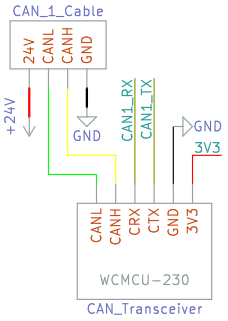
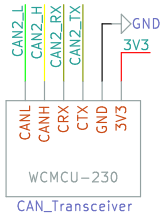
CAN Cable IN From Jugglebot (CAN 1)

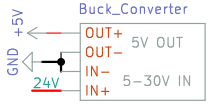


Note: CAN1 is shared with Jugglebot. CAN2 is Ball Butler internal CAN bus.

Ball Butler Internal CAN Bus (CAN 2)

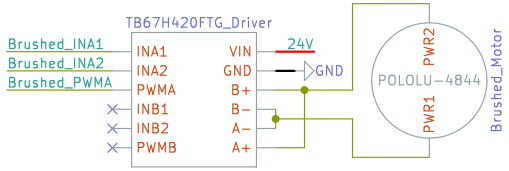


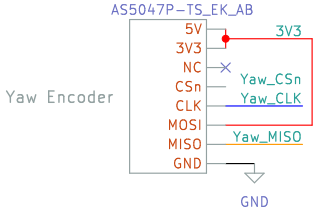
24V to 5V Buck Converter



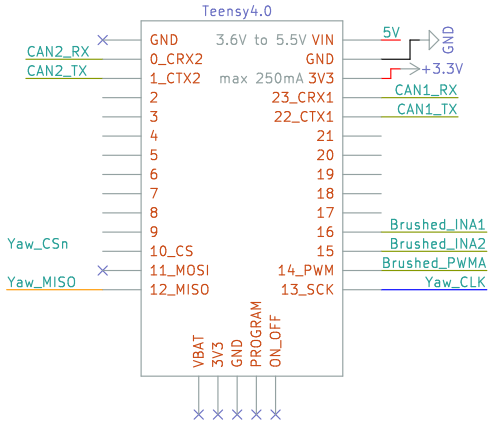
Connect Power Rails

Yaw Axis (Stage 1)





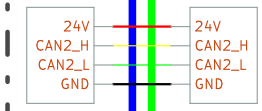
Ball Butler "Brain"



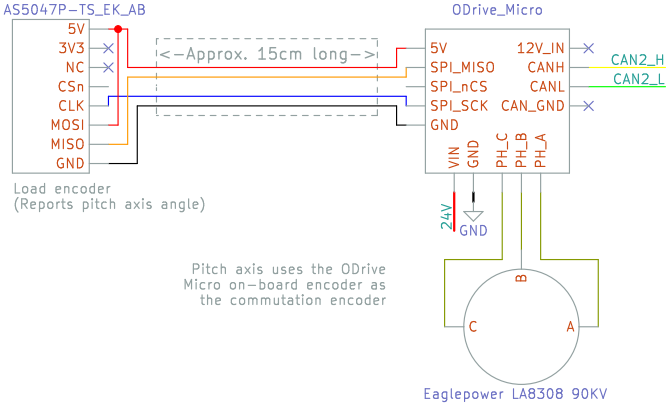
3V3 out powers:
- CAN Transceivers
- Yaw Encoder??

(Should be, but appears to be powered from 5V from pics?)

SLIP RING



Pitch Axis (Stage 2)

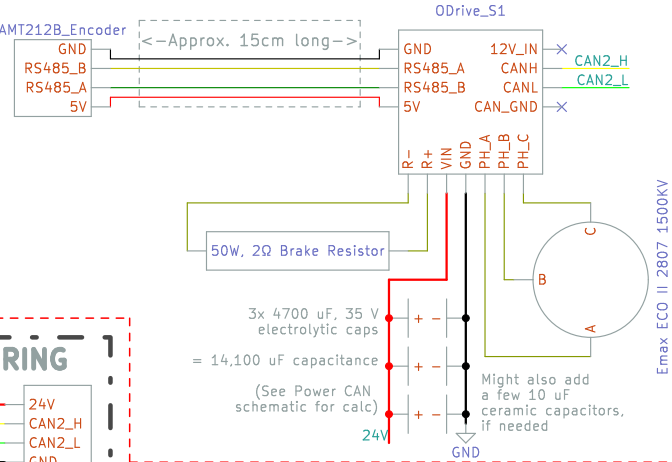


Load encoder (Reports pitch axis angle)

Pitch axis uses the ODrive Micro on-board encoder as the commutation encoder

Eaglepower LA8308 90KV

Throw Axis (Stage 3)



INSIDE THE BASE

ABOVE THE BASE

CAD Model

Select and Press "d" to be taken to the latest CAD model

Programming Logic

File: programming_logic.kicad_sch

Power and CAN Schematic

File: Power and CAN.kicad_sch

Sheet: /
File: ball_butler_circuit_diagram.kicad_sch

Title: Ball Butler Schematic

Size: A4	Date: 2025-09-04	**Rev: 2**
KiCad E.D.A. kicad (6.0.9)		Id: 1/3

CAN1 Frames

Throw Command (To Ball Butler)

Frame Start	<---- Arbitration ----> (bits)											CAN Stuff	<--- Data ---> (bytes)								CAN Stuff	Frame End
	10	9	8	7	6	5	4	3	2	1	0		7	6	5	4	3	2	1	0		
	Command ID							Throw Num					t		z		y		x			

Command ID = 0X7D0
Throw Num indexes as a rolling sequence
(0-31. Loops back to 0 on overflow).

(x, y, z, t) describe the landing/target state of the ball.
x, y, z are 0.1 mm/LSB, giving a maximum value of ~6.5 m
t is 1 ms/LSB, giving a maximum time of ~1.09 min

Throw Feedback (To Jugglebot)

Frame Start	<---- Arbitration ----> (bits)											CAN Stuff	<--- Data ---> (bytes)								CAN Stuff	Frame End
	10	9	8	7	6	5	4	3	2	1	0		7	6	5	4	3	2	1	0		
	Command ID							Throw Num					CRC16		v_z		v_y		v_x			

Command ID = 0X7D1
Throw Num reports back the commanded Throw Number

(v_x, v_y, v_z) describe the landing state of the ball
and allows Jugglebot to orient itself correctly.
These values are 0.2 mm/LSB, giving a max value of ~13.1 m/s

Checksum:
CRC16 (int16) requires CRC-16/CCITT-FALSE over `Throw Command` data (bytes 0-7)
[Allows Jugglebot to confirm catch vel pairing with throw command]

Ball Butler Pose (From Jetson)

Frame A

Frame Start	<---- Arbitration ----> (bits)											CAN Stuff	<--- Data ---> (bytes)								CAN Stuff	Frame End
	10	9	8	7	6	5	4	3	2	1	0		7	6	5	4	3	2	1	0		
	Command ID							–					CRC16		z		y		x			

Frame B

Frame Start	<---- Arbitration ----> (bits)											CAN Stuff	<--- Data ---> (bytes)								CAN Stuff	Frame End
	10	9	8	7	6	5	4	3	2	1	0		7	6	5	4	3	2	1	0		
	Command ID							–					q3		q2		q1		q0			

Pose data to be sent from Jetson at 1-10 Hz

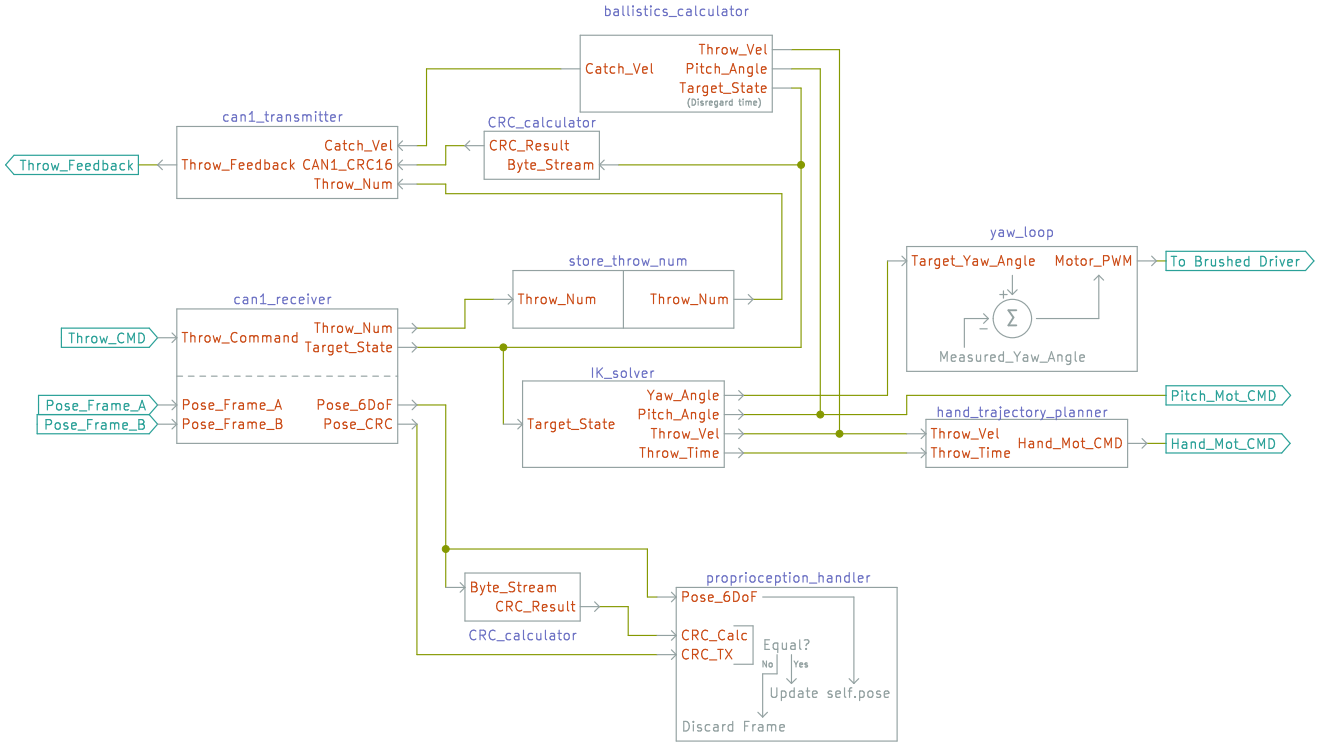
Command IDs:
Frame A = 0x7D2
Frame B = 0x7D3

(x, y, z, q0 .. q4) describes the current pose of the 'Base Box Lid'.

Position:
x, y, z (all int16) are scaled by 0.1 mm, giving a maximum value of ~6.5 m

Orientation:
q0 .. q4 (all int16) describe the orientation to approx 0.005°

Checksum:
CRC16 (int16) requires CRC-16/CCITT-FALSE over Frame A bytes 0-5 + Frame B bytes 0-7
[Ensures the correct pair of frames is matched]



CAN2 Notes

Pitch Motor Command

Pitch Motor Node ID = 1

"Set_Input_Pos" (0x0C) for Pitch ODrive (Micro)
Vel_FF and Torque_FF = 0

Hand Motor Command

Hand Motor Node ID = 2

"Set_Input_Pos" (0x0C) for Hand ODrive (S1)
Input_Pos, Vel_FF and Torque_FF as calculated by planner

To Add/Think About

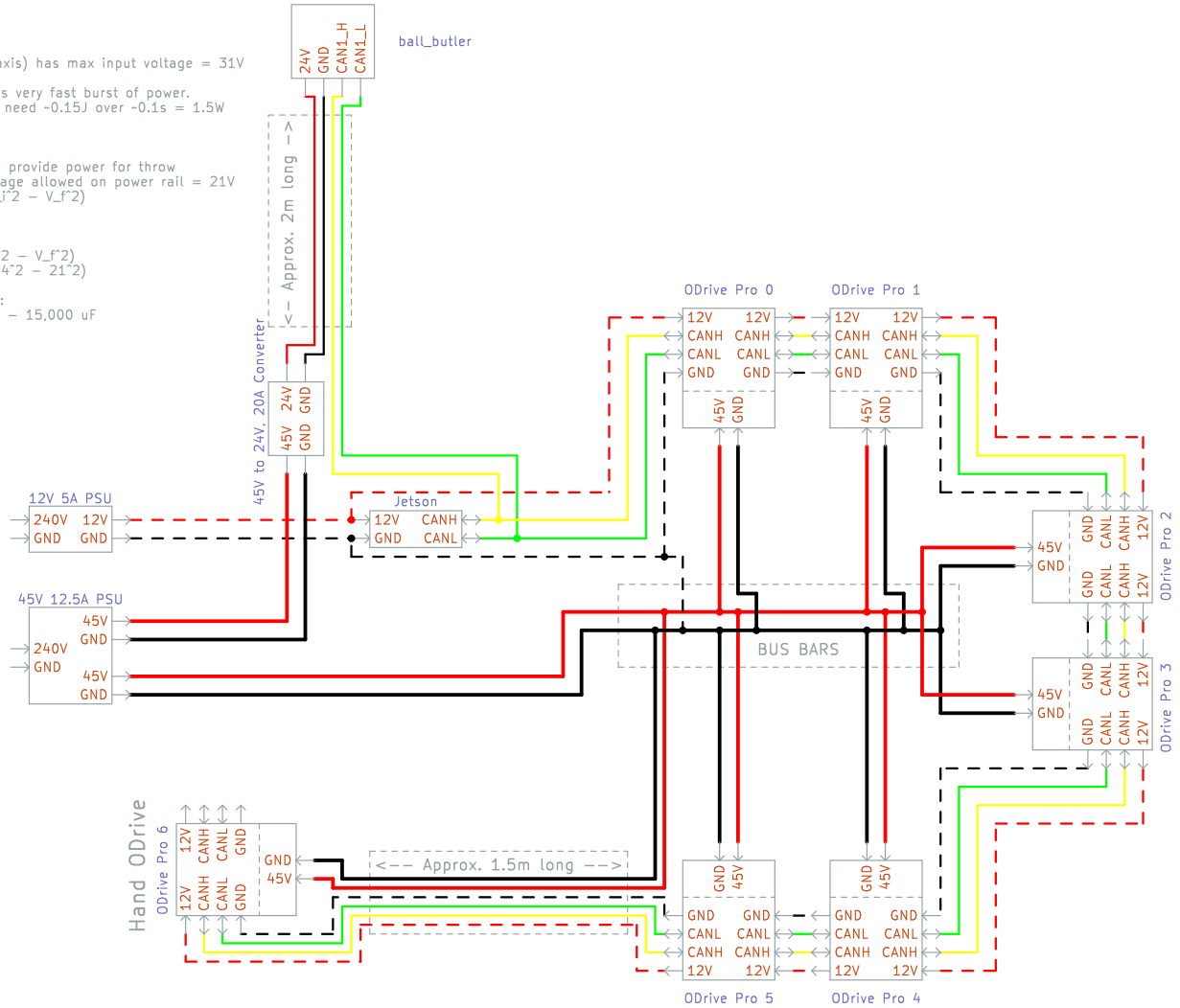
- ODrive Error handling?

Sheet: /Programming Logic/		
File: programming_logic.kicad_sch		
Title: Programming Logic		
Size: A4	Date: 2025-09-04	**Rev: 2**
KiCad E.D.A. kicad (6.0.9)		Id: 2/3

ODrive Micro (BB pitch axis) has max input voltage = 31V

Hand motor (S1) requires very fast burst of power.
From simulation, should need ~0.15J over ~0.1s = 1.5W

Solution:
- 45V to 24V converter
- Capacitors near S1 to provide power for throw
  - Say minimum voltage allowed on power rail = 21V
  - E = 0.5 * C * (V_i^2 - V_f^2)
    - V_i = 24 V
    - V_f = 21 V
    - E = 0.15 J
  - C = 2 * E / (V_i^2 - V_f^2)
    = 2 * 0.15 / (24^2 - 21^2)
    = 2222 uF
  - Allow ~5x margin:
    - C = 10,000 - 15,000 uF



Sheet: /Power and CAN Schematic/
File: Power and CAN.kicad_sch

Title: Power CAN Wiring

Size: A4	Date: 2025-09-04	**Rev: 2**
KiCad E.D.A. kicad (6.0.9)		Id: 3/3