
cpNode Assembly Instructions

Revision v2.0 02/01/2016

Introduction

This document describes the functional blocks of the cpNode and how to assemble it.

Revision History

v1.0	01/04/2014	CC
v1.1	01/29/2014	CC
v1.2	05/05/2014	CC
v1.3	12/26/2014	CC
v1.4	01/15/2015	CC
v2.0	02/01/2016	CC

Model Railroad Control Systems

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1. CPNODE SYSTEM OVERVIEW

The cpNode consists of five main sections.

- Arduino processor board header connectors for I/O ports and system power.
- CMRInet RS-485 drivers, automatic transmit enable circuit (AutoRTS), and network cable terminal pads.
- Remote stall motor controller.
- I2C serial interface for I/O extender cards.
- I/O port option area and connection pads.

All components are through-hole technology for ease of assembly and repair.

Pads for I/O connections are standardized on .100" centers. This provides a wider range of interconnect options and components. The I/O connection design is followed throughout the boards created in the cpNode system. Port connection schemes include screw terminal blocks, header pin connectors (male and female), soldered right angle headers, and direct soldered wires.

The solder pad option area has one configurable area for each I/O port. The option area consists of through-hole resistor pads and a solder jumper. The option area is not connected by default. To connect an I/O pin from the Arduino to a connection pad, either a solder jumper or resistor (normally used for LED current limiting) must be present. Wires can be inserted into the resistor pads if soldering the jumper pad is not desired.

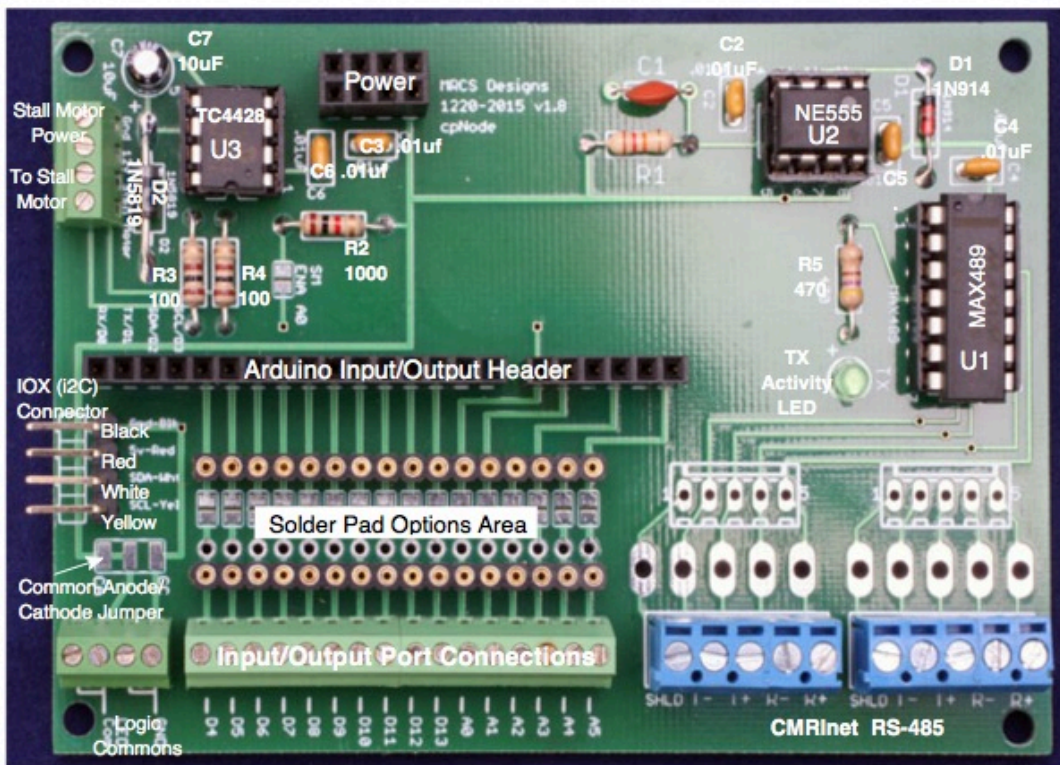


Figure 1 cpNode Component Locations

2. ARDUINO™ PROCESSOR BOARD INTERFACE

The cpNode motherboard provides the physical interconnect to the selected Arduino board and the input/output ports. Tall .100 female headers provide the connection to corresponding male pins on the Arduino board or CPSHIELD. The 2x4 power connector header routes the supplied system power and ground from the processor board.

3. CMRINET (RS-485/RS-422) INTERFACE

The physical communication connection to CMRI serial nodes is RS422 / RS485, 4-wire, half-duplex. Network speeds of 9600, 19200, 28800, 38400, 57600, and 115200 BPS are supported. Transmit enable for the network driver chip is controlled by an AutoRTS circuit. The network connections are daisy chained from node to node for a maximum of 128 nodes. The cpNode supports the CMRI protocol through the RS-485 wire interface. The master or host end of CMRIInet has an RS-232 or USB to RS485 interface, commonly referred to as a “dongle”.

CMRI nodes are connected in daisy chain fashion with four-wire shielded cable. Four-wire cable connects to the RS485IN and RS485OUT terminals on the cpNode. The 5th position in the pad area provides a convenient tie point for the shield drain wire. This pad is not connected to any circuit on the board.

Two pad configurations are available; .100” spaced pads and 3.5mm spaced pads for screw terminal blocks. All similar signals are wired in parallel. Either pad area can be used for the network in or network out connection. A 5th pad is present to tie the shield or drain wires together. This pad does not connect to any ground plane on the cpNode board and is provided for cabling convenience.

CMRIInet signal names are TX+,TX- (Chubb OUT+, OUT-) and RX+,RX- (Chubb IN+, IN-).

A Maxim MAX489 driver chip (U1) provides the connection between the Arduino serial pins D0/RX and D1/TX, and the CMRI network. A socket is recommended for this chip.

4. AUTORTS INTERFACE

CMRIInet operates in Master/Slave transmission mode. Each node has a unique numerical address. The Master polls each node, requesting data. The polled node responds with data. All nodes on the network receive the poll message, but only the addressed node responds. All nodes’ transmit pairs are connected in parallel, as are the receive pairs.

The MAX489 (U1) driver chip contains a pair of line driver circuits, one for transmit and one for receive. The receive side is always enabled. The transmit side is only enabled when the node needs to transmit data to the Master. Traditional hardware implementations would dedicate a software controlled I/O pin to enable/disable the transmit driver.

To conserve I/O pins, transmit enable (TXEN) is controlled by a NE555 (U2) timer chip. The timer is set by the first bit of a byte being sent, holding TXEN high for the duration of the transmitted byte. Additional hold time is added to insure all of the bits are sent before the transmit drivers are disabled. The total enable time is line speed dependent and the timeout interval is set by R1 and C1.

A table of R1/C1 values by line speed is on the schematic. For 9600 and 19200 BPS, a value of .1uF for C1, and a value of 12k for R1 can be used. Testing at both these speeds confirm proper operation.

* AutoRTS Resistor Value		
BPS	R1	C1
9600	12000	.1 uF
19200	6000	.1 uF
28800	3900	.1 uF
38400	3000	.1 uF
57600	2000	.1 uF
115200	1000	.1 uF

Figure 2 AutoRTS Timing Component Values

5. STALL MOTOR INTERFACE

A single stall motor controller is located on the motherboard. The circuit is optional and the components can be left out if the function is not needed. The circuit uses a TC4428 (U3) MOSFET driver to operate a turnout stall motor. Voltage to drive the stall motor is connected to the SM12V connector. The stall motor is connected to the SMOUT connector. The TC4428 has high drive current and can easily run two stall motors.

The input to the TC4428 is directly tied to pin A0 on the input side of the solder options area. If the stall motor controller is not needed, then you need not stuff U3, R2, R3, R4, C6, C7, and D2. Pin A0 then is available as a regular I/O port.

6. I2C INTERFACE

To provide additional input and output ports to a cpNode, I/O extender boards (IOX) connect to the I2C serial bus. This serial bus is tailored to driving low-level devices like LED's and contact sensors. The bus is present in some automobiles and is the interface for many dashboard and interior control functions. The cpNode connects to the input/output extender boards with four-wire cable through the I2C connector (I2CHEADER). Four wire cable harnesses are available from various suppliers like Pololu and Sparkfun. A Molex 2.54mm KK style header will also work.

IOX boards are interconnected in daisy chain fashion using four wire .100 header cables.

An established color code for I2C wires is:

Pin 1	SCL	Yellow
Pin 2	SDA	White
Pin 3	+5v	Red
Pin 4	Gnd	Black

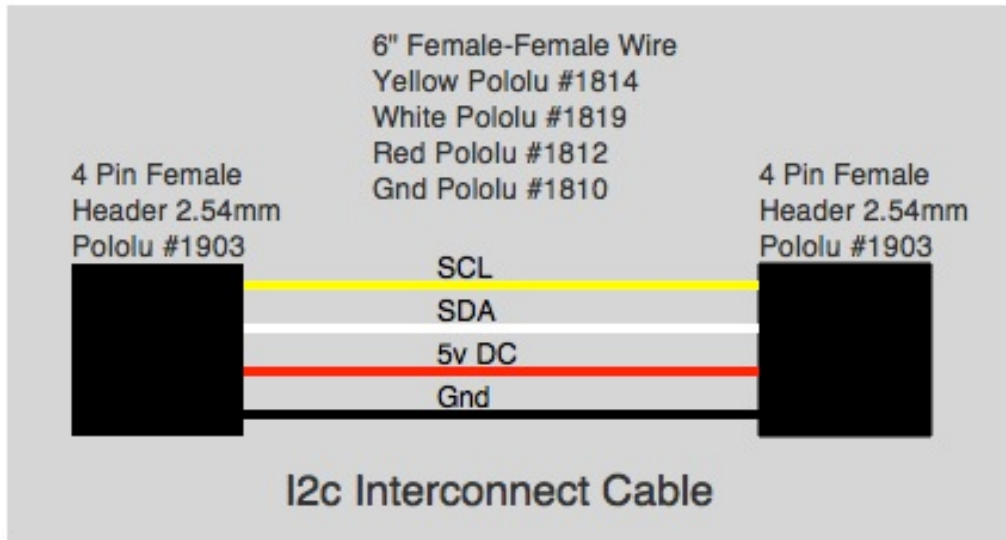


Figure 3 I2C Interconnect Cable

7. GND AND LEDCOM CONNECTORS

There are two common tie points on the logic board. Both sets of pins were intended to provide a convenient GND/common tie point for wire connection at the node location on the layout.

GND is intended to be used as the input line for contact sensors. Just run the GND to one side of a push button, the other side of the button goes to a port defined as INPUT_PULLUP. A built-in weak pull-up resistor is enabled when a port is defined this way.

The LEDCom pins are connected to the CA/CC solder jumper pads. This connection is intended to provide a separate connect point for LEDs, either providing sourcing (+5v) or sinking (GND) which is the same common logic ground as the GND pins. The node design is focused on driving LED based signal heads.

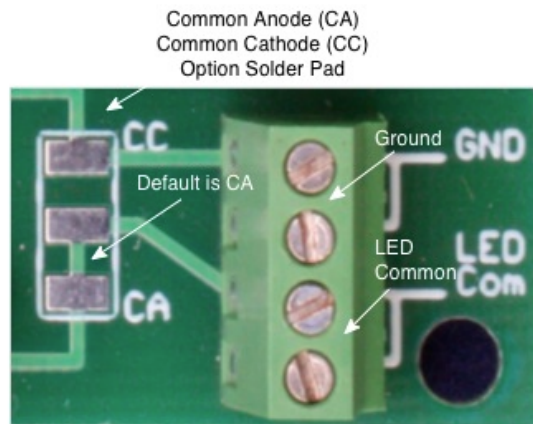


Figure 4 Ground and LED Common Connection

8. BILL OF MATERIALS

A quantity of zero may denote an alternate component or a component that may be used in a particular configuration. The LED limiting resistors are one example.

Description	Ref	Qty
cpNode PCB v2.0 2.70" x 3.90"	PCB1	1
Resistor 1K	R2	1
Resistor 100 Ohm	R3,R4	2
Resistor 470	R5	1
Resistor 12K AutoRTS	R1	1
Capacitor .1uf AutoRTS	C1	1
Capacitor .01uF Bypass	C2-C6	5
Capacitor Electrolytic 10uF 25v	C7	1
MAX489CPD	U1	1
NE555	U2	1
TC4428A MOSFET	U3	1
DIP Socket 14 pin	MAX489	1
DIP Socket 8 pin	NE555,TC4482	2
Diode 1N914	D1	1
Diode Shottky 1N5819	D2	1
Green LED 3mm	TXLED	1
Female socket Hdr 1x16 2.54 mm	NH1	1
Female socket Hdr 1x6 2.54 mm	NH2	1
Female socket Hdr 2x4 2.54 mm	POWERBUS	1
Male pin hdr 1x4 2.54 mm	GND,LEDCOM	1
Male pin hdr 1x16 2.54 mm	IO1,IO2	2
Male pin hdr 1x4 Right Angle 2.54 mm	I2C	1
5 pos Screw Terminal 3.5 mm	RS485IN/OUT	1
5 pos Screw Terminal 3.5 mm	RS485IN/OUT	1
Male pin hdr 1x5 2.54 mm Molex KK	RS485IN	1
Male pin hdr 1x5 2.54 mm Molex KK	RS485OUT	1
4 pos Screw Terminal 2.54 mm	STALLMOTOR	1
4 pos Screw Terminal 2.54 mm	GND,LEDCOM	1
8 pos Screw Terminal 2.54 mm	IO1,IO2	2
SIP 16 machine tool round socket	Option pads	2
DIN RAIL 2.75" 2TK2-12	Mounting	0
	BBLed	
Male pin hdr 1x16,1x6,2x4 2.54 mm	Connect	1

9. ASSEMBLY

- All of the components are through-hole technology with wire leads. A useful tool is a lead bender for forming the leads at 90 degrees for easy insertion into the pad holes. Start with inserting the lower height components.

- Install the IC sockets for U1, U2, and U3. Orient the sockets with pin 1 shown on the silk screen. Low profile sockets should be used to provide clearance for the processor board.

- Bypass Capacitors.
 - Install capacitor C3 (.01uF)
 - Install C4 (.01uF)
 - Install C5 (.01uF)

- AutoRTS Section.
 - Install diode D1 (1N914)
 - Install C2 (.01uF)
 - Install C1, R1. The value depends on line speed. Use the table in the schematic to select the value.

- Transmit Activity LED.
 - Install resistor R5 (470 ohms)
 - Install TX, the transmit activity LED. Pad near TX label is +. Observe the polarity of the component. Long lead on LED is Positive.

- Stall Motor Controller. If the stall motor controller is not needed, skip these steps.
 - Install R2 (1000 ohms)
 - Install R3, R4 (100 ohms)
 - Install C6 (.01uF)
 - Install the electrolytic capacitor C7 (10uf). Observe the polarity of the component using the silkscreen marking of plus and minus.
 - Install diode D2 (1N5819)

- Arduino I/O header and power connector. Install the two tall SIP headers and 2x4 power connector. The pads are offset to hold the headers in place while soldering. Insure the headers are vertical and tight to the PCB.

- Select which RS-485/CMRINet connection scheme you want to use. The .100" pads will accept screw terminal or male header pins. The 3.5mm spaced pads are intended for screw terminal blocks, which accept #24 wire. The .156" Molex male pins mate to a standard Molex female header.

I2C I/O Expander. Install the four pin, right angle connector for I2C I/O expander bus.

Stall Motor Terminals. Insert either screw terminal blocks or header pins for connections to a stall motor.

Input/Output Port Connections. Depending upon the connection scheme, .100" screw terminals, header pins, or other interconnect hardware can be inserted into the pad area.

Logic Common. Two sets of pads are available for ground and common connections to LED's. A solder jumper pad allows the selection of Sourcing (common anode) or Sinking (common cathode) to the LEDCOM header. The board defaults to sourcing (common anode). If sinking desired, cut the bridge trace and apply solder across between the center pad and the pad marked CC.

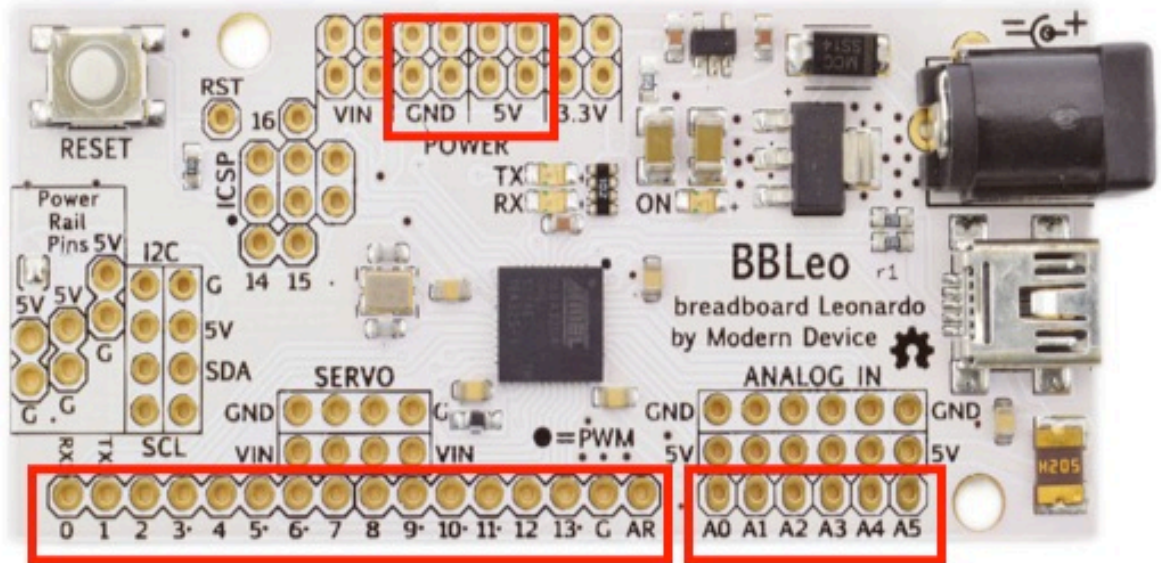
Solder Pad Options. For each data ports, D4-D13 and A0-A5, there is a solder jumper pad and two through-hole component pads. They are intended to be used to configure the electrical path between the I/O pin on the processor board and the physical device connection.

The default circuit path is unconnected; one option must be chosen to complete the circuit. For a straight through connection, bridge the gap with a small amount of solder. Alternatively, a wire jumper can be connected using the through-hole pads.

Current limiting resistors for LEDs can be inserted into the through-hole pads. The solder pads will accommodate surface mount technology (SMT) resistors.

Single inline package (SIP) machine tool pins can be installed to provide flexible re-configuration scenarios.

10. BBLEO INTERCONNECT HEADER PIN ASSEMBLY



cpNode header pin locations shown in Red outlines.

Insert the short end of the male header from the bottom, solder on the top side. The long end of the header faces down and mates with the tall female header on the cpNode motherboard.

Figure 5 BBLeo/cpNode Interconnect