SAFEBACK | SMART AQUACULTURE | GUANGZHOU, CHINA

TK-R12-SC4S-BG Twelve-Way Control Board

4 three-phase groups × 12 outputs · staggered start · phase-loss trip · one 3-phase per group, or one 1-phase per pole

Product datasheet (EN) · Rev. 2026-10 · for export customers

1. Product overview

The TK-R12-SC4S-BG is the high-current **execution end** of the SAFEBACK control layer. It is also a **local controller that can stand duty on its own**: **4 three-phase groups, 12 outputs in total**, with U / V / W in each group switching together, so one board carries four three-phase aerators. It has **three RS485 ports of its own**, so DO and water-quality probes can be wired straight in and the board acts on its own settings, so **it runs without a gateway and keeps running when 4G drops**. Behind a gateway it becomes the gateway's hand, turning remote and cloud decisions into real switching.

The hard part on a large farm is not "can I switch it remotely" but "will four motors starting together pull the transformer down". Four 3 kW motors closing at the same instant stack their inrush, the voltage sags, the gateway reboots, and on a weak branch the breaker trips. This board lets the four groups **come in one at a time** at a settable interval (3–6 s is the factory recommendation), so the inrush is spread out and the voltage holds.

The other point that is easy to miss is **whether the motor is actually turning**. A closed contactor does not mean a running motor: with a lost phase or a jammed impeller the circuit is still live while the motor runs single-phase, and it can burn out in a quarter of an hour. Every group carries one current transformer on each of U, V and W — 12 in total — and the three currents are compared: if one phase falls close to zero while the other two rise, the group is tripped as a phase loss and reported. This protects the motor, not just the contactor.



Fig. 1 Front view: three-phase input and 12 load outputs on the top rail, 12 lever relays below

2. Key features

- **One board, four aerators** — 4 groups × U/V/W = 12 outputs, ≤3 kW per output, covering the mainstream 0.75–3 kW aerator range.
- **Runs standalone and self-heals** — three RS485 ports take DO and water-quality probes directly, and the board acts on its own thresholds; a gateway offline or a 4G outage does not stop it.
- **One flick to power up in the worst case** — every relay has a manual lever: if the control circuit fails, flip the lever to the closed position and the aerator is energised, with no electronics in the path.
- **Staggered start** — the four groups never close together; they come in at a settable interval (3–6 s recommended), which keeps the inrush from collapsing the branch voltage and rebooting the gateway.
- **12 CTs, per-phase monitoring** — one transformer on each phase; a phase loss trips that group immediately and reports it, and a current imbalance raises an alarm before the motor cooks.
- **Drives 3.5 kW directly, no contactor needed** — lever relay contacts rated **up to 50 A**, with a measured electrical life of 20,000 operations (five years or more at ten starts a day).
- **Works without a neutral — and takes up to 12 single-phase aerators** — three-phase three-wire input, no neutral drawn, which is exactly what older rural supplies provide. If every aerator is 220 V single-phase, each of the 12 poles feeds one unit, with the neutral taken from the panel neutral bar and never through the board.
- **3 × RS485 ports plus 12 V out** — cascade with the gateway and stack boards to add capacity; probes and small peripherals can take 12 V straight from the board.
- **Holds state on power loss** — the lever relays are latching, so a power cut does not throw everything open or closed; supply returns and the board carries on as before.
- **Bluetooth local setup** — change the slave address and RS485 baud rate from the phone mini-program, without opening the enclosure or needing a laptop.
- **Immune to switching arcs** — arcs from contactors, pumps and other inductive loads on the same supply do not upset operation.

3. The TK family and model coding

Every SAFEBACK aquaculture product carries the **TK** prefix: **TK – category code + specification number**. The two-letter code identifies the category; the number carries the single most important figure for that product — rated power in watts for powered equipment, measured parameters ×100 for sensors, screen size ×100 for terminals. Gateways and execution boards are coded by role and configuration.

Code	Category	Model	Meaning
GW	4G IoT gateway	TK-4G-GW	4G Cat.1 uplink (coded by role)

Code	Category	Model	Meaning
R12	Twelve-way control board	**TK-R12-SC4S-BG**	R12 = 12 outputs; SC4S = three-phase × 4 groups; BG = enclosure / version code
YL	Impeller aerator	TK-YL1500	Rated power 1500 W
YC	Waterwheel aerator (mains)	**TK-YC750SL**	Rated power 750 W, twin impeller
YC	Waterwheel aerator (mains)	**TK-YC1500SL**	Rated power 1500 W, four impellers
FS	Pneumatic feeder	TK-FS2000	Rated power 2000 W, 30 m conveying
—	Two-bag feeder	TK-150D	150 kg/h class; D = dual hopper
DO / PH / ORP	Single-parameter probes	TK-DO100 / TK-PH100 / TK-ORP100	Single parameter
MP	Integrated multi-parameter probe	TK-MP500	Five parameters

The control layer is a brain and a hand: **TK-4G-GW** reads the probes, runs the rules and talks to the cloud; **TK-R12-SC4S-BG** turns the verdict into twelve real switch operations. The two sit on one RS485 bus speaking one Modbus RTU protocol. To expand, add a gateway sideways and a board lengthways — existing equipment stays as it is.

4. Technical specifications

4.1 Unit and electrical

Item	Specification
Model	TK-R12-SC4S-BG
Type	Twelve-way three-phase high-current control board (execution end)
Outputs	4 groups × (U / V / W) = 12 outputs; the three poles of a group switch together
Input	Three-phase 380 V 50 Hz; two terminals per phase (U, V, W) in parallel feeding the four groups; **no neutral**
Single-phase load	One 220 V unit per pole, **up to 12 when the whole site is single-phase**; the neutral is taken from the panel neutral bar (the board does not switch neutral). The three poles of a group move together, so its three single-phase units start and stop together — pick units of similar rating
Load per output	≤3 kW (0.75–3 kW aerators directly; larger loads via an external contactor)
Switching device	Latching lever relay, contact rating **up to 50 A**, electrical life 20,000 operations
Current monitoring	12 current transformers, one per phase, for phase-loss and imbalance detection
Control supply	DC 12 V; relay operation draws a current spike, so keep 1 A of headroom
Operating modes	**Two**: ① standalone — probes on the three RS485 ports, thresholds held locally, keeps running when the link drops; ② controlled — commands from the TK-4G-GW gateway
Communication	3 × RS485 (Modbus RTU slave), 9600 / 8 / N / 1, slave address 40 by default
Local setup	Bluetooth with the phone mini-program: slave address and RS485 baud rate
Indication	One LED (about 500 ms blink = running normally); one button, not needed in daily use, used for firmware update
Storage	Configuration retained through power loss; a separate partition holds run logs and history

Item	Specification
Protection	The board itself is not waterproof; **inside a rainproof control box (IP55 or better) the system reaches IP65**
Operating environment	−20 to +60 °C, 5% to 95% RH non-condensing
Immunity	Withstands switching arcs and surges from inductive loads at the pond head
Firmware	Over-the-air update with automatic rollback on failure (production firmware governs)

4.2 Terminal assignment

Terminal	Name	Notes
PE	Earth	**Must be connected**, otherwise the enclosure can become live
U / U	U-phase input	Two terminals in parallel, feeding the four groups
U1 U2 U3 U4	U-phase outputs	Groups 1 to 4 respectively
V / V	V-phase input	Two terminals in parallel, feeding the four groups
V1 V2 V3 V4	V-phase outputs	Groups 1 to 4 respectively
W / W	W-phase input	Two terminals in parallel, feeding the four groups
W1 W2 W3 W4	W-phase outputs	Groups 1 to 4 respectively
12V A1 B1 GND	RS485 port 1	A to A, B to B, common ground mandatory; 12 V available for small peripherals
12V A2 B2 GND	RS485 port 2	As above
12V A3 B3 GND	RS485 port 3	As above

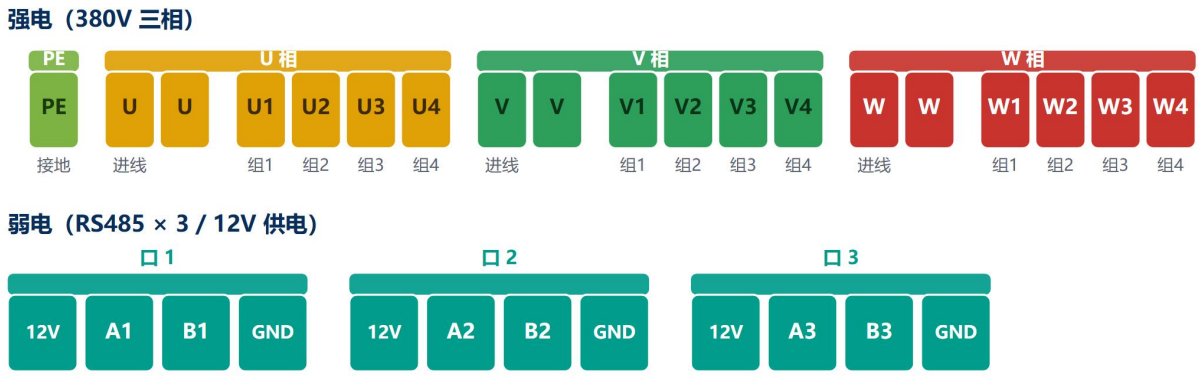
31 terminals in total (see the terminal diagram in section 5). **The board has no neutral**: in three-phase use one group feeds one motor; in single-phase use each pole feeds one 220 V unit, up to 12 in total, with **the neutral taken from the panel neutral bar and never landed on the board**.

4.3 Protection and operating behaviour

Item	Behaviour
Phase-loss trip	The three currents of a group are compared; if one falls close to zero while the others rise, the group is tripped and reported. In single-phase wiring the same test compares the three units of the group, so any one losing current raises the alarm
Current imbalance	An imbalance beyond the set ratio raises an alarm before the motor overheats
Staggered start	The four groups close one at a time at a settable interval, 3–6 s recommended
Power loss	The lever relays are latching: state is held through a power cut and resumed when supply returns
Manual override	A lever on every group forces it closed or open; with the control circuit dead, the lever still energises the aerator
Arc immunity	Arcs from contactors and pumps breaking inductive loads do not disturb the board
Standalone operation	Without a gateway, probes on the three RS485 ports drive the board through local thresholds, delays and deadband; a gateway or 4G outage does not stop it, and data is back-reported on recovery
Interlock	With a gateway, commands come from it; the board's local rules still apply and the two do not conflict

5. Terminals and how it works

5.1 Terminal layout



共 31 位端子；PE 必须接。三相：一组带一台；单相：每极带一台（最多 12 台），零线另引不进本板。A 接 A、B 接 B、GND 共地。

5.2 From incoming supply to load

1. **Incoming** — connect the three phases to the U, V and W input terminals (two per phase, for splitting to the four groups).
2. **Grouping** — U_n, V_n and W_n of group *n* are driven by one lever relay switching all three poles, so the group can never close with a phase missing.
3. **Sensing** — one current transformer on each phase of each group reads the three currents continuously.
4. **Judging** — one phase near zero with the other two rising means phase loss: trip the group and report it; an imbalance beyond the ratio raises an alarm.
5. **Staggering** — when several groups are wanted at once, they close in sequence at the set interval (3–6 s recommended) so the inrush does not stack.
6. **Reporting** — group states, currents and alarms go to the gateway over RS485 and up to the cloud; **without a gateway or with 4G down, the board keeps judging and switching on its own settings**, logging locally and back-reporting afterwards.

6. Installation and site requirements

- **Location** — inside a pond-head control box rated IP55 or better, with 50 mm of clear space above and below for airflow; do not mount it tight against a VFD.
- **Earthing** — PE must be bonded to the enclosure and the earth electrode, with a conductor no smaller than half the phase conductor. An unearthed enclosure can become live.
- **Incoming** — three-phase 380 V with a main breaker and RCD. **The board needs no neutral**; do not land a neutral on any terminal.
- **Outgoing** — three-phase: one group to one three-phase aerator. Single-phase: the three poles of a group each feed one 220 V aerator, with their neutrals joined and run back to the panel

neutral bar (no neutral terminal on the board — never land a neutral on U/V/W). Size the conductors for the load; above 3 kW per output, interpose an AC contactor.

- **12 V supply** — a dedicated supply with at least 1 A of headroom. Do not share a small supply with inductive loads, or relay operation will brown it out and restart the board.
- **RS485** — A to A and B to B; reversed polarity means no response. GND must be common with the gateway, and the bus should be earthed at one point only.
- **Maintenance** — the lever relays **hold their state** after the supply is cut: isolate upstream and prove dead before touching anything. Do not rely on the indicator alone.
- **Emergency override** — if the control circuit or the board fails, flip the lever of the affected group to the closed position with an insulated tool to energise the aerator. Make sure nobody is working on the load side first.
- **Lightning** — in thunderstorm areas fit multi-stage SPDs in the box and bond all metalwork.

7. Configuration and selection

Aerators (three-phase)	Recommended	Notes
1–4	TK-R12-SC4S-BG × 1	One group per motor, which is where staggered start works best
5–8	TK-R12-SC4S-BG × 2	Both boards on the same RS485 bus with different slave addresses
More than 8	Add boards in steps of 4, with 1–N gateways	On scattered ponds use a gateway per pond, for local control and local protection
Automatic control	Board + TK-4G-GW + TK-DO100	DO closed loop: start below the set point, stop when it recovers
Must hold up without a link	R12 running standalone (no gateway)	Probes wired straight in with local thresholds; a gateway or 4G outage changes nothing
All single-phase 220 V	One TK-R12-SC4S-BG for 12 units	One unit per pole, neutral taken from the panel; the three units of a group start together, so pair units of similar rating

Sizing in one line: **count the three-phase aerators, divide by four and round up** — that is the number of boards. Add a gateway and a DO probe for automatic control. The feeders (FS2000 / 150D) carry their own control and take no circuits on this board.

8. Notes for regional markets

This unit runs on DC 12 V and never connects to the grid directly — there is always an adapter or a power supply in between. So what differs is not the voltage level, but the adapter's input range, the radio bands and the certification. Check the table first.

Country / region	Single-phase	Three-phase	Frequency	Relation to this unit
Vietnam	220 V	380 V	50 Hz	Identical
Thailand	220 V	380 V	50 Hz	Identical

Indonesia	220 V	380 V	50 Hz	Identical
Cambodia	220 V	380 V	50 Hz	Identical
Bangladesh	220 V	380 V	50 Hz	Identical
Mongolia	220 V	380 V	50 Hz	Identical
Myanmar	230 V	400 V	50 Hz	+5%
Singapore	230 V	400 V	50 Hz	+5%
Malaysia	240 V	415 V	50 Hz	+9%
India	230 V	400 / 415 V	50 Hz	+5–9%
Philippines	220 V	380 / 480 V	60 Hz	Frequency differs

8.1 Fully compatible — 380 V / 50 Hz

- **Vietnam, Thailand, Indonesia, Cambodia, Bangladesh, Mongolia** — These six markets use the same low-voltage system as China: 380 V three-phase, 220 V phase-to-neutral, 50 Hz. The machine connects directly — no transformer, no re-wound motor. This is where the TK series is easiest to sell against European or American equipment.
- **Vietnam is the reference market** — 0.4 kV three-phase four-wire, 380 V between phases, 220 V phase-to-neutral, 50 Hz — the same as China. Small ponds in the south often have only a single-phase 220 V service, or three-phase with too little capacity; tell us the service type, transformer rating and existing load before ordering. If a single-phase machine is required, specify the D configuration.
- **Phase loss and voltage sag** — Voltage sag at the end of a rural feeder, and phase loss, are the number-one cause of burnt motors — not the voltage level. Fit a phase-failure overload relay per machine; if you run demand-based aeration (C configuration), the control board already provides that protection.

8.2 Wide-range coverage — 400 to 528 V / 50 Hz

- **Malaysia 415 V, India 400–415 V, Singapore 400 V, the Philippines 480 V — no transformer needed** — These voltages look higher than 380 V, but they are not a problem for our machines: the control supply is a 90–528 VAC wide-range input. Single-phase 220 V, 380 V phase-to-phase, 440 / 480 V — all accepted, and 100–745 VDC as well. No step-down transformer, no country-specific model. One machine covers Southeast Asia.
- **CE covers 100–400 VAC only — say so plainly** — Operation between 480 and 528 VAC is fine, but it sits outside the CE certification range. Quote within 400 VAC for tenders and certification files; where 480 V is genuinely used, state it in the technical deviation sheet rather than glossing over it — this is exactly what a customer's acceptance engineer will check.
- **The motor side still deserves a glance** — A wide-range control supply does not make the

motor wide-range. A 380 V three-phase motor on a 415 V supply sees +9.2%, which is inside the ±10% window of IEC 60034-1 and will run; but in hot, humid pond-side enclosures the thermal margin is thin, so for continuous full-load duty confirm the actual voltage once, or take one frame size up. Same logic for 240 V single-phase in Malaysia.

8.3 Different frequency — the Philippines at 60 Hz

- **A 50 Hz motor must not be connected to a 60 Hz supply** — The Philippines runs 220 V / 60 Hz nationwide, with 380 V or 480 V three-phase for industry. On 60 Hz a 50 Hz motor turns 20% faster; for impeller and fan loads shaft power rises with the square to cube of speed, so the demand reaches 1.4–1.7 times rated power — this is not 'a bit faster', it is guaranteed overload.
- **Three ways out — decide before ordering** — ① Order a 60 Hz motor; cleanest. ② Run a VFD with the frequency clamped to 50 Hz, at the cost of about 17% of output. ③ Size up one frame and run it at 60 Hz. This has to be settled at the order stage; it cannot be fixed in the field.
- **Confirm the three-phase voltage as well** — Both 380 V and 480 V three-phase exist in the Philippines — legacy US-era projects are usually 480 V, local distribution usually 380 V. Ask the customer to photograph the panel nameplate before ordering.

8.4 Power draw and contact rating

- **The board itself draws almost nothing** — DC 12 V at about 0.1 A idle — negligible. What matters is the load it switches.
- **Contact rating sets how many machines** — ≤3 kW resistive / ≤1.5 kW inductive per channel, 12 channels within the total rating. A three-phase 380 V load occupies three poles per channel, so the usable channel count depends on load type.
- **Higher grid voltage affects contact endurance** — On 415 V networks (Malaysia, India) the arc voltage across the contacts rises, so inductive loads should be derated. On 60 Hz (the Philippines) relay timing is unchanged, but any motor driven must be a 60 Hz machine.

8.5 Climate and corrosion

- **Hot and humid** — Across Southeast Asia: enclosures IP55 or better with desiccant inside; surge protection on the incoming supply, essential in thunderstorm areas.
- **Salt spray** — Coastal salt spray attacks terminals and PCB solder joints. Inspect terminals every six months, apply anti-oxidation grease, and specify stainless or coated enclosures.
- **Monsoon flooding** — India, Bangladesh, Myanmar: mount above the historical flood level, run cables on trays or overhead.

8.6 Certification and documents

- **Mandatory certification differs by country** — Vietnam CR (QCVN 4:2009/BKHCN for low-voltage equipment), Thailand TISI, Indonesia SNI, the Philippines BPS/PS or ICC, Malaysia SIRIM /

ST, India BIS. Most schemes are mandatory only for certain power ranges — confirm against the local customs requirement.

- **CE and IEC reports are the passport** — Beyond the local schemes, a CE declaration and IEC test reports are the two documents customers ask for most, tenders in particular. Ask before ordering and we ship them with the goods.
- **Language of the documents** — Standard documentation is bilingual Chinese/English. Vietnamese, Thai, Indonesian or Tagalog manuals and nameplates must be requested in advance — they are typeset separately, priced separately, and extend the lead time.

8.7 Five questions before ordering

① Is the pond service three-phase or single-phase? What is the transformer rating?

② What is the measured voltage on site? — the actual reading, not the nominal figure.

③ Is the frequency 50 Hz or 60 Hz? — the Philippines must be confirmed separately.

④ Is the water fresh, brackish or salt? Roughly what salinity?

⑤ Which language do you need for the manual and the nameplate?

This table is a general judgement. Province-level differences — a rural feeder that sits low all year, an extra clearance step at a particular port, a local subsidy scheme — should be added by the local sales team to the project file. For a country not listed here, judge by the same three dimensions: voltage, frequency, certification; if in doubt, ask the factory.

9. Frequently asked questions

Can it work without a gateway? Yes. Wire the probes to the three RS485 ports, set the thresholds and delays locally, and the board switches on the readings. No link, no 4G, no gateway — it still runs. Adding a gateway brings remote access and the cloud on top.

If the board fails, do the aerators stop for good? No. Every group has a manual lever; set it to closed and the aerator is energised by hand, with no electronics in the path.

Can it run single-phase 220 V aerators? Yes — **up to 12 when the whole site is 220 V**. The three poles of a group move together, so in single-phase use each pole feeds one 220 V aerator and the four groups carry 12. **The neutral never enters the board**: the units' neutrals are joined and run back to the panel neutral bar. Note that the three units of a group start and stop together (one lever for three poles), so pick units of similar rating and duty — that also keeps the current comparison and imbalance test meaningful.

How many aerators per board? Four groups of three phases, so four three-phase aerators, at ≤3 kW per output. Larger motors need an external contactor.

Will four motors starting together trip the breaker? Not by default — the groups close one at a time at the set interval (3–6 s recommended), so the inrush does not stack. The interval is

configurable.

What happens on a phase loss? That group trips immediately and is reported, while the other groups keep running. The app shows which group and which phase.

After a power cut, will everything stop or all start? The lever relays are latching: state is held through the outage and resumed on return. Isolate and prove dead before maintenance.

Do I need extra contactors? Not up to 3 kW — the board drives 3.5 kW directly. For very frequent switching or larger loads, add a contactor to extend life.

Is the relay life enough? 20,000 electrical operations, five years or more at ten starts a day. For heavy cycling, add a contactor.

Can it talk to platforms other than yours? Yes — it is a standard Modbus RTU slave, readable by any Modbus master. On the SAFEBACK cloud platform the thresholds, alarms and curves are already built in.

How do I change the address and baud rate? Over Bluetooth from the phone mini-program, with no need to open the enclosure. Default address 40, 9600 / 8 / N / 1.

Is the board itself waterproof? No, it must go inside a control box; in an IP55 or better rainproof box the system reaches IP65.

10. Packing, delivery and commercial terms

- **Packing** — antistatic bag, foam and individual carton, master carton for bulk; carton size and gross weight follow the packing list.
- **Container loading** — 20GP / 40HQ quantities are calculated from the final carton size; our loading plan is confirmed before the order.
- **Lead time** — scheduled on order confirmation; stock availability advised separately.
- **Port of loading** — Nansha / Yantian, China.
- **Documents** — wiring and configuration guide in Chinese and English; a Vietnamese version can be prepared on request.
- **Not included** — control box, SPD arresters, RCD, 12 V power adapter, AC contactors for loads above 3 kW, on-site labour and consumables.
- **Warranty** — one year against manufacturing defects, **counted from the date of manufacture**. Lightning damage, water ingress, overload burning and unauthorised repair are excluded.

11. Contact

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Specifications are subject to change without notice as the product is improved; confirm current data before tendering or volume orders.