

DC Brushless Fan Control & Protection Functions

An engineer's guide to soft-start, locked-rotor protection, speed feedback, constant-speed operation, and thermal / voltage / current / PWM speed regulation for axial fans and blowers.

5 V / 12 V / 24 V / 48 V DC

Axial & Blower Series

Open-Collector Signal Outputs

Custom Wiring & Connectors

Introduction

Modern DC brushless fans do far more than move air. Their on-board electronics can limit inrush current at start-up, protect the fan and its drive under a locked-rotor or over-voltage fault, report real-time speed and health status to the host system, and regulate airflow against temperature, supply-voltage variation, or a direct control command. Specifying the right control functions up front reduces field failures, simplifies EMC compliance, lowers acoustic noise, and allows the host equipment to run quieter and more energy-efficiently.

This guide defines the **14 standard control and protection functions** available across our DC axial fan and blower range. For every function you will find a plain-language description, key electrical characteristics, typical applications, and a timing or performance diagram. Functions marked *built-in* require no extra wire; functions marked *external* use a dedicated, color-coded lead.

Inside this guide

1. Start-Up & Current Management (SS, LP, CL)
2. Voltage & Speed Protection (OVP, CS)
3. Speed Feedback & Diagnostics (FG, RD, RDB, LD)
4. Automatic & Manual Speed Control (TC, RC)
5. External Command Interfaces (VC, CC, PWM)
6. Wire Reference & Ordering Checklist

Function Selection Matrix

AT A GLANCE

Code	Function	Lead color	Type	Primary benefit
SS	Soft Start	Built-in	Start-up control	Ramps current over ~5 s; suppresses inrush current, voltage sag and start-up noise.
LP	Locked-Rotor Protection with Auto-Restart	Built-in	Protection	Removes drive on blockage and restarts automatically every ~5 s once cleared.
FG	Frequency Generator / Tachometer Output	Yellow	Feedback	Pulse train proportional to speed for RPM monitoring and fan-fail detection.
RD	Rotation Detection	White	Feedback	Open-collector alarm: LOW while running, HIGH when the rotor is stalled.
RDB	Rotation Detection (inverted)	Violet	Feedback	Inverse of RD: HIGH while running, LOW when stalled, for active-low logic.
LD	Life / Low-Speed Detection	Brown	Diagnostics	Alarms when speed drops below 70% of rated RPM (bearing wear or low voltage).
OVP	Over-Voltage Protection	Built-in	Protection	Shuts the fan down under an excessive supply voltage; threshold configurable.
TC	Temperature Automatic Control	Green	Closed-loop control	Fan speed follows temperature via an internal or external NTC thermistor.
RC	Manual Variable-Resistor Control	Orange	Manual control	End-user speed adjustment with a 10–100 kΩ potentiometer.
CL	Current Limit	Built-in	Protection	Limits motor current during locked-rotor and restart events.
CS	Fixed Constant-Speed Operation	Built-in	Regulation	Holds rated RPM across a wide supply-voltage window (e.g. 48–72 V).
VC	DC Voltage Speed Control	White	External command	Linear speed command via 0–10 V (0–5 V recommended).
CC	Current-Loop Speed Control	White	External command	Noise-immune 4–20 mA industrial speed command.
PWM	Pulse-Width-Modulation Control	Blue	External command	Digital speed command at 30 Hz–30 kHz via duty cycle.

Design tip: Speed-control functions (TC, RC, VC, CC, PWM) can be supplied with SS soft-start, CL current-limit and CS constant-speed logic integrated together — specify the complete function stack on your order rather than selecting a single code.

SS Soft Start

Built-in · no extra lead

Gradually ramps motor current from zero to the rated value instead of applying full power instantly.

HOW IT WORKS

- When power is applied, current increases linearly until the fan reaches maximum speed and rated current.
- The fan reaches its stable rated speed within approximately **5 seconds**.
- Peak start-up current equals the free-running current (no inrush spike).

TYPICAL APPLICATIONS

Multi-fan systems fed from a single limited-capacity supply, 12/24 V equipment sensitive to voltage sag, battery-powered and portable devices, and installations where start-up noise must be minimized.

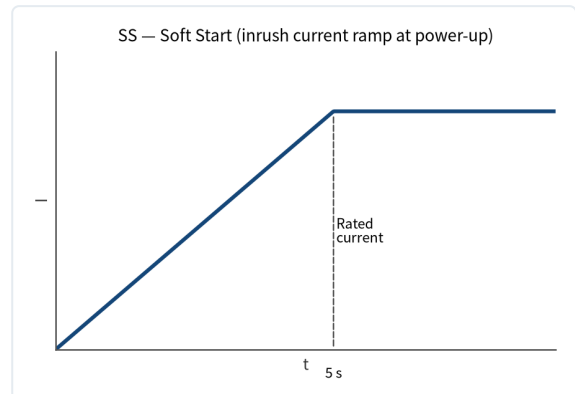


Fig. 1 — Inrush-current protection at power-up (standard function).

LP Locked-Rotor Protection with Auto-Restart

Built-in · no extra lead

Automatically removes drive when the impeller is blocked and restarts the fan after the obstruction is cleared.

HOW IT WORKS

- If the rotor locks, current is first limited to roughly **1/3 of rated current** for detection, then drive is removed.
- The controller attempts a restart approximately every **5 seconds**, using a ~3 s soft-start ramp.
- Normal operation resumes automatically as soon as the impeller is free — no power cycle is required.

TYPICAL APPLICATIONS

Dusty or fiber-laden environments (filters, heat exchangers), equipment where fans are not serviceable in the field, and unattended or outdoor installations.

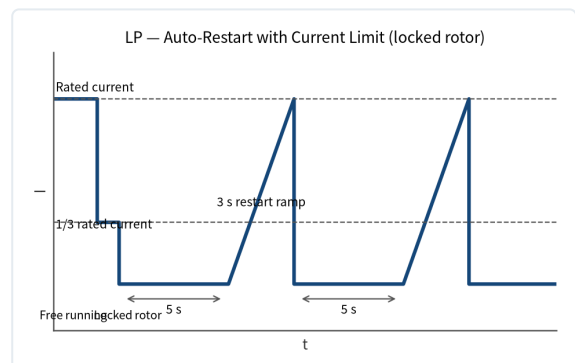


Fig. 2 — Auto-start with current-limit / standard restart function.

CL Current Limit

Built-in · no extra lead

Caps the motor current during a locked-rotor condition and each restart attempt.

HOW IT WORKS

- While the rotor is locked, winding current is held to a safe fraction of its rated value.
- Protects the motor windings, drive electronics and host power supply from sustained over-current.
- Frequently combined with LP auto-restart and with the speed-control functions.

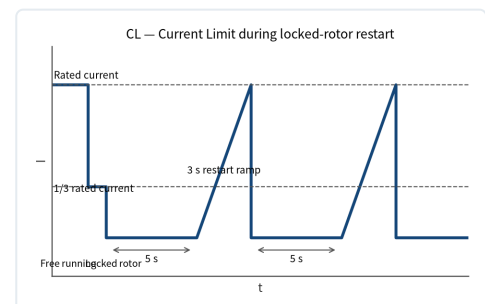


Fig. 10 — Auto-start with current limit during locked-rotor restart.

OVP Over-Voltage Protection

Built-in · no extra lead

Continuously monitors the supply voltage and shuts the fan down when it exceeds the permitted maximum.

HOW IT WORKS

- The protection threshold is defined relative to the rated operating voltage and can be configured at order time.
- As standard, the protection range can be specified up to **2× the rated voltage**: for example a 24 V fan up to 48 V, or a 12 V fan up to 24 V.
- When an over-voltage event is detected, the fan stops and supply current falls to essentially zero.

The exact trip point varies by model and specification — the diagram shows a 48 V unit with the OVP function characterized at 72 V. Confirm the threshold for your application with our engineering team.

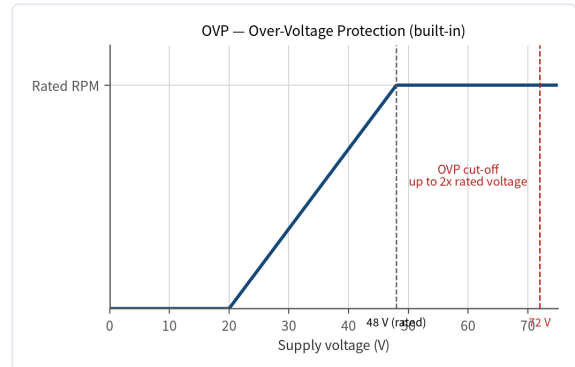


Fig. 7 — Constant-speed / standard function with over-voltage cut-off.

CS Fixed Constant-Speed Operation

Built-in · no extra lead

Maintains the rated speed across an unusually wide supply-voltage range, independent of voltage fluctuation.

HOW IT WORKS

- The drive regulates motor power so that RPM stays constant even when the supply voltage moves well above nominal.
- Example: a fan designed for **4,200 RPM at 48 V** holds that speed as the supply varies from **48 V to 72 V**.
- Guarantees a known airflow and acoustic signature in systems with poorly regulated or charging/battery-backed rails.

TYPICAL APPLICATIONS

Telecom and server power (54 V systems with float-charging batteries), 48 V industrial equipment, and any thermal design that assumes a fixed minimum airflow.

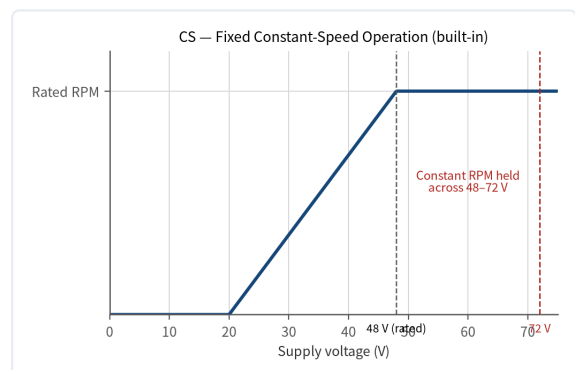


Fig. 11 — Fixed constant-speed (standard) function vs. supply voltage.

FG Frequency Generator / Tachometer Output

Yellow lead

An open-collector pulse train whose frequency is proportional to fan speed.

- The open-collector output connects to an external **pull-up resistor** on the host/reader side.
- Compatible with TTL input logic; the output switches between 0 V and the pull-up voltage.
- Rated for up to **72 VDC** open-collector voltage and **10 mA** maximum sink current.
- The reader and the fan **must share a common ground**. When the rotor stops, the output holds a fixed level.

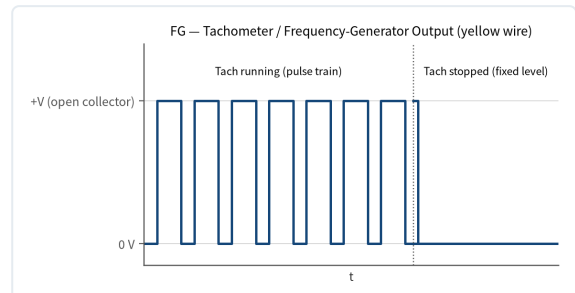


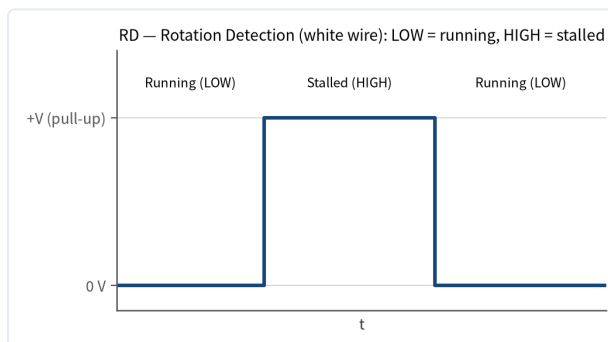
Fig. 3 — Tachometer output while running and when stopped.

Used for real-time RPM readout, closed fan-speed control in the host, and predictive maintenance.

RD Rotation Detection

White lead

Open-collector fan-fail alarm.

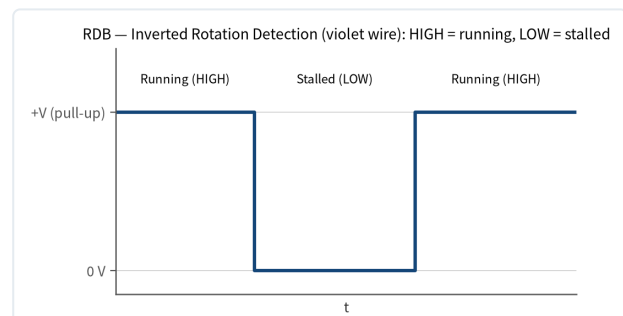


Output is pulled **LOW** while the fan is running and goes **HIGH** when the rotor is stalled. Common ground with the reader is required.

RDB Rotation Detection, Inverted

Violet lead

Inverse-logic fan-fail alarm.



Identical hardware to FG/RD, but the output is **HIGH** while running and **LOW** when stalled — for host inputs that require an active-low alarm.

LD Life / Low-Speed Detection

Brown lead

Alarms when the fan runs below 70% of its rated speed — an early indicator of bearing aging or insufficient supply voltage.

- Open-collector output, same electrical interface as the FG function.
- At normal rated speed the output is LOW; once speed falls under **70% of rated RPM**, the alarm state is asserted.
- Typical causes are end-of-life bearing wear, friction build-up, or a brownout/under-voltage supply.

Recommended for high-reliability systems where thermal performance must be guaranteed over a multi-year service life.

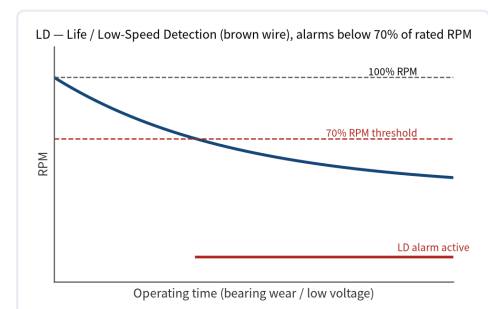


Fig. 6 — Life detection vs. speed degradation.

TC Temperature Automatic Control

Green lead · NTC

Fan speed is governed by measured temperature, so cooling and acoustic noise scale with the actual thermal load.



- An NTC thermistor — either built into the fan or mounted remotely by the customer — sets the speed command.
- CS constant-speed, SS soft-start and CL current-limit logic can all be included.
- Three standard temperature profiles are available (below); set-points and slopes can be customized.

Ideal for quiet office/medical equipment: the fan idles at low speed (or off) when cool and ramps up only as the system heats.

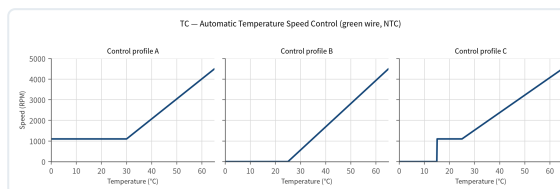
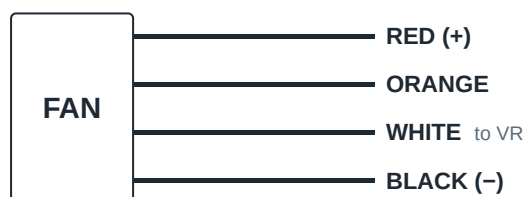


Fig. 8 — Speed vs. temperature, profiles A / B / C. Parameters customizable per customer.

RC Manual Variable-Resistor Control

Orange lead · potentiometer

Speed is set directly by an external potentiometer, giving the end user a manual fan-speed dial.



- The external potentiometer VR may have a maximum value between **10 kΩ** and **100 kΩ**.
- Speed varies linearly with resistance; CS, SS and CL logic can be integrated.
- Three standard response profiles are available (below).

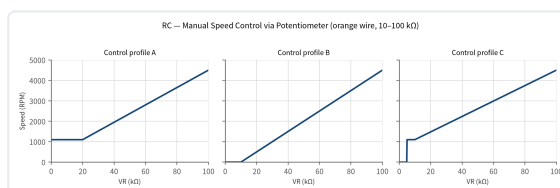


Fig. 9 — Speed vs. VR (kΩ), profiles A / B / C. Parameters customizable per customer.

VC DC Voltage Speed Control

- Speed follows the applied DC voltage; the command range is generally **0–10 V**, with **0–5 V recommended**.
- Simple analog interface for PLC analog outputs, DACs and manual 0–10 V building controls.

White lead · Vin 0–5 VDC

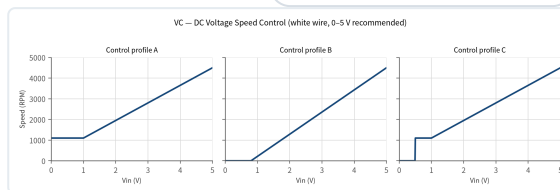


Fig. 12 — Speed vs. Vin, profiles A / B / C.

CC Current-Loop Speed Control

- Speed is commanded by an external current source; the standard range is **4–20 mA** (hardware supports up to 4–50 mA).
- The current loop is highly immune to electrical noise over long cable runs — the standard industrial control interface.

White lead · Iin 4–20 mA

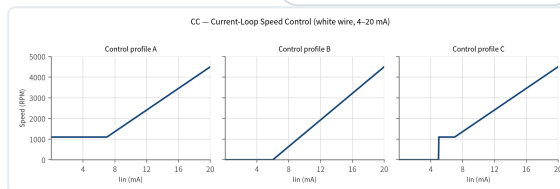


Fig. 13 — Speed vs. Iin, profiles A / B / C.

PWM Pulse-Width-Modulation Control

- Speed is set by the PWM **duty cycle**; frequency is adjustable from **30 Hz to 30 kHz**.
- High-level input voltage **3–10 V**; low level ≤ 0.8 V.
- CS, SS and CL logic can be included; linear speed control from minimum to maximum RPM.

The preferred interface for servers, UPS, inverters and any system with an available microcontroller PWM output.

Blue lead

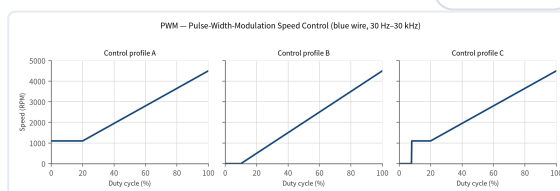


Fig. 14 — Speed vs. duty cycle, profiles A / B / C.

6 Wire Reference & Ordering Checklist

Lead color quick reference

Lead color	Associated function	Signal / notes
 Red	Power (+)	Positive supply; rated per fan model (5 / 12 / 24 / 48 V).
 Black	Power (-) / return	Ground return; may be marked (+) on isolated control interfaces per the wiring diagram.
 Yellow	FG tachometer	Open-collector pulse train, frequency proportional to RPM.
 White	RD / VC / CC	Rotation-detection alarm, 0–10 V command, or 4–20 mA command, depending on model.
 Violet	RDB	Inverted rotation detection (HIGH = running).
 Brown	LD	Low-speed / life-detection alarm below 70% RPM.
 Green	TC	NTC thermistor connection, internal or external.
 Orange	RC	Potentiometer speed-control connection (10–100 kΩ).
 Blue	PWM	PWM duty-cycle command, 30 Hz–30 kHz.

Engineering specification checklist

- ☐ Frame size & series (e.g. 35×35×7 mm axial)
- ☐ Rated voltage & acceptable voltage window
- ☐ Rated / maximum RPM and airflow target (CFM)
- ☐ Bearing type: sleeve / hydraulic / dual ball
- ☐ Control-function code stack (SS, LP, FG, PWM...)
- ☐ Control profile (A / B / C) and set-points
- ☐ Wire count, gauge, length & connector (e.g. JST, Molex)
- ☐ Acoustic / IP-rating / operating-temperature requirements

Customization available

- Custom temperature and speed-command curves
- Internal vs. remote (external) NTC mounting
- Labeling, private-label branding and custom housings
- Tailored wire harnesses, terminals and connectors
- IP-rated, splash-proof and reinforced designs
- Application-specific OVP thresholds and constant-speed windows

Need the right fan configuration for your design?

Send us your thermal requirements and preferred control interface. Our application engineers will recommend the function stack, confirm timing and signal thresholds, and provide free evaluation samples and a full model-specific datasheet — typically within one business day.

[Request Samples & Datasheet](#)[Book a Design Review](#)

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