



Diagnosing Stator Winding Integrity in Outrunner Brushless Motors: A Comprehensive Guide

Abstract

Brushless DC (BLDC) outrunner motors, such as the popular 1100 series size used in slot cars, rely on precise stator winding performance for efficient operation. Faulty windings can lead to reduced torque, overheating, or complete failure. This white paper outlines a systematic approach to testing stator windings using basic tools like a multimeter, focusing on resistance, continuity, insulation, and dynamic spin tests. By following these procedures, technicians can decide if a motor is functional or requires repair/replacement. Results interpretation is provided, emphasizing manufacturer specifications for accuracy. This guide draws from established electrical diagnostics practices to ensure reliable outcomes.

Introduction

In the world of slot cars, outrunner motors represent a compact, high-performance choice due to their lightweight design and efficient power delivery. An “1106” designation refers to a stator diameter of 11 mm and height of 6 mm, typically supporting 12–16.8 vdc voltage ratings with Kv values from 1800-23000. These motors are susceptible to winding damage from crashes or tight drivetrains, improper gear ratio selected for the car weight and track style causing cogging or overheating.

Stator windings—the copper coils embedded in the motor’s stationary core—are critical for generating the electromagnetic fields that drive the rotor. Degraded windings manifest as uneven resistance, shorts to ground, or open circuits, compromising motor efficiency and safety. Routine testing is essential for maintenance, especially post-crash. This white paper provides a step-by-step method to assess winding health, enabling users to classify motors as “good” (operational) or “bad” (faulty).

Background on Brushless Outrunner Motors

Brushless outrunner motors operate on a three-phase AC principle, where the stator’s windings are energized sequentially by an Electronic Speed Controller (ESC) to rotate the external rotor magnets. The stator consists of laminated iron cores with three sets of windings (phases A, B, C) connected in a star (wye) or delta configuration.

Key failure modes in stator windings include:

- **Open circuits:** Broken wires interrupting current flow.
- **Short circuits:** Adjacent turns touching, reducing resistance.
- **Ground faults:** Insulation breakdown connecting windings to the stator core.
- **Imbalanced phases:** Uneven resistance causing vibration or inefficiency.

Typical phase-to-phase resistance for 1100 series motors range from 0.05–1.3 ohms [50mΩ–1300mΩ], depending on Kv rating—lower KV motors have higher resistance due to more turns. Always consult the manufacturer’s datasheet for exact values, as deviations indicate issues.

Tools and Safety Precautions

Required Tools

- Digital milliohmmeter (Available at Amazon: Digital Milliohmmeter, 4-Wire Measurement DC Low Tester, model VC480C+ <https://a.co/d/6JU21VK>.)
- Variable-speed drill (battery-operated, for spin tests).
- Fine wire probes or alligator clips (for secure connections).
- Digital multimeter (with ohmmeter, continuity, and AC voltage modes).
- Optional: LCR meter (for inductance checks) or insulation tester (megohmmeter) for advanced diagnostics.



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Safety Precautions

- Disconnect the motor from the ESC to prevent electrical shock or damage.
- Work in a static-free environment to avoid ESD-induced faults.
- Wear insulated gloves when handling tools.
- Ensure the motor is at room temperature approximately 20°C [68°F] before testing.

Step-by-Step Testing Procedure

Step 1: Visual Inspection

Begin with a non-invasive check:

- Examine the motor exterior for physical damage, such as dents, cracked housing, or exposed wires.
- Rotate the bell (rotor housing) by hand; it should spin freely without grinding or catching.
- Remove the bell if safe, inspecting windings for burnt insulation, melted solder joints, or debris.

Outcome: Proceed if no obvious damage; otherwise, classify as “bad” and consider rewinding or replacement.

Step 2: Continuity and Resistance Measurement (Static Test)



This verifies phase integrity and balance.

1. Label the three motor wires as Phase A, B, and C.
2. Set the multimeter to the lowest ohms range (e.g., 200mΩ if available).
3. Zero the meter (follow meter manufacturer's instructions)
4. Test continuity across each phase pair:
 - A to B
 - B to C
 - C to A
5. Record resistance values. For outrunner motors, expect near-identical readings (see Table A or a manufacturers datasheet for expected readings).
6. Check for open circuits: Infinite resistance (OL) on any pair indicates a break—motor is “bad.”

Advanced Tip: If using Kelvin (4-wire) mode on a precision multimeter, connect as per standard procedure for sub-0.1Ω accuracy.



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Step 3: Insulation and Ground Fault Test

This detects shorts to the stator core.

1. Set multimeter to ohms (high range, e.g., 20k Ω) or megohms if available.
2. Scrape a small area of bare metal on the stator laminations (core) to expose conductive surface.
3. Probe from each phase wire (A, B, C) to the stator core.
4. Readings should be infinite (OL >10M Ω); any finite value indicates insulation failure—motor is “bad.”



Step 4: Dynamic Spin Test (Voltage Generation)



Simulates operation to reveal hidden shorts.

1. Isolate all three wires.
2. Secure the stator in a vise or holder; attach the rotor to a drill chuck.
3. Set multimeter to AC volts (10V range).
4. Spin the rotor at moderate speed (500–1000 RPM) while probing pairs:
 - A to B
 - B to C
 - C to A
5. Voltages should be roughly equal (e.g., millivolts to 5V AC depending on speed and motor Kv); imbalanced readings >10% variance suggests partial shorts.

Listen and Feel: Unusual noise, heat, or drag during spin indicates internal faults like loose magnets or shorted winding turns.

Step 5: Optional Inductance Test

If an LCR meter is available:

1. Just as in the resistance test, measure inductance per phase (A to neutral if star; or phase-to-phase).
2. Values should match specs (typically 5–20 μ H for 1100 series motors) and be balanced.
3. Significant variance points to turn imbalances—motor is “bad.”



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Step 6: No-Load Current Draw (Powered Test)

For final verification (requires ESC and power supply):

1. Connect to an ESC and a power supply at 4-6vdc.
2. Run the system and measure current at idle (should be <0.5A).
3. Excessive draw (>1A) indicates shorted turns.

Interpreting Results

Test	Good Result	Bad Result	Action
Visual Inspection	No damage, free spin	Cracks, burns or bindings	Replace/Repair
Phase Resistance	Balanced within spec ($0.1\Omega \pm 10\%$)	Unequal or infinite	Rewind or discard
Ground Insulation	Infinite ($>10M\Omega$)	Finite ($<1M\Omega$)	Insulation repair needed
Spin Voltage	Equal AC output	Imbalanced ($>10\%$ variance)	Investigate shorts
Inductance (opt.)	Balanced per spec	>Varied 15%	Faulty turns
No load current	<0.5A idle	>1A idle	Shorted windings

- **Good Motor:** Passes all tests; suitable for reuse.
- **Bad Motor:** Fails any test; assess repair feasibility (e.g., rewinding for skilled hobbyists) or replace. Common in high-vibration applications like slot cars.

Conclusion

Testing stator windings on outrunner motors is a straightforward yet critical process that can extend component life in slot cars. By combining static electrical checks with dynamic tests, users can accurately diagnose issues without specialized equipment. Regular inspections post-race or post-crash are recommended. For persistent failures, consult the manufacturers motor datasheets or professional services. Future advancements in automated testers may simplify these procedures, but manual methods remain reliable for field use.



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TABLE A

Mfgr	Motor Size	Kv Label 'Rating'	Average R in Ω
KCR	1106	1800	1.248
KCR	1106	2200	0.894
KCR	1106	3000	0.552
KCR	1106	3200	0.575
KCR	1106	4500	0.313
KCR	1106	6500	0.164
KCR/BM	1106	9000	0.100
KCR/BM	1106	11000	0.077
KCR/BM	1106	18000	0.077
KCR/BM	1106	23000	0.065

DoSlot	1105	2000	1.576
DoSlot	1105	3000	0.670
DoSlot	1105	4000	0.405
DoSlot	1105	6000	0.192

B52	1105	3000	0.579
B52	1105	5500	0.206
B52	1105	7500	0.153
B52	1105	9000	0.097

Parma	1105	3000	0.533
Parma	1105	4500	0.285
Parma	1105	6500	0.141

These are actual readings from sample BLDCs.
Contact the manufacturer for exact information.