Kookabus-02

Eight-port serial bus servo driver with I2C control and a UART backup

Datasheet, board revision 2. Document revision 0.2 (draft), 28 September 2026. Preliminary: no hardware has been built. Values are from design calculations and component datasheets. Items marked TBD depend on firmware that is not yet written.

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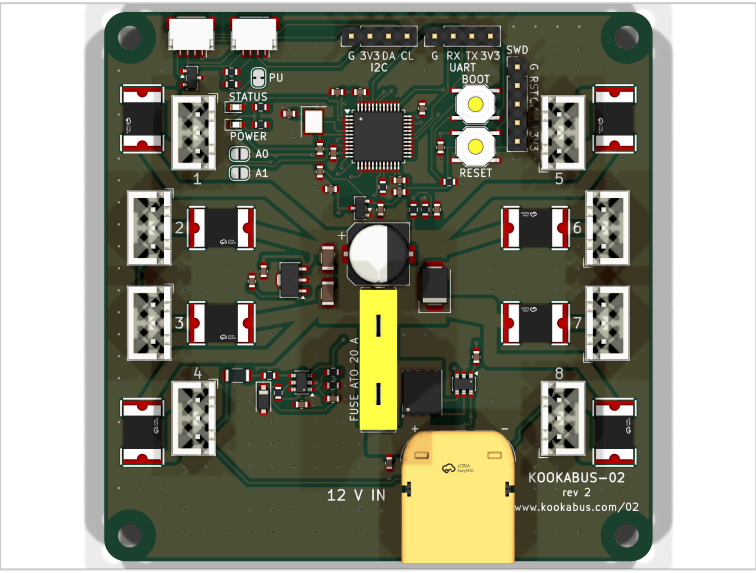


Figure 1. Top view (render). Control connectors along the top edge, the 12 V XT60 input on the bottom edge, four servo ports on each side of the central power hub.

Description

Kookabus-02 drives up to eight Feetech-protocol serial bus servos, such as the ST3215, from a Kookabus (Qwiic/PiicoDev-compatible) I2C host. An STM32F103 microcontroller runs the servos' 1 Mbps half-duplex bus, so the host reads and writes servos with ordinary I2C transactions. The same commands are also available over a 3.3 V UART header, and a 2.54 mm I2C pin header backs up the Kookabus connectors for jumper wires.

A single 12 V supply feeds a central hub through reverse-polarity protection and a 20 A blade fuse. Each port takes its power straight from the hub through its own 3 A resettable fuse, so one stalled or shorted servo trips only its own port.

Applications

- Robot arms, legs and pan-tilt heads built from ST3215, STS, SMS or SCS bus servos
- Adding bus servos to a ROS 2, Raspberry Pi, Jetson or microcontroller robot that already uses Qwiic/PiicoDev sensors
- Bench set-up of servo IDs and limits from a PC through a USB-serial adapter on the UART header

Features

- Eight 3-pin servo ports on one shared bus (servos are addressed by ID), vertical 2.5 mm headers
- 6 to 12.6 V servo supply, 12 V nominal, 20 A total
- XT60 12 V input
- Ideal-diode reverse-polarity protection (MX74700T and a 2 mOhm FET)
- 20 A ATO blade fuse, plus one 3 A resettable PTC per port
- Star power distribution: each port fed directly from the hub on its own copper
- Servo DATA line survives a direct 12 V short indefinitely
- STM32F103C8T6, 72 MHz, 8 MHz crystal
- Control over I2C (two Kookabus connectors plus a 2.54 mm I2C header, addresses 0x14 to 0x17 by jumper) or 3.3 V UART
- Logic can run from the ST-Link or USB-serial adapter for setup and flashing, with no 12 V needed
- Supply voltage monitor on the ADC

- SWD header, BOOT and RESET buttons, ROM serial bootloader on the UART header
- ESD protection on I2C
- 75 x 75 mm, 2 oz copper, four M3 holes, all SMD parts on the top side

1. Block diagram

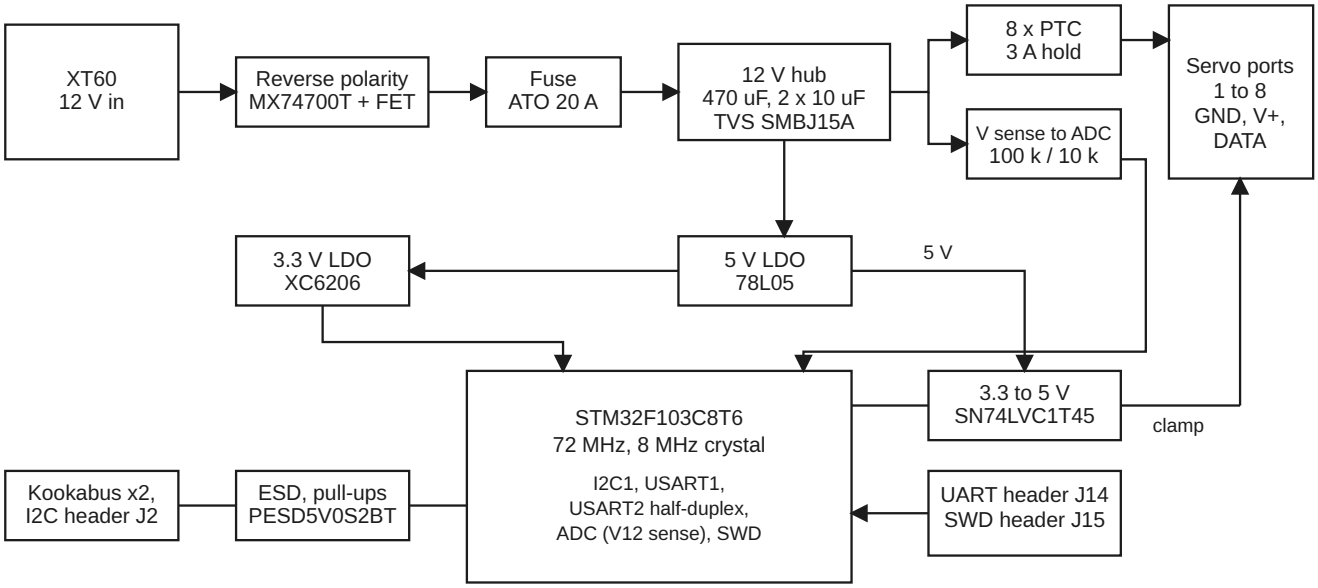


Figure 2. Signal and power flow. Servo power runs on the top copper from the inputs, through the fuse to the hub, and out on eight equal spokes. The bottom layer is a ground plane.

The 5 V rail feeds the 3.3 V regulator directly. With no 12 V, an ST-Link (J15) or USB-serial adapter (J14) can power the logic through its header's 3V3 pin; the servo ports and the 5 V side of the bus translator are then unpowered, so the board can be flashed and configured but cannot move servos. Never connect a 3V3 supply to the headers while 12 V is connected.

2. Absolute maximum ratings

Stresses beyond these values may cause permanent damage. These are limits, not operating conditions.

Parameter	Min	Max	Unit	Limiting part or note
12 V input voltage (XT60) to GND	-30	15	V	Positive: SMBJ15A standoff. The TVS starts to conduct at 16.7 V and a sustained overvoltage blows the 20 A fuse. Negative: a reversed supply is blocked by the ideal-diode FET (30 V VDS).
Transient on the hub (clamped)		24.4	V	TVS clamp at its rated 24.6 A surge. This equals the PTCs' 24 V maximum.
Total input current, continuous		20	A	Fuse rating.
Current per servo port		40	A	PTC maximum fault current. The PTC trips well before this; see 4.1.
DATA pin of a servo port to GND	-0.5	12.6	V	Clamped by the 5.6 V zener through 180 Ohm, indefinitely. Negative voltage is not protected: R7 would exceed its 0.25 W rating.

Parameter	Min	Max	Unit	Limiting part or note
SDA, SCL, UART RX to GND	-0.3	5.5	V	STM32 5 V tolerant pins; PESD5V0S2BT on SDA and SCL.
3V3 pin of a Kookabus connector or the I2C header to GND	-0.3	5.5	V	Feeds only the I2C pull-ups; PESD5V0S2BT clamps above 5 V.
ESD on SDA, SCL (IEC 61000-4-2, contact)		8	kV	PESD5V0S2BT.
Operating ambient temperature	-20	70	°C	Limited by the electrolytic capacitor, connectors and PTC derating. Not characterised over temperature.
Storage temperature	-40	85	°C	

3. Recommended operating conditions

Parameter	Min	Typ	Max	Unit	Note
Servo supply voltage	6	12	12.6	V	ST3215 supply range. A 3S lithium pack (9.0 to 12.6 V) or a 12 V supply.
Current per port, continuous		0.2	2.7	A	0.2 A: an ST3215 holding position. 2.7 A: ST3215 stall at 12 V. The PTC holds 3 A at 25 °C but only 2.5 A at 40 °C; see section 7.
Total current, continuous			16	A	80 % of the 20 A fuse.
3V3 from a programmer (logic only, no 12 V)	3.2	3.3	3.4	V	Into the 3V3 pin of J14 or J15.
Logic supply current		45		mA	Estimate: STM32 at 72 MHz, LEDs, regulators. Drawn from 12 V through the 78L05, or from a programmer's 3V3.
Kookabus or I2C header 3V3 from the host	3.0	3.3	3.6	V	Pull-ups only; under 1 mA.
I2C bus speed		400	400	kHz	STM32F103 fast mode. The board does not stretch the clock.
Servo bus speed		1	1	Mbps	ST3215 default. Other rates TBD in firmware.
Operating ambient temperature	0	25	40	°C	For the full 2.7 A per port. Above 40 °C a stalled servo can trip its PTC.

4. Electrical characteristics

Calculated at 25 °C from component datasheets unless stated. VIN is the XT60 input; V12 is the hub after the ideal diode and fuse; SERVO_Vn is port n's V+ pin after its PTC.

4.1 Power path

Parameter	Condition	Min	Typ	Max	Unit
Ideal-diode FET on-resistance	BRCS016N03ZC		2		mOhm
FET dissipation	8 A (eight servos moving) / 20 A		0.13 / 0.8		W
Reverse current, V12 back into the input	Input removed or reversed		0		A

Parameter	Condition	Min	Typ	Max	Unit
Hub capacitance	470 uF electrolytic plus 2 x 10 uF ceramic		490		uF
PTC hold current	Never trips at or below, 25 °C still air			3.0	A
PTC trip current	Always trips at or above, 25 °C	5.0			A
PTC time to trip	8 A			20	s
PTC resistance	New / after a trip or reflow	12		48	mOhm
Port voltage drop, hub to V+ pin	2.7 A; PTC plus 2.4 to 6.7 mOhm of copper	39		148	mV
Copper difference between ports	Inner ports 2, 3, 6, 7 against outer ports		4		mOhm
PTC dissipation when tripped	Surface up to 125 °C		2		W

4.2 Logic power

Parameter	Condition	Min	Typ	Max	Unit
5 V rail (78L05)	From V12, 30 V input rating	4.75	5.0	5.25	V
5 V rail load capacity				100	mA
78L05 dissipation	12 V in, 45 mA		0.32		W
3.3 V rail (XC6206)	From the 5 V rail	3.23	3.3	3.37	V
POWER LED (yellow)	On whenever 3.3 V is present, 1 kOhm		1.3		mA
STATUS LED (red)	PC13 low, 1 kOhm from 3.3 V		1.4		mA

4.3 Servo bus

Parameter	Condition	Min	Typ	Max	Unit
Bus logic level	SN74LVC1T45 B side at 5 V, 10 kOhm pull-up to 5 V		5		V
Series resistance to DATA	47 Ohm, zener node, 180 Ohm 1206		227		Ohm
Edge time constant	400 pF of servo cabling		90		ns
DATA shorted to 12.6 V	Clamp voltage / current / R7 dissipation		6 / 35 / 0.23		V / mA / W
Direction during reset	PA4 pulled low by 10 kOhm: receive				

4.4 Supply monitor

Parameter	Condition	Typ	Unit
Divider	100 kOhm / 10 kOhm, 1 %, 100 nF filter, V12 to PB1 (ADC1_IN9)	1 : 11	
Full scale / resolution	12-bit ADC, 3.3 V reference	36.3 / 8.9	V / mV
Accuracy	Divider tolerance plus the 3.3 V regulator's 2 %	±3	%
Divider current from V12	12 V	0.11	mA

5. Connectors, buttons and jumpers

5.1 Power input

Ref	Silkscreen	Part	Rating	Note
J1	12 V IN	Amass XT60PW-M (male, PCB, right-angle)	30 A	Mates with a female XT60 pack or supply lead.

5.2 Servo ports

Ref	Port	Part	Pin 1	Pin 2	Pin 3
J4 to J11	1 to 8	CJT A2501WV-3P, 2.5 mm, vertical (Molex 5264 compatible)	GND	V+ (SERVO_Vn)	DATA

All eight DATA pins are one bus: every servo needs a unique ID. Ports 1 to 4 are on the left edge and 5 to 8 on the right, numbered on the silkscreen. The latch side of each header faces the board edge, so plugs can be gripped and released.

> Draft: the pin order is from Feetech-based sources and is still to be confirmed against a real ST3215 lead before the board is ordered.

5.3 Control connectors

Ref	Label	Part	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5
J12, J13	Kookabus	JST SH 1.0 mm 4-way horizontal	GND	3V3 (pull-ups only)	SDA	SCL	
J2	I2C	2.54 mm 1 x 4 header	GND	3V3 (pull-ups only)	SDA	SCL	
J14	UART	2.54 mm 1 x 4 header	GND	RX (in)	TX (out)	3V3	
J15	SWD	2.54 mm 1 x 5 header	GND	NRST	SWCLK	SWDIO	3V3

J12 and J13 are wired in parallel for daisy-chaining and use the Qwiic and PiicoDev pin order. J2 is the same bus on a pin header, in the same pin order, for jumper wires when no Qwiic cable is at hand. Unlike Kookabus-01, the board does not draw power from the Kookabus 3V3 pin; it only feeds the I2C pull-ups (through JP3). The UART header's RX input is 5 V tolerant; TX drives 3.3 V.

5.4 Buttons and jumpers

Ref	Silkscreen	Function	As supplied
SW1	RESET	Resets the microcontroller	
SW2	BOOT	Holds BOOT0 high. Hold BOOT, tap RESET, release BOOT to enter the ROM serial bootloader on J14.	
JP1	A0	Address bit A0 (PA0). Bridged adds 1 to the address.	Open
JP2	A1	Address bit A1 (PA1). Bridged adds 2 to the address.	Open
JP3	PU	Connects the 4.7 kOhm SDA and SCL pull-ups to the host's 3V3. Cut to remove them when the host or another board already provides them.	Bridged (pull-ups on)

5.5 Fuses

F1 is an ATO/ATC blade fuse holder rated 30 A. Fit a 20 A, 32 V ATO blade fuse (Littelfuse 0287020.PXCN or equivalent). The fuse ships separately and must be fitted before use. F2 to F9 are BHFUSE BSMD2920-300-24V resettable PTCs, one per port, soldered in place. A tripped PTC resets by itself once the fault is removed and it has cooled.

6. Control interface

> Draft: the firmware and its register map are not yet written. This section lists what the hardware provides and what the firmware is planned to do. Registers and commands are TBD.

6.1 Planned functions

- Read position, speed, load, voltage and temperature from each servo
- Write target position, speed and acceleration, singly or to several servos at once
- Scan the bus for servos, and assign servo IDs without a separate programmer
- Read the 12 V supply voltage
- The same command set over I2C and the UART header

6.2 I2C address

JP1 and JP2 select one of four addresses, so up to four Kookabus-02 boards can share one I2C bus. The addresses are 0x14 (no jumpers), 0x15 (JP1 bridged), 0x16 (JP2 bridged) and 0x17 (both), clear of Kookabus-01 (0x40 to 0x45) and common Qwiic and PiicoDev devices. The table is also printed on the back of the board.

JP2 (A1)	JP1 (A0)	Address (7-bit)
Open	Open	0x14 (as supplied)
Open	Bridged	0x15
Bridged	Open	0x16
Bridged	Bridged	0x17

6.3 Microcontroller pin use

Pin	Port	Function
2	PC13	STATUS LED, active low
5, 6	PD0, PD1	8 MHz crystal
10, 11	PA0, PA1	Address jumpers A0, A1 (internal pull-ups; bridged reads low)
12	PA2	USART2 TX, single-wire half-duplex servo bus (10 kOhm pull-up)
14	PA4	Servo bus direction: high = transmit (10 kOhm pull-down)
19	PB1	ADC1_IN9, V12 sense
20	PB2	BOOT1, 10 kOhm to GND
30, 31	PA9, PA10	USART1 TX, RX to J14; ROM bootloader
34, 37	PA13, PA14	SWDIO, SWCLK
42, 43	PB6, PB7	I2C1 SCL, SDA (Kookabus J12, J13 and header J2)
44	BOOT0	BOOT button, 10 kOhm to GND

6.4 Flashing

The board needs power to be flashed: 12 V on the XT60, or 3.3 V from the programmer through the header's 3V3 pin (not both). Firmware updates always use one of these two methods.

1. **ST-Link on J15 (SWD)**: works on a blank chip. Use STM32CubeProgrammer, or the Arduino STM32 core with the board set to "BluePill F103C8".

2. **USB-serial adapter on J14**: hold BOOT, tap RESET, release BOOT, then use STM32CubeProgrammer in UART mode.

7. Protection and safety

Event	Response
Supply connected reversed	Blocked by the ideal diode. No current flows and nothing is damaged (up to -30 V).
Short on one servo port, or a servo stalled above 3 A	That port's PTC trips and limits the port to a trickle. The other seven ports keep running. The PTC resets once the fault is removed and it cools.
Servo stalled at 2.7 A	Below the PTC hold current at 25 °C, so the port stays on; the servo's own overload protection must act. In a warm enclosure (40 °C and above) the PTC may trip instead.
12 V applied to a DATA pin (for example a miswired lead)	Clamped to about 6 V through 180 Ohm, indefinitely. The servo bus stops working during the fault; nothing is damaged.
Voltage transient on the supply	Clamped by the SMBJ15A on the hub. A sustained overvoltage above about 17 V blows the 20 A fuse.
Short on the hub, or several ports faulted at once	The 20 A blade fuse opens. Replace it with the same rating.
A programmer's 3V3 and 12 V connected together	Not protected: the programmer and the on-board regulator both drive the 3.3 V rail. Connect the 3V3 pin only when 12 V is off.
Battery over-discharge	Not protected on the board. Read the supply voltage over I2C and stop the servos at the pack's minimum, or use a pack with its own cut-off.

Warning. Lithium packs and bench supplies can deliver hundreds of amps into a short circuit. Fit the 20 A fuse before connecting power, and keep loose metal away from the servo headers. Do not supply more than 12.6 V: the PTCs are rated 24 V and the TVS clamps at 24.4 V, so there is little margin above the servos' own limit. A tripped PTC runs at up to 125 °C; do not touch it.

8. Mechanical

Parameter	Value
Board size	75.0 x 75.0 mm, 3 mm corner radius
Thickness	1.6 mm FR-4, 2 layers, 2 oz copper both sides
Finish	Lead-free HASL, green solder mask, white silkscreen
Mounting holes	4 x 3.2 mm for M3, centres 3.5 mm from each edge (68.0 x 68.0 mm pattern), 3.6 mm radius clear of copper for screw heads
Component height, top	About 20 mm at the ATO fuse, 10.5 mm at the electrolytic capacitor, 8.5 mm at the XT60 (to be measured)
Component height, bottom	None. Through-hole leads protrude up to 1.5 mm.
Connector overhang	XT60: about 0.5 mm past the bottom edge.
Mass	TBD

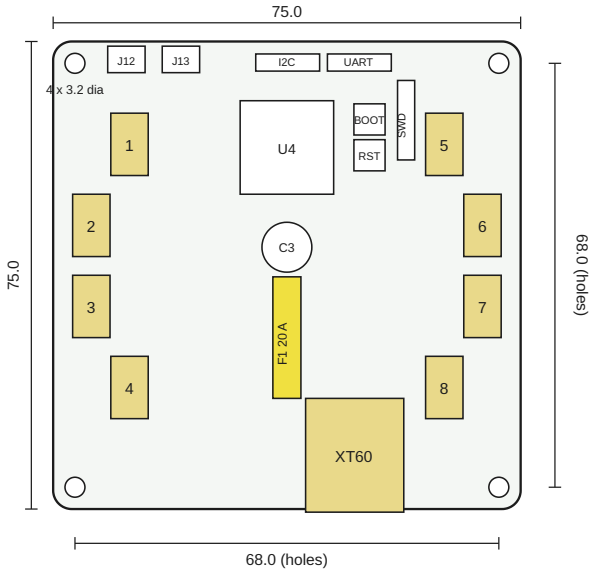


Figure 3. Outline, top view, millimetres. Connector bodies are approximate.

8.1 Connector positions

Board-local coordinates, origin at the top-left corner of the outline as viewed from the top, x to the right, y down.

Ref	x (mm)	y (mm)	Note
J4 to J7, ports 1 to 4 (pin 2)	12.76, 6.68, 6.68, 12.76	16.5, 29.5, 42.5, 55.5	Pins on 2.5 mm pitch along y; 13 mm between ports
J8 to J11, ports 5 to 8 (pin 2)	62.24, 68.32, 68.32, 62.24	16.5, 29.5, 42.5, 55.5	Mirror image of ports 1 to 4
J1 XT60	52.0	59.15	Pins on 7.2 mm pitch along x; face at the bottom edge
J12, J13 Kookabus	11.9, 20.5	3.4	Opening at the top edge
J2 I2C header (pin 1)	33.8	3.3	Pins on 2.54 mm pitch along x
J14 UART (pin 1)	45.2	3.3	Pins on 2.54 mm pitch along x
J15 SWD (pin 1)	56.5	7.5	Pins on 2.54 mm pitch along y
SW2 BOOT, SW1 RESET	50.8	12.6, 18.4	
F1 fuse	37.5	47.5	Blade slots along y
H1 to H4 holes	3.5, 71.5	3.5, 71.5	3.2 mm

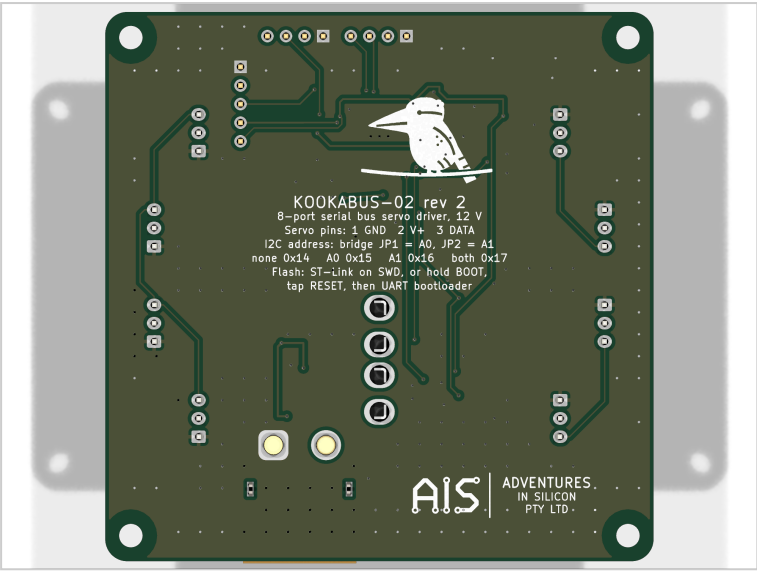


Figure 4. Bottom view (render). Ground plane, usage notes, the I2C address table, the Adventures in Silicon logo and the through-hole pins of the connectors and fuse holder.

9. Application information

9.1 Typical connection

1. Fit a 20 A ATO fuse in F1.
2. Give every servo a unique ID first. Out of the box, ST3215 servos all use ID 1, so connect them one at a time for this step.
3. Plug the servos into any ports.
4. Connect the host's Qwiic or PiicoDev port to J12 or J13 (or jumper wires to the J2 header). Use the other connector to chain further I2C boards.
5. Connect 12 V to the XT60. The POWER LED lights.

9.2 Sizing the supply

An ST3215 draws about 0.2 A holding position and up to 2.7 A stalled at 12 V. Size the supply for the servos that move together and are heavily loaded, not for eight stalls: eight servos moving under moderate load draw about 8 A.

9.3 Thermal

At 8 A the ideal-diode FET dissipates about 0.13 W and each moving port's PTC under 0.1 W. The 78L05 dissipates about 0.3 W from 12 V. No heatsink is needed. The PTCs' hold current falls as they warm (2.5 A at 40 °C, 2.3 A at 50 °C), so in a closed enclosure a servo held near stall for a long time can trip its port. Ventilate the enclosure, or keep sustained loads below the derated hold current.

10. Ordering and fabrication

Item	Detail
Product	Kookabus-02, board revision 2
Supplied as	Assembled board without the 20 A fuse, or bare PCB with the design files
Fuse required	1 x ATO/ATC 20 A 32 V blade fuse

Item	Detail
Design files	KiCad 10 project, Gerbers, drill, position and BOM files, JLCPCB assembly BOM and placement files
Key components	STM32F103C8T6, MX74700T ideal-diode controller (TI LM74700-Q1 compatible), BRCS016N03ZC 30 V FET, 8 x BSMD2920-300-24V PTC, SN74LVC1T45 translator, 78L05, XC6206P332MR, SMBJ15A TVS, PESD5V0S2BT ESD, XT60PW-M, XF-507P fuse holder, A2501WV-3P servo headers

11. Revision history

Board rev	Date	Change
1	28 September 2026	First design: eight ports, STM32F103 with native USB, three parallel 12 V inputs. The MCU area was re-laid out after review: crystal beside the MCU, decoupling capacitors on their pins, shorter reset line.
2	28 September 2026	Cost-down: USB-C removed (with its ESD chip, CC and pull-up resistors and the BAT54C OR diode); XT60 is the only 12 V input (screw terminal and barrel jack removed); new 2.54 mm I2C pin header J2; address jumpers moved to PA0/PA1, addresses set to 0x14 to 0x17; website address on the front and the address table and Adventures in Silicon logo on the back.

Document rev	Date	Change
0.1	28 September 2026	First draft, for board revision 1. Calculated values only; firmware interface to be defined.
0.2	28 September 2026	Updated for board revision 2. I2C addresses defined.

Adventures in Silicon Pty Ltd. Kookabus-02 Datasheet, document revision 0.2 (draft), 28 September 2026.

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