



Soldering Wiring to an Electronic Speed Controller (ESC) Best Practices with Emphasis on Heat Management and Solder Type

Introduction

An Electronic Speed Controller (ESC) is an electronic circuit that controls the speed, direction, and braking of a brushless DC motor (BLDC), used in brushless slot cars. ESCs typically feature pads or terminals for connecting power wires (e.g., track power leads), and brushless motor wires. Soldering these wires is essential for creating secure, low-resistance connections that can handle high currents without failure.

Improper soldering can lead to issues such as cold joints (poor conductivity), short circuits, or thermal damage to the ESC's internal components like the MOSFETs. Heat is a primary concern, as excessive temperatures or prolonged exposure can melt solder on the MOSFETs, degrade insulation, warp boards, or cause delamination. Similarly, the choice of solder type affects joint strength, flow, and long-term reliability. This paper focuses on these aspects while providing a step-by-step guide.

Materials and Tools

To solder wires to an ESC, gather the following:

- **Soldering Iron:** A temperature-controlled soldering iron with a fine tip for precision work. Avoid unregulated irons that can overheat.
- **Solder:** Discussed in detail below.
- **Flux:** Rosin-core or no-clean flux pen for better wetting and reduced oxidation.
- **Wires:** Silicone-insulated, high-strand-count wires rated for the ESC's amperage (e.g., 22 AWG for track power wiring).
- **Helping Hands or Vise:** To secure the ESC and wires.
- **Desoldering Tools:** Wick or pump for corrections.
- **Safety Gear:** Safety glasses, ventilation (fume extractor), and heat-resistant mat.

Solder Type Selection

The choice of solder is crucial for achieving strong, reliable connections while minimizing risks during application. Solder is an alloy that melts to form a bond between metals, and its composition affects melting point, flow, and mechanical properties.

- **Leaded vs. Lead-Free Solder:**
Leaded solder, such as 60/40 (60% tin, 40% lead – Sn60/Pb40) or 63/37 eutectic alloys, are highly recommended for ESC soldering due to its lower melting point (around 183-190°C or 361-374°F) and excellent flow characteristics.
Lead-free alternatives (e.g., SAC305: 96.5% tin, 3% silver, 0.5% copper) have higher melting points (217-220°C or 423-428°F), requiring more heat, which increases the risk of damaging the ESC. Avoid lead-free solder unless mandated by regulations (e.g., RoHS compliance), as it can lead to brittle joints and requires higher soldering temperatures.
- **Additives and Enhancements:** For optimal performance, use leaded solder with a small percentage of silver (e.g., 2-4%) added to leaded alloys (Sn62/Pb36/Ag2). This improves conductivity, reduces oxidation, and enhances wetting on copper pads, making it ideal for high-current applications like ESCs. Rosin-core solder (with built-in flux) is preferred over solid wire, as the flux aids in cleaning surfaces and promoting adhesion.
- **Diameter and Form:** Opt for 0.8-1.0mm diameter solder wire for general ESC work.

In summary, 60/40 leaded solder with rosin core and optional silver content strikes the best balance for ease of use, reliability, and minimal heat application in ESC soldering.

Procedure

Follow these steps for soldering wires to an ESC:

1. **Preparation:** Clean the ESC pads and wire ends with isopropyl alcohol to remove contaminants. Strip the wire insulation (about 4-5mm) and tin the ends by applying a thin layer of solder. Pre-tin the ESC pads as well, especially if they are not already tinned.



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2. **Positioning:** Secure the ESC in a vise. Align the wire with the pad, ensuring no strain or misalignment.
3. **Soldering:** Set the iron temperature appropriately (detailed in the next section). Apply flux to the pad. Heat the pad and wire simultaneously with the soldering iron tip for 2-3 seconds, then touch the solder to the heated joint (not the iron) to allow it to flow naturally. Avoid direct melting of solder on the iron, as this can create cold joints. **Make sure you do not bridge the soldering pads -or- bridge from a soldering pad to a component on the circuit board.**
4. **Cooling and Inspection:** Remove the iron and hold the wire steady until the solder solidifies (5-10 seconds). Blow gently on the joint to accelerate cooling if needed. Inspect for shiny, concave fillets without bridges or voids.

Heat Management

Heat is the most critical factor in ESC soldering, as ESCs contain heat-sensitive components that can fail if exposed to temperatures above 150-200°C (302-392°F) for extended periods. Overheating can cause desoldering of internal parts, or PCB delamination.

- **Temperature Settings:** Use a soldering iron set to 300-400°C (572-752°F) depending on the task:
 - 300-350°C (572-662°F) for delicate motor wires to minimize heat transfer.
 - 340-400°C (644-752°F) for track wiring to pads.
 - Always start lower and increase if needed; higher temperatures allow quicker soldering, reducing overall heat exposure.
- **Techniques to Minimize Heat:**
 - *Work quickly: Limit iron contact to 3-5 seconds per joint.*
 - Use flux liberally to improve heat transfer and reduce required time.
 - Solder one pad at a time, allowing cooling intervals (30-60 seconds) between adjacent pads.
 - For repairs, use a heat sink (e.g., alligator clip) on nearby components to dissipate heat.
 - Avoid high-heat settings on thin pads; use “low heat solder” (lead types) to enable lower iron temperatures.
- **Signs of Heat Damage:** Matte or discolored solder, lifted pads, or non-functional ESC. If damage occurs, desolder and inspect internals.

Proper heat management ensures the ESC's longevity, maintaining its efficiency and preventing failures during operation.

Safety Considerations

- Work in a well-ventilated area to avoid inhaling flux fumes.
- Handle hot tools carefully to prevent burns.
- Use leaded solder with caution; wash hands after use and avoid ingestion.
- Read and follow instructions on the solder and flux container or packaging.
- Ensure the ESC is disconnected from power during soldering to prevent shorts or shocks.
- For high-amperage ESCs, verify wire gauge to avoid overheating in use.

Conclusion

Soldering wires to an ESC is a skill that combines technique, material selection, and caution. By prioritizing leaded solder types like 60/40 with rosin core for their ease and reliability and managing heat through appropriate temperatures and quick application, enthusiasts can achieve durable connections without compromising the ESC's integrity. Adhering to these practices reduces failure rates and enhances system performance.

This and other white papers, guides and drawings are available on the [Tech page](#) of the KC Racing website.



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Products

Below are products, that are available on Amazon, we have successfully used for soldering wires to ESCs

Soldering Iron

One recommended soldering kit is a FNIRSI Mini Digital Kit

Amazon Link - <https://a.co/d/b6ZGFnv>



No Clean Flux Pen

3 Pieces No Clean Soldering Pen Rosin Solder Pen for Electronics Tapping Wiring Liquid Solder, Welding Maintenance of PCB Board

Amazon Link - <https://a.co/d/hk0SKDs>



Solder 60/40 Rosin Core

HGMZZQ 60/40 Tin Lead Solder Wire with Rosin core for Electrical Soldering 0.031" [0.8mm]

Amazon Link - <https://a.co/d/aMoy1TT>



Solder with 2% silver content

RadioShack SnPbAg 62/36/2 Silver-Bearing Rosin-Core Solder, 0.015" .4mm]

Amazon Link - <https://a.co/d/6lJzeV>

