Each box is one circuit. Read left to right, top to bottom. The label on a pin is its net.

Power entry

J2 — 2P30 battery 4S
BAT_IN → BAT_FUSED: F1
Q1_GATE → VBUS: Q1 BZT52C12
VBUS → GND: R1 10k
VBUS_Q1_GATE → Q1_GATE: Q1 BZT52C12
VBUS → GND: D2
GND_VBUS → GND: C1 220u 35V
VBUS → GND: C2 100n 50V

Logic rails

VSYS → +5V: D3 SS34
+5V → GND: C3 22u 10V
+5V → +3V3: U6 AP2112K-3.3
+5V → GND: C4 1u
+3V3 → GND: C5 1u
+3V3 → +1V8: U7 AP2112K-1.8
+1V8 → GND: C6 1u
+3V3 → LED_PWR: R2 1k
GND → LED_PWR: D1 Green
+5V → GND: C60 1u
+3V3 → GND: C59 1u

Motor supply switch

VM_GATE → VBUS_S: SW1
VBUS → VM_GATE: R9 100k
VBUS → VM_GATE: Q6 BZT52C12
VM_GATE → M_DRIVE: R10 47k
VM_GATE → GND: C52 10n 50V
ESTOP_RUN → M_DRIVE: Q4 BSS138
GND → ESTOP_RUN: R11 100k

Accessory power outputs (VBUS eFuse, 5 V switch)

GND → VBUS_EXT: J24
VBUS → ACC_OVP: R63 887k 1%
VBUS → ACC_OVP: C76 1u 50V X7R
VBUS → ACC_OVDT: R64 56.2k 1%
VBUS → ACC_OVDT: C77 47n
VBUS → ACC_ILIM: R65 7.15k 1%
VBUS → VBUS_EXT: C78 100n 50V
U16 eFuse: VBUS_EXT → GND: R15
VBUS_EXT → ACC_ESTOP: R14
+3V3 → ACC_ESTOP: R66 10k
ESTOP_RUN → ACC_ESTOP: R67 47k
ACC_SHDN → GND: C81 10n
GND → VS_EXT: J26
+5V → VS_EXT: U17 TPS2553DRVR
VS_EXT → ACC_NFLT: R16
ACC_ILIM → GND: R68 49.9k 1%
+5V → GND: C79 1u
VS_EXT → GND: C80 1u
+3V3 → LED_ACC: R69 470
ACC_NFLT → LED_ACC: D5

Wheel drivers

U8 DRV8313
MOT_EN 26, MI_IN1 27, MI_IN2 25, MI_EN 24, MI_IN3 23, DRV_NSLEEP 17, DRV_NRESET 16, DRV_NFAULT 18
VM 4, VMOT 11, GND 14, 20, 28, 6, 7, 10, 5, 8, 9, 1, 2, 3, 15, 29
UB_CPL: C35 10n 50V → GND
UB_VCP: C36 100n 25V → GND
UB_V3P3: C37 470n 10V → GND
UB_VMOTH: C38 100n 50V → GND
UB_VMOT: C39 100n 50V → GND
UB_VMOT: C40 10u 50V → GND
MI_OUT1 1, MI_OUT2 2, MI_OUT3 3: J2
+3V3 → DRV_NFAULT: R15 10k

U9 DRV8313
MOT_EN 26, MI_IN1 27, MI_EN 24, MI_IN2 25, MI_IN3 23, DRV_NSLEEP 17, DRV_NRESET 16, DRV_NFAULT 18
VM 4, VMOT 11, GND 14, 20, 28, 6, 7, 10, 5, 8, 9, 1, 2, 3, 15, 29
U9_CPL: C41 10n 50V → GND
U9_VCP: C42 100n 25V → GND
U9_V3P3: C43 470n 10V → GND
U9_VMOTH: C44 100n 50V → GND
U9_VMOT: C45 100n 50V → GND
U9_VMOT: C46 10u 50V → GND
MR_OUT1 1, MR_OUT2 2, MR_OUT3 3: J3
+3V3 → DRV_NSLEEP: R21 100k

Power flags

GND, VBUS, +5V, VSERVO, I2C_VREF2, VMOT

Duo S and level translation

J8 ↔ J9 (Duo S)
MR_IN3, CS_KNEE_R, CS_ROTOR_R, MR_IN1, MR_IN2, CS_KNEE_L, SPI_MOSI_RAW, SPI_MISO, SPI_SCK_RAW, GND
VSYS, VSYS, GND, CON_TX, CON_RX, MOT_EN_REQ, GND, IMU_INT1, SERVO_R_PWM, GND, SERVO_L_PWM, CS_ROTOR_L, DRV_NFAULT
GND, GND, ESTOP_ARM_1V8, GND, DRV_NSLEEP_1V8, DRV_NRESET_1V8, GND, ML_IN1_1V8, ML_IN2_1V8, ML_IN3_1V8, WDT_KICK_1V8, I2C_SDA_1V8, I2C_SCL_1V8, VSYS
U4 SN74LVC8T245PW
+1V8 → VCCA: C7 100n
+3V3 → VCCB: C8 100n
ML_IN1_1V8 ↔ ML_IN1
ML_IN2_1V8 ↔ ML_IN2
ML_IN3_1V8 ↔ ML_IN3
WDT_KICK_1V8 ↔ WDT_KICK
DRV_NSLEEP_1V8 ↔ DRV_NSLEEP
DRV_NRESET_1V8 ↔ DRV_NRESET
ESTOP_ARM_1V8 ↔ ESTOP_ARM
ML_IN1_1V8 → GND: R22 100k
ML_IN2_1V8 → GND: R23 100k
ML_IN3_1V8 → GND: R24 100k
WDT_KICK_1V8 → GND: R18 100k
DRV_NSLEEP_1V8 → GND: R19 100k
DRV_NRESET_1V8 → GND: R20 100k
ESTOP_ARM_1V8 → GND: R12 100k

Safety

+3V3 → WDT_RCEXT: R3 100k 1%
WDT_RCEXT → WDT_CEXT: C9 100n C0G/X7R
U14 74LVC1G123DCU: WDT_RCEXT, WDT_CEXT, GND, WDT_KICK → WDT_OK
+3V3 → VCC: C10 100n
U15 74LVC1G11DBV: ESTOP_RUN, MOT_EN_REQ, WDT_OK → MOT_EN
+3V3 → VCC: C11 100n
MOT_EN_REQ → GND: R16 100k
MOT_EN → GND: R25 100k
U10 ESTOP_SUPPLY, ESTOP_OK
ESTOP_OK → GND: R17 10k
+3V3 → ESTOP_SUPPLY: R59 1k
ESTOP_SUPPLY → ESTOP_OK: D4
+3V3 → GND: C53 100n
ESTOP_OK → ESTOP_CLEAR: R60 10k
+3V3 → GND: C58 100n
U12 ESTOP_CLEAR, MOT_EN_REQ, ESTOP_ARM, ESTOP_RUN
U13 +3V3, GND, ESTOP_CLEAR

I2C, IMU and rail monitor

+3V3 → I2C_VREF2: R4 100k
+1V8 → I2C_VREF2: C12 100n
U1 PCA9306DCU: VREF1, VREF2, EN, SCL1, SDA1, SCL2, SDA2, GND
I2C_SCL_1V8 → SCL1: R5 2.2k
I2C_SDA_1V8 → SDA1: R6 2.2k
+3V3 → SCL2: R7 2.2k
+3V3 → SDA2: R8 2.2k
SCL2 → I2C_SCL
SDA2 → I2C_SDA
+3V3 → GND: C13 100n
U7 ADS1115IDGS: ADDR, ALERT/RDY, AIN0, AIN1, AIN2, AIN3, SCL, SDA, GND
ADC_VBAT → AIN0
ADC_VSERVO → AIN1
ADC_VMOT → AIN3
SCL → I2C_SCL
SDA → I2C_SDA
ADDR → GND
VBUS → ADC_VBAT: R30 100k 1%
ADC_VBAT → GND: R31 10k 1%
ADC_VBAT → GND: C14 100n
VSERVO → ADC_VSERVO: R32 47k 1%
ADC_VSERVO → GND: R33 10k 1%
ADC_VSERVO → GND: C15 100n
+5V → ADC_V5: R34 47k 1%
ADC_V5 → GND: R35 10k 1%
ADC_V5 → GND: C16 100n
VMOT → ADC_VMOT: R51 100k 1%
ADC_VMOT → GND: R52 10k 1%
ADC_VMOT → GND: C54 100n

5 V buck

U11 TPS62933DRLR
VBUS → VIN: R36 442k 1%
VBUS → VIN: C19 10u 50V X7R
BK5_EN → EN: R37 90.9k 1%
VBUS → VIN: C20 10u 50V X7R
BK5_RT → RT: R38 43k 1%
VBUS → VIN: C50 100n 50V
BK5_BOOT → BOOT: C21 0.1u 25V
BK5_SW → SW: BK5_SW
BK5_SW → L1
BK5_FB → FB: R39 57.6k 1%
BK5_FB → GND: R40 10.2k 1%
BK5_COMP → COMP: R41 16.9k 1%
BK5_COMP → GND: C26 4700p
BK5_COMP → GND: C25 47p
+5V → VOUT: C22 47u 16V X5R
+5V → VOUT: C23 47u 16V X5R
+5V → VOUT: C24 47u 16V X5R
+5V → GND: C82 47u 16V X5R

6 V buck

U12 TPS62933DRLR
VBUS → VIN: R42 442k 1%
VBUS → VIN: C27 10u 50V X7R
BK6_EN → EN: R43 90.9k 1%
VBUS → VIN: C28 10u 50V X7R
BK6_RT → RT: R44 40.2k 1%
BK6_SW → SW: BK6_SW
BK6_SW → L2
BK6_BOOT → BOOT: C29 100n 25V
BK6_FB → FB: R46 20.0k 1%
BK6_FB → GND: C33 15p C0G
BK6_FF → FF: R47 4.99k 1%
VBUS → VIN: C51 470n 50V X7R
VBUS → VIN: C55 470n 50V X7R
VSERVO → VOUT: C30 47u 16V X5R
VSERVO → VOUT: C31 47u 16V X5R
VSERVO → VOUT: C32 47u 16V X5R
VSERVO → VOUT: C57 47u 16V X5R
VSERVO → VOUT: C83 47u 16V X5R
VSERVO → BK6_EN: R45 100k 1%

SPI connectors and ESD

J5 SPI_SCK, SPI_MISO, SPI_MOSI, CS_ROTOR_L
J6 SPI_SCK, SPI_MISO, SPI_MOSI, CS_ROTOR_R
J7 SPI_SCK, SPI_MISO, SPI_MOSI, CS_KNEE_L
J8 SPI_SCK, SPI_MISO, SPI_MOSI, CS_KNEE_R
U5 +3V3, GND, SPI_SCK, SPI_MISO, SPI_MOSI, CS_ROTOR_L
U6 +3V3, GND, SPI_SCK, SPI_MISO, SPI_MOSI, CS_ROTOR_R
U7 +3V3, GND, SPI_SCK, SPI_MISO, SPI_MOSI, CS_KNEE_L
U8 +3V3, GND, SPI_SCK, SPI_MISO, SPI_MOSI, CS_KNEE_R

I2C display

J23 GND, +3V3, I2C_SDA_EXT, I2C_SCL_EXT
I2C_SDA → I2C_SDA_EXT: R61 33
I2C_SCL → I2C_SCL_EXT: R62 33
I2C_SDA_EXT → GND: C24
I2C_SCL_EXT → GND: C61 100n

SPI terminations

SPI_SCK_RAW → SPI_SCK: R13 33
SPI_MOSI_RAW → SPI_MOSI: R14 33
+3V3 → CS_ROTOR_L: R49 10k
+3V3 → CS_ROTOR_R: R50 10k
+3V3 → CS_KNEE_L: R53 10k
+3V3 → CS_KNEE_R: R54 10k

Return-transfer capacitors

+3V3 → GND: C62 100n
+3V3 → GND: C63 100n
+3V3 → GND: C64 100n
+3V3 → GND: C65 100n
+3V3 → GND: C66 100n
+3V3 → GND: C67 100n
+3V3 → GND: C68 100n
+3V3 → GND: C69 100n
+3V3 → GND: C70 100n
+3V3 → GND: C71 100n
+3V3 → GND: C72 100n
+3V3 → GND: C73 100n
+3V3 → GND: C74 100n
+3V3 → GND: C75 100n

Knee servos

J20 SERVO_L_SIG, VSERVO, GND — PH3240 knee L
SERVO_L_PWM → SERVO_L_SIG: R26 330
SERVO_L_SIG → GND: R28 10k
VSERVO → GND: C17 220u 16V
J21 SERVO_R_SIG, VSERVO, GND — PH3240 knee R
SERVO_R_PWM → SERVO_R_SIG: R27 330
SERVO_R_SIG → GND: R29 10k
VSERVO → GND: C18 220u 16V

Status and test points

MOT_EN → LED_EN: R57 1k
GND → LED_EN: D7
+3V3 → LED_FAULT: R58 1k
DRV_NFAULT → LED_FAULT: D8
TP1 MOT_EN, TP2 MOT_EN, TP3 GND, TP4 GND, TP5 VBUS, TP6 VMOT, TP7 VSERVO, TP8 +5V, TP9 ESTOP_RUN, TP10 DRV_NFAULT, TP11 GND

Mounting holes

H1 M2.5 Duo S standoff
H2 M2.5 Duo S standoff
H5 M2.5 Duo S standoff
H6 M2.5 Duo S standoff
H7 M2.5 Duo S standoff
H8 M2.5 Duo S standoff

Unverified proposal; see hardware/kicad/README.md. Before ordering (1 oz outer + 1 oz inner copper)
Generated by hardware/kicad/generate_carrier.py; edit the script, not this file
Beltlab Robotics
Sheet: /
File: balance_carrier.kicad_sch
***Title: Robotics Board Expansion Milk-V Duo: Milk-V Duo S + DRV8313 x2 + ***
Size: A1 | Date: 2026-11-16 | **Rev: 0.9 all-in-one proposal**
KiCad E.D.A. 10.0.8 | id: 1/1