Smoothieboard V2

Motion controller board datasheet · Prime 2660, Prime 2590 and Core

Open-hardware motion controller for CNC mills, routers, laser cutters and 3D printers.

Order option	PCB revision	Component-side marking	Motion outputs	Expected board ID
Prime · TMC2660	P11	`Proto11`, also `BID1` and `2660`	Four onboard stepper drivers	`01`
Prime · TMC2590	P12	`Proto12`	Four onboard stepper drivers	`00`
Core	P1	`Smoothieboard v2 Core`, `Proto1`, `BID2`	Four step/direction channels on J5	`02`

With Ethernet at left, look for the Prime revision at the right edge or the Core revision below J5. The `version` command reports the board ID and firmware build.

RoboSprout Prime · RoboSprout Core

Prime P11/P12 · Motor supply guidance (p. 3) is 12–24 V DC. Check the separate switched-load feed and Prime contacts (p. 7). Current and thermal limits are open.

Core P1 · The main supply range is open. Check J9 polarity (p. 8), J5 contacts (p. 11) and drive compatibility (p. 12).

Before applying load power

Check	What to confirm
1. Identify the board	Match the marking (p. 2), board ID and fitted connectors. Check assembly errata (p. 16).
2. Check logic only	Keep motors and loads disconnected. Check the logic source (p. 4), rail LEDs (p. 2) and firmware (p. 14). Record `version` and check endstop states with `M119` (p. 9) before homing.
3. Review each load	Check supply and current limits (p. 3) and startup and halt states (p. 13). Obtain a supported rating for the actual assembly and load before energizing any path with an open limit.

Find a specification

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Board specifications

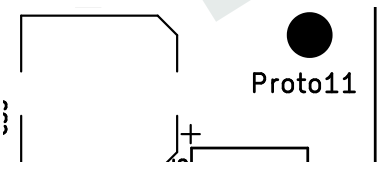
Processor, memory, interfaces and breakout

Feature	Prime 2660, Prime 2590 and Core
Processor · U2	STM32H745xI with dual 32-bit Arm cores
Cortex-M7	400 MHz in the reviewed Prime build. 480 MHz MCU maximum. Double-precision FPU, DSP and 16 KiB each of instruction and data cache.
Cortex-M4	240 MHz MCU maximum. The documented firmware setup boots only the M7.
On-chip RAM	1,056 KiB across system SRAM (864 KiB), instruction TCM (64 KiB) and data TCM (128 KiB), plus 4 KiB of backup SRAM.
Internal flash · U2	2 MiB, two 1 MiB banks. The reviewed firmware links here.
External flash · U4	1 MiB (8 Mbit) AT25SF081 serial NOR on Quad SPI. Can store the optional Prime USB loader.
Total onboard flash	**3 MiB** across two devices. Application firmware uses internal flash. microSD capacity is separate.
Ethernet · J4	One 8P8C (RJ45) jack with integrated magnetics, LAN8720A PHY, 10BASE-T and 100BASE-TX
USB device · J1	USB Type-B, USB 2.0 full speed (12 Mbit/s signaling), onboard device PHY
USB host hardware · J2	USB Type-A with a switched 5 V feed. Reserved in the reviewed firmware.
Removable storage · J3	microSD with four-bit SDMMC and card detect. Configuration, update and job files.
Expansion and debug	Nine Gadgeteer headers with GPIO, SPI, I²C, timer/PWM and analog inputs. SWD and debug serial.
Motion and sensor I/O	Four axes (onboard on Prime, J5 on Core), six endstops, three thermistor terminals and one probe input. Fourth thermistor channel is onboard on Prime and at J5 on Core.
Real-time clock	On-chip clock with external crystal and optional coin-cell holder BT1. Clock and file timestamps (p. 21)

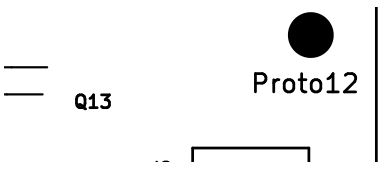
See component and clock sources and the firmware memory map.

Revision marking close-ups

These enlarged component-side silkscreen plots show the revision text beside the right PCB edge. Use the full board views in Appendix A for orientation.



Prime 2660 · P11



Prime 2590 · P12



Core · P1

First-power and host-port notes

Rail indicators. The lower-right row marks `VFET`, `VMOT` and `3.3V` on Prime, and `Vin` and `3.3V` on Core. `Vin` follows Core VFET. The numbered LEDs show firmware status (p. 14).

USB mass storage. With the machine idle, mass storage shows the microSD card and disconnects USB serial. Eject the volume from the host to reboot and restore serial. USB mode handling

Card selection. Use FAT32 microSDHC for setup and firmware updates. The running image enables exFAT, but the SD update loader requires a FAT volume it can read. See update and recovery (p. 14).

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Electrical limits and power

Board conditions, motor current and absolute limits

Electrical operating conditions

VMOT is motor power. VFET is switched-load power. Figures are guidance or nominal values.

Parameter	Applies to	Lower	Nominal	Upper	Basis and conditions
Motor supply at VMOT	Prime	12 V DC	—	24 V DC	Application guidance. The wiki's 4.75 V figure is below the onboard logic converter's startup region and the TMC2660 IC operating range. See power paths (p. 4).
Switched-load supply at VFET	Prime	—	—	24 V DC	Published range ceiling for the loads. Confirm board operating envelope, including transients and load return topology.
Main supply at VFET	Core	—	—	—	Feeds both the switched loads and the onboard regulator. The board supply range remains open.
External logic supply input	All	—	5 V DC	—	Regulated supply at J42. Input tolerance, source current limit and coexistence limits remain open.
Internal logic supply at regulator	All	—	5 V DC	—	The onboard regulator is rated 3 A at component level. Accessory current is open for each power source and ambient condition.
Gadgeteer supply pins	All	—	3.3 V and 5 V DC	—	Shared current-limited rails per CAD. Confirm total and per-connector budgets.

Prime motor-current guidance

Prime variant	Published selection guidance	Qualification still needed
TMC2660	1.2–2.2 A	Published range lacks a current convention and thermal conditions.
TMC2590	2.4–4.6 A	Another published range starts at 2.5 A. Current convention, cooling and simultaneous-axis limits remain open.

Measure J9 current with axes holding and moving. Check startup and deceleration. Power paths (p. 4)

Prime bed output and supply entry

The wiki's 250 W example draws 20.8 A at 12 V, above its approximate 10–12 A figure. Both VFET inlets share one rail. The bed switch and output connector still carry the full current. Do not wire that example directly to the board. Continuous and pulse limits remain open.

24 V load example. A 60 W bed draws 2.50 A. Two 24 W heaters and a 0.25 A fan draw 2.25 A through the shared cutoff. VFET supplies 4.75 A total before inrush. Board current limits remain open.

Component stress limits

Circuit	Pin or device stress	Absolute limit
Prime VMOT	TMC2660 VS or TMC2590 bridge drain–source	30 V upper or 30 V magnitude, respectively
Prime and Core VFET	Heater switch and cutoff drain–source	30 V magnitude
Prime and Core VFET	Cutoff gate–source	±20 V
Main logic feed	AP22814A enable	Local input + 0.3 V

Board limits remain open. **32 V exceeds Core's switched-load device limits.**

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Power trees

Prime and Core supply paths

The power trees show functional paths. Returns, protection and connector limits are specified separately. Use the connector numbering for the corresponding PCB revision.

Prime 2660 and Prime 2590

Motor supply VMOT at J9	→	Motor bus	→	**Four stepper power stages and probe connector J31 contact 1**
VMOT	→	Onboard 5 V regulator and source selection	→	**Board 5 V rail**
Load supply VFET at J12/J16	→	Independent switched bed return	→	**J14 bed output**
VFET	→	Shared high-side cutoff and individual low-side switches	→	**J17–J20 heater and fan outputs**

Core

Main supply VFET at J9	→	Onboard 5 V regulator and source selection	→	**Board 5 V rail**
VFET	→	Shared switch to FET_CUT	→	**J8/J10/J12/J16 positive contacts**
VFET	→	Separate branch	→	**J11 positive contact, with its own low-side switch**

Logic-supply paths and return connections

Path on all three layouts	Circuit and loading implications
Main converter	JP16 bridged disables the converter and switch. Calculated detector release is near 8.1 V. Feedback targets 4.99 V before the switch. Actual switching points and current remain open.
USB device J1	JP17 open interrupts VBUS. JP15 bridged disables the switch. USB data takes a separate path. Firmware advertises 100 mA. Estimated switch trip is 1.45 A.
External 5 V input J42	Feeds board 5 V through a source-selection switch without dedicated regulation or limiting. Numbered contacts (p. 9)
Board 5 V	Feeds J43, Core J5 contacts 1–4, Core J6 contact 1 and the 3.3 V converter. Connect external logic power at J42.
Board 3.3 V	The MT3410L has a nominal 3.34 V target. Core J5 contact 10 is on this rail. J41 contact 1 is the debugger’s voltage reference.
Limited accessory rails	All nine Gadgeteer headers share one limiter per rail. Include endstops and probe bias on the selected rails. The estimated trip is 0.32 A per rail, extrapolated from the MT9700 formula. Usable current remains open.

CAD shows JP15 and JP16 open and JP17 bridged. Confirm fitted states. Check inrush, source transitions and backfeed. J2 uses a separate switch. MT9700 · TPS5430 · AP22814A

Prime J12/J16 share one supply. Use the load connector return, which joins logic ground at NT9. Core J9 returns to ground and J12/J16 are outputs.

Include 3.3 V converter input draw in the 5 V budget. Core drives need separate motor power.

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Sensor inputs and probe

Field inputs, jumper selection and comparator behavior

Sensor inputs

Function	Provision	Complete before release
Endstops	Six filtered inputs with configurable sensor supply and pull-up. Contact and jumper map (p. 9)	Confirm connector thresholds, slow-edge behavior, cable limits and powered-sensor compatibility.
Thermistors	Three buffered external inputs. The fourth input uses an onboard thermistor on Prime and a breakout contact on Core.	Supported sensors, usable range, tolerance and system accuracy.
Probe	Dedicated comparator circuit with jumper-dependent voltage range. Prime connector has a motor-voltage feed in addition to the probe circuit.	Confirm pin order, threshold and hysteresis by jumper position and revision. Published threshold figures differ by documentation revision.
Gadgeteer analog input	Six analog-capable contacts on the two analog expansion headers.	State valid input range, allowed source impedance, reference and any onboard conflicts.

Powered endstops. The 3.3 V 74LCX07 buffer has component input limits of LOW at or below 0.8 V and HIGH at or above 2.0 V. Confirm the fitted board's limits and switching behavior. Use a compatible interface for 12 V or 24 V sensors. The selectable endstop supply is 3.3 V or 5 V. Buffer characteristics

Powered probe integration

Function	Prime P11/P12	Core P1
Probe output	J31 contact 4	J7 contact 1
Probe return	J31 contact 3	J7 contact 2
Probe power	J31 contact 2 offers the limited rail selected by JP8 (1–2 for 5 V, 2–3 for 3.3 V). Contact 1 carries VMOT.	J7 provides signal and return. Provide the sensor's supply separately.
Range jumper, rear side	JP18	JP8
Input bias	Bridging JP7 connects the limited 5 V rail to the signal through a diode and 1 kΩ resistor.	Same JP7 circuit.

Comparator range jumper

Jumper state	Circuit at the signal contact	Ideal rising or falling crossing
Bridged by PCB design	Bypasses one 7.1 kΩ resistor. The divider is 7.1 kΩ series and 1 kΩ to ground.	About 2.9 V
Open	The added 7.1 kΩ remains in series. The divider is 14.2 kΩ series and 1 kΩ to ground.	About 5.5 V

The estimates use nominal resistors and a driven signal, with a 0.36 V comparator reference. A 5 V signal cannot reach the calculated open-jumper crossing. JP7 controls bias only. The published 45 V figure remains unqualified. Confirm fitted jumper states, actual switching and input limits before wiring a probe.

The comparator output goes to PB10 on all three layouts. It goes high above the crossing with the board pull-up and low below it. With the probe module enabled, check the actual idle and triggered reports using `M119`. The Prime CNC sample uses `probe_pin = PB10^`. Probe configuration guide · Comparator data

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Onboard stepper driver specifications

Prime 2660 and Prime 2590 · Component figures and board conditions

See board operating guidance (p. 3) and microstepping and pulse demand (p. 21).

TMC2660 on Prime 2660

Feature	Specification
Board implementation	Four two-phase bipolar stepper channels. Each driver integrates two MOSFET H-bridges.
Prime operating guidance	12–24 V DC at VMOT. Motor current guidance is 1.2–2.2 A per channel.
IC supply voltage	9–29 V operating range. 30 V absolute maximum at the normal supply input.
IC phase current	2.2 A RMS per coil in motion, 2.8 A RMS for 2 s on and 6 s off. Trinamic's 50 cm² example layout at ambient ≤50 °C and chopper ≤40 kHz.
Control and diagnostics interface	STEP/DIR motion inputs, SPI configuration and status
Microstepping	Up to 256 microsteps per full step. MicroPlyer can interpolate a 16-microstep input to 256.
Current regulation	SpreadCycle chopper with programmable slew rate
Load sensing and adaptive current	StallGuard2 sensorless load and stall detection. CoolStep adjusts motor current with load.
IC protection and diagnostics	Overcurrent, short to ground, overtemperature and undervoltage

TMC2590 on Prime 2590

Feature	Specification
Board implementation	Four bipolar axes. Each uses four Si4542DY dual MOSFET packages in the P12 layout.
Prime operating guidance	12–24 V DC at VMOT. Motor current guidance is 2.4–4.6 A per channel. Additional cooling may be needed.
IC and bridge limits	TMC2590 IC operates at 5–60 V. The Si4542DY bridge has 30 V MOSFET stress limits. Board voltage margin and phase current require testing.
Control and diagnostics interface	STEP/DIR motion inputs, SPI configuration and status
Microstepping	Up to 256 microsteps per full step. MicroPlyer can interpolate a 16-microstep input to 256.
Current regulation	SpreadCycle chopper, differential current sensing and programmable gate drive
Load sensing and adaptive current	StallGuard2 sensorless load and stall detection. CoolStep adjusts motor current with load.
IC protection and diagnostics	Short to ground, short to supply, overcurrent, overtemperature and undervoltage

Setting motor current on Prime

The reviewed firmware treats `[current control]` values and `M907` as **amperes peak per phase** on both drivers. `M906` takes milliamperes peak. The driver diagnostic derives an RMS value as peak × 0.707 for a sinusoidal phase-current reference.

Command readback gives the requested value. Driver diagnostics calculate from the programmed current scale and configured sense resistor. Verify the fitted resistor, driver profile and measured phase current. Use the separate motor-enable controls to disable the driver. Current control code

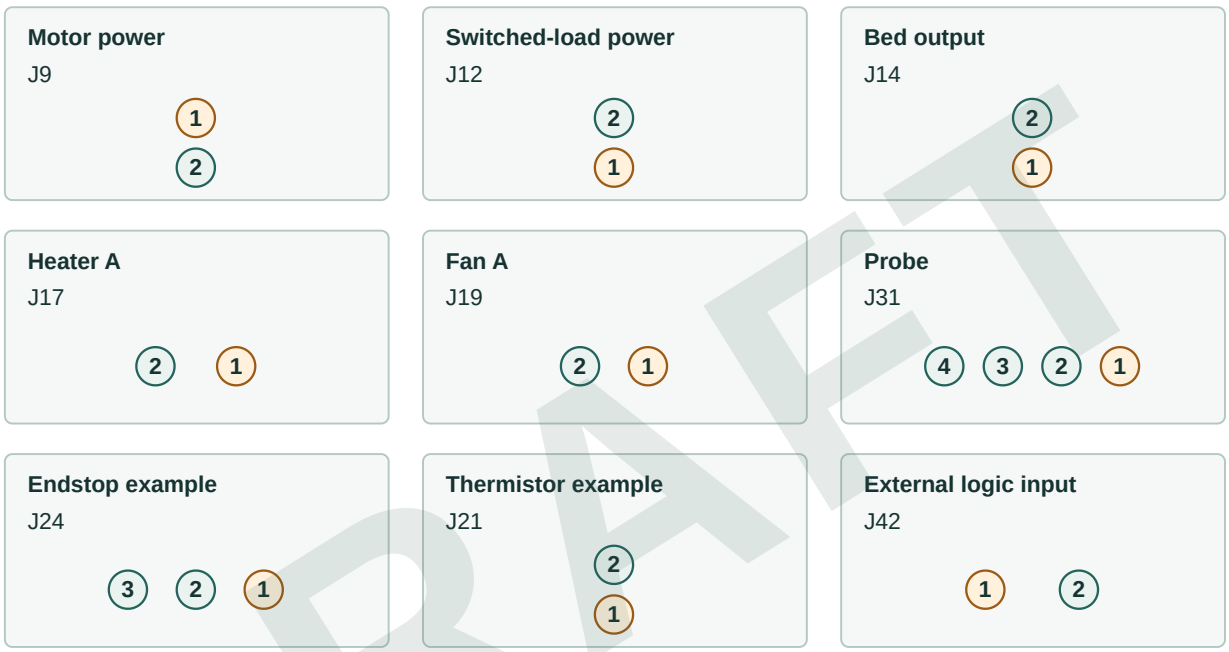
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Prime connector details

Prime 2660 and Prime 2590 · Numbered contact views and net assignments

Component-side connector diagrams identify the board geometry. Left and right refer to the board drawings with USB at left. The numbered schematic contact is authoritative when a footprint has alternate pads. Verify fitted parts and polarity before connecting power.

COMPONENT SIDE · USB CONNECTORS TO THE LEFT · NOT TO SCALE



Connector	Contact 1	Contact 2	Contact 3	Contact 4	Mating/implementation note
J5–J8, motors	Coil B2	Coil B1	Coil A2	Coil A1	J5 `alpha` (X), J6 `beta` (Y), J7 `gamma` (Z), J8 `delta` (A). Confirm the fitted connector and profile.
J9, motor input	VMOT	Ground	—	—	XT30 layout. J10 is an alternate footprint on the same nets.
J12/J16, load input	VFET	Load return	—	—	XT30 layouts. J11 is an alternate footprint on the same nets.
J14, bed	VFET	Switched return	—	—	XT30 layout. J13 is an alternate footprint on the same nets.
J17/J18, heaters	From shared cutoff	Switched return	—	—	Heater footprint options are assembly dependent.
J19/J20, fans	From shared cutoff	Switched return	—	—	Molex KK 2.54 mm footprint.
J31, probe	VMOT	Jumper-selected 5 V or 3.3 V limited rail	Ground	Probe comparator input	Molex KK 2.54 mm footprint. The supply-select bridge is JP8. JP18 changes the input comparator network.

Four-wire motor check. With power removed, identify the two winding pairs on the disconnected motor by resistance or from its wiring drawing. Connect one pair to 1–2 and the other to 3–4. Verify current before jogging.

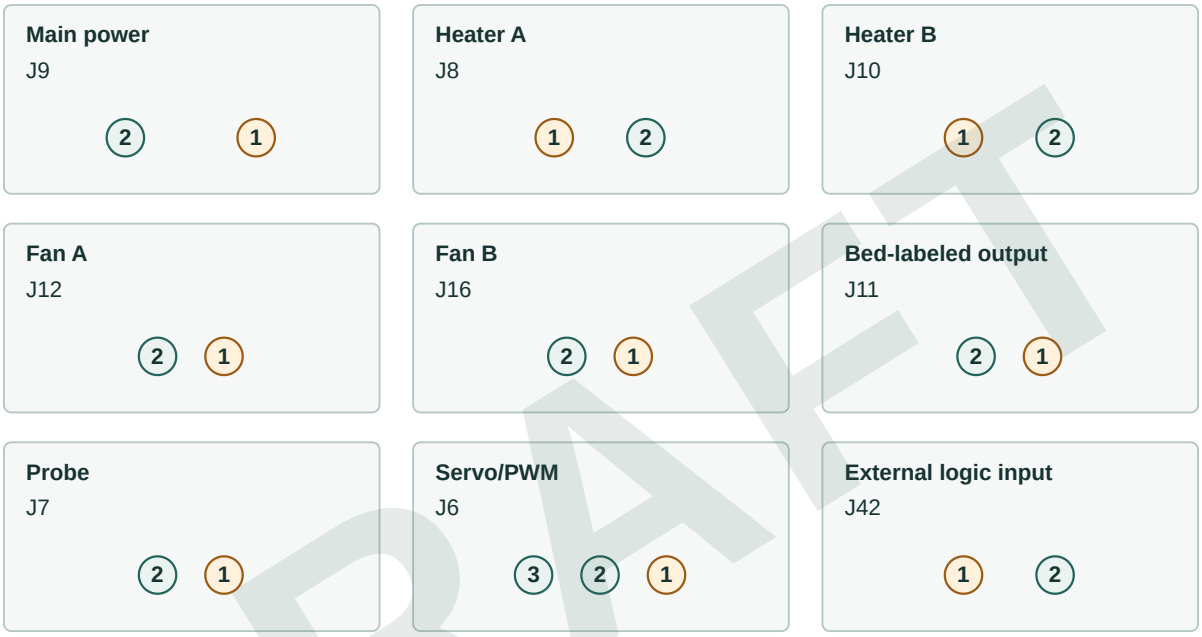
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Core connector details

Core P1 · Main input, output and probe orientation

Check J9 before applying power. With USB on the left as drawn, left contact 2 is ground and right contact 1 is VFET. On the disconnected board, confirm ground continuity and check the mating cable polarity separately. Errata (p. 16)

COMPONENT SIDE · USB CONNECTORS TO THE LEFT · NOT TO SCALE



Connector	Contact 1	Contact 2	Contact 3	CAD implementation
J9, main supply	VFET	Ground	—	XT30 footprint. PCB polarity marks are reversed. See the check below.
J8/J10, heater circuits	From shared cutoff	Switched return	—	3.50 mm blocks. Positive is left here and right at J11/J12/J16, as drawn.
J12/J16, fan circuits	From shared cutoff	Switched return	—	Molex KK 2.54 mm footprints. Circuit ratings are open.
J11, bed-labeled output	VFET	Switched return	—	Molex KK 2.54 mm footprint with its own low-side circuit.
J7, probe	Comparator input	Ground	—	Molex KK 2.54 mm. JP8 changes the comparator network on Core.
J6, servo/PWM	Shared board 5 V	Ground	Inverted PWM, 5 V pull-up	Molex KK 2.54 mm. Q6 inverts GC 6 (`PWM2_1`). Check pulse polarity, reset state and 5 V load.

Core switched-output limits

Q4 and Q5/Q8 have 30 V drain-to-source stress limits. A connected heater can bring its off-state return to nearly VFET. On Prime and Core, the cutoff gate drive is nominally −16.4 V at 24 V and −21.8 V at 32 V, against a ±20 V gate limit. Cutoff MOSFET · Heater MOSFET

J11 bypasses Q4. Its return and the fans use 2N7002 transistors. Only the heater returns have ground clamps. Verify suppression of positive turn-off spikes with the intended load and cable.

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Shared field terminals

Thermistors, endstops, auxiliary power and control signals

Connector	Numbered contacts	Firmware or electrical notes
J21–J23, thermistors	1 sensor node, 2 ground	Buffered inputs on Prime and Core. See the channel map below.
J24–J29, endstops	1 selected supply, 2 ground, 3 filtered signal	X−/X+/Y−/Y+/Z−/Z+ reach PD0/PI3/PI1/PA9/PI0/PH15 via a buffer.
J42, external logic input	1 regulated 5 V in, 2 ground	3.50 mm terminal block footprint. Use a current-limited source. See power paths (p. 4).
J43, 5 V output	1 5 V rail out, 2 ground	3.50 mm terminal block footprint. Available current depends on the active source and board load.
J30, serial debug	1 ground, 2 board RX (PD6), 3 board TX (PD5)	3.3 V logic. See the debug UART settings (p. 14).
J44/J45, relay control	1 switched 5 V, 2 ground	See the relay drive and load limits (p. 13).

Thermistor channel assignments

Channel	Sensor connection	Processor pin and firmware alias
T1	J21	PF11 · `ADC1_1`
T2	J22	PF12 · `ADC1_2`
T3	J23	PB0 · `ADC1_3`
T4	Prime onboard TH1. Core J5 contact 40, with sensor return to board ground.	PA0_C · `ADC1_0`

Connect a passive thermistor between the sensor node and ground. J21–J23 use a nominal 4.7 kΩ pull-up to 3.3 V, a 1 µF filter capacitor and a unity-gain buffer powered by 5 V. Match the sensor curve. With heater power isolated, a 4.7 kΩ test resistor at J21–J23 gives 1.65 V and about 111 °C with the fallback curve. `M105` reports an invalid infinite result as −100 °C. Heater fault behavior (p. 13) · Thermistor configuration

Dry-contact endstop example

X-min on Prime P11/P12 and Core P1

Board contact	Switch terminal
J24 contact 2, ground	COM (common)
J24 contact 3, filtered signal	NC (normally closed)
J24 contact 1, selected supply	Leave unconnected at the switch

Rear jumpers for J24–J29, in order. JP1–JP6 select the contact 1 rail. CAD bridges 1–2 for 5 V. Pads 2–3 select 3.3 V. JP9–JP14 are bridged in CAD and pull the signal up through 10 kΩ. Each input has a 100 nF capacitor and a 1 kΩ series resistor into the 74LCX07. Verify the fitted bridges with power removed. Jumper locations and pad nets (CSV)

X-min example. With JP9 closed and JP1 on a powered rail, set `minx.pin = PD0^` in `[endstops]`. The `^` pulls up the controller side of the open-drain buffer. With drive power isolated, use `M119` to check 0 at rest and 1 when pressed. On Core, check the approved profile before enabling homing. Prime CNC sample · Endstop guide

See the board renderings for USB, Ethernet and microSD locations and the contact inventory for footprints.

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Expansion and debug contacts

Gadgeteer pin assignments, firmware functions and shared signals

Gadgeteer contact 1 is the shared current-limited 3.3 V rail, contact 2 is the shared current-limited 5 V rail and contact 10 is ground. The processor pin assignments below apply to Prime P11/P12 and Core P1. Use 3.3 V signaling and check the circuit before assigning a shared contact.

Header	Connector	3	4	5	6	7	8	9
GA	J32	PJ6	PJ9	PJ10	PJ11	PE6	PE5	PE12
GB	J33	PD9	PB9	PH14	PK0	PK1	PH8	PA8
GC	J34	PD14	PD12	PD10	PI5	PI6	PI7	PI2
GD	J35	PE7†	PD8	PB11	PE9†	PE11	PE13	PE14
GE	J36	PE8†	PJ7	PJ8	PD15	PB5	PA6	PA5†
GF	J37	PB1†	PJ4	PA4†	PG0	PJ3	PG1†	PJ2
GG	J38	PH2	PH4	PC0	PF15	PH3	PF0	PF1
GH	J39	PC3	PA3	PC2	PF2	PI10	PH7	PB12
GI	J40	PF10	PF6	PF4	PI8	PE4	PI9	PC13

† **3.3 V-only processor pin (ST class TT).** Use 3.3 V signaling on unmarked contacts as well. The 5 V supply contact powers accessories. For 5 V digital peripherals, use an interface that provides 3.3 V signaling at the board and accounts for either side being off. STM32 pin definitions and limits

Contacts	Function or shared connection, in contact order
GA 7–9	Motor SPI controller out, controller in, clock. Shared with the four Prime drivers or Core J5. GA 7 and 8 are reversed in the linked firmware pinout.
GB 4–5, GD 4–5	Serial TX/RX pairs via 100 Ω series resistors. Firmware pinout labels them UART1 and UART0 respectively.
GB 8–9, GG 8–9	I²C3 and I²C2 respectively, SDA then SCL. Each line has a 1 kΩ pull-up to board 3.3 V.
GC 6–9, GD 6–9	PWM2_1–4 and PWM1_1–4 respectively. Each timer shares one frequency. The servo example uses GC 6. Core J6 inverts that signal.
GA 5, GE 5; GE 7–9	Quadrature channels A and B. GE 7–9 are expansion SPI controller out, controller in and clock.
GH 3–5, GI 3–5	Unbuffered analog inputs with individual protection diodes. See the contact and firmware map below.

Debug J41 (2 × 5, 1.27 mm). 1: 3.3 V reference, 2: SWDIO, 4: SWCLK, 6: SWO, 7: key position, 8: TDI, 10: reset. Contacts 3, 5 and 9 are ground.

Reviewed firmware pinout · Reviewed PCB layouts

Expansion analog inputs

Contact	GH · J39	GI · J40
3	PC3 · ADC1_5 · D21	PF10 · ADC3_1 · D16
4	PA3 · ADC1_6 · D20	PF6 · ADC3_3 · D17
5	PC2 · ADC1_4 · D19	PF4 · ADC3_4 · D18

Use 3.3 V signaling and contact 10 as the return. The usable measurement range and source impedance remain open. See the clamp erratum (p. 16).

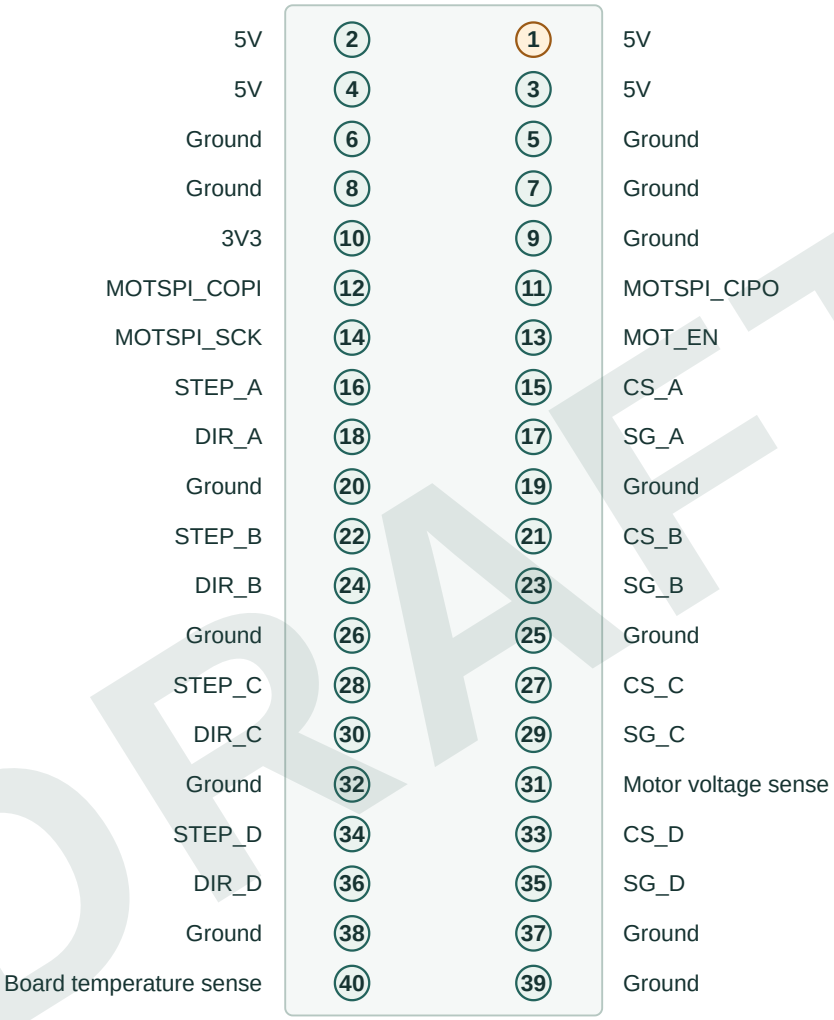
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Core external driver socket

Core P1 · All 40 contacts from the PCB layout

COMPONENT SIDE · USB CONNECTORS TO THE LEFT · CORE DRIVER SOCKET J5

The lower contact numbers are nearest the top edge of the board.



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Core motor-voltage sense

J5 power contacts carry logic rails. Supply the driver separately. Contact 31 is a sensing input. Verify the component-side JP18 before connecting a sense lead.

Core JP18 bridge	J5 contact 31 to PH5	Breakout requirement
1–2 · CAD default	100 kΩ / 10 kΩ divider, followed by 1 kΩ. Nominal scale factor 11.	Confirm the fitted bridge and approved voltage range, including transients.
2–3 · direct ADC path	Direct to PH5, with a nominal 11 kΩ path to ground through R60 and R62.	Provide an externally conditioned ADC-level signal. Do not apply motor voltage in this mode. Match the firmware scale to the external divider.

The reviewed Prime build defaults `vmotor` to `ADC3_5` with scale 11. Check the configured reading with `get volts vmotor` and a meter before applying drive power. J5 contact 40 is the separate thermistor input (p. 9). Firmware voltage monitor

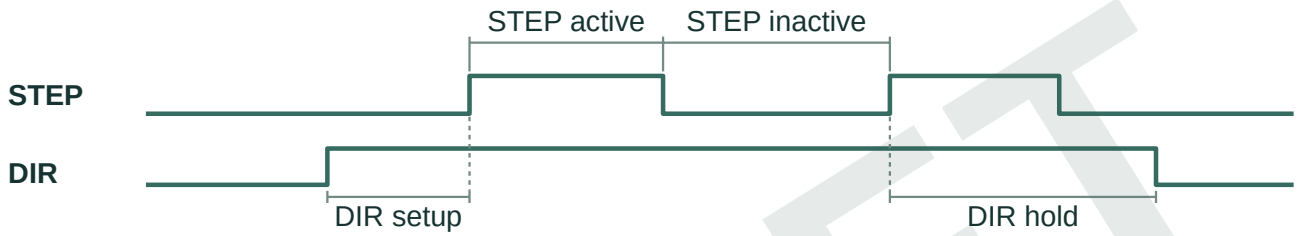
External logic and motion timing

Core driver and Gadgeteer interface behavior

STEP/DIR timing at the drive input

The reviewed firmware defaults to a 200 kHz step timer (5 µs nominal tick), or 50 kHz in debug builds. `step_pulse_us` sets the delay of a separate timer armed after asserting STEP. Its 1 µs default does not specify the connector pulse width. Firmware can write DIR and assert STEP in the same tick. Timer configuration · Step generation

Measure pulse widths, DIR setup and hold, and enable-to-first-step time at the drive input. The supported rate under simultaneous axis load remains open. See pulse demand (p. 21).



Illustrative rising-edge timing. Use the edge and thresholds specified by the drive.

Core external-drive interface example

Core P1 socket J5 carries four STEP and DIR pairs and a shared enable. These are direct 3.3 V processor signals. The breakout must provide any required level conversion, line drive, isolation and reset bias.

Core group and actuator	STEP contact and pin	DIR contact and pin	Ground contacts
A · `alpha`	16 · PD3	18 · PD4	19, 20
B · `beta`	22 · PK2	24 · PG2	25, 26
C · `gamma`	28 · PG3	30 · PG4	32
D · `delta`	34 · PC6	36 · PG5	37–39

Contact 13 is shared enable (PH13). Use the listed returns for compatible single-ended signals and supply the drive separately. Before applying drive power, confirm the external driver profile (p. 14), enable polarity and reset bias. Check terminal states (p. 13) and timing at the receiver.

Example receiver	Requirements at the receiver
TI DRV8825 IC	2.2 V minimum high. STEP needs at least 1.9 µs high and low. DIR setup and hold each need 650 ns. Check bias and timing on the actual carrier.
Leadshine DM556E hardware v2.0	Isolated inputs require a 5 V or 24 V interface matched to S2. Pulse width is at least 2.5 µs and DIR setup at least 5 µs. Direct J5 signaling falls below the receiver's high threshold.

Reading expansion analog inputs

The six GH/GI inputs are unbuffered. Source resistance and clamp leakage can shift the level at the contact. Check source and contact voltages separately. Expansion pin map · Clamp erratum (p. 16)

The thermistor module accepts `ADC1` aliases only. GH lacks a thermistor pull-up. On GI, set `sensor = ADC3_1,1.0` under `[voltage monitor]` and use `get volts sensor` to read contact 3. The reading assumes a 3.3 V reference. `get volts vref` estimates the actual reference separately. The 16-bit conversion format does not specify board accuracy. ADC1 code · ADC3 code

DRAFT

Startup, halt and recovery

Output states, motion and load interfaces

All three layouts share these control paths. Firmware behavior below assumes the reviewed Prime defaults. Confirm the installed image and profile, especially when driving Core J5.

Control path	Circuit and default bias	Reviewed firmware behavior
Bed, heaters, fans and relays	A pull-up disables the U9 buffer when 5 V is present and PF14 is released. The bed positive contact still receives VFET.	Firmware enables U9 during configuration. HALT releases PF14 and disables buffered gate drive.
Shared heater and fan supply	A pull-down biases PD7 off. This cutoff feeds both heaters and both fans.	Firmware drives PD7 high to enable the shared supply and low on HALT.
Motor enable	PH13 goes to the active-low inputs of the Prime drivers or to Core J5 contact 13. The PCB layouts show no pull resistor on this net.	HALT deasserts the configured global enable, disables each actuator and stops motion.
Heater and switch modules	Temperature control clears the heat target and commands its heater off on HALT.	Digital and sigma-delta switches honor `halt_set_to` unless excluded. Hardware PWM writes its stored duty value.

Hold and halt. Feed hold pauses motion. In the v1.0.12 source, `!` and `~` can act inside a received line. Later reviewed source requires the first character. HALT disables global enables. `M999`, `$X` or a configured button action can reassert them. Resolve the fault and re-home before resuming.

Machine stop. The optional firmware button is polled. If HALT is cleared with a locking button still held, the firmware rechecks it on a later poll. Use independent machine emergency-stop and energy isolation. See button settings (p. 14).

Thermistor faults. With a heater target above 2 °C, an infinite or out-of-range reading clears the target and commands the heater off. A separate 1 Hz check broadcasts HALT. Measure open/short readings and shutoff time on the board. Firmware

Startup · Motion halt · Switch halt · Console · M999

Motion and loads

Interface	Features	Electrical fields to release
Prime onboard stepper outputs	Four bipolar stepper channels. Both driver chips support up to 1/256 microstepping, SpreadCycle, StallGuard2 and CoolStep.	Continuous and peak phase current, RMS or peak convention, current-setting accuracy, airflow derating and concurrent axes. Validate firmware support and tuning for each advanced mode.
Core driver breakout	Four step/direction, chip-select and driver diagnostic groups, shared enable and SPI, power and sense connections.	Logic thresholds, drive current, enabled state, step pulse width and direction setup/hold times.
Prime bed output	Two parallel low-side MOSFETs. J14 positive stays connected to VFET.	Continuous and pulse current, duty cycle, connector temperature and allowable load type.
Prime heater/fan outputs	Four low-side switches share one high-side cutoff. The diodes connect from load ground to the switched returns.	Per-channel and total load, switching conditions and external suppression for inductive loads.
Core switched outputs	Heaters use power MOSFETs. Fans and bed-labeled J11 use 2N7002 transistors.	Evaluate each path separately. Core output circuit (p. 8)
Relay-control outputs	J44 (SSR1, PI4) and J45 (SSR2, PB7) switch board 5 V onto contact 1. Contact 2 is ground. A low processor output turns the switch on when U9 is enabled.	Check current budget and loaded on/off levels. See relay input selection (p. 17).

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Firmware and configuration

Supported features, update method and assembly-specific baseline

Firmware and host interfaces

Interface	Documented behavior or status
Configuration	Put `config.ini` at the microSD root and check the startup UART log.
USB device J1	One CDC serial interface by default, with an optional second. The `msc` command switches to SD mass storage if enabled. Mode and card notes (p. 2)
Debug serial J30	Reviewed Prime firmware uses 115200 baud, 8 data bits, no parity, 1 stop bit and no flow control. For startup logs, connect board TX to a 3.3 V logic adapter RX and join grounds. UART source
USB host J2	Reserved in the reviewed firmware.
Ethernet J4	Networking is off by default. Before enabling it, check the profile's HTTP, FTP and plain TCP shell settings. Use the local `net` command to read the active IPv4 address. Network settings (p. 25)
Expansion and debug	Firmware support depends on bus, pin assignment and module. The debug connector exposes the processor debug signals.

Update and recovery

With load power isolated, back up `config.ini` and save the approved image as `flashme.bin` at the FAT32 card root. Run `flash` from the idle console, or reboot with `[system] flash_on_boot` enabled and valid startup. Keep logic power on. Prime download · Release v1.0.12

After reboot, use the log and `version` to confirm the build. The loader can rename the file to `flashme.old` even after a write failure. Verify the profile before restoring load power. If the image will not start, use STM32 BOOT0 USB or SWD service recovery. Service instructions · Loader source

Optional USB update loader. Prime runs this loader from serial flash and writes to a 1,920 KiB internal region. `dfu_enable` defaults to off. Verify loader and image compatibility. Setup · Program area

Firmware applicability

Firmware item	Status
Identify the running image	`version` reports build target, build, board ID, clock and step-ticker frequency. Compare the board ID with the assembly marking on p. 2.
Prime driver selection	Both Prime variants use the Prime target. Axes X through A default to TMC2660 for ID `01` or TMC2590 otherwise. Each actuator's `driver` setting can override the default.
Core external STEP/DIR	Core straps give ID `02`. A Prime-target image still defaults to TMC2590. With an approved image and STEP/DIR profile, check `driver = external` per actuator and shared enable polarity at J5.
Choose the correct example	Check the installed build before applying newer sample settings. The reviewed source has no separate Core build target. `external-drivers.ini` uses Gadgeteer GF. For Core use the J5 map (p. 11) and a profile for the fitted drive.

Prime status LEDs. Startup lights 4 → 3 → 2 → 1. LED 1 flashes at console idle. LED 2 indicates a queued move and flashes on halt. Both flash on configuration errors. Check the serial log. Firmware

Firmware button. `[kill button]` is disabled in the reviewed CNC and 3D printing profiles. When enabled, the module checks for a logical low at 5 Hz. Its `unkill_enable` fallback is `true`. With `toggle_enable = true` and automatic unlock enabled, releasing the input can clear HALT. Button implementation

Qualification. With machine energy isolated, check terminal states during reset, boot, update, brownout, HALT and each unlock. Check shared motor enable while the processor is held in reset.

See Prime sample profile values (p. 21) and settings and defaults (p. 22).

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Mechanical and environmental

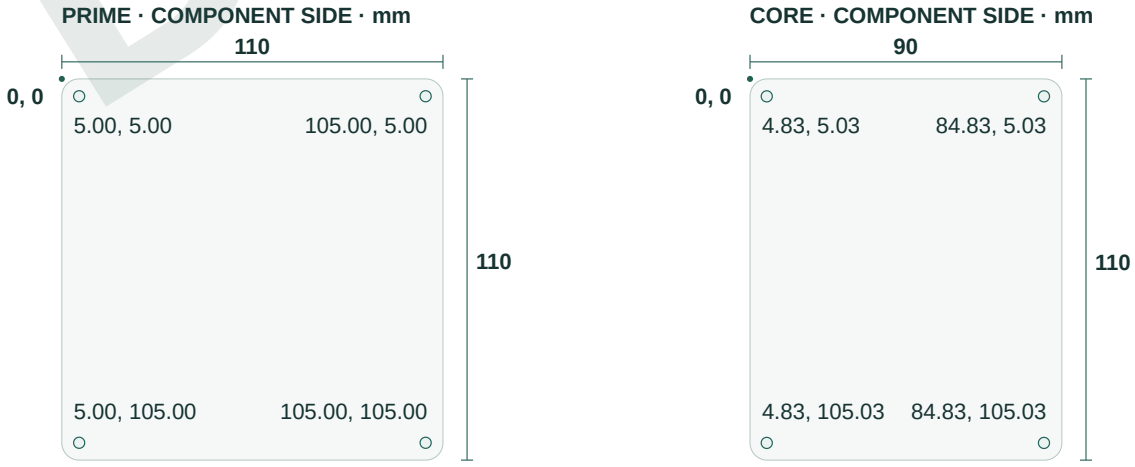
PCB, nominal assembly envelopes and installation

Parameter	Prime 2660 / 2590	Core
Bare PCB outline	110 × 110 mm	90 × 110 mm
Nominal PCB thickness	1.60 mm	1.60 mm
Corner radius	5 mm	5 mm
Mounting pattern	Four Ø3.2 mm holes on 100 × 100 mm centers	Four Ø3.2 mm holes on 80 × 100 mm centers
STEP model outline	112.89 × 110 mm	93.06 × 110 mm
Left-edge overhang at SW1 reset button	2.89 mm	3.06 mm
microSD setback from left edge (modeled)	0.10 mm	1.33 mm
J2 USB-A height above PCB top	14.66 mm	14.66 mm
BT1 holder projection below PCB	3.65 mm	3.65 mm
Underside projection without BT1	P11: 2.37 mm · P12: 2.85 mm	2.37 mm
Overall STEP model height	19.91 mm	19.91 mm
Unmated J5 driver socket above PCB top	—	8.55 mm
Tolerances, installed clearances and environmental limits	Open	Open

Size the standoff gap for fitted tails, solder, insulation and tolerances. Check plug, card and reset access and the mated Core J5 stack. Prime 2660 STEP · Prime 2590 STEP · Core STEP

Mounting datum. With components up and USB at left, use the projected top-left board corner. X extends right and Y extends down.

Mounting and enclosure bonding. H3/H4 at left have Ø6.4 mm ground pads. H1/H2 at right are unplated. Metal hardware at H3/H4 can bond board ground to the chassis. Check fitted ground links and chassis contact at the USB and Ethernet shells.



Mounting-hole centers in (X, Y) millimetres, measured from the marked datum.

DRAFT

Errata and revision control

Board identification, open hardware issues and document revisions

Draft hardware errata

Confirm affected assemblies against the PCB revision and fitted parts. Record measured behavior and approved corrective actions in the qualification record.

Scope	Reported behavior	Draft treatment
V2 expansion analog inputs	The report identifies GH/GI contacts 3–5. P11, P12 and P1 specify LESD8D3.3CAT5G protection at D16–D21. Leakage may affect readings.	Confirm the fitted parts, source impedance and input error across the supported range. Rework requires separate qualification. Analog protection issue
Core P1 heater orientation	With USB on the left, the positive contact is on the left at J8/J10 and on the right at J11/J12/J16 in the PCB layout.	Use the numbered connector view (p. 8) and verify the fitted terminals before wiring.
Core P1 J9 power markings	The CAD silkscreen places + beside ground and − beside VFET. The assembly markings need confirmation.	Use the J9 contact view (p. 8) and verify ground and cable polarity before applying power.
Probe input	A circuit revision is under consideration.	Keep probe behavior and range qualified to the actual hardware revision.

Ordering, compliance and revision control

Order Prime with the intended driver or select the distinct Core product. Ordering codes, assembly suffixes and serial ranges still need confirmation. Assembly-level declarations, environmental qualification and production test criteria are open. The Open Source Hardware Association registers the Smoothieboard v2 project as FR000021. The hardware repository records the design licence. Project registration

All revisions in this table are dated 2026-11-21.

Draft	Changes
21–66	Adds power and drive constraints, mechanical fit, connector and jumper details, firmware checks and a qualification record.
15–20	Adds field terminals, first-power checks, host behavior, relay control and Core switched-output constraints.
14	Identifies expansion analog protection parts and the firmware paths for GH and GI.
13	Adds enlarged component-side revision marks from the three PCB layouts.
12	Adds model markings, expected firmware board IDs and the project open-hardware registration.
11	Documents the thermistor input circuits and flags the conflicting Prime bed-load example.
10	Documents the probe supply, bias and range jumpers with calculated switching points.
09	Traces startup and halt control for switched loads and motors. Clarifies hardware-PWM switch behavior.
08	Compares firmware fallbacks with pinned Prime profiles and adds configuration value and unit guidance.
07	Adds the mating connector reference and flags an older Core parts list and alternate connector models.
06	Reconciles the nine Gadgeteer headers with the PCB layouts and firmware aliases. Adds shared functions and debug contacts.
05	Traces logic power, shared accessory limiters and load returns. Adds calculated switch thresholds with their qualification status.
04	Adds a dry-contact endstop example and design references for powered probes and Core external drives.
03	Adds nominal assembly envelopes and clearances from the three STEP models. Clarifies how to read configuration defaults.
02	Identifies assembly layouts and firmware baseline. Adds connector and installation detail and conditions for open specifications.
01	Initial electrical, mechanical and firmware draft with three appendices.

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Mating parts and sources

Connector families, installation checks and design references

Match the fitted contacts, key, pin 1 and wire entry before ordering. Strip length, torque and wire range apply to the named terminal. For KK 254, the Molex 08-50-0113 tin crimp takes 22–30 AWG and insulation up to 1.57 mm.

Board connector	Mating part or termination	Installation check
All J1–J4	USB Type-B device cable, USB Type-A host plug, microSD card and 8P8C Ethernet plug, respectively.	See host availability and card support on pp. 2 and 14.
All J21–J23. Prime J19/J20. Core J7/J11/J12/J16.	Two-position Molex KK 254 housing, e.g. 22-01-2027.	Match the 2695 housing to the fitted 6410-style header and its friction ramp.
All J24–J29. Core J6.	Three-position KK 254 housing, e.g. 22-01-2037.	Match pin 1 and the friction ramp.
Prime J31	Four-position KK 254 housing, e.g. 22-01-2047.	Check contact 1 against the motor supply shown in the Prime pinout.
Prime J5–J8, motors	P11 models KK 254 for housing 22-01-2047. P12 models fixed 3.50 mm Phoenix PT 1984633 blocks.	For the fitted PT block, strip 5 mm and tighten to 0.22–0.25 N·m. Verify connector and wire limits.
Prime J17/J18, heaters	When the modeled Phoenix MCV 1843606 header is fitted, use MC plug 1840366. The PCB also provides 2.54 mm pads.	For that MC plug, strip 7 mm and tighten to 0.22–0.25 N·m. Allow plug withdrawal clearance.
Prime J9/J12/J16 inputs and J14 bed	The modeled XT30 inputs take cable sockets. The modeled J14 bed output takes cable pins.	Check the actual contacts. J10/J11/J13 are unrated 2.54 mm alternatives.
Core J9 input	The XT30 footprint calls for sockets. The assembly STEP depicts pins.	Match the fitted contacts and verify polarity (p. 8).
All J42/J43. Core J8/J10.	3.50 mm, two-position terminals. Prime J43 models the same MCV header as J17/J18 on a fixed-block footprint.	Identify the fitted style before selecting a plug or preparing wire.
All J15, J30 and J44/J45	Single-row 2.54 mm pin headers. Three contacts on J30 and two on the others.	J15 contacts 1 and 2 are board 3.3 V and ground. Accessory current is open. J30 has no adapter power contact.
All J32–J40 Gadgeteer	A straight-through 10-position receptacle cable for the 2 × 5, 1.27 mm pin header.	Check pin 1 at both ends and account for both supply contacts.
All J41 debug	A 2 × 5, 1.27 mm Cortex debug receptacle. Confirm physical clearance at key position 7.	J41 contact 1 is the target 3.3 V reference. Use the debug cable only on J41.
Core J5	2 × 20 mating pin header on 2.54 mm pitch.	Check the 40-contact socket on the board. The earlier Core parts list shows a 30-contact J14 and predates the J5 layout.

Molex housing and crimp · Phoenix PT block and MC plug · Arm debug connector

Relay interface references

Use a separate driver for relay coils. External voltage at contact 1 can backfeed board 5 V. For input selection, Omron's G3NA-D210B-UTU DC input requires at least 4 V on and at most 1 V off, drawing up to 5 mA. Verify these margins at the receiver with both outputs loaded. Compatibility remains open.

Sources

- Pinned hardware CAD · Prime specifications · P11 schematics · Prime product · Core product
- Firmware and bootstrap · Pin map · Clock setup
- STM32H745xI processor · AT25SF081 flash
- Trinamic TMC2660 datasheet and Trinamic TMC2590 datasheet.

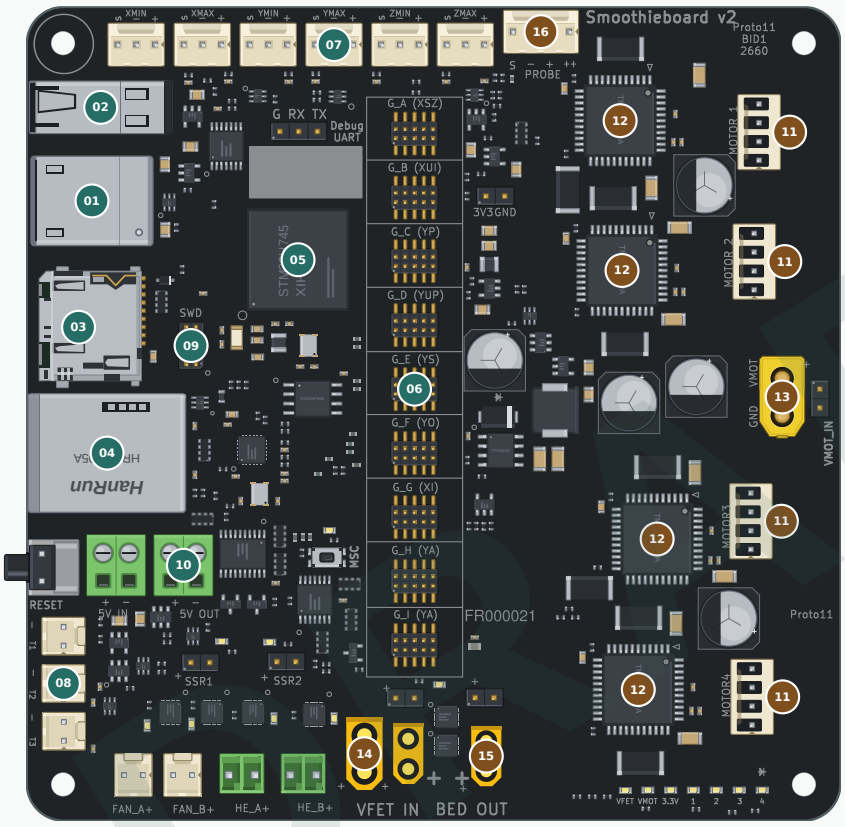
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Prime 2660 · P11

Appendix A · Board renderings

The component-side drawings use each revision’s PCB layout. Numbered callouts identify connectors and functional areas by reference designator. Use the matching revision’s connector tables and schematic when wiring.

COMPONENT SIDE



110 × 110 mm PCB

Prime 2660

Smoothieboard V2 · P11

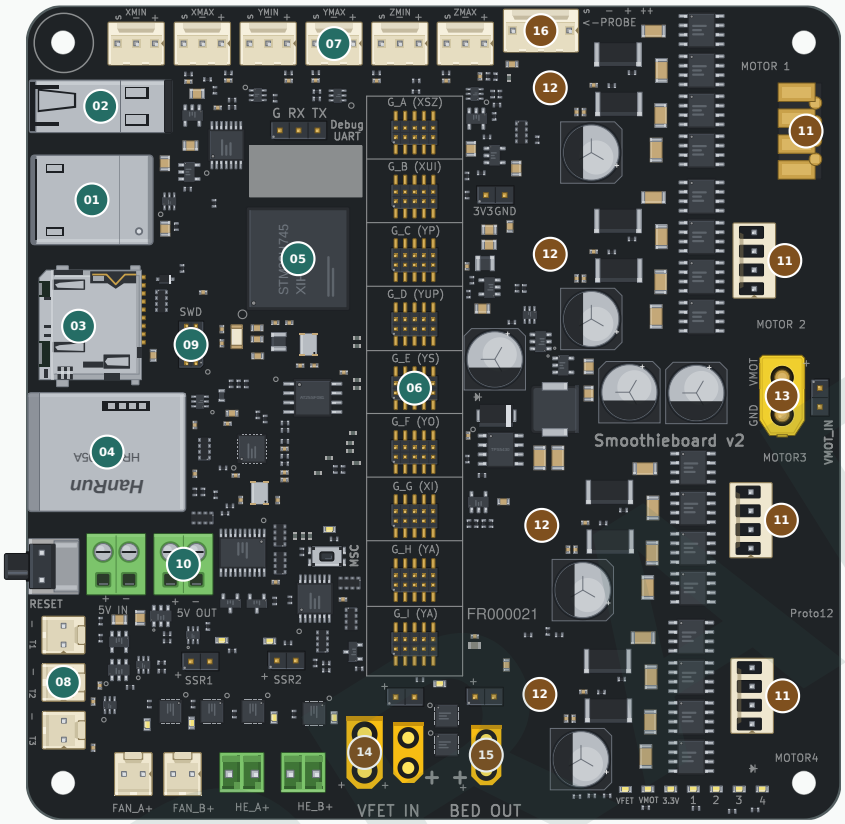
01	**USB device**	J1 · USB-B
02	**USB host hardware**	J2 · USB-A
03	**microSD**	J3
04	**Ethernet**	J4 · 10/100 Mbit/s
05	**STM32H745 processor**	U2
06	**Gadgeteer expansion**	J32–J40 · GA–GI
07	**Endstop inputs**	J24–J29
08	**Thermistor inputs**	J21–J23
09	**SWD debug**	J41
10	**5 V input / output**	J42, J43
11	**Motor outputs**	J5–J8 · A–D
12	**TMC2660 stepper drivers**	U3, U5, U6, U7 · Integrated power MOSFETs
13	**Motor power input**	J9 · VMOT
14	**Load power input**	J12, J16 · VFET
15	**Bed output**	J14
16	**Probe input**	J31

The four TMC2660 drivers integrate their power MOSFETs.

Prime 2590 · P12

Appendix A · Board renderings

COMPONENT SIDE



110 × 110 mm PCB

Prime 2590

Smoothieboard V2 · P12

01	**USB device**	J1 · USB-B
02	**USB host hardware**	J2 · USB-A
03	**microSD**	J3
04	**Ethernet**	J4 · 10/100 Mbit/s
05	**STM32H745 processor**	U2
06	**Gadgeteer expansion**	J32–J40 · GA-GI
07	**Endstop inputs**	J24–J29
08	**Thermistor inputs**	J21–J23
09	**SWD debug**	J41
10	**5 V input / output**	J42, J43
11	**Motor outputs**	J5–J8 · A–D
12	**TMC2590 stepper drivers**	U3, U5, U6, U7 · External power MOSFETs
13	**Motor power input**	J9 · VMOT
14	**Load power input**	J12, J16 · VFET
15	**Bed output**	J14
16	**Probe input**	J31

The four TMC2590 drivers use external power MOSFETs.

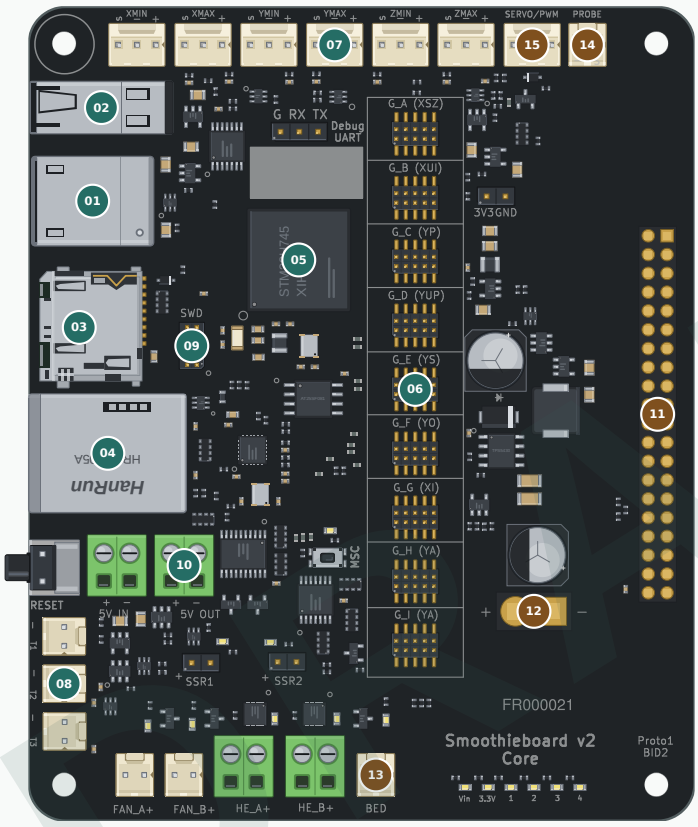
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Core · P1

Appendix A · Board renderings

Verify J9 polarity before applying power. With USB at left, contact 2 (ground) is on the left and contact 1 (VFET) on the right. The PCB drawing shows reversed polarity markings. Check the numbered view (p. 8).

COMPONENT SIDE



90 × 110 mm PCB

Core

Smoothieboard V2 · P1

01	**USB device**	J1 · USB-B
02	**USB host hardware**	J2 · USB-A
03	**microSD**	J3
04	**Ethernet**	J4 · 10/100 Mbit/s
05	**STM32H745 processor**	U2
06	**Gadgeteer expansion**	J32–J40 · GA–GI
07	**Endstop inputs**	J24–J29
08	**Thermistor inputs**	J21–J23
09	**SWD debug**	J41
10	**5 V input / output**	J42, J43
11	**External driver interface**	J5 · 40 contacts
12	**Load power input**	J9 · VFET
13	**Switched load outputs**	J8, J10, J11, J12, J16
14	**Probe input**	J7
15	**Servo / PWM header**	J6

The 40-pin driver interface connects to external stepper drivers or a breakout.

Smoothieware wiki and sample profiles

Appendix B · Documentation and configuration examples

On the wiki, choose **Show Only V2** from the version menu before following version-specific wiring or configuration steps. Check the board revision and firmware applicability (p. 14) before using an example.

Topic	Documentation
Start and upgrade	Getting started · Basics · How to wire · SD card setup · Download firmware · Flash firmware · Recovery · Migrate from GRBL · Migrate from Marlin
Machine guides	CNC mill · Laser cutter · 3D printer · Pick and place · Lathe · Electronic leadscrew
Board and connections	Smoothieboard V2 Prime · Prime schematic · Core P1 design files · STM32H7 pin usage · Pin configuration · Differences from V1
Configure motion	Configuration file · Configuration options · Motion control · Kinematics · Additional axes · Axis slaving · GRBL mode · Current control · Endstops · Probing
Configure tools	Laser module · Spindle module · Extruder · Temperature control · Switch inputs and outputs
Operate and troubleshoot	Communication · G-code reference · Console commands · Feed hold and cycle start · Emergency stop · Software · Network · USB · UART · Troubleshooting · Error messages

Prime configuration examples

Setting	Fallback	CNC example	3D printing example	Check before use
X axis steps/mm and rate	80 steps/mm, 30,000 mm/min	800 steps/mm, 1,800 mm/min	100 steps/mm, 30,000 mm/min	Calibrate travel and set a verified speed limit.
X motor current request	No current override	1.8 A peak	1.5 A peak	Check motor, fitted shunts and the current convention (p. 6).
X-min homing	Disabled unless enabled	PD0 with pull-up, home to min at 30/5 mm/s	Same as CNC	Check switch state, direction and usable travel with the actual mechanism.
Hotend temperature control	Disabled unless enabled	No hotend instance	Enabled with EPCOS100K preset	Verify the sensor and output before heating.

Microstepping and pulse demand. Both Prime drivers default to 32 incoming microsteps per full step, with interpolation off. In MicroPlyer's 16-to-256 mode, calculate `steps_per_mm` from the 16 incoming pulses per full step. For an external drive, match `steps_per_mm` to the resolution set on the drive.

Multiply steps/mm by actuator speed in mm/min and divide by 60. The CNC example requests 24,000 pulses/s on X (800 × 1800 ÷ 60). Firmware reduces the actuator speed limit if the requested pulse rate exceeds the timer frequency. See drive timing (p. 12) for receiver constraints.

CNC example · 3D printing example · Gadgeteer driver example

Clock and file timestamps

BT1 is marked unpopulated in the layouts. The specified holder accepts CR1216 or CR1225 cells and feeds only the processor backup input. Check the holder fitted to your board. Holder drawing and compatibility

Read the clock with `date`, or set it with `date YYMMDDhhmmss` (24-hour time). After reboot, firmware-written FAT timestamps use a fixed date until the console or network time sets the clock. Test clock retention and file timestamp accuracy separately. Console command · Timestamp code

DRAFT

System, motion and planning

Appendix C · Key V2 configuration settings · 1 of 4

Use the INI section and key shown on each row. `alpha`, `minx`, `hotend`, and `fan` are example instance names. Select the matching actuator, endstop, tool, or switch from the configuration for your board and firmware.

The Default column shows the fallback for an omitted key in a configured section, using the SmoothieV2 source dated 2026-10-22. Sample configurations may override these values. Shipped profiles require separate confirmation. Enter numbers without grouping commas, units or explanatory text. `""` denotes an empty string and `nc` means no pin is assigned.

See Configuration options, the configuration file guide, the wiki settings database (YAML), and the examples at the reviewed firmware revision.

INI section	Key	Default	What it controls
`[general]`	`grbl_mode`	`false`	Enable GRBL-compatible command and status behavior.
`[general]`	`config-override`	`false`	Load saved `M500` overrides at startup.
`[system]`	`step_frequency`	`200,000` Hz (50,000 debug)	Set the step timer frequency in Hz.
`[system]`	`step_pulse_us`	`1` µs	Set the timer delay used to clear STEP. See timing (p. 12).
`[system]`	`msc_enable`	`true`	Enable USB mass-storage access.
`[consoles]`	`second_usb_serial_enable`	`false`	Enable the second USB serial console.
`[uart console]`	`enable`	`false`	Enable the serial console on a hardware UART.
`[uart console]`	`baudrate`	`115,200` baud	Set the serial console baud rate.
`[motion control]`	`arm_solution`	`cartesian`	Select the machine kinematics.
`[motion control]`	`default_feed_rate`	`4,000` mm/min	Default feed rate for cutting or printing moves.
`[motion control]`	`default_seek_rate`	`4,000` mm/min	Default rapid move rate.
`[motion control]`	`default_acceleration`	`100` mm/s²	Default acceleration for planned moves.
`[motion control]`	`x_axis_max_speed`	`60,000` mm/min	Limit X travel speed.
`[motion control]`	`y_axis_max_speed`	`60,000` mm/min	Limit Y travel speed.
`[motion control]`	`z_axis_max_speed`	`300` mm/min	Limit Z travel speed.
`[motion control]`	`max_speed`	`0` (disabled)	Limit coordinated move speed.
`[motion control]`	`must_be_homed`	`false` (true on delta)	Require homing before motion.
`[motion control]`	`save_wcs`	`false`	Persist work coordinate offsets.
`[motion control]`	`mm_per_line_segment`	`0` mm	Control straight-move segmentation length.
`[motion control]`	`mm_per_arc_segment`	`0` mm (automatic)	A longer length overrides the calculated length.
`[motion control]`	`mm_max_arc_error`	`0.01` mm	Set the chord error used to calculate arc segments.
`[planner]`	`junction_deviation`	`0.05` mm	Adjust cornering speed through move junctions.
`[planner]`	`z_junction_deviation`	`-1` (inherit XY)	Adjust cornering as a Z-only move begins.
`[planner]`	`minimum_planner_speed`	`0` mm/s	Set the planner's minimum junction speed.
`[conveyor]`	`queue_delay_time_ms`	`100` ms	Set the initial move-queue delay in ms.

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Motor drivers, endstops and homing

Appendix C · Key V2 configuration settings · 2 of 4

INI section	Key	Default	What it controls
[actuator]	alpha.steps_per_mm	80 steps/mm	Set steps per unit of travel for the actuator.
[actuator]	alpha.max_rate	30,000 mm/min	Limit the actuator's motion rate.
[actuator]	alpha.acceleration	-1 (inherit motion)	Set the actuator acceleration limit.
[actuator]	alpha.step_pin	PD3 (Prime build), nc (other builds)	Assign the STEP pin for an external driver.
[actuator]	alpha.dir_pin	PD4 (Prime build), nc (other builds)	Assign the direction pin for an external driver.
[actuator]	alpha.en_pin	nc	Assign the enable pin for an external driver.
[actuator]	alpha.driver	Prime driver by board ID[1]	Select the driver type.
[actuator]	alpha.microsteps	32	Use powers of two from 1 through 256 for onboard drivers.
[actuator]	alpha.reversed	false	Reverse the actuator direction.
[actuator]	delta.slaved_to	""	Set which primary actuator the secondary motor follows.
[actuator]	common.check_driver_errors	true	Check onboard driver fault status.
[actuator]	common.halt_on_driver_alarm	false	Halt on detected driver alarms.
[current control]	alpha.current	Unset	Request peak phase current in amperes on Prime. Omission supplies no override.
[endstops]	minx.enable	false	Enable the named endstop.
[endstops]	minx.pin	nc	Assign the endstop input.
[endstops]	minx.axis	"" (axis required)	Assign the endstop to an axis.
[endstops]	minx.homing_direction	none	Use home_to_min, home_to_max or none.
[endstops]	minx.homing_position	0 mm (min), 200 mm (max)	Set the machine coordinate at home.
[endstops]	minx.max_travel	500 mm	Set the maximum search distance during homing.
[endstops]	minx.fast_rate	100 mm/s	Set the initial homing approach speed.
[endstops]	minx.slow_rate	10 mm/s	Set the slow homing approach speed.
[endstops]	minx.retract	5 mm	Set the retract distance before the slow approach.
[endstops]	minx.limit_enable	false	Use the endstop as a hard limit.
[endstops]	common.debounce_ms	0 ms	Set debounce in 10 ms steps during motion.
[endstops]	common.homing_order	"" (simultaneous)	Set the axis homing sequence.

[1] In a Prime-target build, ID 01 defaults to tmc2660 and other IDs default to tmc2590 on X through A. See Core external-driver applicability (p. 14).

Homing and hard limits sample the input at 100 Hz. A 1–10 ms setting requires two consecutive active samples. Homing back-off also uses the configured value as a millisecond wait. Endstop code

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Probing, temperature and extrusion

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INI section	Key	Default	What it controls
[zprobe]	enable	false	Enable the probe module.
[zprobe]	probe_pin	nc	Assign the probe input.
[zprobe]	slow_feedrate	5 mm/s	Set the slow probing speed.
[zprobe]	fast_feedrate	100 mm/s	Set the rapid probing approach speed.
[zprobe]	return_feedrate	0 (automatic)	Return speed in mm/s. Auto uses twice slow, capped at fast.
[zprobe]	probe_height	5 mm	Set the starting clearance for probing.
[zprobe]	max_travel	200 mm	Limit the probe search distance.
[zprobe]	reverse_z	false	Reverse the Z probing direction.
[zprobe]	debounce_ms	0 ms	Set debounce in 1 ms steps during probing.
[temperature control]	hotend.enable	false	Enable the named temperature controller.
[temperature control]	hotend.sensor	thermistor	Select the sensor type.
[temperature control]	hotend.thermistor_pin	ADC1_1 (Prime build), "" (other builds)	Assign the analog thermistor input.
[temperature control]	hotend.thermistor	"" (no preset)	Fallback curve uses 100 kΩ at 25 °C and β = 4066 K.
[temperature control]	hotend.heater_pin	PE0 (Prime build), nc (other builds)	Assign the heater control output.
[temperature control]	hotend.max_pwm	255	Limit heater PWM on the 0–255 scale.
[temperature control]	hotend.p_factor	10	Set proportional PID gain.
[temperature control]	hotend.i_factor	0.3	Set integral PID gain.
[temperature control]	hotend.d_factor	200	Set derivative PID gain.
[temperature control]	hotend.min_temp	0 °C	Set the lower allowed temperature reading.
[temperature control]	hotend.max_temp	300 °C	Set the upper allowed temperature reading.
[temperature control]	hotend.runaway_heating_timeout	300 s	Set the heating runaway timeout.
[extruder]	hotend.enable	false	Enable the named extruder.
[extruder]	hotend.tool_id	0	Associate the extruder with a tool number.
[extruder]	hotend.filament_diameter	0 (disabled)	Set filament diameter in mm for volumetric extrusion.
[extruder]	hotend.retract_length	3 mm	Set firmware retraction distance.

The sensor read callback defaults to 20 reads per second. `runaway_cooling_timeout` inherits the configured heating timeout. After reaching target, the default `runaway_range` is ±20 °C. These are firmware settings. See heater fault behavior (p. 13).

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Laser, switched outputs and networking

Appendix C · Key V2 configuration settings · 4 of 4

INI section	Key	Default	What it controls
[laser]	enable	false	Enable the laser module.
[laser]	pwm_pin	nc	Assign the laser power PWM signal.
[laser]	ttl_pin	nc	Assign the separate laser on/off signal.
[laser]	inverted_pwm	false	Invert the laser PWM signal.
[laser]	maximum_power	1	Set the maximum normalized laser output.
[laser]	minimum_power	0	Set the minimum normalized firing power.
[laser]	maximum_s_value	1	Set the G-code S value corresponding to full scale.
[laser]	default_power	0.8	Set the initial laser power request.
[laser]	proportional_power	true	Scale requested power with actual move speed.
[switch]	fan.enable	false	Enable the named switch instance.
[switch]	fan.input_pin	""	Assign the switch's input pin.
[switch]	fan.output_pin	nc	Assign the switch's output pin.
[switch]	fan.output_type	"" (type required)	Use digital, sigmadeltapwm or hwpwm for an output.
[switch]	fan.input_on_command	""	Bind the command that turns the output on.
[switch]	fan.input_off_command	""	Bind the command that turns the output off.
[switch]	fan.startup_state	false	Set the output state at firmware start.
[switch]	fan.halt_set_to	false	HALT state for participating digital and sigma-delta outputs. Hardware PWM uses the stored duty value.
[network]	enable	false	Enable the network module.
[network]	ip_address	auto (DHCP)	Set the network address or select DHCP.
[network]	ip_mask	255.255.255.0	Set the static IPv4 subnet mask.
[network]	ip_gateway	192.168.1.1	Set the static IPv4 gateway.
[network]	hostname	smoothiev2	Set the network hostname.
[network]	shell_enable	false	Enable the network command shell.
[network]	webserver_enable	false	Enable the HTTP server.
[network]	ftp_enable	false	Enable the FTP server.

Ethernet setup. The CNC and 3D printing examples set the three service flags to `true` while leaving the network module disabled. Before setting `enable = true`, set unused services to `false`. Keep HTTP (80), FTP (21) and the plain TCP command shell (23) on a trusted network.

Address check. Run `net` on the local console after starting the network. It reports the active IP, mask, gateway and DNS when the stack is up. The reviewed build can fall back to `192.168.1.45` after an unsuccessful DHCP attempt. Check the displayed address before connecting and use a unique static address if needed. Network source

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