

A Deeper Dive Into

^ Using an Arduino as a CMRI Node

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A Deeper Dive Into Using an Arduino as a CMRI Node

The CMRI system created by Dr. Bruce Chubb in 1985 and has a long and proven history of being a dependable layout control system. This clinic will demonstrate two use cases of an Arduino utilizing the CMRI protocol for servo control (turnouts) and push buttons/LEDs (control panel). The demonstration will be done on the famous John Allen's Timesaver Puzzle in N-Scale and will show the Arduino CMRI node integrated into JMRI

What's Inside This Clinic

- **Agenda**

- Quick overview - Inventor, NMRA Standard, Open Source Arduino Library
- Components of a CMRI System – RS-485, Nodes, JMRI
- Take a “look” under a couple of layouts
- Build a CMRI System

CMRI (Computer Model Railroad Interface)

- **NMRA** – Layout Control Specification

- [https://www.nmra.org/sites/default/files/standards/sandrp/Other Specifications/lcs-9.10_cmri_intro_v1.0.pdf](https://www.nmra.org/sites/default/files/standards/sandrp/Other%20Specifications/lcs-9.10_cmri_intro_v1.0.pdf)
- [https://www.nmra.org/sites/default/files/standards/sandrp/Other Specifications/lcs-9.10.1_cmrinet_v1.1.pdf](https://www.nmra.org/sites/default/files/standards/sandrp/Other%20Specifications/lcs-9.10.1_cmrinet_v1.1.pdf)

- **CMRI** – <https://www.jlcenterprises.net/>

- The CMRI system was created by Dr. Bruce Chubb in 1985, and introduced to the model railroad community through a 16-part series of articles in Model Railroader magazine.
- In 2014 the CMRI Protocol was adapted as a Group Standard by the NMRA and listed in their standard's section (as listed above)
- Hardware and software designs are Open Source with excellent documentation.
- There is an NMRA Special Interest Group, CMRI SIG, providing information and discussion regarding CMRI.

CMRI (Computer Model Railroad Interface)

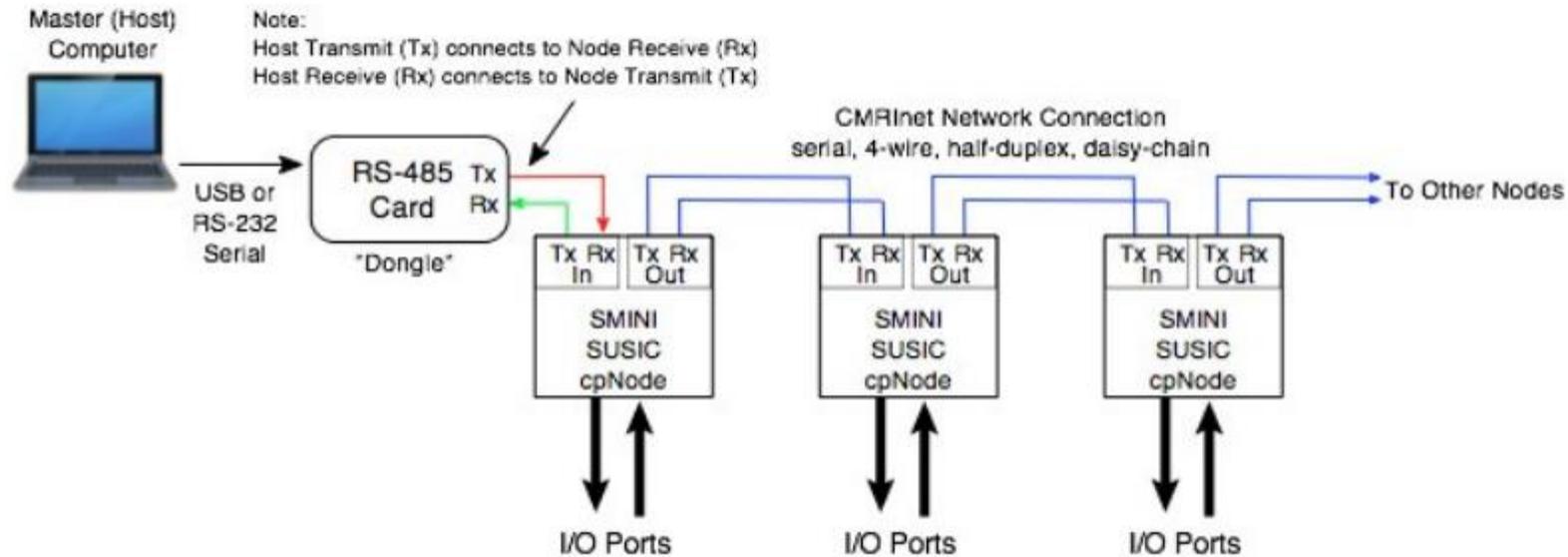
- **ArduinoCMRI** – <https://github.com/madleech/ArduinoCMRI>
 - Library for connecting your Arduino with JMRI by emulating Bruce Chubb's Computer/Model Railroad Interface (CMRI) System. Provides maximum flexibility to tailor your solution to fit your needs
 - Features:
 - Simple API that handles GET, SET, and POLL requests from JMRI automatically.
 - Easy access to input and output data.
 - Emulates an SMINI up to a SUSIC with up to 2048 digital lines available.
 - Error tolerant.

CMRI System Components

- **JMRI** – <https://www.jmri.org/help/en/html/hardware/cmri/CMRI.shtml>
 - JMRI libraries have been built-in to support CMRI serial hardware.
 - Each CMRI node is capable of communicating independently with a computer via serial I/O.
 - Perhaps obvious, but each CMRI node must have a different unique address.
- **Node** –
 - Commercial Nodes: SMINI or SUSIC
 - Arduino Node: cpNode
- **RS485** – Electrical standard designed for connecting multiple masters together on a single bus.
 - The original CMRI system used a shared serial bus, and so does Arduino CMRI
 - No fixed master and slave roles.
 - Excellent for long distances or split grounds.
 - Each node connects to the bus using a small bus transceiver IC (i.e. MAX485)
 - Pair of pins (A and B) control the direction, or mode of communication
 - At any point in time the node is either talking or listening on the bus

CMRI Network

CMRI-net Connection



<https://www.jlcenterprises.net/pages/the-computer-advantage>

<http://www.modelrailroadcontrolsystems.com/content/Designing%20with%20cpNode%2020160630.pdf>

JLC Enterprises – SMINI Node

- Product Website – <https://www.jlcenterprises.net/collections/mini-node/products/super-mini-node>



Plus Additional \$24 →

SUPER MINI NODE (SMINI)

SALE **\$ 28.00** ~~\$ 32.00~~

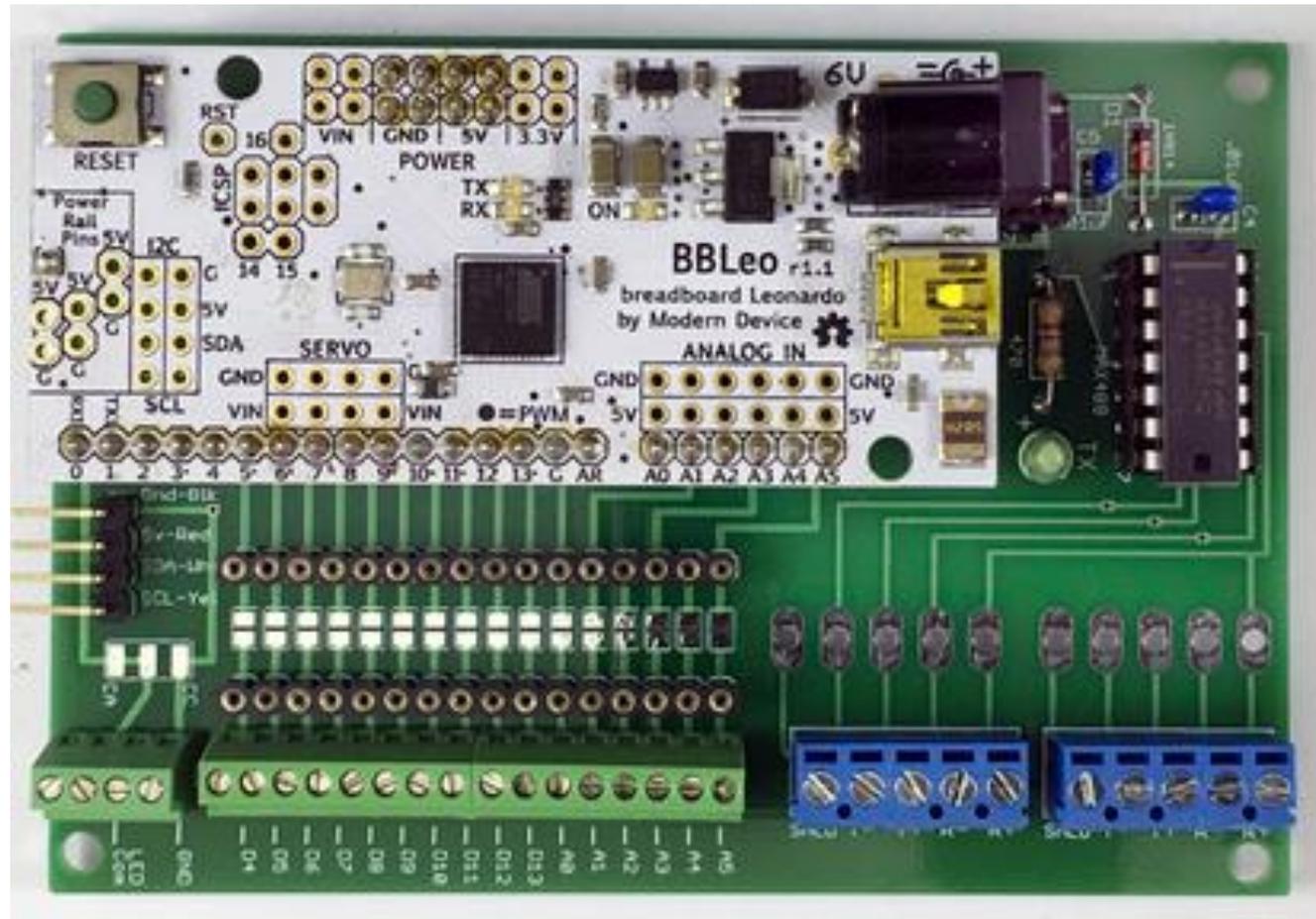
This Super Mini-node card combines all the advanced features of the SUSIC with 48 output and 24 input I/O lines. It's really a single card providing a complete standalone serial node with 72 I/O lines. Cost for do it yourself assemblers can be as low as \$1 per I/O line. That makes the cost of all the electronics almost insignificant when compared to the cost of the signals!

Requires the purchase of 16F877 MICROCONTROLLER IC PROGRAMMED FOR SUSIC AND SMINI

Model Railroad Control Systems - cpNode

- Product Website – <http://www.modelrailroadcontrolsystems.com/cpnode-version-2-5/>

Cost \$80

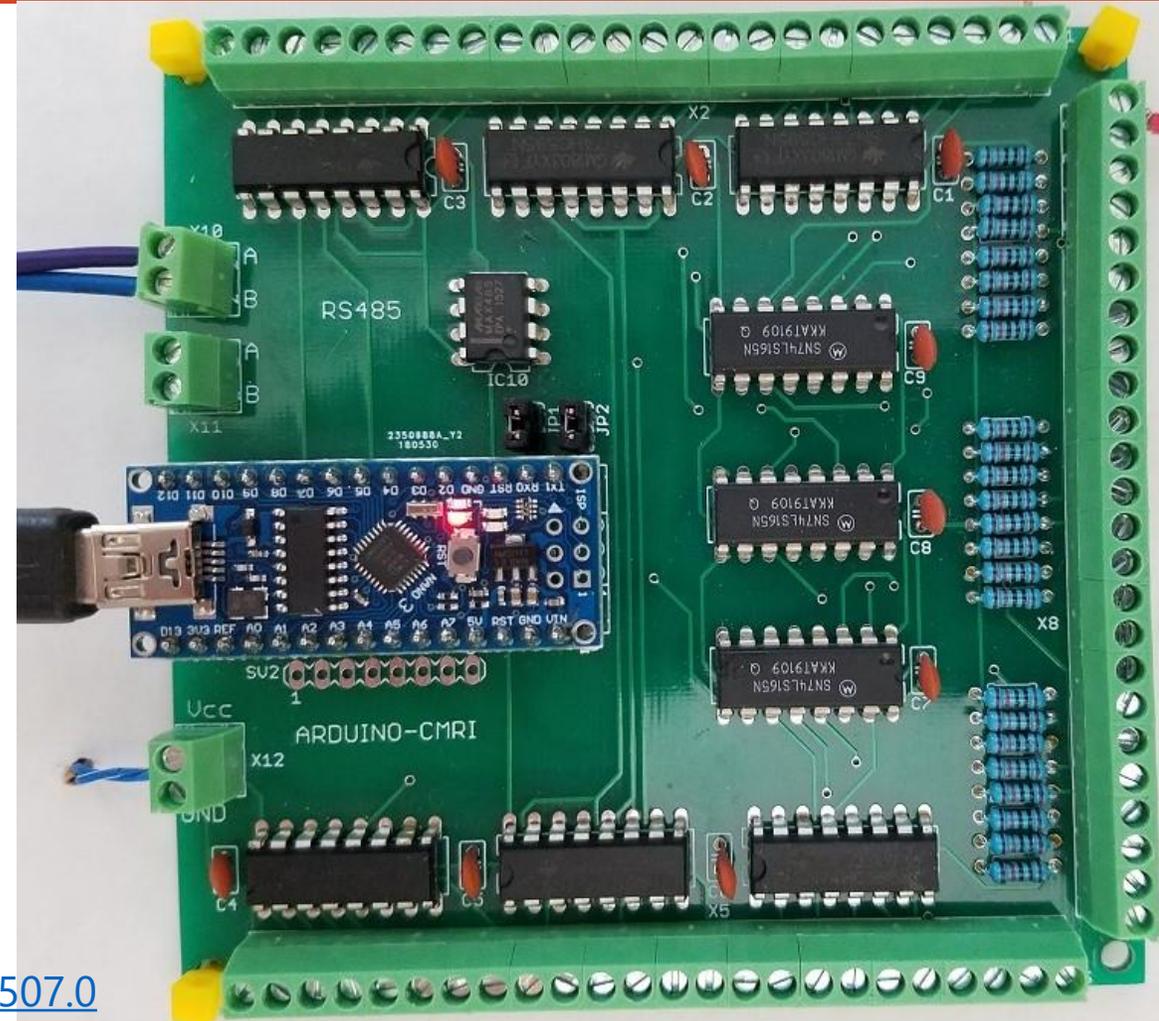


Arduino SMINI Node

• Parts List – Cost

- MAX 485 (RS485 Chip) \$0.26
- 74LS165 (Qty 3) \$0.98 each
- 74LS1595 (Qty 6) \$0.75 each
- 100nF Capacitor (Qty 9) \$0.07 each
- 10K Ohm Resistor (Qty 24) \$0.06 each
- 3.5mm Screw Terminal (Qty 39) \$0.07 each
- Circuit Board \$1.50
- Arduino Nano \$4.20

Total \$15.70



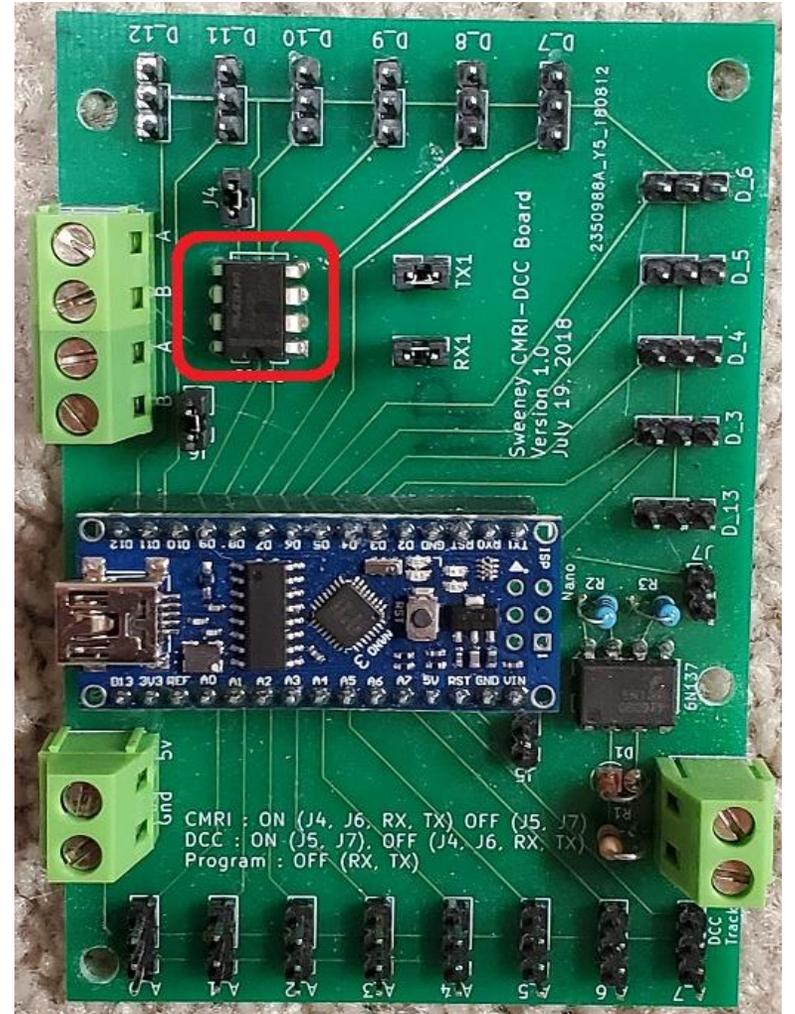
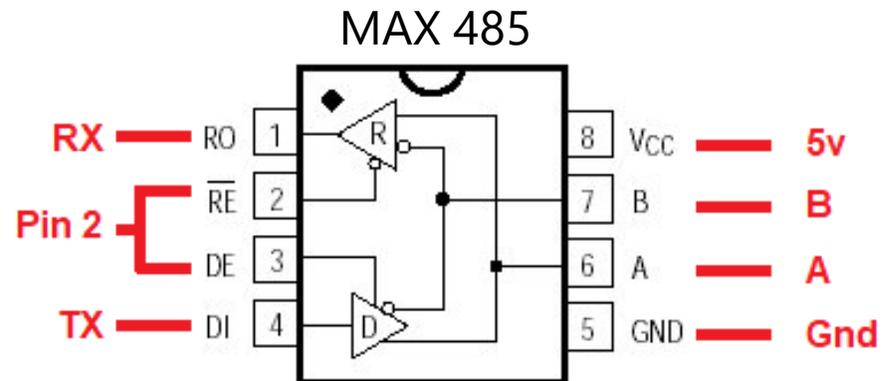
- **Locoduino** – <http://forum.locoduino.org/index.php?topic=507.0>
- **Michael Adams** – <http://www.utrainia.com/65-arduinocmri-and-rs485>

Arduino Servo Node

• Parts List– Cost

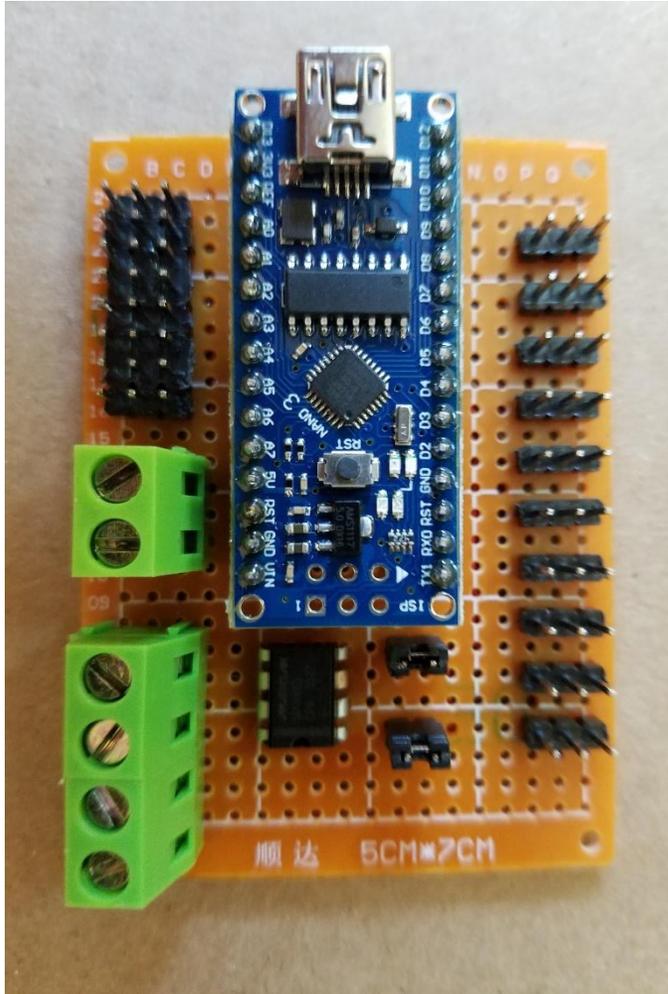
- MAX 485 (RS485 Chip) \$0.26
- 3.5mm Screw Terminal (Qty 3) \$0.07 each
- Circuit Board \$1.50
- Arduino Nano \$4.20

Total \$6.17

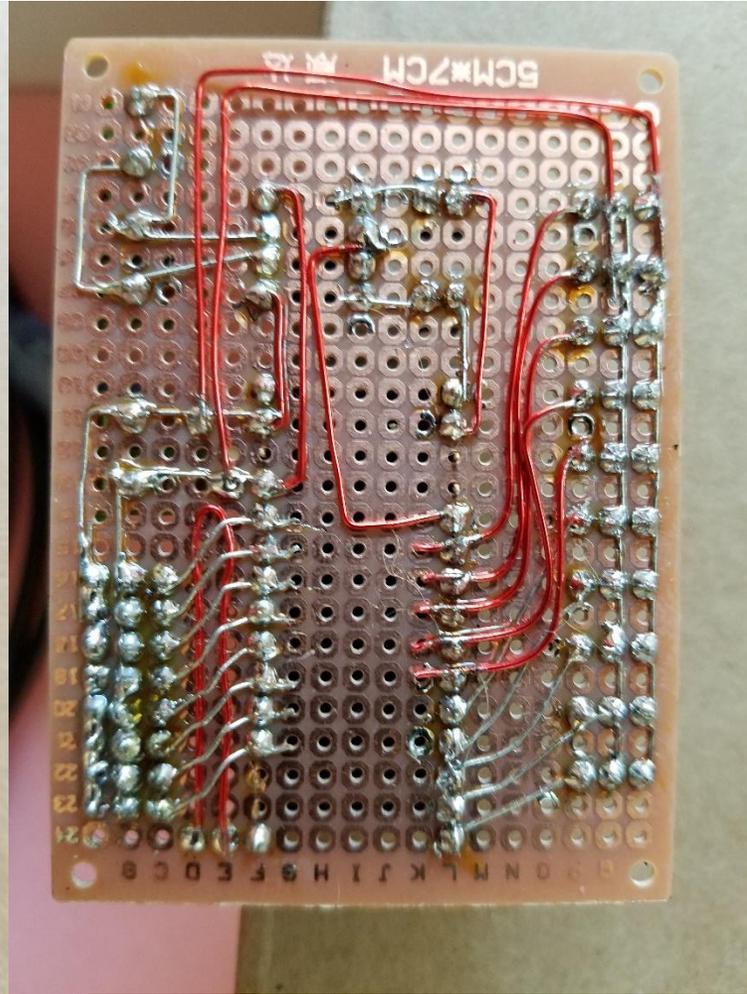


Arduino Servo Node – Version 0.1 to Version 1.0

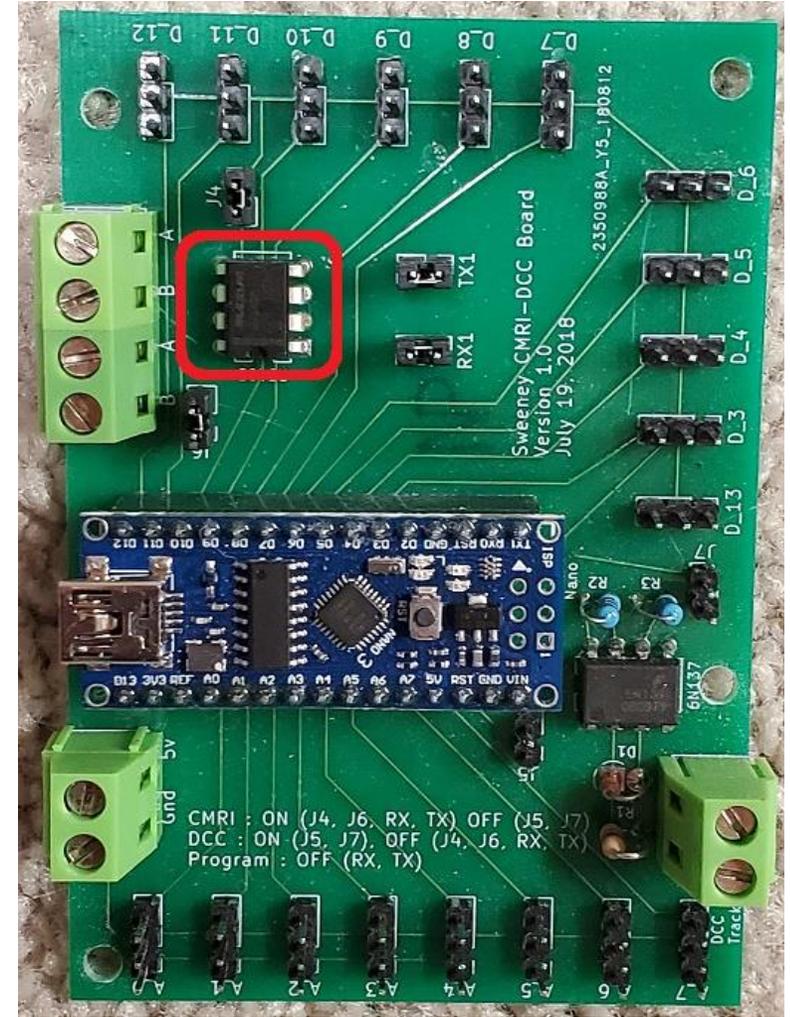
Version 0.1 Top



Version 0.1 Bottom



Version 1.0



“Under” the Sunset Valley

- **Bruce Chubb's Layout** – has over 2,000 CMRI Input/Output lines



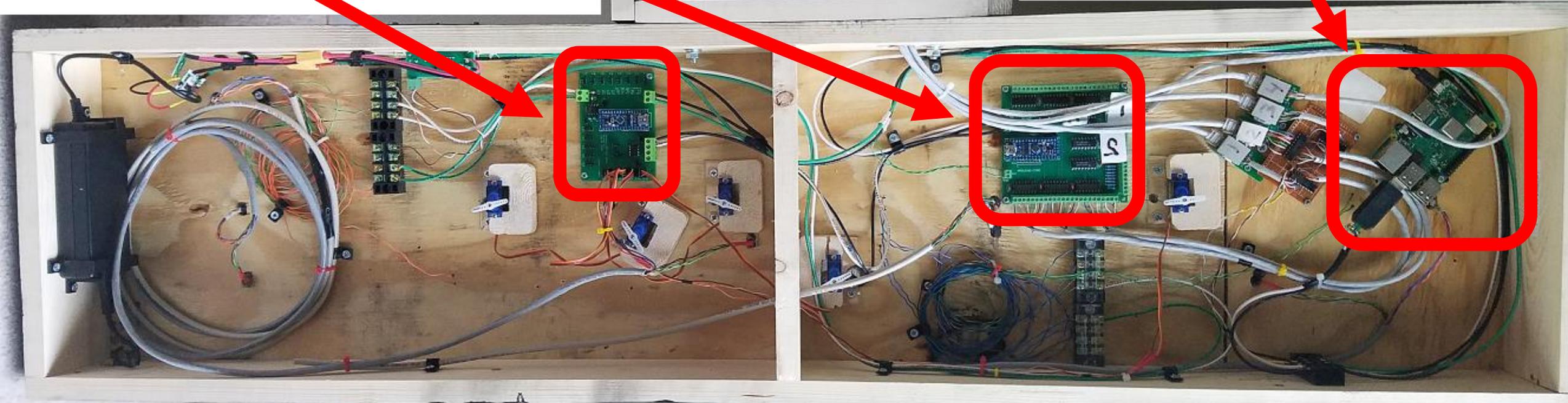
"Under" the Timesaver

- Nodes

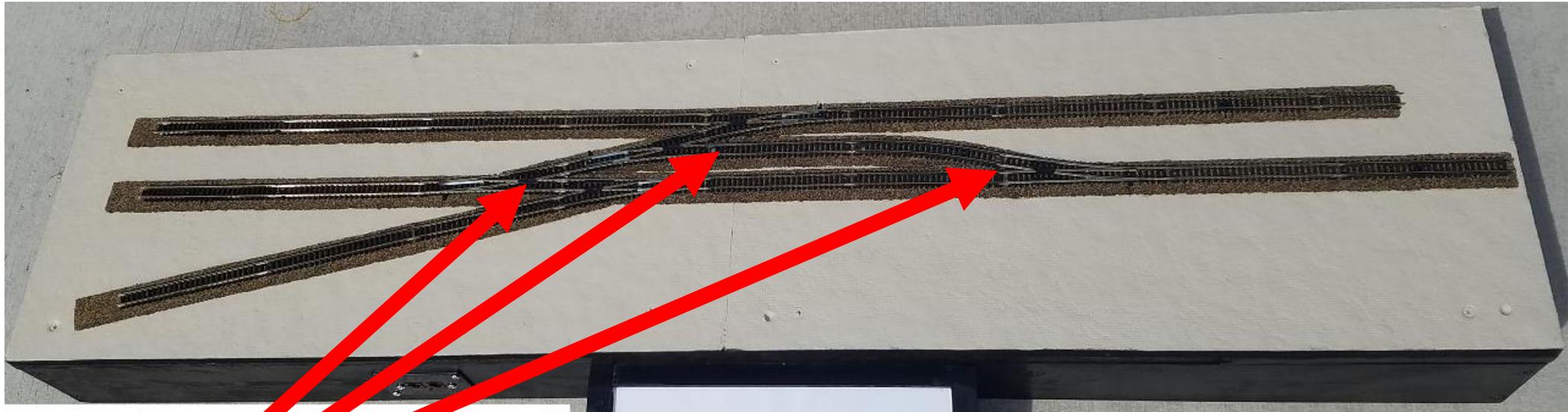
- Arduino SMINI
- Arduino Servo Node

- JMRI

- Raspberry PI
<https://mstevetodd.com/rpi>

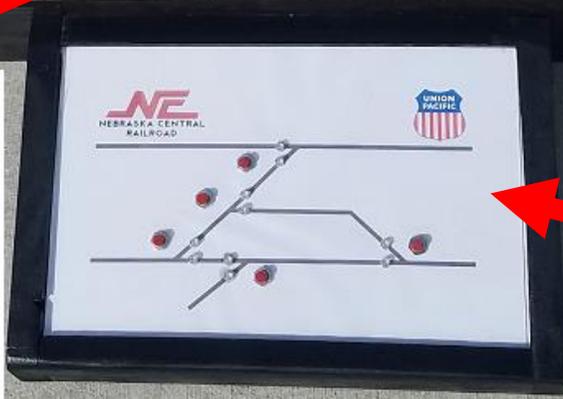


"Top" of the Timesaver



- 5 Turnouts Toggled by Arduino Servo Node

- SG90 Servo's

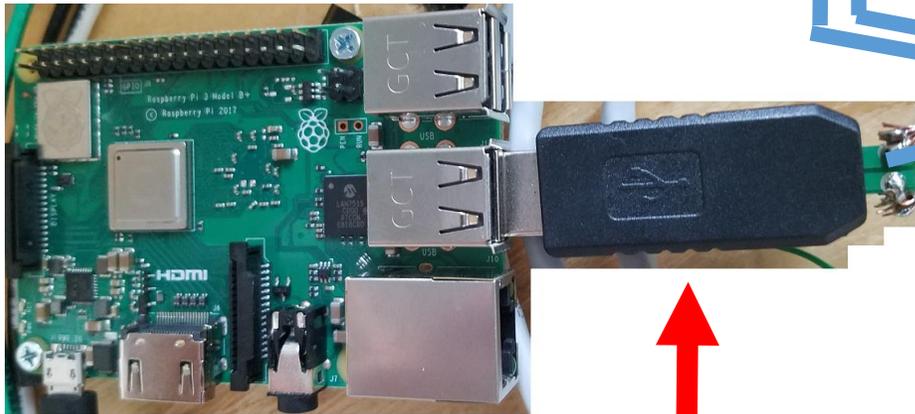


- Control Panel Controlled by Arduino SMINI

- Pushbuttons and LEDs

The Timesaver CMRI Network

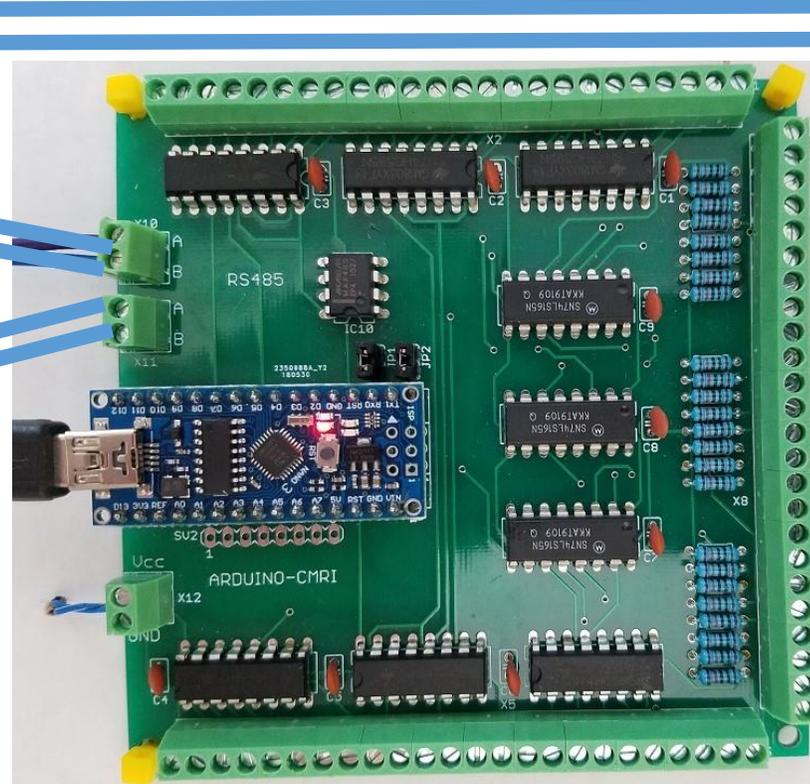
RS485 Network



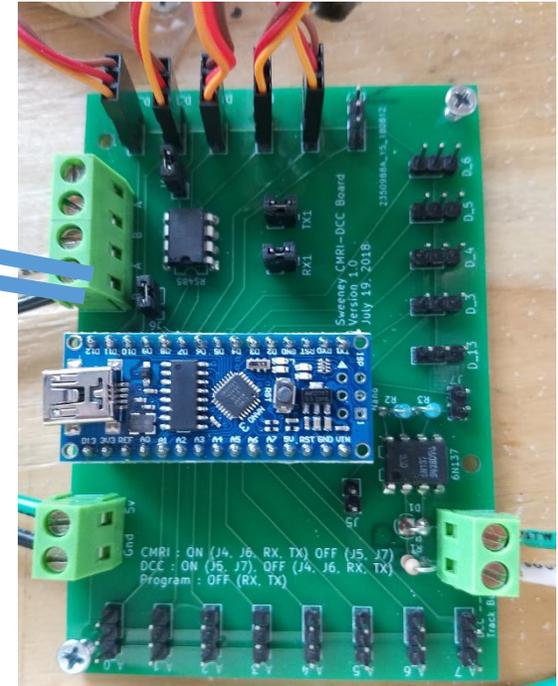
Raspberry Pi
running JMRI



USB - RS485



Arduino SMINI
Controls Pushbuttons and LEDs



Arduino Servo Node
Toggles Turnouts via SG90 Servos



Let's Build a Simple CMRI System (In Clinic Demo)

Components

- Computer
 - Arduino IDE
 - JMRI
 - USB RS485 Transceiver
- RS485 "Network"
- Arduino SMINI
 - LED
 - Toggle Switch

Code for Arduino SMINI (only need to change NODE #)

```
#include <Auto485.h>
#include <CMRI.h>
#include <SPI.h>

#define CMRI_ADDR 0 // select the CMRI node address
#define DE_PIN 2 // Arduino pin 2 -> MAX485 DE and RE pins

// pin 74HC165
const byte LATCH_165 = 9;

// pins 74HC595
const byte LATCH_595 = 6;
const byte DATA_595 = 7;
const byte CLOCK_595 = 8;

Auto485 bus(DE_PIN); // RS485 bus transceiver
CMRI cmri(CMRI_ADDR, 24, 48, bus); // sets up an SMINI. SMINI = 24 inputs, 48 outputs

void setup() {
  bus.begin(9600, SERIAL_8N2); // open the RS485 bus at 9600bps
  pinMode(LATCH_595, OUTPUT);
  pinMode(DATA_595, OUTPUT);
  pinMode(CLOCK_595, OUTPUT);
  SPI.begin (); // serial data protocol used to control 74HC165
  pinMode (LATCH_165, OUTPUT);
  digitalWrite (LATCH_165, HIGH);
}
```

```
void loop() {
  // 1: main processing node of cmri library
  cmri.process();

  // 2: update output
  digitalWrite(LATCH_595, LOW); // Start by setting Latch Low
  shiftOut(DATA_595, CLOCK_595, MSBFIRST, cmri.get_byte(5)); // Send the 6th byte first
  shiftOut(DATA_595, CLOCK_595, MSBFIRST, cmri.get_byte(4)); // Send the 5th byte next
  shiftOut(DATA_595, CLOCK_595, MSBFIRST, cmri.get_byte(3)); // Send the 4th byte next
  shiftOut(DATA_595, CLOCK_595, MSBFIRST, cmri.get_byte(2)); // Send the 3rd byte next
  shiftOut(DATA_595, CLOCK_595, MSBFIRST, cmri.get_byte(1)); // Send the 2nd byte next
  shiftOut(DATA_595, CLOCK_595, MSBFIRST, cmri.get_byte(0)); // Send the 1st byte last
  digitalWrite(LATCH_595, HIGH); // Set the Latch High to update the Data

  // 3: update inputs
  digitalWrite (LATCH_165, LOW); // pulse the parallel load latch
  delay(1); // wait while data loads
  digitalWrite (LATCH_165, HIGH);
  cmri.set_byte(0, ~(SPI.transfer(0)));
  cmri.set_byte(1, ~(SPI.transfer(0)));
  cmri.set_byte(2, ~(SPI.transfer(0)));
}
```

In Clinic

DEMO

Thank You !!



Questions/Answers

Circuit Boards

- **JLCPCB** – <https://support.jlcpb.com/article/13-who-is-jlcpb>
 - JLCPCB is the largest PCB prototype enterprise in China and a high-tech manufacturer specializing in quick PCB prototype and small-batch PCB production.
 - Generally always have a sale
 - This week: \$15 for Qty 10 – 100m x 100mm – 2 sided PCB - includes shipping