E-Drive Electric Outboard

This E-Drive Repair Manual is divided into two parts.

Part I.	pertains to E-Drive with remote throttle control manufactured beginning in 2008 with s/n MKAI4018040 and later	**pages 1** through **10**
Part II.	pertains to E-Drive with remote throttle control manufactured prior to s/n MKAI4018040	**pages 11** through **23**

When working on any E-Drive motor, prior to looking for problems with the motor, check the condition of the customer's batteries for voltage/state of charge. Test the batteries as follows: Measure the voltage of each battery. A good, fully charged battery should be at 12.6-12.9 volts. If battery voltages are less than this, recharge the batteries and retest.

After charging, the batteries should all have equal voltages. If not, check the charger leads and charger function, check the electrolyte levels in each battery's cells, load test the batteries found to be weak or faulty. If you are unable to load test the batteries with a battery tester use the motor as a load test. Run the motor under load for a short period of time and recheck battery voltages for any batteries that are rapidly discharging for not holding a charge. Replace any faulty batteries or charger, if found. In our experience with E-Drive motors many customer complaints of motor malfunctions have been traced to battery problems and remember, even "new" batteries can be found to be defective or faulty.

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

Part I. E-Drive with remote throttle control (serial number MKAI4018040 and later or earlier units that have been updated)

In order to properly diagnose and service E-Drive electric outboard motors with s/n MKAI4018040 and later we would advise that you have the following on hand:

1. A 48-volt power supply or 4 series linked 12-volt batteries.
2. A "test" p/n 2770217 throttle assembly
3. A "test" p/n 2047412 throttle cable
4. A good quality V.O.M. (multi-meter)
5. Ordinary hand tools such as Phillips screwdrivers, pliers, wire strippers/crimpers, wrenches, etc…

Part I - Case I. Motor does not run / does not respond to throttle commands

Part I - Case II. LCD is always ON (icons are displayed) even though the key switch is turned off.

Part I - Case III. While the E-Drive motor is being operated the fuel gauge icon flashes on /off and the hours of run time indicator display 0.0 hours.

Part I - Case IV. While operating the E-Drive the LCD goes blank, The E and F on the fuel gauge icon flashes, and the motor will not run.

Part I - Case V. When the E-Drive key is switched ON, audible click is heard at the contactor, the LCD backlight comes on, but no icons are displayed and the motor prop does not spin when the throttle is advanced.

Part I - Case VI. The motor functions normally, but the lift system does not operate.

Part I - Case VII. The audible "click" is heard when the key is switched "ON", the LCD is on, but the motor doesn't always run, hesitates, requires throttle lever to be moved forward and back to make the prop spin.

Part I - Case VIII. Tilt gauge, (if motor is so equipped), does not operate

Part I - Case IX. The motor can be heard running, but the boat does not move in response.

Part I - Case X. Throttle LCD "Fuel Gauge" does not show "full tank"

Part I - Case XI. Throttle LCD "Fuel Gauge" shows "full tank" when turned on, then after running for a short period of time the key switch is turned OFF then back ON the "Fuel Gauge" only shows ½ full.

Part I - Case XII. E-Drive motor was raised up, the watercraft was trailered to the water for use, but the lift system will not lower the motor.

Part I - Case XIII. When operating in reverse the E-Drive motor swings up and out of the water.

Part II. E-Drive with remote throttle control (serial number prior to MKAI4018040 unless converted to digital system)

In order to properly diagnose and service E-Drive electric outboard motors with s/n prior to MKAI4018040 we would advise that you have the following on hand:

1. A 48-volt power supply or 4 series linked 12-volt batteries.
2. A "test" throttle assembly (p/n 2770216).
3. "Test" throttle cables (p/n 2041401 and p/n 2041402).
4. A good quality V.O.M. (multi-meter)
5. Ordinary hand tools, such as Phillips screwdrivers, pliers, wire crimpers, wrenches, etc.

***NOTE:** The analog control system (throttle assembly, main control board, and two throttle cables) is obsolete and no longer available. The analog system has been replaced by a digital control system (p/n 2774008) consisting of a new main control board, throttle assembly, and throttle cable. Any of the following repair procedures listed under Part II of this manual that advise replacing the analog throttle assembly, main control board, or throttle cables as a corrective action will now require replacement of the analog system with the digital control system.

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

Part II - Case I. Motor does not run / does not respond to throttle commands

Part II - Case II. Throttle Assembly can not be turned off (motor always operational / display always lit).

Part II - Case III. Tilt system does not operate

Part II - Case IV. Tilt gauge, (if motor is so equipped), does not operate

Part II - Case V. Throttle LCD "Fuel Gauge" does not show "full tank"

Part II - Case VI. Throttle LCD "Fuel Gauge" shows "full tank" when turned on, then after running for a short period of time the key switch is turned OFF then back ON the "Fuel Gauge" only shows ½ full.

Part II - Case VII. Throttle LCD only displays "Throttle Fault" when key switch is turned ON.

Part II - Case VIII. Throttle LCD only displays "Throttle Fault" and "Prop Obstructed" icons when key switch is turned ON.

Part II - Case IX. Throttle LCD flickers on and off.

E-Drive Electric Outboard

Part I. E-Drive with remote throttle control

(serial number MKAI4018040 and later or earlier units that have been updated)

In order to properly diagnose and service E-Drive electric outboard motors with s/n MKAI4018040 and later we would advise that you have the following on hand:

1. A 48-volt power supply or 4 series linked 12-volt batteries.
2. A "test" p/n 2770217 throttle assembly
3. A "test" p/n 2047412 throttle cable
4. A good quality V.O.M. (multi-meter)
5. Ordinary hand tools such as Phillips screwdrivers, pliers, wire strippers/crimpers, wrenches, etc…

Part I - Case I. Motor does not run / does not respond to throttle commands

Step 1. Test with known good "test" throttle assembly. (If "test" throttle assembly is not available use the customer's throttle and go to **Step 2** below.)

- **A.** If motor functions properly with "test" throttle assembly, the customer's throttle is faulty and needs to be replaced.
- **B.** If motor does not function with "test" throttle assembly, proceed to **Step 2** below.

Step 2. Check to ensure proper polarity and voltage (48 volts) at the E-Drive battery leads. Inspect battery leads and connections (including the series connections between the four batteries) for corrosion and security. Check for any fuses or circuit breakers installed in the power leads or series connectors. If fuses or resettable circuit breakers have been installed, check fuses for continuity and breakers to see if they have tripped. Replace fuses or reset breakers, if needed.

Step 3. Make sure the key switch is in the ON position. **(See Figure 1, page 2)**

- **A.** If "throttle lever → N" icon is displayed when the key switch is turned ON, the throttle is not in the neutral position. Place throttle in neutral position to reset system.
- **B.** If the "Prop Obstruction" icon is displayed when the master key switch is turned ON:
  - **B-1.** Move throttle control lever to neutral
  - **B-2.** Tilt motor up
  - **B-3.** Turn key switch "OFF"
  - **B-4.** Free obstruction
  - **B-5.** Turn key switch "ON", lower motor, and re-test for proper operation.

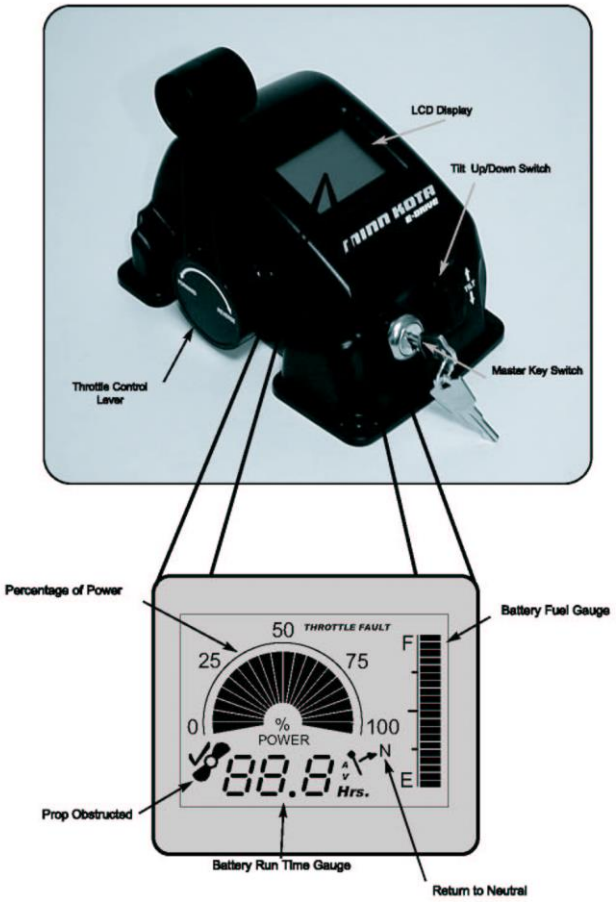


Figure 1

Step 4. Make sure that the throttle assembly, throttle cable, and E-Drive motor throttle cable are properly connected. Disconnect the throttle cable from the throttle assembly plug end and motor assembly plug end. Examine the throttle assembly, cable, and motor plug ends for damaged or corroded pins. If any damage is noted you will need to replace, as necessary.

Step 5. Inspect the throttle cable along its entire length for damage or cuts. (We have received reports of throttle cables being damaged/chewed/cut by rodents.) Check to make sure that no portion of the throttle cable has been submerged in the water for a length of time as this may have caused the cable to degrade and show continuity to more than one pin when tested end-to-end.

A. Perform an end-to-end continuity check on the throttle cable (p/n 2047412). **(For pin out connections see page 10.)** Continuity should be noted from end-to-end of the throttle cable across the pin locations indicated pin 1 to only pin 1, pin 2 to only pin 2, pin 3 to only pin 3, pin 4 to only pin 4, pin 5 to only pin 5, and pin 6 to only pin 6. If continuity is not found as noted in the pin guide or if continuity is found across more than the 2 pins, then throttle cable is faulty and needs to be replaced.

Step 6. Remove the black plastic E-Drive control board shroud to expose the main control board and contactor. Check for proper voltage and polarity at the contactor and main control board input terminals (see wiring diagram on **page** 9).

NOTE: Use care when testing/working around the E-Drive main control board and contactor when power is applied as 48-volts can burn/weld across any accidentally shorted terminals or contacts. Be sure to remove any rings or jewelry.

A. Visually check to verify that all wires are securely attached to the correct terminals.

A-1. Disconnect motor red (+) and motor black (-) wires from the control board. Apply 12-volts directly to the wires to verify that the motor will run. If motor runs go to **Step 6-B**. If motor fails to run then the problem is in the lower unit.

A-2. Disassemble the lower unit and check for loose brush wire leads at the brush plate, damaged brushes or brush springs, brushes not making good contact with the armature commutator, or armature commutator segments that are open or dead. Replace any parts found to be faulty then reassemble and reseal the lower unit. When the lower unit is reassembled and resealed, re-test the motor unit to verify that it runs when connected directly to 12 volts. Reconnect motor red (+) and black (-) leads to their proper locations on the control board and test for motor function.

B. Inspect the main control board for any visual damage. Replace control board if any bulged or split capacitors, burned spots, evidence of overheating, or short circuit is noted.

C. With the E-Drive motor connected to a known good (or a "test") throttle assembly and connected to 48 volts, check for motor function. Turn the key switch clockwise to ON. An audible "click" should be heard at the motor (contactor). When an audible click is heard, compare the voltage found across the B+ at the front post of the contactor and B- terminal on the board to the voltage found across the B+ and B- terminals on the control board. They should be the same. If they are not the same then the contactor or B+ connection at the contactor may be faulty. If the connections are secure the contactor is bad and will need to be replaced.

C-1. If the motor works with the "test" throttle assembly the customer's throttle assembly is faulty and needs to be replaced.

C-2. If the motor does not operate with the "test" throttle, use a V.O.M. to measure the voltage across the B- terminal on the main control board and the front post of the contactor. (Depending on battery condition, a voltage of 47-52 volts should be noted.) If less than 36-volt (or no voltage is noted), charge batteries / check connections to make certain adequate voltage is supplied to the motor.

Step 7. As noted previously, an audible "click" should be heard when the key is switched ON. If no click is heard and good voltage was noted across the B- terminal and front post of the contactor then the key switch could be faulty. Test the key switch as follows:

A. Disconnect the throttle extension cable (p/n 2047412) from the throttle assembly. Examine the six pins and sockets for damage, corrosion, or breakage. Replace the throttle assembly/throttle cable if any damage is found.

B. Turn the key switch to the ON position and check for continuity across the pins 2 and 4 of the throttle assembly female plug end. **(See page 10 for pin locations at the female end of the 6-pin connector.)**

B-1. If no continuity is found at **Step 7-B**, remove the two screws from the underside of the throttle assembly and remove the throttle assembly cover to expose the key switch wire terminals. Check to make sure that the brown and orange wires are securely attached to the back of the key switch. If the wires are secure and no continuity was found, the switch is at fault and needs to be replaced.

B-2. If continuity was found at **Step 7-B** and a continuity test has not been done on the p/n 2047412 throttle cable, do so at this time. If any fault is found with the throttle cable, replace it.

Step 8. The E-Drive key switch controls the large contactor (p/n 2040700) that is used to switch on/off the 48-volts supplied to the main control board.

A. With 48 volts supplied to the E-Drive battery leads, turn the key switch ON and use a V.O.M. to check the voltage across the brown (- negative) and orange (+ positive) wires on the left side of the contactor. If all previous tests checked okay and 48 volts is not measured across the orange and brown wires, the main control board is faulty and needs to be replaced.

B. If 48 volts is noted across the brown and orange wires when the key is switched ON, but no audible click is heard at the contactor, then the contactor is faulty and needs to be replaced. (**NOTE:** The contactor can also be checked by disconnecting the B- battery lead from the main control board, removing the brown wire from the terminal on the left side of the contactor, and touching the B- battery lead temporarily to the terminal where the brown wire was connected. If the contactor is functioning properly an audible "click" will be heard at the contactor when the B- wire touches the terminal.)

C. If 48 volts was found across the brown and orange wires on the contactor and an audible "click" is heard when the key switch is ON, then check the voltage across the black battery (B-) wire / board terminal and the red (B+) wire / board terminal coming from the rear threaded post on the underside of the contactor. The voltage measured should be the same as the voltage found when checking across the battery (B+) and the front post of the contactor to the battery (B-) lead connected to the control board.

C-1. If voltage is not the same at both test points or no voltage is found at the control board B+ and B- terminals, then the contactor is faulty and needs to be replaced.

C-2. If voltage is equal at both test points and the motor still does not function properly, the main control board is faulty and needs to be replaced.

Part I - Case II. LCD is always ON (icons are displayed) even though the key switch is turned off.

Step 1. This can occur if the E-Drive key switch is turned ON when the E-Drive is connected to batteries and a battery charger(s) are plugged in to AC (still charging the batteries). When the batteries are being recharged the voltage at each battery can be close to 15 volts. If the key switch is turned on at this time 60 volts can be supplied to the main control board rather than the 48 volts normally supplied from the four series linked 12-volt batteries. This high voltage can damage the main control board. When this occurs the main control board must be replaced to return the E-Drive to normal ON/OFF key switch function.

Part I - Case III. While the E-Drive motor is being operated the fuel gauge icon flashes on /off and the hours of run time indicator display 0.0 hours.

Step 1. This "malfunction" is an indication that the combined battery voltage supplied to the E-Drive motor is falling below 38 volts under load.

A. Measure battery voltage at each battery. Recharge batteries and re-measure the voltage of each battery.

NOTE: A battery that is less than 8 volts cannot be recharged by Minn Kota chargers that were manufactured prior to mid-2009 (or less than 4 volts for Minn Kota chargers made after mid-2009). Batteries discharged below these levels must be recharged by connecting them in parallel with another 12-volt battery to bring the battery voltage above the low threshold levels of the Minn Kota charger.

B. The batteries should all have equal voltage after charging. If not, check the charger leads and function, check the battery electrolyte levels in each cell, load test batteries, and replace any batteries found to be weak or faulty.

C. Retest / run motor under load. If the motor again display flashing fuel gauge/0.0 hours then one or more of the batteries may not be holding a charge or may not be getting recharged. Test charger output / function. Replace any faulty batteries or malfunctioning charger.

Part I - Case IV. While operating the E-Drive the LCD goes blank, The E and F on the fuel gauge icon flashes, and the motor will not run.

Step 1. This "malfunction" is an indication that the combined battery voltage supplied to the E-Drive motor is below 36 volts.

A. The batteries must be recharged, charging system checked, and any faulty batteries or chargers replaced to correct this "malfunction".

Part I - Case V. When the E-Drive key is switched ON, audible click is heard at the contactor, the LCD backlight comes on, but no icons are displayed and the motor prop does not spin when the throttle is advanced.

Step 1. The main control board is faulty and needs to be replaced.

Part I - Case VI. The motor functions normally, but the lift system does not operate.

Step 1. Remove the black plastic shroud from the back of the E-Drive motor and locate the yellow and green lift actuator leads. Disconnect them from the control board.

Step 2. Apply 12 volts directly to the yellow and green actuator leads. +12v to the yellow wire and -12v to the green should raise the motor, reversing the polarity should lower the motor.

A. If the actuator fails to run when 12-volts is applied to the leads, the actuator is faulty and needs to be replaced.

B. If the actuator runs, go to **Step 3**.

Step 3. Using your V.O.M., check continuity through the resistor (p/n 2994071) located in the black actuator wire. (**NOTE:** this resistor is mounted between the contactor and the control board.)

A. If no continuity is found, the resistor is faulty and needs to be replaced.

B. If continuity is noted, go to **Step 4**.

Step 4. Use your V.O.M. to test for D.C. output voltage across the red and black actuator leads coming from the main control board. With the E-Drive connected to 48 volts, the key switched ON, and the UP/DOWN switch held in either position you should measure 48 volts (+48 or -48 depending on your V.O.M. connections and which side of the UP/Down rocker switch is pressed).
(**NOTE:** The actuator output voltage is supplied though a PWM controller being driven at a 25% duty cycle so although your V.O.M. shows 48 volts the actuator is "seeing" the equivalent of 12 volts.)

A. If no voltage or considerably lower voltage is noted at this test step the main control board is faulty and needs to be replaced.

Part I - Case VII. The audible "click" is heard when the key is switched "ON", the LCD is on, but the motor doesn't always run, hesitates, requires throttle lever to be moved forward and back to make the prop spin.

Step 1. This can occur if the electrical connection between the motor brushes and armature commutator is poor due to wear or contamination caused by water leaking into the motor.

A. Disassemble the motor unit to inspect the brushes and armature commutator, clean, replace any faulty or worn components. Reseal the motor lower unit using new seals and o-rings, as required.

Part I - Case VIII. Tilt gauge, (if motor is so equipped), does not operate

Step 1. Check battery connections on backside of tilt gauge. The tilt gauge must be connected to 12 volts in order to function.
NOTE: Power for the trim gauge can be supplied by the boats accessory wiring circuit or one of the series linked 12 volt batteries used to power the E-Drive motor. If one of the E-Drive batteries is used to power the tilt gauge we suggest an on/off switch be installed in this 12 volt tilt gauge electrical circuit.

Step 2. Check connections from sending unit to back of tilt gauge for corrosion and security. Clean if needed and test for function.

Step 3. Observe the tilt gauge sending unit lever arm as the motor is being tilted up or down. The lever arm should contact the E-Drive motor main extrusion and move/rotate as the motor is tilted up or down. If it fails to rotate check the sending unit spring for proper installation and position.

A. The tilt gauge sending unit is a potentiometer and a simple resistance check can be performed to determine if it is good or bad. Connect a VOM to the 2 leads coming from the sending unit and move the spring loaded sending unit arm. A changing resistance value should be noted as the arm is moved. If not the sending unit is faulty and needs to be replaced.

B. If the sending unit checks ok and proper voltage and polarity is provided to the gauge but the gauge fails to function, then the gauge is faulty and needs to be replaced.

Part I - Case IX. The motor can be heard running, but the boat does not move in response.

Step 1. The prop drive pin has sheared. Replace pin and test run motor for proper operation. Listen for any unusual sounds coming from the motor lower unit. Unusual noises could indicate internal damage to the motor when the drive pin was sheared. If noted, disassemble motor lower unit to determine cause of noise and repair, as required.

NOTE: When reinstalling prop inspect prop for damage, check inside the prop hub at the drive pin slot, also check the plastic bushing in the prop hub for damage and make sure to re-install the o-ring on the prop shaft. We recommend a light coating of grease or "Never-Seez" on the mating surfaces of the prop shaft and prop.

Part I - Case X. Throttle LCD "Fuel Gauge" does not show "full tank"

Step 1. Check combined battery voltage (or the voltage at each battery and sum the total). The combined voltage required to show Full, ¾, ½, ¼, and Empty are listed below:

F	(Full) = 51.96 volts
-	(3/4) = 50.76 volts
-	(1/2) = 49.56 volts
-	(1/4) = 48.36 volts
E	Empty = 47.16 volts

If, after being recharged, the combined battery voltage does not reach or exceed 51.96 volts the batteries and/or battery charger(s) are at fault. After recharging, all four batteries should be at 12.99-13 volts each or slightly higher. If one or more batteries are not at this value, they will need to be replaced and the charger output for those batteries will need to be checked (and the charger replaced, if necessary).

Part I - Case XI. Throttle LCD "Fuel Gauge" shows "full tank" when turned on, then after running for a short period of time the key switch is turned OFF then back ON the "Fuel Gauge" only shows ½ full.

Step 1. Condition described is normal. When the key switch is first turned ON (after recharging), the microprocessor on the main control board takes a reading of the combined battery voltage and displays the appropriate "fuel gauge" reading (i.e. 51.96 volts equals a full "tank" reading). This information is then used by the microprocessor to establish a battery run time and discharge profile based on the speed setting and amp draw of the motor.

After running a short period of time, if the key switch is turned OFF and then turned back ON the microprocessor again checks voltage. Now the combined battery voltage has been lowered due to the motor having been operated. The new fuel gauge reading will be represented on the LCD and the microprocessor will establish a "new" battery run time and discharge profile based on the lower battery voltage. However, this "new" run time and discharge profile will not be truly accurate as the combined available amperage from the batteries will be greater than is indicated by the batteries "float" voltage.

For this reason, we would suggest that the key switch not be turned off while the E-Drive motor is being used for a boat outing. Not turning the key OFF will allow the microprocessor to use the initial voltage profile for more accurate "fuel gauge" and run time values.

Part I - Case XII. E-Drive motor was raised up, the watercraft was trailered to the water for use, but the lift system will not lower the motor.

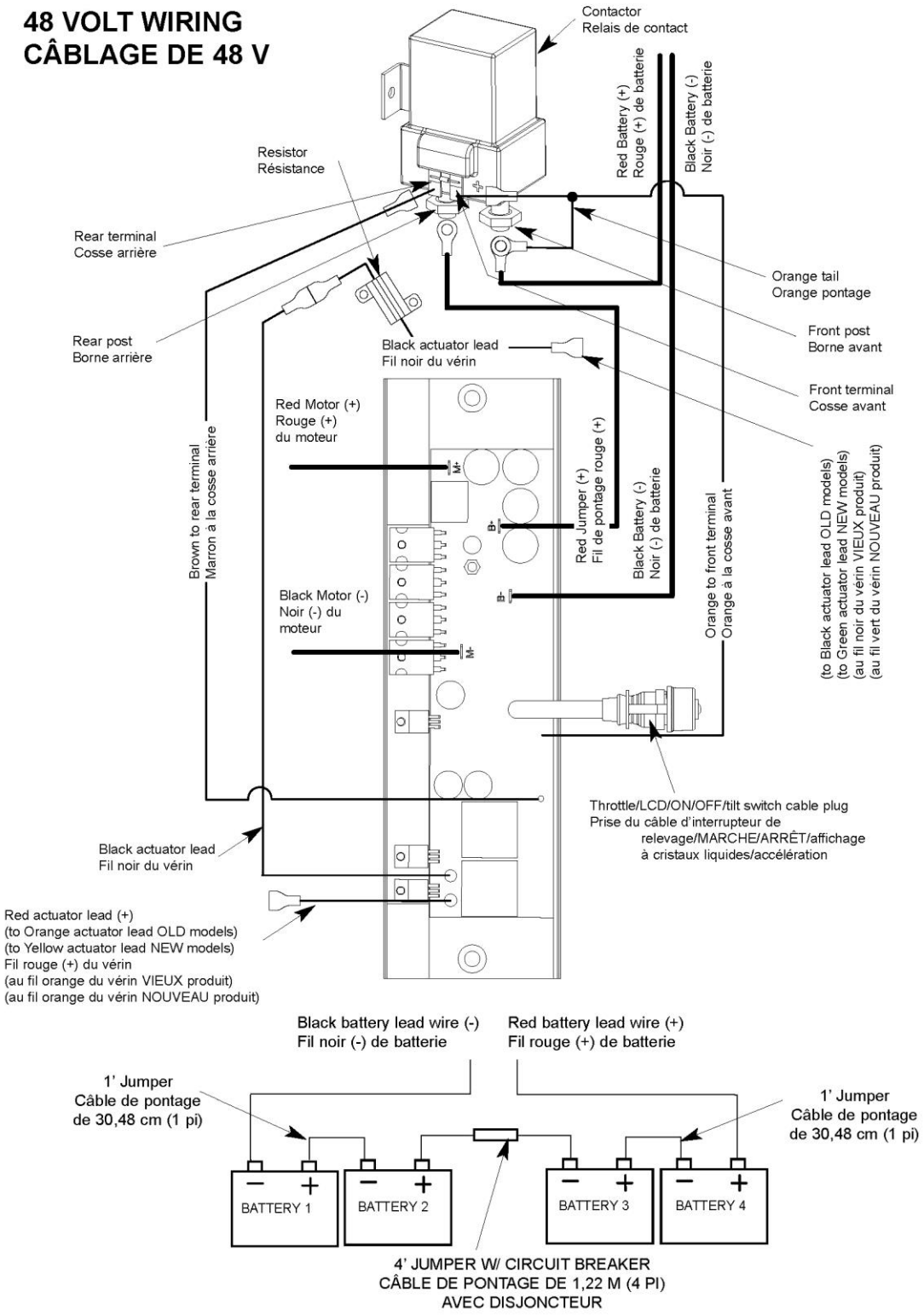
Step 1. Test actuator by disconnecting the yellow and green actuator leads from the red and black leads coming from the main control board. Apply 12 volts directly to the yellow and green leads. (Reverse polarity to retract/extend the actuator ram.)

A. If the actuator ram does not retract / extend or the leads spark badly when connected to the 12-volt power source the actuator has been damaged and needs to be replaced.
NOTE: Please note that whenever the E-Drive motor is being trailered on the watercraft with the motor raised up the tilt lock arm ***must*** be used! Failure to use the tilt lock arm will result in damage to the lift system actuator and will void the warranty on the lift actuator.

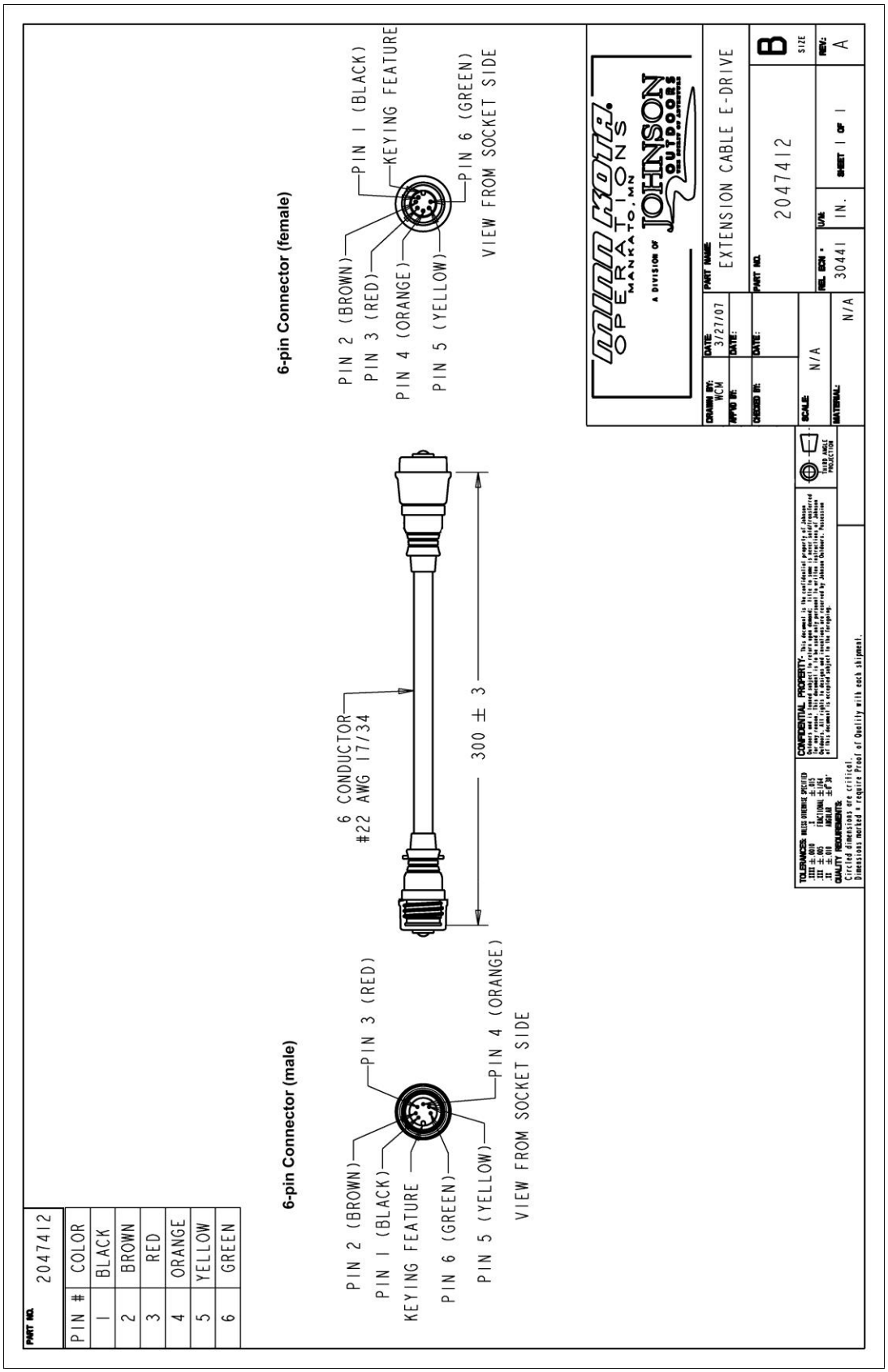
Part I - Case XIII. When operating in reverse the E-Drive motor swings up and out of the water.

Step 1. The E-Drive motor has a built-in breakaway system that allows the motor unit to swing up in the event of striking an underwater obstruction. The motor swinging up when reverse thrust is applied is an indication that the breakaway system has released. In most instances the breakaway system will reset automatically when forward thrust is applied. If the breakaway system does not automatically reset place the throttle lever in neutral, raise the motor's lower unit out of the water (using the lift/tilt switch), turn off the key switch, and then exert downward pressure on the motor's lower unit to re-engage the breakaway catch pin.

A. If the motor breaks away when the motor is in reverse thrust without hitting something, then the breakway latch, p/n 2047200, is defective and will need to be replaced.



Wiring Diagram
p/n 2044007, 2044008, & 2044009



Pin-Out for Throttle Cable / Throttle Assembly

Part II. E-Drive with remote throttle control
(serial number prior to MKAI4018040 unless converted to digital system)

In order to properly diagnose and service E-Drive electric outboard motors with s/n prior to MKAI4018040 we would advise that you have the following on hand:

1. A 48-volt power supply or 4 series linked 12-volt batteries.
2. A "test" throttle assembly (p/n 2770216).
3. "Test" throttle cables (p/n 2041401 and p/n 2041402).
4. A good quality V.O.M. (multi-meter)
5. Ordinary hand tools, such as Phillips screwdrivers, pliers, wire crimpers, wrenches, etc.

*__NOTE:__ The analog control system (throttle assembly, main control board, and two throttle cables) is obsolete and no longer available. The analog system has been replaced by a digital control system (p/n 2774008) consisting of a new main control board, throttle assembly, and throttle cable. Any of the following repair procedures listed under Part II of this manual that advise replacing the analog throttle assembly, main control board, or throttle cables as a corrective action will now require replacement of the analog system with the digital control system.

Part II - Case I. Motor does not run / does not respond to throttle commands

Step 1. Check to ensure proper polarity and voltage, (48 volts), at the E-Drive battery leads. Inspect all battery leads. Inspect all battery connections (including the series connection between the four 12-volt batteries) for corrosion and security. Check for any circuit breakers installed in the E-Drive power leads or series connections. If push-to-reset breakers have been installed, check to see if they have tripped open and reset, if needed.

Step 2. Make sure master key switch is in the ON position. **(see Figure 1, page 2)**

- **A.** If an "N" icon is displayed on LCD when master key switch is turned ON. Throttle control lever is not in neutral position. Place throttle control lever in neutral position to reset system.
- **B.** If the "Prop Obstruction" icon is displayed when the master key switch is turned ON:
  - **B-1.** Move throttle control lever to neutral
  - **B-2.** Tilt motor up
  - **B-3.** Turn master key switch "OFF"
  - **B-4.** Free obstruction
  - **B-5.** Turn master key switch "ON"
  - **B-6.** Lower motor
  - **B-7.** Re-test for proper operation.

Step 3. Make sure that the E-Drive throttle assembly is properly plugged in. Remove the throttle cable plug from the underside of the throttle assembly and examine the throttle cable pins in the throttle assembly for damage/straightness. (Several dealers/riggers have bent the pins in the throttle assembly when attempting to connect the throttle cable.) Be sure to line up the polarizing key in the plug and receptacle before pushing together then twist the plug collar to secure the connection. If the pins are bent or damaged, the throttle assembly will need to be replaced. (*See NOTE at start of Part II.)

Step 4. Check the throttle cable along its entire length for damage or cuts. (We have received reports of throttle cable being damaged/chewed/cut by rodents.)
Perform a continuity check on both throttle cables (p/n 2041401 & 2041402) for pin out connections **(see pages 20 & 22 for pin-out diagrams).** Continuity should be noted from one end of the throttle cable to the opposite end across the pins indicated and ONLY those 2 pins, no other should show continuity. If continuity is not found at all pins as noted in the pin-out guide or if continuity is noted across more than 2 pins, then the throttle cable is defective and needs to be replaced. (*See NOTE at start of Part II.)

Step 5. Check for proper voltage and polarity at the contactor and main control board input terminals **(see wiring diagrams on page 19-18 and 19-19).**

A. Remove the E-Drive control board shield assembly to expose the main control board and contactor.

B. Visually check to see that all wires are securely attached to the proper terminals.

C. Inspect main control board for any visual damage, replace control board if any burned spot, evidence of overheating, or short circuit is noted.

D. With the E-Drive motor connected to a known good throttle assembly or a "test" throttle assembly, and connected to 48 volts, check for motor function. If the motor works with the "test" throttle assembly the customer's throttle assembly is faulty and needs to be replaced. (*See NOTE at start of Part II.) If motor does not operate with the test throttle use a VOM to measure the voltage across the *B-* terminal and the front post of the contactor. (Depending on battery state of charge a voltage of 47-52 volts should be seen.)

E. If "test" throttle assembly is not available and the customer's throttle assembly is being used, turn the E-Drive throttle assembly key switch to the "ON" position. When the switch is turned on an audible "click" should be heard at the contactor.

E-1. If audible "click" of contact engaging is not heard the cause could be a faulty key switch, damaged/corroded/broken throttle cable wires or connector pins, a faulty control board, or a faulty contactor. Test as follows to determine which part(s) need to be replaced:

a. Disconnect throttle cable from throttle assembly and examine the twelve (12) pins and sockets for damage, corrosion, misalignment, and breakage. Replace throttle assembly /throttle cable if damage is found. If no damage found, turn the key switch "ON" and use a VOM to check continuity across pins 11 and 18 on the throttle assembly **(see page 23 for pin-out diagram of throttle assembly).**

a-1. If no continuity is found, key switch is faulty and needs to be replaced. (*See NOTE at start of Part II.)

a-2. If continuity is found, reconnect throttle cable and proceed to next step.

b. Locate the large connector plug in the throttle cable. Disconnect the plug and examine the eleven (11) pins and sockets for corrosion, misalignment, or breakage. Replace if damage is noted. With key switch "ON" use a VOM to check for continuity across pins 7 and 15 on the plug end coming from the throttle assembly **(see page 22 for p/n 2041402 throttle cable pin-out diagram).**

b-1. If no continuity is found, this section of the throttle cable is faulty and needs to be replaced. (*See NOTE at start of Part II.)

b-2. If continuity is found and the female socket plug end appears sound, reconnect the throttle cable plug ends and proceed to next step.

c. If you have not already done so, remove the p/n 2770222 shield assembly (black plastic cover) from the back of the E-Drive main extrusion to expose the control board. Locate and remove the throttle cable connector plug from the control board and examine the throttle cable for water damage and the plug end pins and sockets for corrosion, damage, mis-alignment or breakage. Replace as needed. When reconnecting or replacing the throttle cable reroute and wire tie the cable up away from the bottom end of the extrusion shield so it is not in the water when the E-Drive is in use. (*See NOTE at start of Part II.) With key switch "ON" use VOM to check for continuity across pins 8 and 10 on the plug end coming from the throttle assembly **(see page 20 for p/n 2041401 cable pin-out diagram).**

c-1. If no continuity is found this throttle cable section is faulty and needs to be replaced. (*See NOTE at start of Part II.)

c-2. If continuity is found, proceed to next step.

d. With E-Drive motor battery leads connected to 48-volt power source (power supply or 4 series linked 12-volt batteries), turn key switch "ON" and check voltage across the brown and orange wires connected to terminals on left side of contactor.

d-1. If voltage equal to voltage of power source is noted, but no audible "click" of the contactor engaging is heard, then the main control board is good but the contactor is faulty and needs to be replaced.

d-2. If voltage equal to supply voltage of power source is not found, the control board is at fault and needs to be replaced. (*See NOTE at start of Part II.)

F. If audible "click" is heard when key switch is turned "ON" use a VOM to measure the voltage across the *B*- and *B*+ board terminals. This voltage should equal the voltage across the *B*- terminal and the front post of the contactor. If no voltage is measured, then the contactor is faulty and needs to be replaced.

G. If in **Step 5-F** proper voltage and polarity was found at the *B*- and *B*+ control board terminals when the key switch was turned "ON", but the throttle assembly LCD does not display, the motor does not run when throttle lever is advanced, the tilt system does not function, and all throttle cable connectors, pins and sockets have been examined and continuity checks performed, then the main control board is faulty and needs to be replaced. (*See NOTE at start of Part II.)

H. If in **Step 5-F** voltage was noted at the *B*- and *B*+ control board terminals when the key switch was turned "ON", the throttle assembly LCD displays, and the tilt system functions, but the motor does not run when the throttle lever is advanced, then check the main board output to the motor at the *M*– and *M*+ board terminals. If a voltage is present, proceed to **Step 6**. If no voltage is present, then the main control board is faulty and needs to be replaced. (*See NOTE at start of Part II.)

Step 6. Test lower unit directly (bypassing the throttle assembly and control board), to determine if it runs.

A. Connect the black and red motor brush leads, (connected to the *M-* and *M+* terminals shown on control board wiring diagram), directly to 12 volts. The motor propeller should turn at a relatively low R.P.M.

B. If the motor does not run in **Step 6-A**, a problem exists in the lower unit. Disassemble the lower unit and check for loose brush wire leads at the brush plate, damaged brushes or brush springs, brushes not making contact with the armature commutator, or armature commutator sections that are open or dead. Replace any parts found to be bad and reassemble/reseal motor lower. When reassembled/resealed, re-test motor to verify that it runs by connecting to 12 volts as per **Step 6-A**.

C. Hook the red battery lead to red brush lead (normally connected to the control board). 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 turn and the motor starts and runs fine, the armature may have an open/dead spot. Replace armature.

Part II - Case II. Throttle Assembly can not be turned off (motor always operational / display always lit).

Step 1. The throttle key was turned ON while the motor was connected to batteries and the batteries were being charged. The software in later model control boards was changed to address this issue. Replace the main control board. (*See NOTE at start of Part II.)

A. Instruct the consumer that the key switch should not be turned ON while the batteries are being charged.

Part II - Case III. Tilt system does not operate

Step 1. Check all battery connections, plug connections, and terminal connections for corrosion and security. Clean, if needed, and test for function. The lift motor is a 12-volt motor.

Step 2. On some older E-Drive motors there are two tilt switches. One is located on the throttle assembly and the other on the back of the E-Drive motor. If one switch operates properly and the other does not, check for proper continuity through the malfunctioning switch. Replace, as needed, and test for proper operation. If neither tilt switch operates, proceed to **Step 3**. (NOTE: Newer E-Drive motors have only one trim switch located on the throttle assembly. **Steps 2-A**, **3-A**, and **3-B** applies to these motors.)

A. If the malfunctioning switch is the switch located on the throttle assembly and the switch tested fine for continuity, disconnect and remove the throttle cable from the underside of the throttle assembly. Inspect the connection on the cable side for bent pins. Straighten pins or replace cable, as needed and test for proper operation. (Bent pins are considered “accidental damage” and are not covered by the warranty.)

Step 3. Disconnect the tilt actuator leads from the control board assembly. Connect the actuator leads directly to 12 volts and observe actuator for extension/retraction. Reverse polarity at the actuator leads to reverse the actuator direction of travel.

A. If the actuator fails to operate when 12 volts is connected to the leads, the actuator is faulty and needs to be replaced.

B. Using your V.O.M., check continuity through the resistor (p/n 2994071) located in the black actuator wire. (**NOTE:** This resistor is mounted between the contactor and the control board.)

B-1. If no continuity is found, the resistor is faulty and needs to be replaced.

B-2. If continuity is noted, go to **Step 3-C**

C. If the resister continuity checked out fine and the actuator functions properly when connected directly to 12 volts, but the actuator fails to operate when connected to the main control board assembly then the tilt actuator circuit on the control board is faulty and the main control board will need to be replaced. (*See NOTE at start of Part II.)

Part II - Case IV. Tilt gauge, (if motor is so equipped), does not operate

Step 1. Check battery connections on backside of tilt gauge. The tilt gauge must be connected to 12 volts in order to function.

NOTE: Power for the trim gauge can be supplied by the boats accessory wiring circuit or one of the series linked 12 volt batteries used to power the E-Drive motor. If one of the E-Drive batteries is used to power the tilt gauge we suggest an on/off switch be installed in this 12 volt tilt gauge electrical circuit.

Step 2. Check connections from sending unit to back of tilt gauge for corrosion and security. Clean if needed and test for function.

Step 3. Observe the tilt gauge sending unit lever arm as the motor is being tilted up or down. The lever arm should contact the E-Drive motor main extrusion and move/rotate as the motor is tilted up or down. If it fails to rotate check the sending unit spring for proper installation and position.

A. The tilt gauge sending unit is a potentiometer and a simple resistance check can be performed to determine if it is good or bad. Connect a VOM to the 2 leads coming from the sending unit and move the spring loaded sending unit arm. A changing resistance value should be noted as the arm is moved. If not the sending unit is faulty and needs to be replaced.

B. If the sending unit checks ok and proper voltage and polarity is provided to the gauge but the gauge fails to function, then the gauge is faulty and needs to be replaced.

Part II - Case V. Throttle LCD "Fuel Gauge" does not show "full tank"

Step 1. Check combined battery voltage (or the voltage at each battery and sum the total). The combined voltage required to show Full, ¾, ½, ¼, and Empty are listed below:

F	(Full) = 51.96 volts
-	(3/4) = 50.76 volts
-	(1/2) = 49.56 volts
-	(1/4) = 48.36 volts
E	Empty = 47.16 volts

If, after being recharged, the combined battery voltage does not reach or exceed 51.96 volts the batteries and/or battery charger(s) are at fault. After recharging, all four batteries should be at 12.99-13 volts each or slightly higher. If one or more batteries are not at this value, they will need to be replaced and the charger output for those batteries will need to be checked (and the charger replaced, if necessary).

Part II - Case VI. Throttle LCD "Fuel Gauge" shows "full tank" when turned on, then after running for a short period of time the key switch is turned OFF then back ON the "Fuel Gauge" only shows ½ full.

Step 1. Condition described is normal. When the key switch is first turned ON (after recharging), the microprocessor on the main control board takes a reading of the combined battery voltage and displays the appropriate "fuel gauge" reading (i.e. 51.96 volts equals a full "tank" reading). This information is then used by the microprocessor to establish a battery run time and discharge profile based on the speed setting and amp draw of the motor.

After running a short period of time, if the key switch is turned OFF and then turned back ON the microprocessor again checks voltage. Now the combined battery voltage has been lowered due to the motor having been operated. The new fuel gauge reading will be represented on the LCD and the microprocessor will establish a "new" battery run time and discharge profile based on the lower battery voltage. However, this "new" run time and discharge profile will not be truly accurate as the combined available amperage from the batteries will be greater than is indicated by the batteries "float" voltage.

For this reason, we would suggest that the key switch not be turned off while the E-Drive motor is being used for a boat outing. Not turning the key OFF will allow the microprocessor to use the initial voltage profile for more accurate "fuel gauge" and run time values.

Part II - Case VII. Throttle LCD only displays "Throttle Fault" when key switch is turned ON.

Step 1. Throttle Assembly is faulty and needs to be replaced. Replace with known good/new Throttle Assembly and re-test for proper operation. (*See NOTE at start of Part II.)

Step 2. If problem persists, check throttle cable, cable connections, and main control bard as per the procedure outlined in **Case 1, Steps 3 - 5.** Replace parts as needed. (*See NOTE at start of Part II.)

Part II - Case VIII. Throttle LCD only displays "Throttle Fault" and "Prop Obstructed" icons when key switch is turned ON.

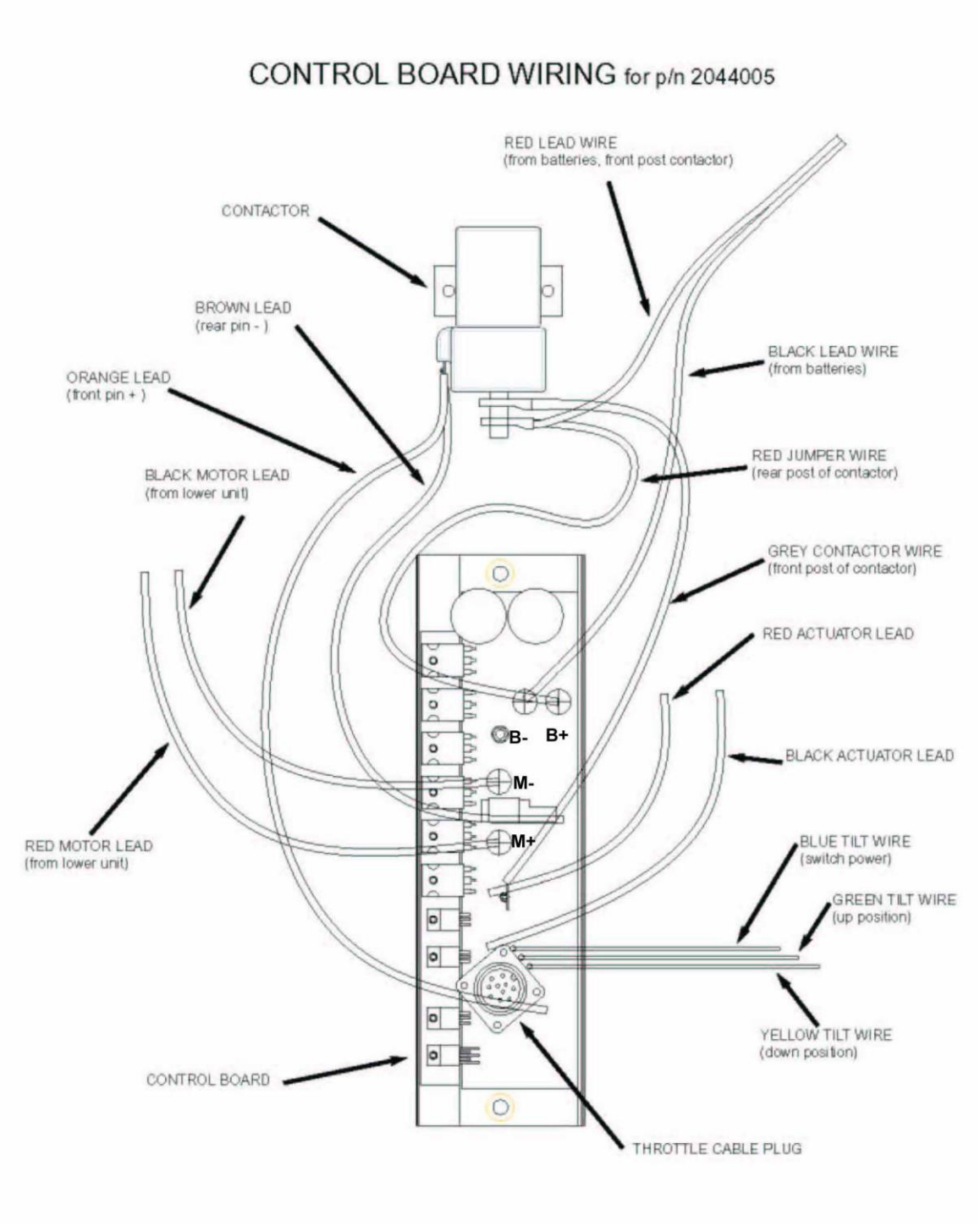
Step 1. The main control board is at fault and needs to be replaced. Replace board and re-test for proper operation. (*See NOTE at start of Part II.)

Part II - Case IX. Throttle LCD flickers on and off.

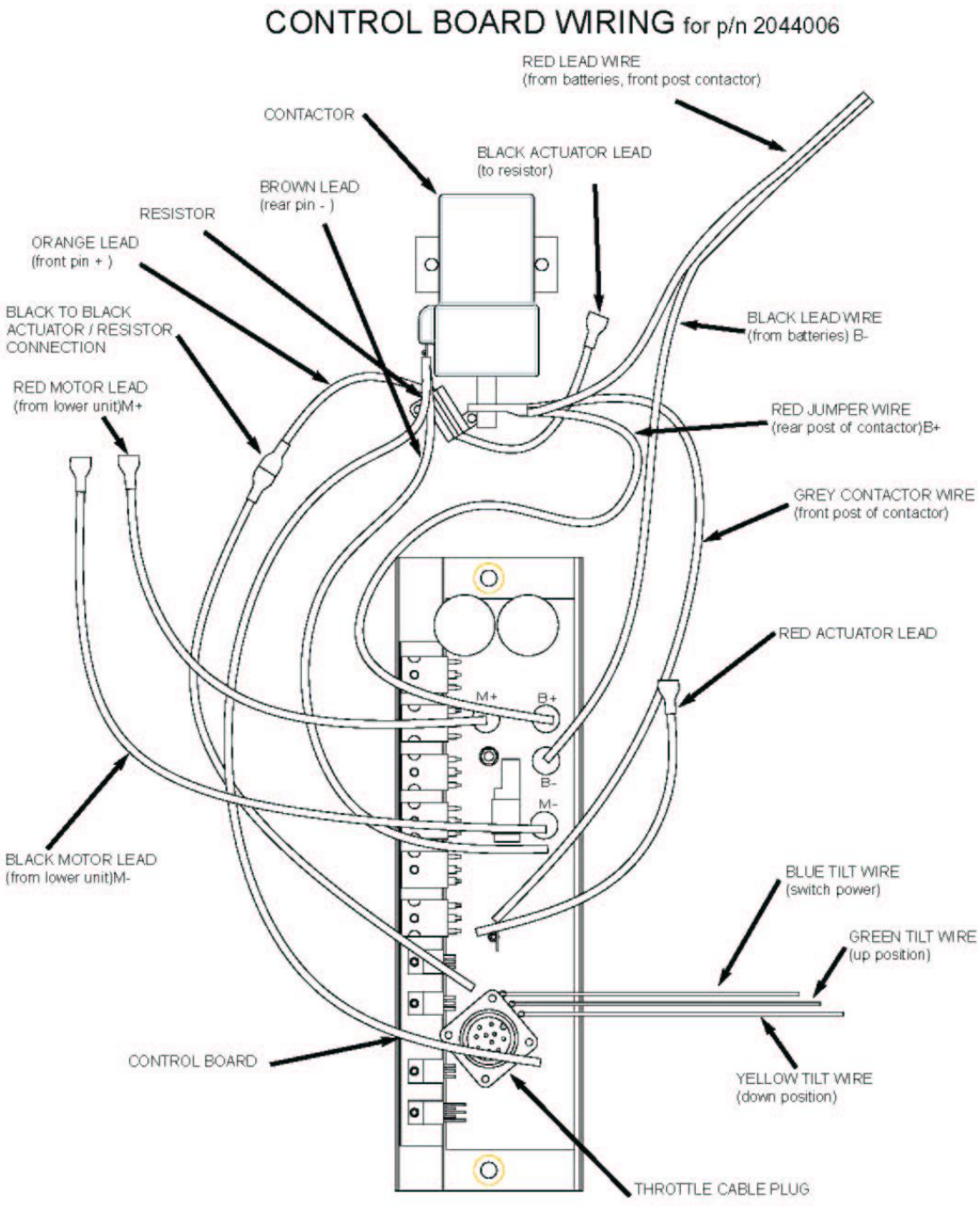
Step 1. Check all plug connections for corrosion and security.

Step 2. Perform a continuity check on both throttle cables (p/n 2041401 & 2041402) for pin out connections **(see pages 20 & 22 for pin-out diagrams)**. Continuity should be noted from one end of the throttle cable to the opposite end across the pins indicated and ONLY those 2 pins, no other should show continuity.

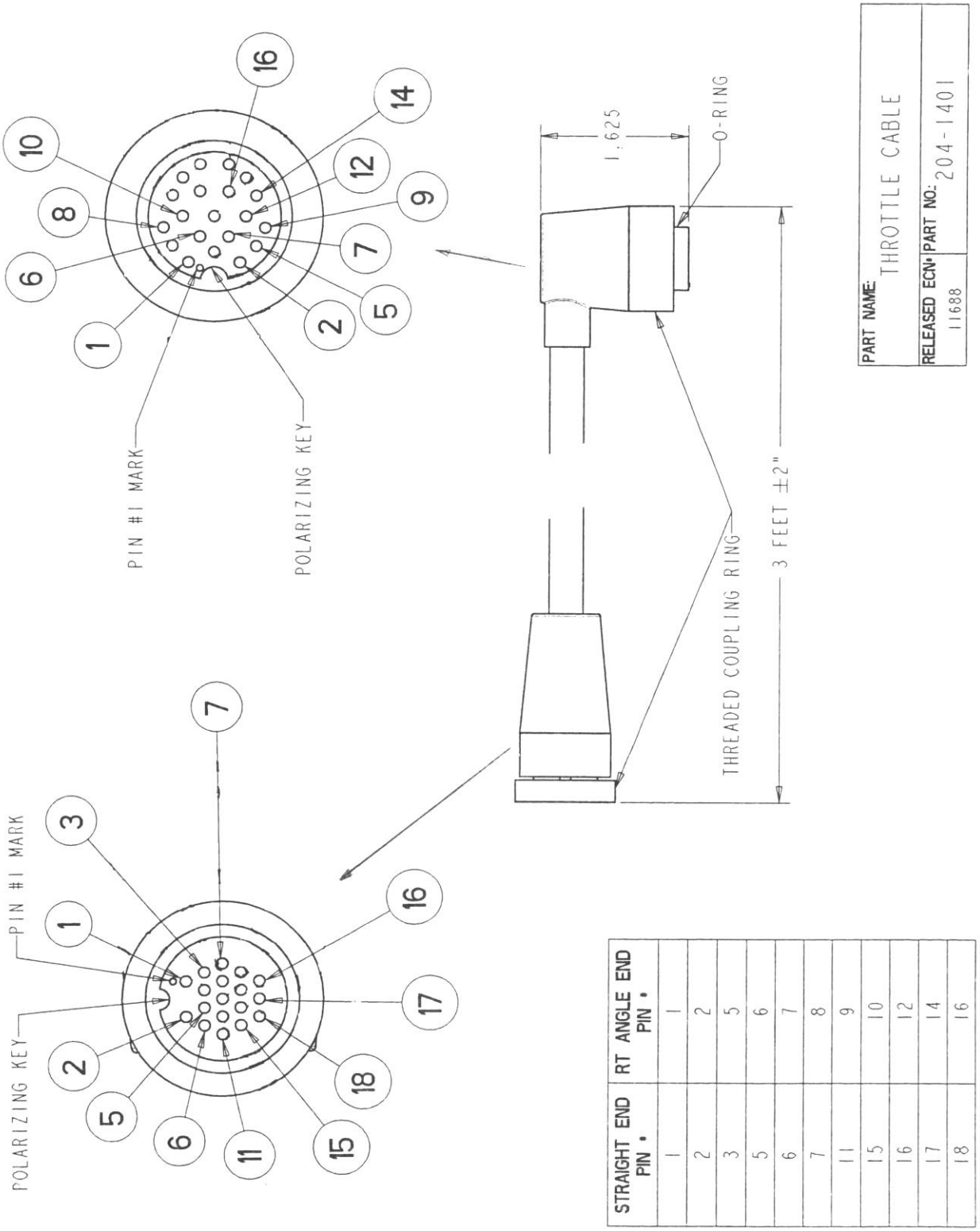
A. If continuity is not found at all pins as noted in the pin-out guide or if continuity is noted across more than 2 pins, then the throttle cable is defective and needs to be replaced. (*See NOTE at start of Part II.)



Wiring Diagram
p/n 2044005

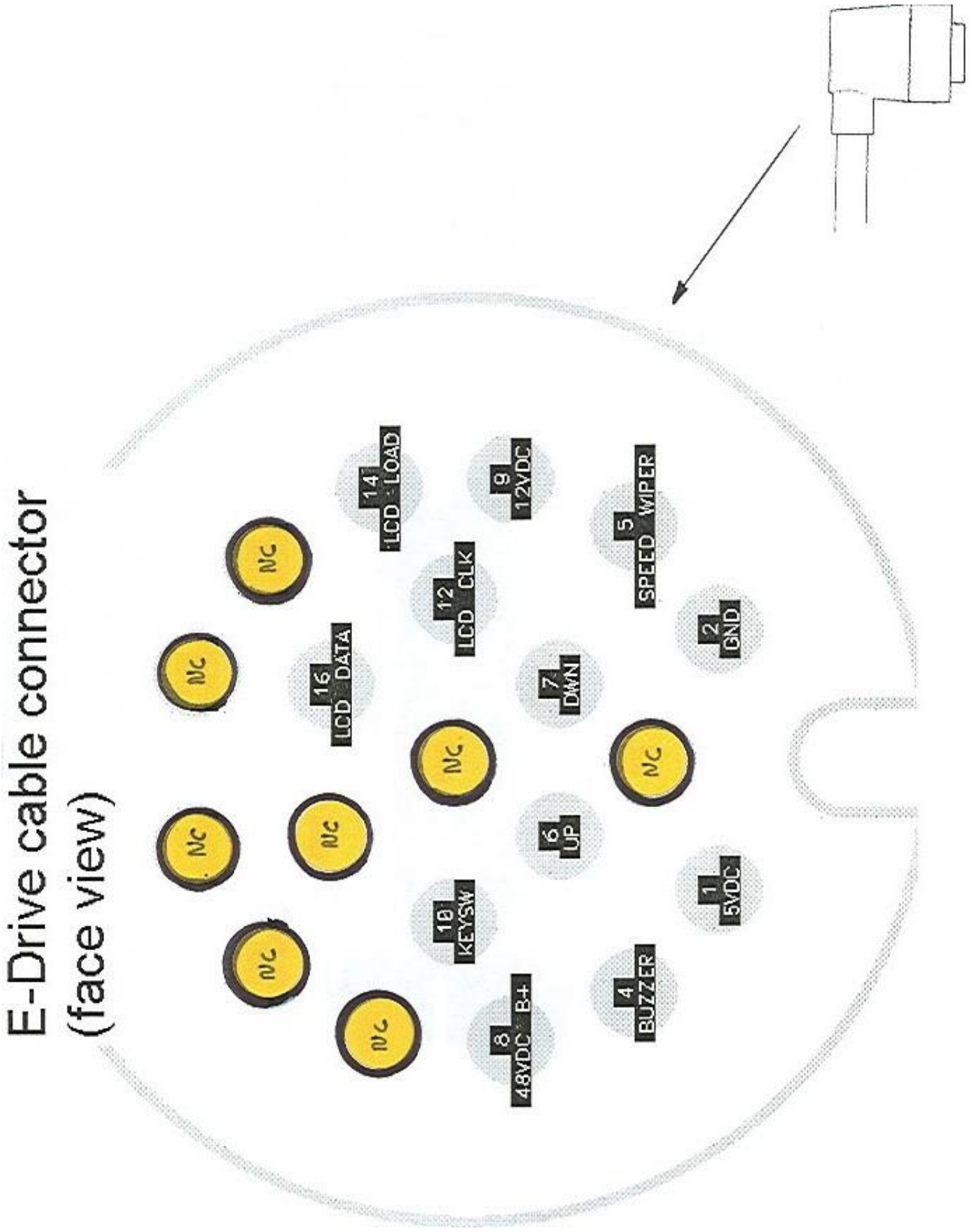


Wiring Diagram
p/n 2044006

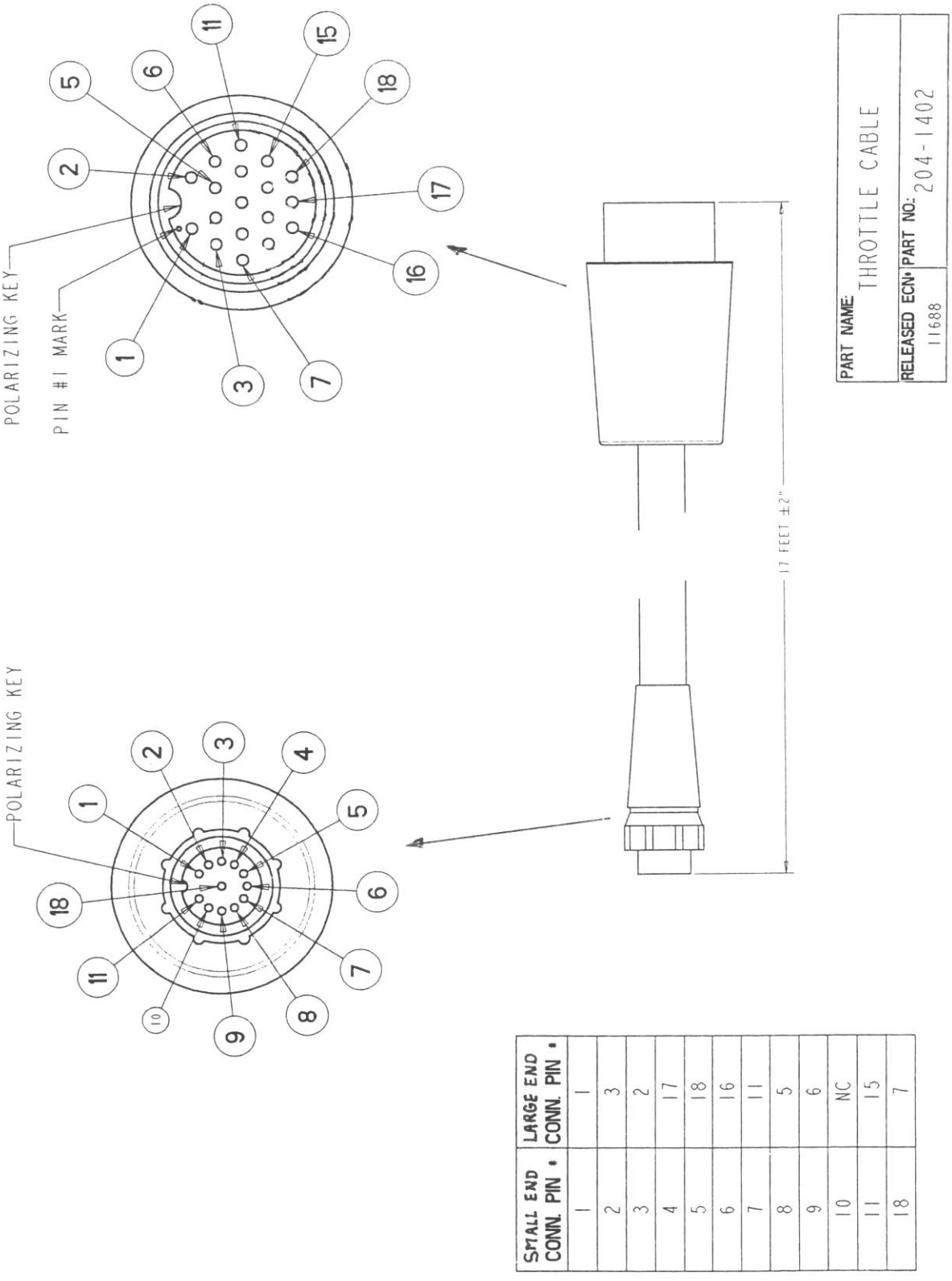


STRAIGHT END PIN #	RT ANGLE END PIN #
1	1
2	2
3	5
5	6
6	7
7	8
11	9
15	10
16	12
17	14
18	16

Throttle Cable Pin-Out Diagram
p/n 2041401

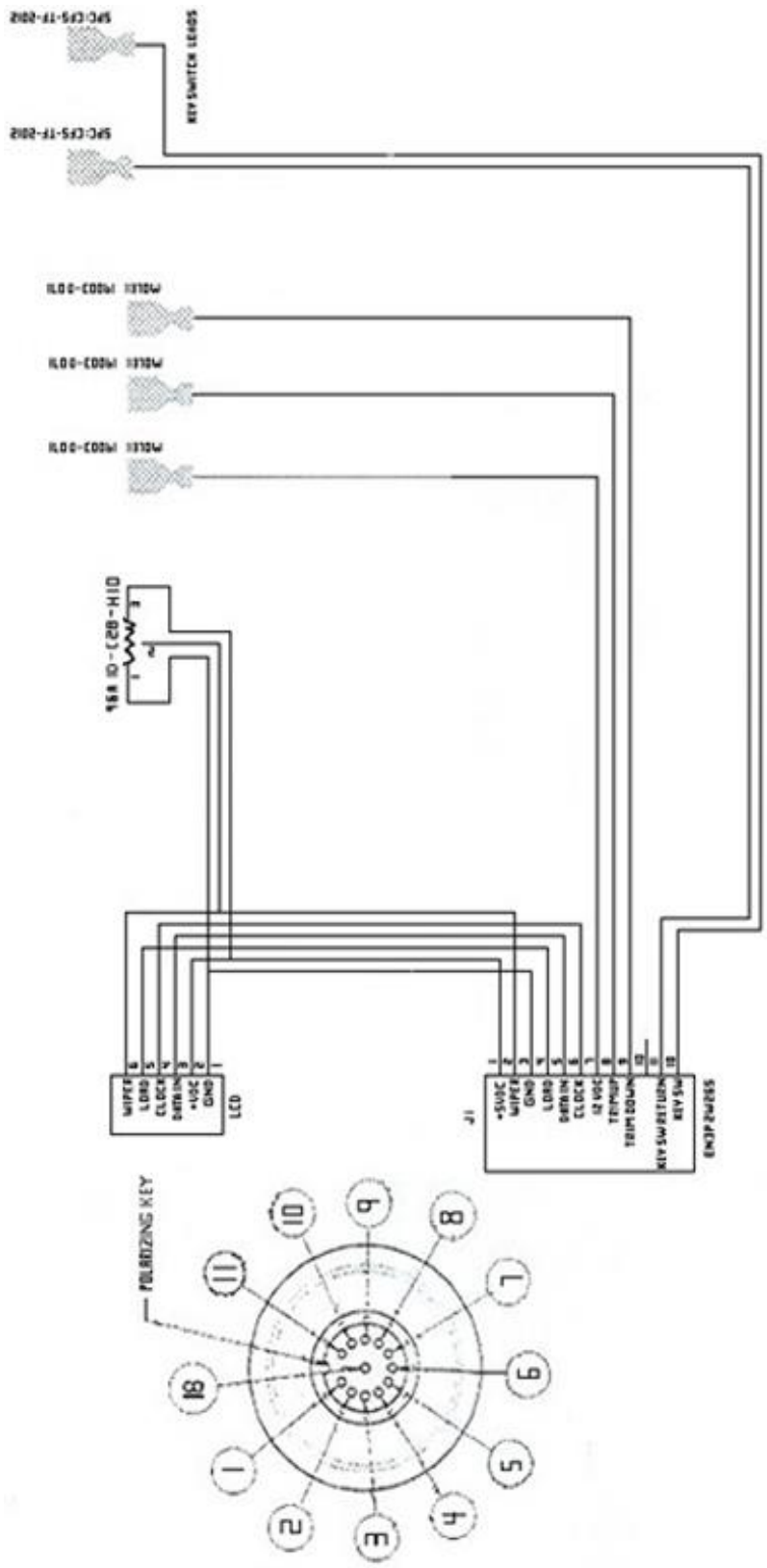


Throttle Cable Pin-Out Diagram (p/n 2041401)
(plugs into main control board)



SMALL END CONN. PIN #	LARGE END CONN. PIN #
1	1
2	3
3	2
4	17
5	18
6	16
7	11
8	5
9	6
10	NC
11	15
18	7

Throttle Cable Pin-Out Diagram
p/n 2041402



Plug Pin-Out Diagram
(on bottom of throttle assembly)