Smoothieboard V2

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

Smoothieboard V2 is an open-hardware controller for CNC mills, routers, lasers and 3D printers. Prime integrates four stepper drivers. Core provides a breakout interface for external drivers.

Models

Model	KiCad revision	Motion outputs	Nominal bare PCB
Prime 2660	P11	Four onboard Trinamic TMC2660 stepper channels	110 × 110 mm
Prime 2590	P12	Four onboard Trinamic TMC2590 stepper channels	110 × 110 mm
Core	P1	Four step/direction channels on a driver breakout header	90 × 110 mm

Board specifications

Feature	Prime 2660, Prime 2590 and Core
Processor	STM32H745XI with dual 32-bit Arm cores
Cortex-M7	Up to 480 MHz per ST. The reviewed SmoothieV2 Prime build configures 400 MHz. Double-precision FPU, DSP instructions, 16 KiB instruction cache and 16 KiB data cache.
Cortex-M4	Up to 240 MHz per ST. The SmoothieV2 bootstrap leaves this core asleep.
On-chip RAM	1 MiB class. 864 KiB system SRAM, 192 KiB tightly coupled RAM and a separate 4 KiB backup SRAM.
Internal flash	2 MiB dual-bank MCU flash (2 × 1 MiB)
External flash	1 MiB (8 Mbit) AT25SF081 Quad-SPI serial NOR flash
Total onboard flash	**3 MiB installed** across the two devices. Removable microSD capacity is separate.
Ethernet	One 10/100 Mbit/s Ethernet port
USB	One device port with firmware serial and mass-storage modes. One host port reserved in hardware.
Removable storage	One microSD slot for configuration, firmware updates and files
Expansion and debug	Nine Gadgeteer headers with GPIO, SPI, I²C, timer/PWM and analog channels. Dedicated SWD debug connector.
Motion and sensor I/O	Four step/direction channels, six endstop inputs, three external temperature inputs and one probe input
Real-time clock	On-chip RTC with optional backup supply

See board sources and firmware references for component capacities and clock configuration.

Find a specification

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Electrical limits and power

Supply rails, preliminary operating figures and current guidance

Electrical operating conditions

Published figures are preliminary where the conditioning, accuracy or test basis is still open. A dash means a bound is unspecified in this draft. The rail labels VMOT and VFET refer to motor and switched-load power respectively.

Parameter	Applies to	Min	Typ / nominal	Max	Conditions and evidence
Motor supply at VMOT	Prime	12 V DC	24 V DC	24 V DC	Documented supply recommendation. Confirm transient and brownout margin and load-dependent input current.
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	—	—	—	Core layout uses this input for switched loads and the onboard power architecture. The regulator input is specified up to 32 V. Board and output envelope remains open.
External logic supply input	All	—	5 V DC	—	Dedicated input and return. Confirm voltage tolerance, inlet current limit and behaviour with other sources attached.
Internal logic supply at regulator	All	—	5 V DC	—	The onboard regulator is rated 3 A. Budget board consumption and verify available accessory current separately 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.
Core driver-bus logic and timing	Core	—	—	—	Validate input/output levels, source/sink drive, active polarity and timing under the chosen firmware.

Prime motor-current guidance

Prime variant	Recommended motor-current range	Qualification still needed
TMC2660	1.2–2.2 A	RMS or peak convention, ambient, airflow and simultaneous-axis load
TMC2590	2.4–4.6 A	Same conditions. Additional cooling may be needed.

Absolute maximum ratings

Board-level absolute ratings are open for VMOT, VFET, logic supply, GPIO and comparator input pins, motor and load outputs, and temperature. Specify independent stress limits with pin domain, duration and power state. Semiconductor stress limits and connector ampacity appear in their own source documents. See the ratings evidence and release checks.

Power and protection

- **Prime.** The motor feed supplies the stepper stages and the onboard logic regulator. A separate switched-load rail feeds the bed and auxiliary output circuits. Bed output has its own low-side switch path. A common high-side cutoff feeds the two heater and two fan outputs.
- **Core.** The main power input and switched-output arrangement differ from the Prime. The separate driver header carries control and sense signals. Check the Core schematic for how to power an external driver board.
- **Logic.** The documented 5 V paths are the onboard regulator, USB device power and the external logic input. Source selection uses ideal-diode circuits. The dedicated 5 V output and current-limited Gadgeteer header supply have different paths and current budgets.
- **Fault states.** Record rail and output behavior during power sequencing, reset, firmware update, undervoltage, overload and shutdown. Treat each power path and load group separately when qualifying cutoff behavior.

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Motion, loads and sensing

Driver variants, switched outputs and measurement inputs

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	Low-side switched return with a dedicated positive/return pair for the load.	Continuous and pulse current, duty cycle, power-connector temperature rise and allowable load type.
Prime heater/fan outputs	Four channels share a high-side cutoff path.	Per-channel and combined safe load, switching frequency, minimum pulse widths and inductive load requirements.
Core switched outputs	Lower-power circuit with different terminals and output stages.	Qualify each output and shared path separately from Prime.
Relay control outputs	Signal-level control outputs are described in the Prime documentation.	Output voltage, current, polarity and supported external interface requirements.

Sensor inputs

Function	Provision	Complete before release
Endstops	Six dedicated inputs.	External connector pin order, thresholds, pull and filter circuits, mode/polarity, supply pin tolerance and cable guidance.
Thermistors	Three external temperature channels and an onboard temperature channel in the firmware pin map.	External analog range, divider and reference values, tolerance, resolution versus system accuracy and supported sensor types.
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.

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Onboard stepper drivers

Prime 2660 and Prime 2590 · Board guidance and Trinamic IC features

The component capabilities below are for the driver ICs. Use the preliminary operating figures for the complete Prime assembly and its cooling conditions. Core exposes the driver signals on a breakout header.

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 voltage and phase current	Up to 30 V DC. Trinamic specifies 2.2 A RMS continuous or 2.8 A RMS boost per coil at the IC level, subject to thermal conditions.
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 two-phase bipolar stepper channels. Each driver controls external N-channel and P-channel MOSFETs.
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.
Power stage sizing	Phase current and voltage depend on the external MOSFETs, current-sense resistors and cooling.
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

The board current guidance still needs RMS or peak convention, ambient temperature, airflow and simultaneous-axis load to be specified.

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Connectors and expansion

Board designators, numbered contacts and expansion signal nets

Connectors and expansion

Connector references here are KiCad designators. Contact order is by numbered pad. The final drawing needs a component-side view, pin-one mark, mating connector and cable insertion direction for each field terminal.

Function	Prime designators and verified CAD notes	Core designators and verified CAD notes
Host, storage, network	J1 USB device, J2 USB host hardware, J3 microSD, J4 Ethernet	Same designators
Stepper and driver interface	J5–J8. Pads 1–4 run B2, B1, A2, A1 on each channel.	J5, 2 × 20 contacts on 2.54 mm pitch
DC motor power	J9 pads 1/2 are VMOT and ground. J10 is a parallel layout footprint. Confirm fitted connector by assembly.	Separate driver power integration depends on breakout and driver.
DC switched-load power	J12 and J16 pads 1/2 are VFET and switched-load ground. J11 is a parallel layout footprint.	J9 pads 1/2 are VFET and ground.
Prime bed output	J14 pads 1/2 are VFET and switched bed return. J13 is a parallel layout footprint.	Independent output mapping by Core schematic
Dedicated probe	J31 pad 1 is VMOT and pad 3 is ground. Confirm signal and low-voltage feed identities from the input circuit before issuing a wiring table.	Confirm by shipped revision and Core circuit.
Expansion and debug	J32–J40 Gadgeteer, J41 debug	Same designators
External logic power and 5 V output	J42 external 5 V input, J43 5 V rail output. For both, pad 2 is ground.	Same designators

For every Gadgeteer header, contact 1 is the current-limited 3.3 V rail, contact 2 is the current-limited 5 V rail and contact 10 is ground. The following table gives the hardware net names. A firmware alias can differ from the hardware net name.

Header	Connector	3	4	5	6	7	8	9
GA	J32	PJ6	PJ9	PJ10	PJ11	Motor SPI COPI	Motor SPI CIPO	Motor SPI clock
GB	J33	PD9	GB_4	GB_5	PK0	PK1	I2C3 SDA	I2C3 SCL
GC	J34	PD14	PD12	PD10	TIM8 CH1	TIM8 CH2	TIM8 CH3	TIM8 CH4
GD	J35	PE7	GD_4	GD_5	TIM1 CH1	TIM1 CH2	TIM1 CH3	TIM1 CH4
GE	J36	PE8	PJ7	PJ8	PD15	SPI1 COPI	SPI1 CIPO	SPI1 clock
GF	J37	PB1	PJ4	PA4	PG0	PJ3	PG1	PJ2
GG	J38	PH2	PH4	PC0	PF15	PH3	I2C2 SDA	I2C2 SCL
GH	J39	ADC1 CH13	ADC1 CH15	ADC1 CH12	PF2	PI10	PH7	PB12
GI	J40	ADC3 CH6	ADC3 CH8	ADC3 CH9	PI8	PE4	PI9	PC13

The motor SPI contacts share the driver bus. Other expansion contacts share onboard functions. The firmware pin map lists specific MCU pins that lack 5 V tolerance. Publish tolerances at the external connector after reconciling the board circuit, power state and selected function.

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Core breakout and GPIO

External drive signals, shared pins and voltage domains

Core driver breakout contact groups

The 40-contact driver breakout is J5 on Core. Use the component-side orientation from the Core layout when identifying contact 1.

Function	Contacts in pad order	Signal order
Supply and ground	1–4, 5–9, 10	5 V, ground, 3.3 V
Shared driver controls	11–14	SPI CIPO, SPI COPI, motor enable, SPI clock
Axis A	15–18	Chip select, step, stall diagnostic, direction
Axis B	21–24	Chip select, step, stall diagnostic, direction
Axis C	27–30	Chip select, step, stall diagnostic, direction
Axis D	33–36	Chip select, step, stall diagnostic, direction
Voltage and board temperature sense	31, 40	Motor-voltage sense input, board-temperature sense input
Additional returns	19–20, 25–26, 32, 37–39	Ground

GPIO and voltage-domain notes

Use the numbered connector table for the physical pin position. Use the board-specific firmware pin map for the processor pin and firmware aliases. The same processor pin can be exposed at a breakout and used by an onboard device. Mark such pins as shared or reserved in the finished inventory.

Pin or group	Location or use	Voltage and availability
PG1	Gadgeteer GF contact 8	Firmware pin map lists this pin as **not 5 V tolerant**.
PA5 and PE9	Firmware pin map lists these for SPI0 clock and a PWM channel	Firmware pin map lists both as **not 5 V tolerant**. Confirm their external mapping per revision.
GH/GI analog contacts 3–5	Six expansion ADC inputs	Treat as 3.3 V analog-domain signals. See the protection-diode erratum.
Motor SPI and shared outputs	Shared expansion contacts and onboard functions	Check both the PCB net and firmware alias before assigning the contact.
USB, Ethernet, microSD, debug, onboard temperature and rail sensing	Dedicated or onboard signals	Keep these entries visible in the inventory so they are easy to distinguish from general-purpose breakout pins.

Full firmware pin map, including onboard functions and all Gadgeteer headers

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Firmware and configuration

Host services, microSD and the board settings readers need first

Firmware and host interfaces

Interface	Documented behavior or status
Configuration and update	SmoothieV2 loads `config.ini` from microSD. The standard running-firmware update file is `flashme.bin`. Initial programming has a separate bootstrap procedure.
USB device	Supports USB serial and a mass-storage mode activated by button or command. Record the exact supported classes and the tested operating systems for the release.
USB host	Host port present in hardware. Firmware support is currently unavailable.
Ethernet	Hardware present. The Prime documentation describes network services including HTTP and Telnet. Record firmware revision and tested services.
Expansion and debug	Firmware support depends on bus, pin assignment and module. The debug connector exposes the processor debug signals.

Configuration at a glance

SmoothieV2 reads the INI-format configuration from the microSD card. Settings below are a quick index to the firmware samples. A revision-specific firmware reference should carry the full setting list, accepted values, defaults, units, and trigger behavior.

Configuration	What to look for
`[system]`	Firmware update on boot, USB mass storage, step pulse width and frequency, and output enable pins. Examples include `flash_on_boot`, `msc_enable`, `step_pulse_us` and `step_frequency`.
`[motion control]`, `[planner]`	Kinematics, trajectory planning, travel and speed limits.
`[actuator]`	Driver selection, motor travel calibration and step/direction/enable assignments. For an external driver, the sample uses `alpha.driver`, `alpha.step_pin`, `alpha.dir_pin` and `alpha.en_pin`.
`[tmc2660]`, `[tmc2590]`, `[current control]`	Variant-specific driver settings and motor current.
`[endstops]`, `[zprobe]`	Input assignment and polarity, homing, probe setup and behavior.
`[switch]`, `[temperature control]`, `[laser]`	Pin assignment, signals or commands that trigger outputs, and tool-specific behavior.
`[voltage monitor]`, `[network]`	Rail monitoring and host networking.

Firmware examples include configurations for CNC, lathe and 3D printing and a dedicated external-driver example. SmoothieV2 configuration samples

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Mechanical, errata and references

Dimensions, open engineering notes and source documents

Mechanical and environmental

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
Maximum installed height, connector overhang and tolerances	Open	Open
Operating and storage environment, humidity and airflow derating	Open	Open

The mechanical figures are nominal CAD dimensions. The assembly drawing should include connector overhang, installed height, cable bend and service clearance.

Draft hardware errata

Affected hardware revisions and corrective actions are pending review.

Scope	Reported behavior	Draft treatment
V2 analog inputs	The analog protection diodes can begin conducting within the intended input range and cause inaccurate readings.	Flag the accuracy issue and the 3.3 V input domain. Keep component changes and rework under hardware engineering review. Analog protection issue
Core output connector orientation	The two hotend output connectors are reversed relative to the other switched-output connectors.	Identify polarity individually by contact and board revision in the released connector diagram.
Core power silkscreen	The input connector marked XT30 has a reported silkscreen polarity issue.	Mark the printed polarity as unreliable on affected assemblies. Use the exact assembly's schematic and pin mapping before wiring.
Probe input	A circuit revision is under consideration.	Keep probe behavior and range qualified to the actual hardware revision.

Ordering, compliance and revision control

Ordering SKU, assembly identification, applicable compliance declarations, qualified operating environment, and production test criteria remain open. Confirm any certification scope for each revision before publishing it on the datasheet.

Sources

- Hardware CAD at the reviewed revision. Prime P11/P12 PCB files and Core P1 board file.
- Smoothieboard V2 Prime specifications and Prime TMC2660 schematic reference.
- RoboSprout Prime and RoboSprout Core.
- SmoothieV2 firmware and bootstrap notes and firmware pin map.
- STMicroelectronics STM32H745xI datasheet, Renesas AT25SF081 datasheet and SmoothieV2 clock configuration.
- Trinamic TMC2660 datasheet and Trinamic TMC2590 datasheet.

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