Lower Unit / Motor Assembly

In addition to the following written pages covering differing repair cases/scenarios at the end of this chapter there are instructions for replacing composite shafts and thru-bolt & end play specifications. There are also few videos for disassembly & reassembly of lower units for your reference in the Service Videos/Motors Service Videos folder.

Click on blue Case to jump to the linked discussion/resolution

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Case I. Lower unit does not run

Step 1. Check to ensure proper voltage. Inspect all battery connections, trolling motor plug (if installed), and any butt splice connections in battery leadwire for corrosion and security.

Step 2. Test lower unit directly (bypass all switches and/or control board).

- **A.** Connect the lead wire to battery.
- **B.** Hook the black battery lead directly to the black brush lead that exits the motor assembly.
- **C.** Hook the red battery lead to red brush lead that exits the motor assembly. The motor should run. If not, a problem exists in the lower unit. Disassemble lower unit and check for voltage at the brushes, water damage, brushes not making proper contact, and an open armature.
  - **C-1.** An open armature will have some segments on the commutator that are dead. If the brushes happen to stop on this open segment, it will not run. If you can turn the prop a quarter and the motor starts and runs fine, the armature may have an open/dead spot. Replace armature.

Case II. Motor runs backwards

Step 1. Polarity reversed to armature. Possible causes include:

- **A.** Wired backwards – at battery or switch if a 5-speed model, or at board output if variable speed.
- **B.** Brush plate in upside down
  - **B-1.** On 4" motors the red brush lead is on the bottom; opposite on smaller motors.
  - **B-2.** On 4" Terrova & all 4 ½" motors, the red brush is on the right side when viewing the brush plate from opposite the prop end.
  - **B-3.** On E-Drive motors, the red brush is on the left side when viewing from opposite the prop.
- **C.** Magnet shell upside down (on 3 ¼" or 3 5/8" motor assemblies the marking notch should be on the bottom towards the skeg)

Case III. On a 5-speed motor: Motor works at all speed settings, but the customer is complaining that there is no variation between speeds.

Step 1. Perform an amp draw check while the motor is running in a water test tank.

- **A.** If the amps step up as the speed setting increases, the motor is performing as designed.
- **B.** If the amp draw does not increase along with the speed settings check the amp draw of each speed directly through the speed coil:
  - **B-1.** Remove the control box cover. Disconnect wires from the foot pedal (if a foot-control motor) or at the switch in the control box (if hand-control) from the wires to the lower unit.
  - **B-2.** With the lower unit still in a water test tank, connect -12 volts to the black motor/brush lead.
  - **B-3.** Connect +12 volts to each colored speed coil wire coming up through the motor tube from the lower unit. The motor will run (on the separate speed designations) as you make each connection. Note the amp draw as you test the different colored wires.
    - **a.** If the amp draw does not vary as you make the different connections (with the lower unit still in a water test tank) replace the front end bell/potted speed coil assembly.
    - **b.** If the amp draw does vary as you make the different connections, replace the 5-speed switch.

Case IV. On a 5-speed motor: Motor works on high speed, but missing some or all of the lower speeds

Step 1. Check speed coil functionality. (There is a video of this test in the Service Videos/Motors Service Videos folder titled *Speed Coil Test.*)

- **A.** Connect battery lead wire to battery.
- **B.** Hook the black battery lead directly to the black brush lead that exits the motor assembly.
- **C.** Touch the red battery lead to each colored speed coil wire one at a time. The motor should run as you make each connection.
- **D.** If the motor fails to run as you touch any of the colored speed coil wires, the problem is either speed coil is faulty and needs to be replaced or the speed coil jumper wire is not connected to the back of the brush plate (connected to the back of the red brush in the lower unit).
  - **D-1.** If the motor runs as you touch the red battery lead to some of the colored speed coil wires, but not all the speed coil wires, the speed coil is faulty and needs to be replaced.
  - **D-2.** If the motor runs as you touch the red battery lead to each speed coil wire, proceed to **Step E**.
- **E.** Speed switch is defective. Replace Speed switch. Test motor for proper operation.

Case V. On a variable-speed motor: Motor works on high speed only

Step 1. The PWM circuit of the main board is not operating correctly. This could be due to a failure on a main control board component or due to a shorted condition causing the PWM portion of the board to be bypassed.

- **A.** Control boards can be checked while "outside" of the motor. Provide proper voltage to the board. On the board output side connect a test light. Depending on the specific model being serviced, connect either a footpedal or a MOM/OFF/CON switch. If the board utilizes a magnetic reed switch for momentary on/off you will need a magnet to operate the board in MOM. While increasing speed on the potentiometer, the test light should vary in intensity.

Step 2. If the motor being serviced has an internal grounding/bonding wire connected to the lower unit and that grounding/bonding wire is shorted to the black brush lead or black brush shunt wire the PWM portion of the control board will be bypassed. The motor will then run at high speed only when the motor is turned on.

- **A.** Open the lower unit and inspect the routing of the brush shunt wires and the bonding/grounding wire. The brush shunt wires should not be touching the inside case of the motor or the bonding wire. This could also happen anywhere along the wire bonding wire and the black lead if the insulation was cut or scraped away. (If this scenario occurred on the red brush lead there would be a direct short causing other issues.)

Case VI. Customer complains the trolling motor is draining battery / batteries down too fast

Motors with a control board draw a small amount of amps whenever they are hooked to a power supply. (The relays are engaged.) Although this is a small amount, it will drain batteries down over time if the motor is left plugged in. We recommend unplugging the motor when not in use.

Step 1. Perform amp draw test while motor is under load in a water test tank (amp draw specs are listed in the annual Minn Kota product catalogs and on the top of the parts lists found on the online Parts & Warranty Portal).

- **A.** If amp draw meets or is less than stated specs, the motor is not the cause of the problem.
- **B.** If amp draw is higher than stated specifications:
  - **B-1.** Spin the prop by hand and feel for broken magnets.
  - **B-2.** Remove the propeller to check for line or weeds wrapped tightly around the armature.
  - **B-3.** Check for proper/even torque of thru bolts.
  - **B-4.** Check for shorted armature (commutator to armature shaft should not show continuity).
  - **B-5.** The center section with magnets could be partially demagnetized causing high amp draw.

Case VII. Customer complains that motor is noisy

Step 1. Possible causes:

- **A.** Propeller may be damaged or out-of-balance.
- **B.** Water in lower unit
- **C.** Broken brush plate
- **D.** Grease or replace spherical or flange bearing
- **E.** Chipped/broken brushes (new brushes may take a few hours of operation to "seat" or round to the commutator and quiet down)
- **F.** Ensure rear seal shield (3 ¼" and 3 5/8" motors only) is securely in place and not "squealing" or rubbing against armature shaft
- **G.** Chipped/broken magnets – a rule of thumb is if the magnet that chips out is less than 1 square inch, the magnet shell is still functional.
- **H.** On 4" motors (bung on magnet center section), pull up lightly on brush wires to ensure all slack is out of lower area (so armature does not rub on the slack from the brush leads)
- **I.** Rough/worn commutator (where brushes ride) on armature. Smooth with fine sandpaper or emery cloth. If scratched too deeply, replace armature.
- **J.** Ensure the E-ring is securely snapped into place behind commutator. (Engine Mount models utilize a bushing instead of the E-ring.)
- **K.** Ensure the bearing on the front end of the armature rotates smoothly.
  - **K-1.** A bearing puller should be used to remove the rough bearing from the armature when installing new bearing. Press or drive on inner race only when seating new bearing on shaft.
- **L.** The motors are "timed". Before you open a lower unit it is a good idea to use a grease pencil or put a piece of tape across the joints of the lower unit (front endbell to center housing and center housing to rear endbell). Cut the tape with razor blade. Use these marks to assemble the lower unit exactly as it was prior to disassembly.
- **M.** When re-assembling a motor assembly ensure you evenly tighten the thru-bolts. (Tighten one a little, then the other, etc... Torque specs listed on **page 5**.)

Case VIII. Customer complains of low power/thrust

Step 1. Check to ensure proper voltage. Inspect all battery connections, trolling motor plug (if installed), and any butt splice connections in battery leadwire for corrosion and security.

Step 2. Amp draw is a direct correlation to thrust. Test lower unit amp draw directly (bypass all switches and/or control board) while motor is under load in a water test tank.

- **A.** If amp draw meets specifications then the lower unit meets thrust specifications (amp specs are listed in the annual Minn Kota product brochures).
  - **A-1.** Possible problem in wiring, switches, or control boards of motor or in boat's supply voltage.
  - **A-2.** Test amp draw specifications with voltage through complete trolling motor (remove any plug the consumer/dealer may have installed on the leadwire) to determine if a trolling motor problem exists or if there is a supply voltage problem to the trolling motor.
- **B.** If amp draw is lower than stated specifications:
  - **B-1.** Inspect for water in lower unit.
  - **B-2.** Inspect brushes and armature for discoloration or other signs of overheating (smell burnt). Replace parts as needed.
  - **B-3.** Suspect low magnetism of motor shell. (Magnets lose power with time and usage.)
- **C.** If amp draw is higher than stated specifications:
  - **C-1.** Remove the propeller to check for line or weeds wrapped tightly around the armature.
  - **C-2.** Check for proper/even torque of thru bolts.
  - **C-3.** Check for shorted armature (commutator to armature shaft should not show continuity).
  - **C-4.** The center section with magnets could be partially demagnetized causing high amp draw.

Case IX. Customer complains that motor is vibrating excessively

Step 1. Possible causes include:

- **A.** Prop pin bent
- **B.** Prop – damaged or out-of-balance. Due to variables in materials, leading edge differences, and tolerance variations, some vibrations can be attributed to the prop. An easy fix is to:
  - **B-1.** Disconnect leads from the battery.
  - **B-2.** Remove the prop nut, keeping the prop pin horizontal.
  - **B-3.** Remove the prop.
  - **B-4.** Rotate the prop 180 degrees from the original position.
  - **B-5.** Re-install the prop and prop nut.
  - **B-6.** Re-test motor in water test tank. If vibration is not cured, replace with new propeller and re-test. If excessive vibration is still present, proceed to **Step 1C**.
- **C.** Armature – bent shaft or out-of-balance armature stack.
  - **C-1.** Remove the prop from the armature shaft.
  - **C-2.** Run the motor (never operate the motor for extended periods of time while out of water) on medium-to-high speed and watch the armature shaft for a "wobble" that may indicate a bent shaft. If wobble is noted, replace armature. You may also put your finger on the armature shaft to feel for a wobble, or briefly touch the shaft with a sharp pointed marker while it is spinning. A solid mark around the armature indicates a fairly straight shaft, while an inconsistent line may represent a bent armature shaft.

Case X. Motor stops running while in use. Motor starts running again after it is pulled up out of the water and is placed back in the water, after the control box is struck, or after the prop is turned slightly.

Step 1. The malfunction listed above is most likely due to an intermittent or marginal electrical connection at the armature windings and commutator.

- **A.** Disassemble the motor lower unit. Inspect for water damage. If water is present, repair as necessary.
- **B.** Inspect the armature. Examine the commutator sections for discoloration and arcing caused by the brushes as they make contact with "good/live" commutator sections and "bad/dead" sections. Test armature commutator sections for continuity from one section to the next going around the circumference of the commutator.
  - **B-1.** Replace armature if severe arcing is noted or if no continuity is found when testing commutator sections.
- **C.** Examine commutator section "tangs" that connect armature windings to each commutator section. Each "tang" should be pressed down flush to the brush surface of the commutator section. If any space is noted between the "tang" and the commutator "face" the potential for an intermittent electrical connection exists and the armature needs to be replaced.

Case XI. Motor assembly is burnt. Is this a warranty situation?

Step 1. Inspect the lower unit to make see if the motor was stalled out with the power on. (i.e. if the brushes show signs of setting in one position with power applied to the lower unit.) This can manifest itself in two ways (depending on the severity of the situation, the voltage applied, and the speed setting of the motor):

- **A.** the commutator (com) may be completely burnt/blackened, but the brush positions across from each other on the com are still copper colored or;
- **B.** the com still looks fine, but the two brush positions are burnt

Both of the above situations are indications that the motor was somehow turned on with the prop blocked. Many times this will be a catastrophic failure showing melted wires up the shaft (and all the way down to the footpedal, if the motor is a cable-steer.) This is not a factory defect and would not be considered a warranty situation.

Case XII. Motor show signs of corrosion / electrolysis

Note: For more information regarding electrolysis, please refer to **Service Bulletin SB040914** regarding **Battery Selector Switches**.

Step 1. Ensure that this issue is not due to saltwater corrosion on a non-Ripide motor.
- **A.** Saltwater corrosion on a non-Riptide model is not covered by the Minn Kota warranty.

Step 2. If the motor is a 24-volt or 36-volt model, is the crank battery being used as one of the trolling motor batteries?
- **A.** If no, go to **Step 3**.
- **B.** If yes, ensure the crank battery is the first battery in the trolling motor battery system. (The negative lead of the trolling motor should be connected to the crank battery.)

Step 3. On Maxxum/Fortrex models: If the motor is a later model Universal Sonar (or any US motor that has had an internal ground / bonding wire installed from the brush plate mounting screw to the directional indicator light circuit) ensure the ground is connected to the negative (-) side of the indicator light.
- **A.** If you are not sure which wire is the negative (-) side, power up the motor and turn it on (the light is designed to have voltage applied to it when the propeller is spinning). With your VOM (multi-meter) set to check for VDC, touch the probes to either wire on both sides of the indictor light. If you have a +12VDC reading, the negative side is the one that your black probe is touching.

Step 4. The brush shunt wire may be inadvertently touching the inside of the motor case. This is more apt to happen on 4" & 4 ½" motor assemblies after the lower unit has been opened during field repairs.

Step 5. Check for shorted armature (commutator to armature shaft should not show continuity).

SPECIFICATIONS

Thru-bolt tightening specifications

- 3 ¼" motors = 25-35 inch pounds
- 3 5/8" motors = 35-45 inch pounds
- 4" & 4 ½" motors = 40-50 inch pounds
- 4 5/8" motors = 40-50 inch pounds

End-play specifications

- End-play should be .015" -.050", if necessary use extra nylatron washers. Too much or too little endplay will result in motor running hot or wearing out prematurely.

COMPOSITE SHAFT REPLACEMENT

For motors with threaded shafts (non-Terrova, non-Ulterra, non-Ultrex)

Instructions to remove lower unit from composite shafts

Step 1. Tighten the shaft and lower unit assembly in a bench vise. Utilize the Tube Holding Block Set (Minn Kota p/n 2881022) to lessen chances of scarring the shaft. The motor assembly should be slid directly next to the block set.

Step 2. Heat the bung area with a commercial heat gun to loosen the LocTite. If you use a propane torch as a heat source, you risk blistering the paint. The heat needed to break down the LocTite is 450 degrees Fahrenheit for 5 minutes. We use LocTite 661 (with #7649 primer). If you cannot locate LocTite 661, 271 is more readily available and substantially less expensive. It will suffice for service work in the field.

NOTE: Be careful not to heat the shaft itself (this is the reason the tube blocks should be slid down directly next to the bung when clamped in the vise). While the composite shafts are very strong, the combination of heat and the twisting force can break them.

Step 3. Unscrew the lower unit from the shaft while hot. Once you break loose the LocTite, do not stop unscrewing or the LocTite may re-set.

Step 4. Clean the residue out of the threads of the lower unit with the hollow tap kit (Minn Kota p/n 2881021).

A. Slide the lower unit wires through the hole in the tap.

B. While holding the lower unit upside down, gently screw the tap into the motor assembly letting the residue fall out. Be careful not to cross-thread the motor.

Installation Instructions:

Step 1. If activator is available apply according to threads on motor shaft following manufacturer's instructions. (If activator is not available allow 2-3 days for LocTite to fully cure prior to motor use.)

Step 2. Start threads of shaft into the Motor Lower Unit bung.

Step 3. As you continue to turn the shaft into the Motor Lower Unit completely cover at least three (3) threads with LocTite).

Step 4. Secure shaft in bench vise as described in **Step 1** of removal (above), grasp lower unit and turn it fully tight.

For motors with "D"-shaped threaded shafts (Terrova, Ulterra, Ultrex)

This shaft type is bonded into the center section in a manner that cannot be duplicated in the field, and, as a result, the shaft replacement requires Center Section and Shaft Assembly replacement or complete Lower Unit/Shaft Assembly replacement.

For Center Section and Shaft Assembly replacement, only the longer shafts versions are stocked. It will be necessary to cut the shaft to length using a hacksaw prior to installing any motor components in the center section. Once the shaft is cut to length, you will need to drill a pass-through hole for the control box at the top of the shaft and then rebuild lower unit in the new center section.

Note: Freshwater 55# thrust motor require Lower Unit/Shaft replacement, it is not possible to feed a US2 cable into or out of the center section for these motors, so Center Section and Shaft replacement is not possible.