxvalue1-minvalue1)/2)*0.707*1000*CF)/mVperamp))
CH2_I = float("{0:.2f}".format((((maxvalue2-minvalue2)/2)*0.707*1000*CF)/mVperamp))
CH3_I = float("{0:.2f}".format((((maxvalue3-minvalue3)/2)*0.707*1000*CF)/mVperamp))
#print("CH0 Current = " + str(CH0_I))
#print("CH1 Current = " + str(CH1_I))
#print("CH2 Current = " + str(CH2_I))
#print("CH3 Current = " + str(CH3_I))
# Do not read below 100mA
if (CH0_I < 0.1):
    CH0_I = 0.0
if (CH1_I < 0.1):
    CH1_I = 0.0
if (CH2_I < 0.1):
    CH2_I = 0.0
if (CH3_I < 0.1):
    CH3_I = 0.0
#print('CH1: ' + str(CH0_I))
sys.stdout.write('CH1: ' + str(CH0_I))
sys.stdout.write('\n')
```

```
134   sys.stdout.write('CH2: ' + str(CH1_I))
135   sys.stdout.write('\n')
136   sys.stdout.write('CH3: ' + str(CH2_I))
137   sys.stdout.write('\n')
138   sys.stdout.write('CH4: ' + str(CH3_I))
139   sys.stdout.write('\n')
140
141
142
```

```
#!/usr/bin/env python3

"""
Program to read "4" Lionel Train Track Voltages

To install A/D Library, use the following:
sudo pip3 install adafruit-ads1x15

Or alternatively to install with examples:
do apt-get update
sudo apt-get install build-essential python-dev python-smbus python-pip
sudo pip install adafruit-ads1x15

To check I2C addresses:
sudo i2cdetect -y 1

Notes for setting up A/D Module:
-------------------------------
1) For 16 bit A/D the scaling is as follows:
digital = [(2^16)-1 / 2] = 26,399

2) Scaled Reading = [((A/D_value/digital) * (Gain)) * FS]
Where Vcc = voltage input, and FS is the Full Scale value to read (ie 100.0 = 100.0%)

"""

# Import Libraries:
# -----------------
from time import sleep
import Adafruit_ADS1x15
import sys, re

# Uncomment One of the following:
# -------------------------------
# Create an ADS1115 ADC (16-bit) instance.
adc = Adafruit_ADS1x15.ADS1115(address=0x48)
# Or create an ADS1015 ADC (12-bit) instance.
#adc = Adafruit_ADS1x15.ADS1015()

# Note you can change the I2C address from its default (0x48), and/or the I2C
# bus by passing in these optional parameters:
#adc = Adafruit_ADS1x15.ADS1015(address=0x49, busnum=1)

# Choose a gain of 1 for reading voltages from 0 to 4.09V.
# Or pick a different gain to change the range of voltages that are read:
#  - 2/3 = +/-6.144V
#  -   1 = +/-4.096V
#  -   2 = +/-2.048V
#  -   4 = +/-1.024V
#  -   8 = +/-0.512V
#  -  16 = +/-0.256V
# See table 3 in the ADS1015/ADS1115 datasheet for more info on gain.

#print('Reading ADS1x15 values, or press Ctrl-C to quit...')

# Global Variables:
# -----------------
CH = [0]*4 # Create a List for all the "4" ADC channel values (0-3).
FS = 25.0 # Full Scale  with Vcc @ 3.30 volts
CH0_V = 0.0   # New Channel Readings (float)
CH1_V = 0.0
CH2_V = 0.0
CH3_V = 0.0
Vmax = 25.0 # Maximum scaled voltage
Vmin = 0.0  # Minimum scaled voltage
GAIN = 1 # Choose for 3.3 volts Supply
digital =  26399 # [(2^16)-1 / 2]
```

```
68
69  # Function to Read A to D Converter:
70  # ---------------------------------
71  def Read_AD():
72      global FS
73      for i in range(4): # Read All Channels
74              # Read the specified ADC channel using the previously set gain value.
75              CH[i] = adc.read_adc(i, gain=GAIN)
76              # Note you can also pass in an optional data_rate parameter that controls
77              # the ADC conversion time (in samples/second). Each chip has a different
78              # set of allowed data rate values, see datasheet Table 9 config register
79              # DR bit values.
80              #values[i] = adc.read_adc(i, gain=GAIN, data_rate=128)
81              # Each value will be a 12 or 16 bit signed integer value depending on the
82              # ADC (ADS1015 = 12-bit, ADS1115 = 16-bit).
83      # Print the ADC values.
84      #print('| {0:>6} | {1:>6} | {2:>6} | {3:>6} |'.format(*CH)) # Debug print string
        values
85      CH0 = float("{0:.2f}".format(((CH[0]*GAIN)/digital) * FS))
86      CH1 = float("{0:.2f}".format(((CH[1]*GAIN)/digital) * FS))
87      CH2 = float("{0:.2f}".format(((CH[2]*GAIN)/digital) * FS))
88      CH3 = float("{0:.2f}".format(((CH[3]*GAIN)/digital) * FS))
89      return (CH0, CH1, CH2, CH3)
90
91  # Create a table for troubleshooring (comment out when complete)
92  #print('| {0:>6} | {1:>6} | {2:>6} | {3:>6} |'.format(*range(4))) # Create 4 table colums
93  #print('-' * 37) # Print 37 dashes
94
95
96  (CH0_V, CH1_V, CH2_V, CH3_V) = Read_AD() # Goto Function and get results
97
98  sys.stdout.write('CH1: ' + str(CH0_V))
99  sys.stdout.write('\n')
100 sys.stdout.write('CH2: ' + str(CH1_V))
101 sys.stdout.write('\n')
102 sys.stdout.write('CH3: ' + str(CH2_V))
103 sys.stdout.write('\n')
104 sys.stdout.write('CH4: ' + str(CH3_V))
105 sys.stdout.write('\n')
106
107
108
109
110
111
```

```
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context.set('DELAY',msg.delay,'file')\n    return;\n}\n    //   Delete
the line below (or put // at the start)\n    node.warn(\"Payload
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is just to show you\n    //context.set('DELAY',msg.delay);\n
context.set('DELAY',msg.delay,'file')\n    return;\n}\n    //   Delete
```

```
the line below (or put // at the start)\n    node.warn(\"Payload
received\");        //  this is just to show you\n    let delay =
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context.set('DELAY',msg.delay,'file')\n    return;\n}\n    //   Delete
the line below (or put // at the start)\n    node.warn(\"Payload
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context.set('DELAY',msg.delay,'file')\n    return;\n}\n    //   Delete
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context.set('DELAY',msg.delay,'file')\n    return;\n}\n    //   Delete
the line below (or put // at the start)\n    node.warn(\"Payload
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node.warn(\"Delay received\");        //  this is just to show you\n
//context.set('DELAY',msg.delay);\n
context.set('DELAY',msg.delay,'file')\n    return;\n}\n    //   Delete
the line below (or put // at the start)\n    node.warn(\"Payload
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context.set('DELAY',msg.delay,'file')\n    return;\n}\n    //   Delete
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//context.set('DELAY',msg.delay);\n
context.set('DELAY',msg.delay,'file')\n    return;\n}\n    //   Delete
the line below (or put // at the start)\n    node.warn(\"Payload
received\");        //  this is just to show you\n    let delay =
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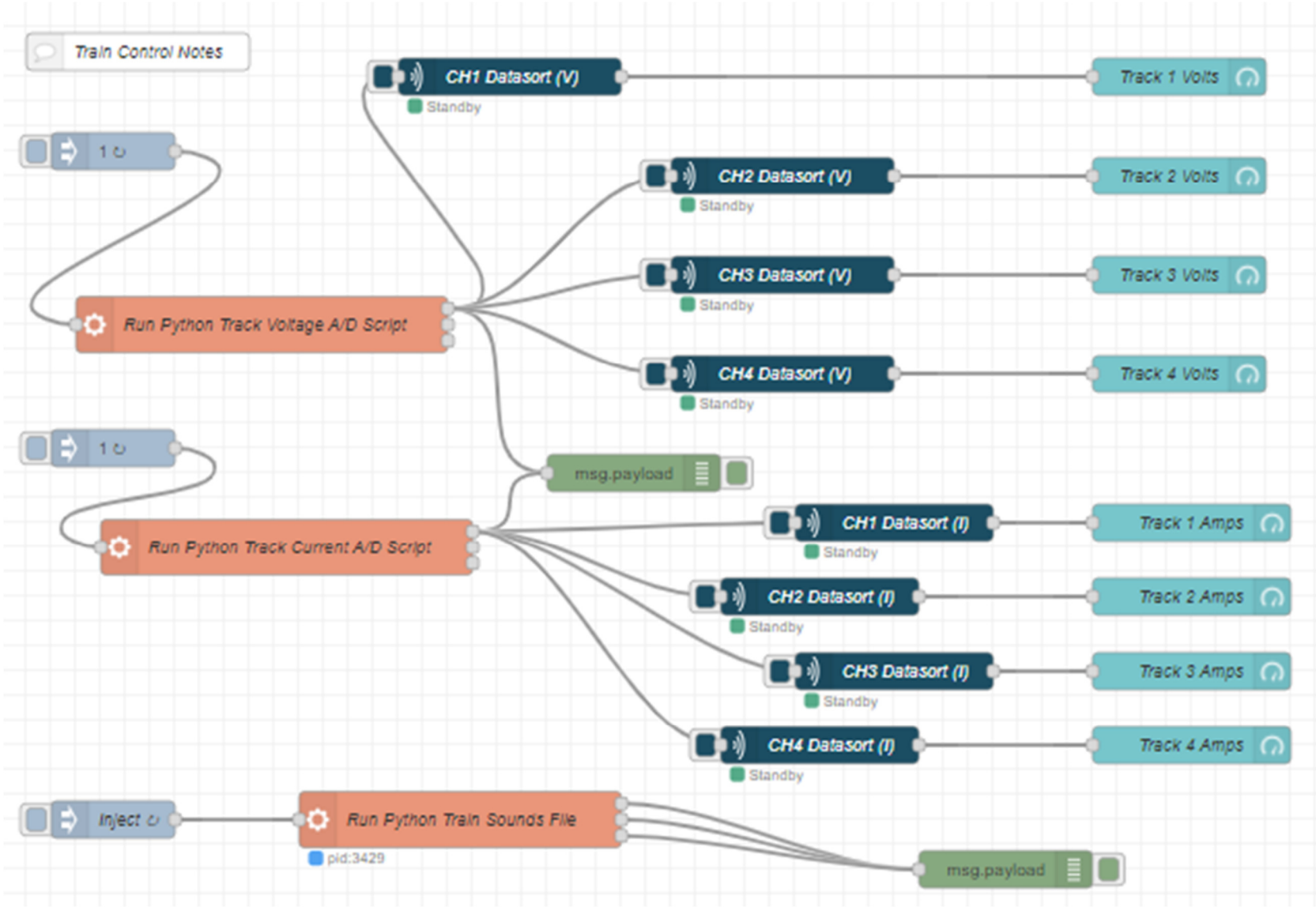
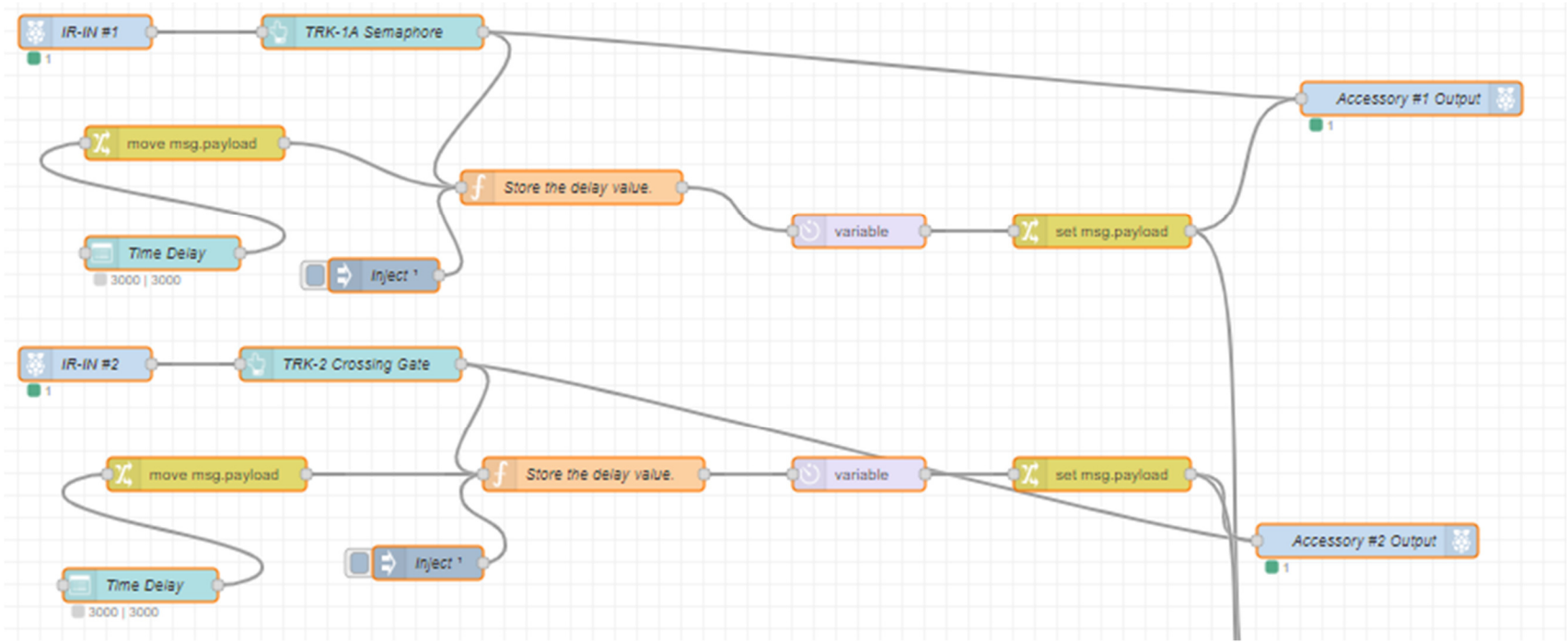
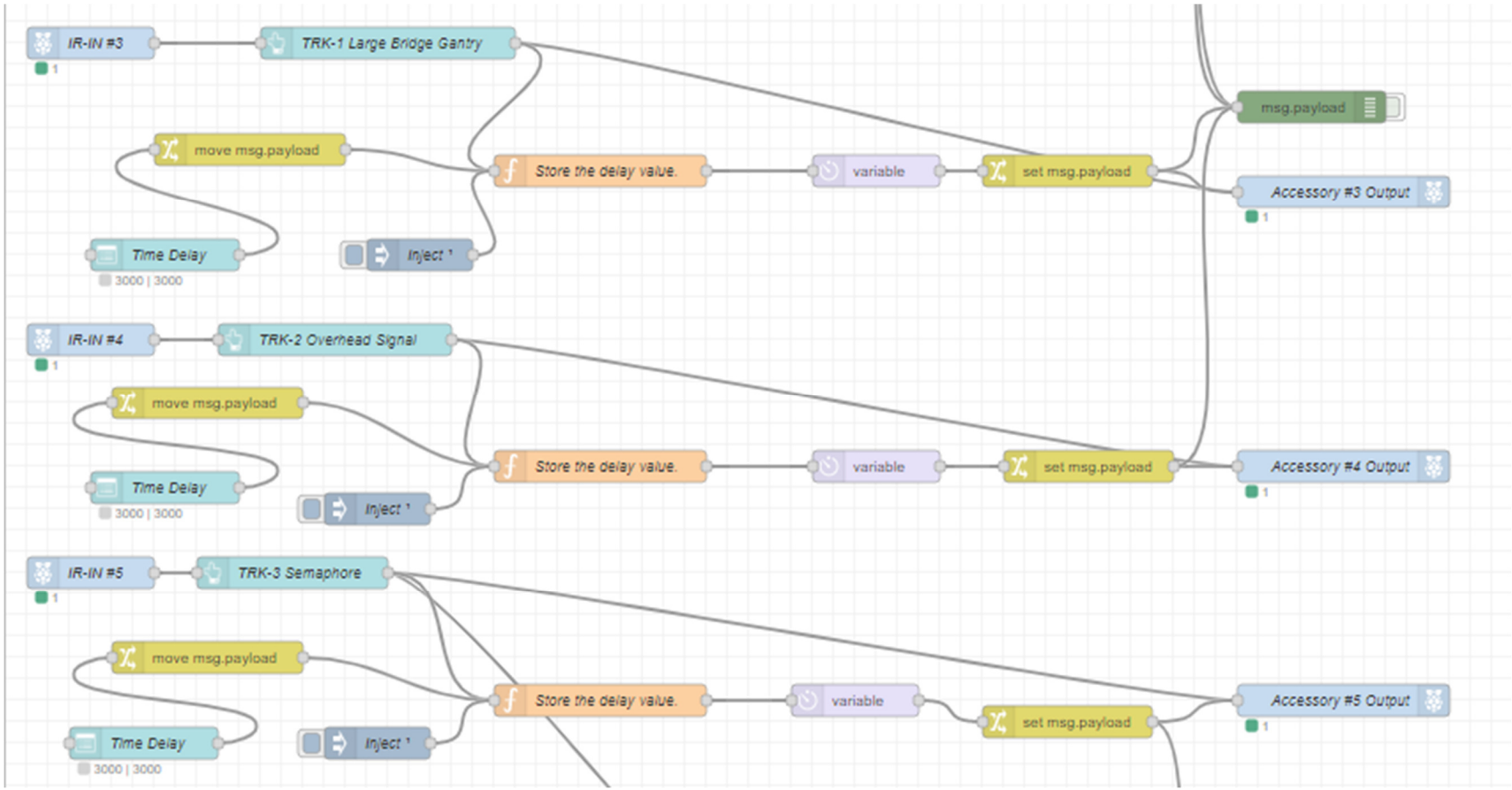
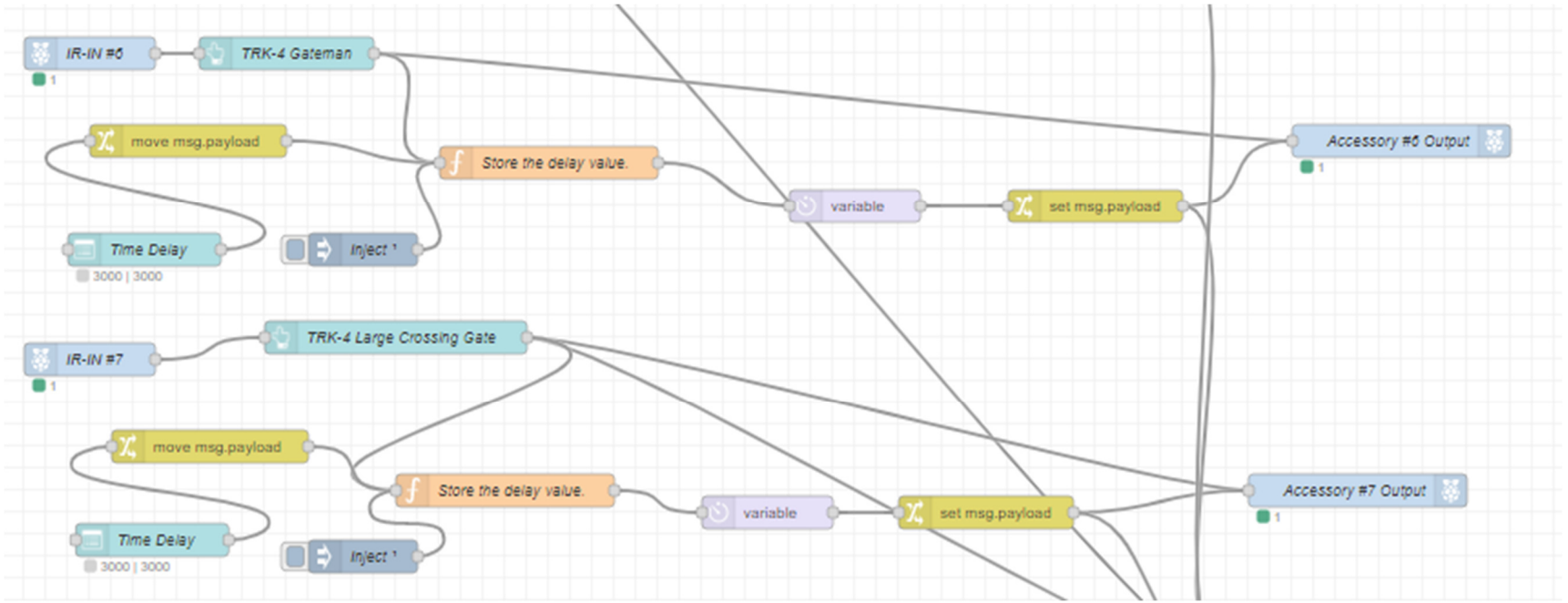
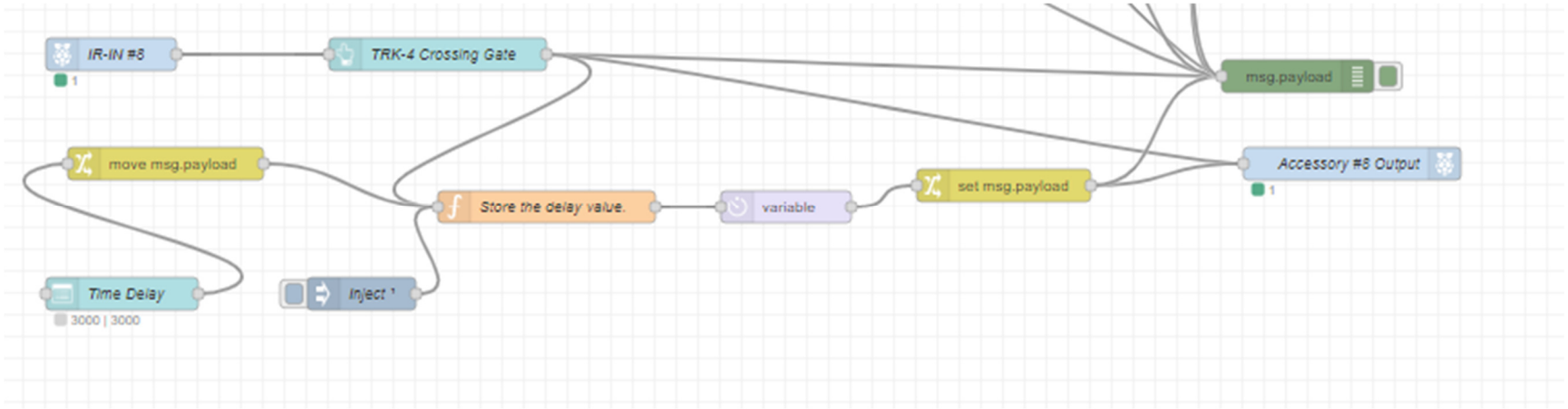

Train Control Notes
CH1 Datasort (V)
Standby
Track 1 Volts
1
CH2 Datasort (V)
Standby
Track 2 Volts
CH3 Datasort (V)
Standby
Track 3 Volts
Run Python Track Voltage A/D Script
CH4 Datasort (V)
Standby
Track 4 Volts
1
msg.payload
CH1 Datasort (I)
Standby
Track 1 Amps
Run Python Track Current A/D Script
CH2 Datasort (I)
Standby
Track 2 Amps
CH3 Datasort (I)
Standby
Track 3 Amps
CH4 Datasort (I)
Standby
Track 4 Amps
Inject
Run Python Train Sounds File
pid:3429
msg.payload


IR-IN #1
1
TRK-1A Semaphore
Accessory #1 Output
1
move msg.payload
Store the delay value.
variable
set msg.payload
Time Delay
3000 | 3000
Inject 1
IR-IN #2
1
TRK-2 Crossing Gate
move msg.payload
Store the delay value.
variable
set msg.payload
Accessory #2 Output
1
Inject 1
Time Delay
3000 | 3000


IR-IN #3
1
TRK-1 Large Bridge Gantry
move msg.payload
Store the delay value.
variable
set msg.payload
msg.payload
Accessory #3 Output
1
Time Delay
3000 | 3000
Inject 1
IR-IN #4
1
TRK-2 Overhead Signal
move msg.payload
Store the delay value.
variable
set msg.payload
Accessory #4 Output
1
Time Delay
3000 | 3000
Inject 1
IR-IN #5
1
TRK-3 Semaphore
move msg.payload
Store the delay value.
variable
set msg.payload
Accessory #5 Output
1
Time Delay
3000 | 3000
Inject 1


IR-IN #6
TRK-4 Gateman
1
move msg.payload
Store the delay value.
variable
set msg.payload
Accessory #6 Output
1
Time Delay
3000 | 3000
Inject '
IR-IN #7
TRK-4 Large Crossing Gate
1
move msg.payload
Store the delay value.
variable
set msg.payload
Accessory #7 Output
1
Time Delay
3000 | 3000
Inject '


IR-IN #8
TRK-4 Crossing Gate
1
msg.payload
move msg.payload
Store the delay value.
variable
set msg.payload
Accessory #8 Output
1
Time Delay
3000 | 3000
Inject '

Electronic BOM (Bill of Materials)

Quantity	Part Number / Description	Manufacturer
4	2200uF electrolytic Capacitors rated for 50Vdc	Any
4	10 KΩ 10-Turn Potentiometer	Any
4	40 KΩ 1/8 Watt resistor	Any
1	Raspberry Pi 3B+ or 4	Amazon, Canakit or Pi-Shop
2	5Vdc wall plug in power adaptor rated 5 Vdc @ 2.5 amps	Amazon or Adafruit
1	8 Channel Relay Board rated 5 Vdc, opto-isolated inputs, logic low inputs.	Amazon or Sainsmart
2	ADS1115 16 bit A/D converter	Amazon or Adafruit
8	Osoyo Infra-Red Obsticle Detectors	Amazon
4	ASC712-20 AC Current Sensors	Amazon
4	Full Wave Bridge Rectifier rated 50 PIV @ 1 amp	Amazon or Digikey
1	Elecrow 7" Touch Screen Display with Stand and spearkers and volume control. Minimum Resolution = (1024 X 600)	Amazon
1	HCDC RPi GPIO Status LED & Terminal Breakout Board	Amazon
?	Misc. (terminal blocks, crimp connectors, wire, ty-wraps, etc.)	Amazon / Various

I/O Mapping Tale

Accessary #	Accessory Name	GPIO (input) From IR Sensor Board "out pin"	GPIO (output) to relay Board	Relay Board Pin
1	Track #1A Semaphore	GPIO6	GPIO17	IN1
2	Track #2 Crossing Gate	GPIO13	GPIO18	IN2
3	Track #1 Large Bridge Gantry	GPIO19	GPIO27	IN3
4	Track #2 Overhead Signal	GPIO26	GPIO22	IN4
5	Track #3 Semaphore	GPIO12	GPIO23	IN5
6	Track #4 Gateman	GPIO16	GPIO24	IN6
7	Track #4 Large Crossing Gate	GPIO20	GPIO25	IN7
8	Track #4 Crossing Gate	GPI21	GPIO5	IN8

Notes:

1) All GPIO Inputs are to digital inputs using "pullup" high resistors
2) All GPIO outputs are set to digital outputs (high level = off, low level = on)

Power Distribution

Power Source	Connections
Lionel ZW Transformer (A)	Track # 1 power and Track # 1: • Switch Track (Bottom) & Switch Light • Switch Track (Upper) & Switch Light • Uncoupler • Log Car Unloader
Lionel ZW Transformer (B)	Track # 2 power
Lionel ZW Transformer (C)	Track # 3 power
Lionel ZW Transformer (D)	Track # 4 power and Track # 4: • Switch Track (Bottom) & Switch Light • Switch Track (Upper) & Switch Light • Uncoupler
Lionel Aux Power Transformer (12 Vac Winding)	• Lighted red/green Tower Beacon • Blinking Water Tower • Lighted Billboard • Street Lamps • B&O House • Welsh Tavern • Track #3 Blinking Trestle Bridge • Platform Station Light and Operations • Red / Green Light Semaphore
Lionel Aux Power Transformer (16 Vac Winding)	• Track # 3 Semaphore Lights • Track # 4 Gateman House Light • Track #1A Semaphore • Track #2 Crossing Gate • Track #1 Large Bridge Gantry • Track #2 Overhead Signal • Track #3 Semaphore • Track #4 Gateman • Track #4 Large Crossing Gate

5 Vdc Power transformer	5 Volt Relay Board (to power relay's only)
5 Vdc Power transformer	To power Raspberry Pi and Touch Screen
3.3 Vdc Source Wiring (derived from Raspberry Pi)	• Optical Power Sensors • Track Current Sensors • A/D conversion Modules

I/O Mapping Tale

Accessary #	Accessory Name	GPIO (input) From IR Sensor Board "out pin"	GPIO (output) to relay Board	Relay Board Pin
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7	Track #4 Large Crossing Gate	GPIO20	GPIO25	IN7
8	Track #4 Crossing Gate	GPI21	GPIO5	IN8

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Power Distribution

Power Source	Connections
Lionel ZW Transformer (A)	Track # 1 power and Track # 1: - Switch Track (Bottom) & Switch Light - Switch Track (Upper) & Switch Light - Uncoupler - Log Car Unloader
Lionel ZW Transformer (B)	Track # 2 power
Lionel ZW Transformer (C)	Track # 3 power
Lionel ZW Transformer (D)	Track # 4 power and Track # 4: - Switch Track (Bottom) & Switch Light - Switch Track (Upper) & Switch Light - Uncoupler
Lionel Aux Power Transformer (12 Vac Winding)	- Lighted red/green Tower Beacon - Blinking Water Tower - Lighted Billboard - Street Lamps - B&O House - Welsh Tavern - Track #3 Blinking Trestle Bridge - Platform Station Light and Operations - Red / Green Light Semaphore
Lionel Aux Power Transformer (16 Vac Winding)	- Track # 3 Semaphore Lights - Track # 4 Gateman House Light - Track #1A Semaphore - Track #2 Crossing Gate - Track #1 Large Bridge Gantry - Track #2 Overhead Signal - Track #3 Semaphore - Track #4 Gateman - Track #4 Large Crossing Gate
5 Vdc Power transformer	5 Volt Relay Board (to power relay's only)
5 Vdc Power transformer	To power Raspberry Pi and Touch Screen
3.3 Vdc Source Wiring (derived from Raspberry Pi)	- Optical Power Sensors - Track Current Sensors - A/D conversion Modules