WILSONVILLE ROBOTICS

FRC TEam 1425 “Error Code Xero”

CartBot CONTROL SYSTEM

31 May 2017 10:42

# Issues/TBD

1. line fuse rating
2. motor breaker rating
3. control system fuse/breaker rating
4. is there a minimum length of time in POWER ON (disabled and joystick released) before going to READY?
5. warning messages in POWER ON if deadman switch and/or joystick aren’t released? Or perhaps a new UNSAFE state that’s distinct from POWER ON because it doesn’t show credits?
6. Is there a minimum length of time in READY (with joystick released) before going to ENABLED?
7. power-on screen message (team and/or individual credits?)
8. add electrical schematics/specifications
9. verify the chassis and control panel connector types
10. document the chassis-to-control panel cable pinout
11. calibrate and document the joystick-to-motor controller curves
12. verify joystick X/Y axes and motor controller L/R connections
13. Check the battery low-voltage thresholds for reasonable behavior under load. We don’t want unnecessary “charge required” faults but we also want to protect the battery.
14. Check the battery voltage bar graph scaling and adjust spec/code as needed for best utility.
15. Disable the backlight to conserve power when CartBot has been in POWER ON state for more than 3 (TBD) minutes or when the battery voltage is dangerously low (below 10.0V (TBD))
16. Are there other types of faults that we could reasonably detect?

# Chassis

## Connectors

* IEC 320 C5 power inlet with detachable cord, charger
* Anderson Power Products SB50, red, battery
* cable with molded D9M connector, control panel

## Fuses/Breakers

* 110V fuse holder (3AG 3A) for charger power
* 2 40A snap-action breakers (internal) for motors
* 1 3A fuse (internal) for control system

## Indicators

* charger power (green)
* charger charging (red)
* decorative lighting?

# Control Panel

## Connectors

* D9F connector, chassis cable

## Controls

* main power switch
* 2 motor enable (deadman) switches, wired in parallel
* Joystick, X-Y analog, spring return to center

## Indicators

* 4-line x 20-character LCD display, LED backlight, white-on-blue
* speaker/buzzer?
* decorative lighting?

# Operating STATES

There are 6 defined operating states: POWER OFF, CHARGING, POWER ON, READY, ENABLED and BATTERY FAULT. Conditions and outputs for each state are described below.

For safety, software shall not allow transitions to the ENABLED state when the joystick is not centered.



## Power OFF

### conditions

* charger power disconnected
* main power switch OFF

### outputs

* charger power indicator OFF
* charger active indicator OFF
* Arduino power OFF
* motor controller power OFF
* 4x20 display blank, backlight OFF

Power off

## Charging

### conditions

* charger power connected
* main power switch may be ON or OFF

### outputs

* charger power indicator ON
* charger active indicator OFF, FLASHING or ON (depending on battery charge status)
* Arduino power OFF
* motor controller power OFF
* 4x20 display blank, backlight OFF

Charging

## Power ON

### conditions

* charger power disconnected
* main power switch ON
* battery voltage > 10.5V

### outputs

* charger power indicator OFF
* charger active indicator OFF
* Arduino power ON
* motor controller power OFF
* display backlight ON
* display rows 1-3 show credits (text TBD; scrolling?)
* display row 3 changes to “Low Battery” warning when the battery voltage is less than 11.2V
* display row 4 shows battery voltage bar graph, 10.5V..12.4V with 10.5, 11.0, 11.5, 12.0 distinguished as shown

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Power on, full charge (≥12.4V)

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Power on, 11.8V

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 Low Battery   
|••••

Power on, low battery (10.8V)

## READY

### conditions

* charger power disconnected
* main power switch ON
* both safety switches RELEASED
* joystick at NEUTRAL
* battery voltage > 10.5V

### outputs

* charger power indicator OFF
* charger active indicator OFF
* Arduino power ON
* motor controller power ON
* motors STOPPED
* display backlight ON
* display row 1 shows “READY”
* display rows 2-3 blank
* display row 3 changes to “Low Battery” warning when the battery voltage is less than 11.2V
* display row 4 shows battery voltage bar graph, 10.5V..12.4V with 10.5, 11.0, 11.5, 12.0 distinguished as shown

READY   
   
   
|••••|••••|••••|••••

Enabled, not moving, full charge (≥12.4V)

READY   
   
   
|••••|••••|•••

Enabled, not moving, 11.8V

READY   
   
 Low Battery   
|••••

Enabled, not moving, low battery (10.8V)

## ENABLED

### conditions

* charger power disconnected
* main power switch ON
* either one or both safety switches PRESSED
* battery voltage > 10.5V

Once CartBot has entered the ENABLED state, it shall not return directly to the READY state.

### outputs

* charger power indicator OFF
* charger active indicator OFF
* Arduino power ON
* motor controller power ON
* motors MOVING as directed by joystick

Motion isn’t linear! Only forward motion has a “fast” speed. Reverse and turn-only motions are limited to “slow” speed. Actual speeds TBD.

* display rows 1-2 show direction and speed
* display row 3 blank
* display row 3 changes to “Low Battery” warning when the battery voltage is less than 11.2V
* display row 4 shows battery voltage bar graph, 10.5V..12.4V with 10.5, 11.0, 11.5, 12.0 distinguished as shown

These pictures are approximations; the display should use the HD74480 A02 arrow characters rather than the ASCII characters shown here.

^   
   
|••••|••••|•••

Moving forward slowly

^   
 ^   
   
|••••|••••|•••

Moving forward faster

^ >   
 ^   
   
|••••|••••|•••

Moving forward and turning right

> >   
   
|••••|••••|•••

Turning in place

V   
   
|••••|••••|•••

Moving backward

^   
 Low Battery   
|••••

Moving forward slowly, low battery (10.8V)

## BATTERY FAULT

### conditions

* charger power disconnected
* main power switch ON
* battery voltage 10.5V

### outputs

* charger power indicator OFF
* charger active indicator OFF
* Arduino power ON
* motor controller power ON
* motors STOPPED
* display backlight ON
* display row 1 shows “DISABLED”
* display row 2 blank
* display row 3 shows “Charge Now”
* display row 4 shows battery voltage bar graph, 10.5V..12.4V with 10.5, 11.0, 11.5, 12.0 distinguished as shown (in this state, the row will be blank or showing just the 10.5V marker)

DISABLED   
   
 Charge Now   
|

Power on, battery fault ( 10.5V)

# battery voltage - Analog to digital conversion

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **divider top** |  | 10000 |  |  |  |
| **divider bottom** | | 4700 |  |  |  |
| **Vref (Vcc)** |  | 5.00 |  |  |  |
|  |  |  |  |  |  |
|  |  | **Vin** | **Vdiv** | **AnalogRead** | **scaled** |
| **Vmin** |  | 10.50 | 3.36 | 686 | 0 |
| **Vmax** |  | 12.50 | 4.00 | 817 | 20 |
|  |  |  |  |  |  |
|  |  | 10.40 | 3.33 | 680 | -1 |
|  |  | 10.50 | 3.36 | 686 | 0 |
|  |  | 10.60 | 3.39 | 693 | 1 |
|  |  | 10.70 | 3.42 | 699 | 1 |
|  |  | 10.80 | 3.45 | 706 | 3 |
|  |  | 10.90 | 3.49 | 713 | 4 |
|  |  | 11.00 | 3.52 | 719 | 5 |
|  |  | 11.10 | 3.55 | 726 | 6 |
|  |  | 11.20 | 3.58 | 732 | 7 |
|  |  | 11.30 | 3.61 | 739 | 8 |
|  |  | 11.40 | 3.64 | 745 | 9 |
|  |  | 11.50 | 3.68 | 752 | 10 |
|  |  | 11.60 | 3.71 | 758 | 10 |
|  |  | 11.70 | 3.74 | 765 | 12 |
|  |  | 11.80 | 3.77 | 771 | 12 |
|  |  | 11.90 | 3.80 | 778 | 14 |
|  |  | 12.00 | 3.84 | 784 | 14 |
|  |  | 12.10 | 3.87 | 791 | 16 |
|  |  | 12.20 | 3.90 | 798 | 17 |
|  |  | 12.30 | 3.93 | 804 | 18 |
|  |  | 12.40 | 3.96 | 811 | 19 |
|  |  | 12.50 | 4.00 | 817 | 20 |
|  |  | 12.60 | 4.03 | 824 | 21 |
|  |  | 12.70 | 4.06 | 830 | 21 |
|  |  | 12.80 | 4.09 | 837 | 23 |
|  |  | 12.90 | 4.12 | 843 | 23 |
|  |  | 13.00 | 4.16 | 850 | 25 |
|  |  | 13.10 | 4.19 | 856 | 25 |
|  |  | 13.20 | 4.22 | 863 | 27 |
|  |  | 13.30 | 4.25 | 870 | 28 |
|  |  | 13.40 | 4.28 | 876 | 29 |
|  |  | 13.50 | 4.32 | 883 | 30 |
|  |  | 13.60 | 4.35 | 889 | 30 |
|  |  | 13.70 | 4.38 | 896 | 32 |
|  |  | 13.80 | 4.41 | 902 | 32 |
|  |  | 13.90 | 4.44 | 909 | 34 |
|  |  | 14.00 | 4.48 | 915 | 34 |
|  |  | 14.10 | 4.51 | 922 | 36 |
|  |  | 14.20 | 4.54 | 928 | 36 |
|  |  | 14.30 | 4.57 | 935 | 38 |
|  |  | 14.40 | 4.60 | 941 | 38 |