

# Wiring Guide

Two power rails. One computer. This guide shows what connects to what, and in what order.

MABEL · 59 DOF mobile bimanual platform · Jetson Thor compute

## PRIMARY RAIL

# 24 V

Compute, both arms,  
neck yaw, lift

## SECONDARY RAIL

# 12 V

Base, hands, boards,  
neck servos

## LINKS TO THOR

# 7

Ports in use, carrying  
15 devices

## What is in here

Pages 2 and 3 are power. Pages 4 and 5 are data. Page 6 is the order to power everything up.

Read both diagrams left to right. The box on the left is the source. Everything to the right of it is fed by it.

## What the colours mean



Colour shows the rail, not the part. Orange is 24 V. Teal is 12 V. A dashed grey box is wired but not used in the standard build.

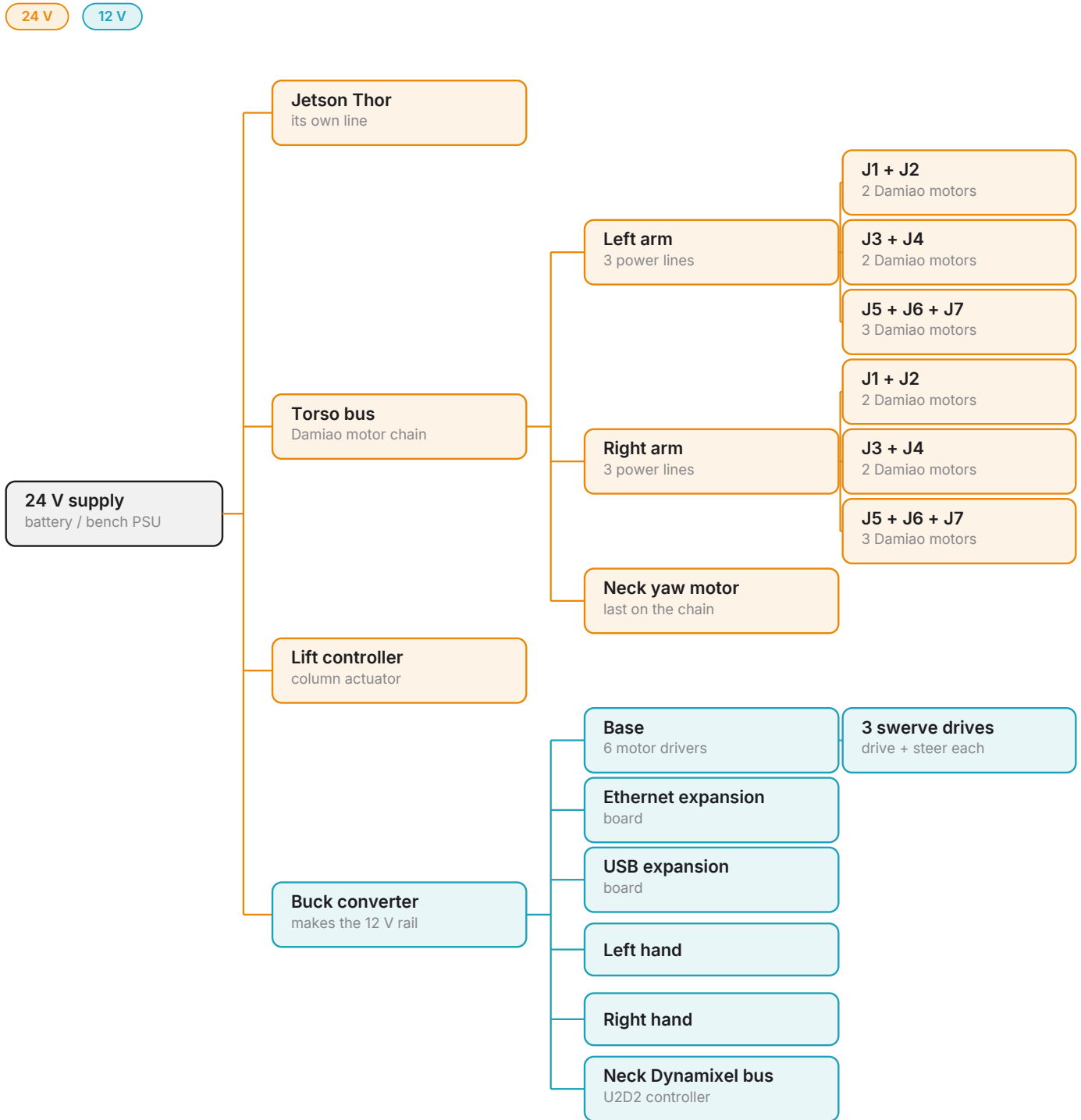
## What is not in here

CAN and serial signal wiring. Those share the same looms but need their own document.

Fuse ratings and wire gauge. Measure the stall current on your own build first.

# Power

One supply. Four branches leave it. One of them makes the 12 V rail.



Each arm gets three power lines, one per group of joints. If a connector works loose, you lose one group instead of the whole arm. The neck yaw motor is a Damiao motor, so it sits at the end of the same 24 V chain. The other two neck joints are Dynamixels and run on 12 V.

# What each line feeds

Every load, and where it taps in.

| LOAD                                   | RAIL    | TAPS FROM      | NOTES                                                |
|----------------------------------------|---------|----------------|------------------------------------------------------|
| <b>24 V — straight from the supply</b> |         |                |                                                      |
| Jetson Thor                            | 24 V    | Supply         | Its own line. Motor spikes must not reach it.        |
| Torso bus                              | 24 V    | Supply         | Feeds both arms and the neck yaw motor.              |
| Arms — J1 + J2                         | 24 V    | Torso bus      | Shoulder pair. One line per arm.                     |
| Arms — J3 + J4                         | 24 V    | Torso bus      | Mid-arm pair. One line per arm.                      |
| Arms — J5 + J6 + J7                    | 24 V    | Torso bus      | Forearm and wrist. One line per arm.                 |
| Neck yaw motor                         | 24 V    | Torso bus      | Last stop on the chain.                              |
| Lift controller                        | 24 V    | Supply         | Its own line. Biggest current spike on the robot.    |
| Buck converter                         | 24 V in | Supply         | Makes the 12 V rail.                                 |
| <b>12 V — from the buck converter</b>  |         |                |                                                      |
| Base motor drivers                     | 12 V    | Buck converter | Six drivers. Two per swerve module.                  |
| Ethernet expansion board               | 12 V    | Buck converter | Also carries both Teensies.                          |
| USB expansion board                    | 12 V    | Buck converter | Ten devices. Never run it bus-powered.               |
| Left hand                              | 12 V    | Buck converter | Power only. Data goes over USB.                      |
| Right hand                             | 12 V    | Buck converter | Power only. Data goes over USB.                      |
| Neck Dynamixel bus                     | 12 V    | Buck converter | 12 V on the servo bus. The U2D2 is powered over USB. |

## Two rules

### Never share a run back to the supply.

Thor, the lift controller and the torso bus each get their own pair. A few extra metres of cable removes a whole class of fault that is hard to find later.

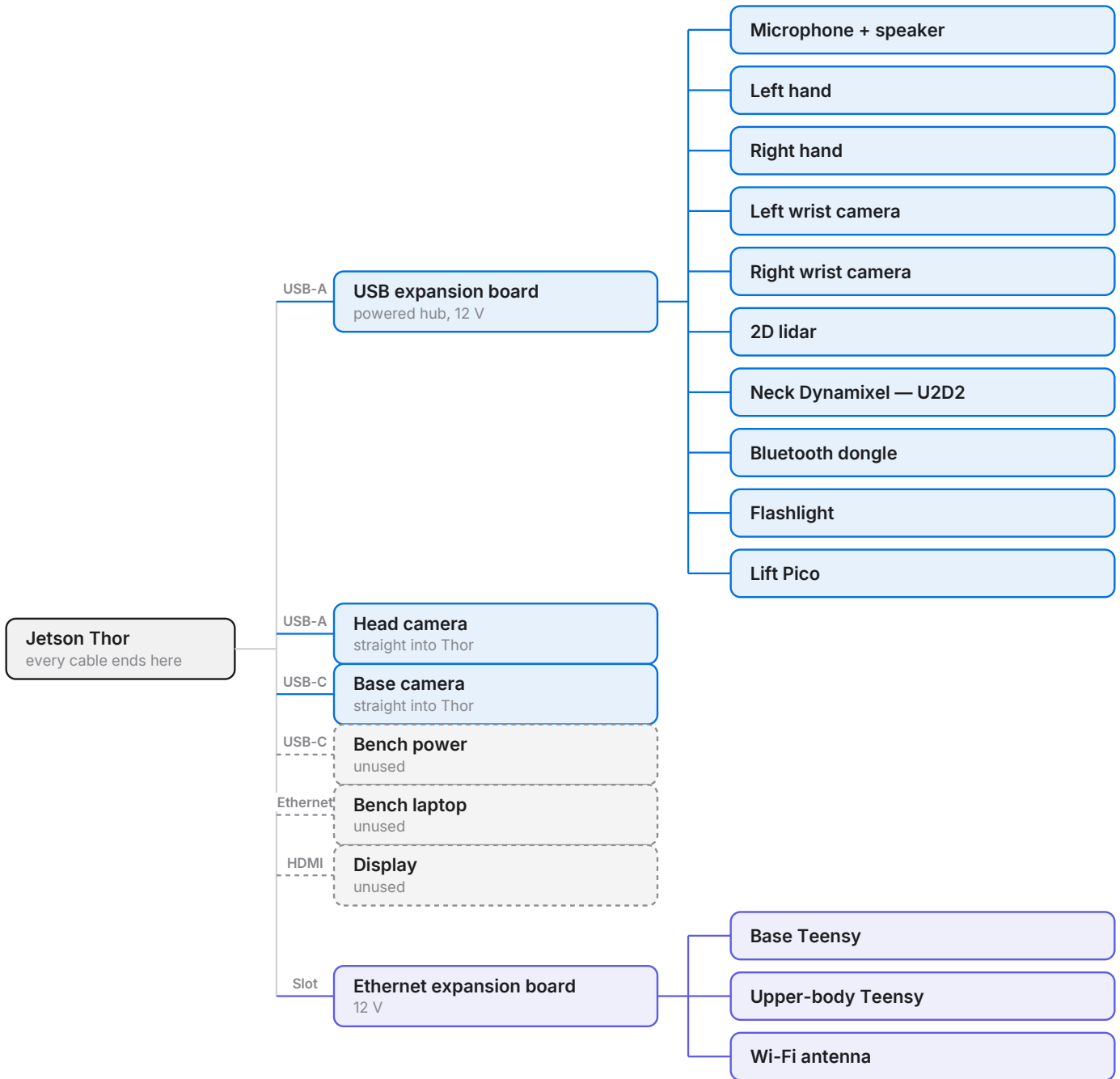
### The buck converter is a single point of failure.

Everything on 12 V depends on it. If the hands, the base and the USB tree all go dark at once, check it first.

# Data

Every cable ends at Thor. Seven links leave it.

USB Slot Unused



The port name sits on each line. The head and base cameras go straight into Thor because they need the bandwidth. Everything on the hub is either slow or a single wrist stream. Dashed grey links are wired but not used.

# Where each cable goes

Find the port, find the device.

| PORT                                   | GOES TO                  | NOTES                                             |
|----------------------------------------|--------------------------|---------------------------------------------------|
| <b>On Thor</b>                         |                          |                                                   |
| <b>USB-A — port 1</b>                  | USB expansion board      | The hub, and the ten devices on it.               |
| <b>USB-A — port 2</b>                  | Head camera              | Direct, to keep it off the hub.                   |
| <b>USB-C — port 1</b>                  | Base camera              | Needs USB 3. Keep it off the hub.                 |
| <b>USB-C — port 2</b>                  | Bench power              | Unused. Spare input if you run Thor on the bench. |
| <b>Ethernet</b>                        | Bench laptop             | Unused. For testing one subsystem at a time.      |
| <b>HDMI</b>                            | Display                  | Unused. For bring-up and recovery.                |
| <b>Expansion slot</b>                  | Ethernet expansion board | Both Teensies and the antenna.                    |
| <b>On the USB expansion board</b>      |                          |                                                   |
| <b>Audio</b>                           | Microphone + speaker     | Mic and speaker on one device.                    |
| <b>Hands</b>                           | Left hand, right hand    | Data only. Power comes from 12 V.                 |
| <b>Wrist cameras</b>                   | Left, right              | The two biggest streams on the hub.               |
| <b>Lidar</b>                           | 2D lidar                 | Serial over USB.                                  |
| <b>Neck servos</b>                     | U2D2 controller          | Signal path to the Dynamixels.                    |
| <b>Bluetooth</b>                       | Mouse dongle             | Operator input during bring-up.                   |
| <b>Flashlight</b>                      | Flashlight               | Lights the scene for the wrist cameras.           |
| <b>Lift</b>                            | Lift Pico                | Serial link to the lift board.                    |
| <b>On the Ethernet expansion board</b> |                          |                                                   |
| <b>Base Teensy</b>                     | Base                     | Runs the swerve drives.                           |
| <b>Upper-body Teensy</b>               | Torso, arms, neck        | Runs the upper body.                              |
| <b>Wi-Fi antenna</b>                   | Network                  | Teleoperation and logging.                        |

## Label both ends of every cable before you power up.

Ten black cables into one hub all look the same. Bind the cameras and the lidar to udev rules by serial number, because the port order changes on every reboot.

# Power it up in this order

Work outward from the supply. Check each level before you add the next.

- 1 Start with nothing connected**  
Turn on the 24 V supply. Leave Thor, the torso bus, the lift controller and the buck converter unplugged. Check the voltage at the terminals.
- 2 Add Thor and the lift controller**  
These are the two dedicated 24 V lines. Let Thor boot all the way. If the supply sags now, it will sag worse later.
- 3 Add the buck converter, with nothing on it**  
Check for 12 V at its output before you plug anything into it.
- 4 Add the arms, one line at a time**  
J1 + J2, then J3 + J4, then J5 + J6 + J7. Left arm first. Each group should hold position before you add the next one. The neck yaw motor goes last.
- 5 Add the base**  
Six drivers, three swerve modules. Keep the wheels off the ground until the control loop is working.
- 6 Add the USB hub**  
Start with the lift Pico and the audio device. Check they appear. Then add the hands, the lidar and the U2D2. Wrist cameras last.
- 7 Add the head and base cameras**  
Straight into Thor, not the hub. If a camera appears but will not stream, the problem is bandwidth.
- 8 Add the expansion slot**  
Check that both Teensies and the antenna appear before you hand over to the autonomy stack.

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## If something is dead

### WHAT YOU SEE

### WHAT TO CHECK

Hands, base and USB tree, all at once

The buck converter.

One group of joints on one arm

The connector on that line.

Every Damiao motor, neck yaw included

The torso bus.

One USB device, after a reboot

Port order, not wiring.