

## ***Description***

Microprocessor-based position controller, driving 2 linear actuators based upon two potentiometer inputs, providing diagnostics and field calibration

## ***Hardware specifications***

Operating Ambient:	-30F to 120F
Construction:	6.75" x 5.0" circuit board to match – provided enclosure (mounted inside port thrust duct)
Power Terminal Blocks:	Screw-type terminal blocks, 14-22 AWG.
Over-current Adjustment:	3A to 15A amps, on-board potentiometer.
Actuator Outputs:	Two bi-directional, solid-state MOSFET, 15 amp max
Actuator Inputs:	Two 10K potentiometers
Actuator Terminal Blocks:	Screw-type terminal blocks, 14 – 22 AWG
Hand-lever Input:	Two 10K potentiometers
Diagnostic LED Outputs:	Two, rated +12 VDC, 40m A maximum
Calibration Switch Input:	Momentary switch closure, rated +12V, 25mA minimum
Hand-lever Terminal Blocks:	Screw-type terminal blocks, 14 – 22 AWG

## ***Software specifications***

### **Auto-Calibrate Mode:**

Both hand levers must be in the released position. The buckets can be in any position.

This mode is entered within 15 seconds of powering up the computer then pressing and releasing the momentary switch on the instrument panel. After 15 seconds, the calibration mode cannot be entered.

During the 15 second period, the hand levers will not directly control the actuators.

Both LED's on the instrument panel will flash rapidly.

The pilot then fully engages each hand lever and holds for 3 seconds, then fully releases each hand lever. Each actuator will run to the fully retracted and fully extended positions.

The potentiometer values of all four points will be recorded automatically and stored in memory.

When the auto-calibrate mode has been completed, the LED's will be steady and the pilot will regain control of the actuators.

Typically, the entire period of operation will be completed in less than 30 seconds.

### ***User mode***

Based on the stored potentiometer values from the auto-calibrate period, the software will equate a hand lever potentiometer value to an actuator potentiometer value by running the actuator motor.

This will be a linear relationship. For example, if the hand levers are retracted 50% of the total distance, the actuator will extend to 50% of the total distance.

The control will shut down if the actuator motor is running and the control senses a current greater than the over-current adjustment (see hardware spec) for a time set by the dip switch (see Option Switches section).

Each time the bucket is fully extended or fully retracted, this position will be compared with the position stored during the auto-calibrate period. If these values are the same, the control continues to operate normally. If the bucket is unable to reach the calibrated position, due to an obstruction, the motor will shut off after 3 or 5 seconds depending on the dip switch setting, and the LED will display an error code (see Diagnostics).

Each time the pilot moves the hand levers, the control will try to move the bucket to the calibrated position.

### ***Diagnostics***

The two instrument panel LEDs will be on when there are no faults. When there is a fault, the LED will flash a number of times, corresponding to the following error code. Each LED operates independently.

- 1 flash = Bucket can't fully open.
- 2 flashes = Bucket can't fully close (reverse).
- 3 flashes = Actuator potentiometer failure, ohmic value out of range.
- 4 flashes = Bucket not able to reach correct position per hand lever.
- 5 flashes = Hand lever potentiometer failure, ohmic value out of range.
- 6 flashes = Recalibration required.
- 7 flashes = Cycle power off and on; calibration error.

### ***Option switches***

Switch	Switch set to "open" side	Switch set to "number" side
S1	Actuator motors run 100%	Actuator motors run 80% of full speed
S2	Over-current timeout = 3 seconds	Over-current timeout = 5 seconds
S3	Hand-levers dampened 2% of range	Hand-levers dampened 4% of range
S4	Disable ramping actuator speed	Enable ramping when motor at full speed

### ***Electrical actuator specifications***

- Volts: + / - 12 volts nominal
- Load: 30 lbs. @ 3 amp
- Peak load, Momentary: 60 lbs.
- Motor current (at rated load): 2.25 amps
- Motor locked rotor current: 18 amps
- Clutch current: 0.6 amps
- Stroke (max) 3 inches
- Maximum no load speed: 3 inches/second
- Weight: 2.4 lbs.
- Operating temp Range: -40°F (-40°C) to + 158°F (70°C)
- Operating voltage range: +/- 11.5 to 16.0 Vdc

**NOTE:** If voltage drops below 12 Vdc, actuator will continue to operate at a decreased performance level.

- Construction:
  - Aluminum die cast housing
  - Powder-coated for corrosion resistance
  - Permanently lubricated metal gear drive
  - Stainless steel output shaft
  - Sealed construction
  - Dust proof and splash proof

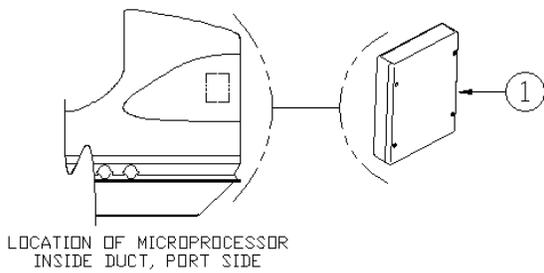
- Polypak rod seal
- 4-start stainless steel Acme screw 7-wire, 20 gauge, shielded cable, 3 feet long

### ***Installing reverse thrust potentiometer controls***

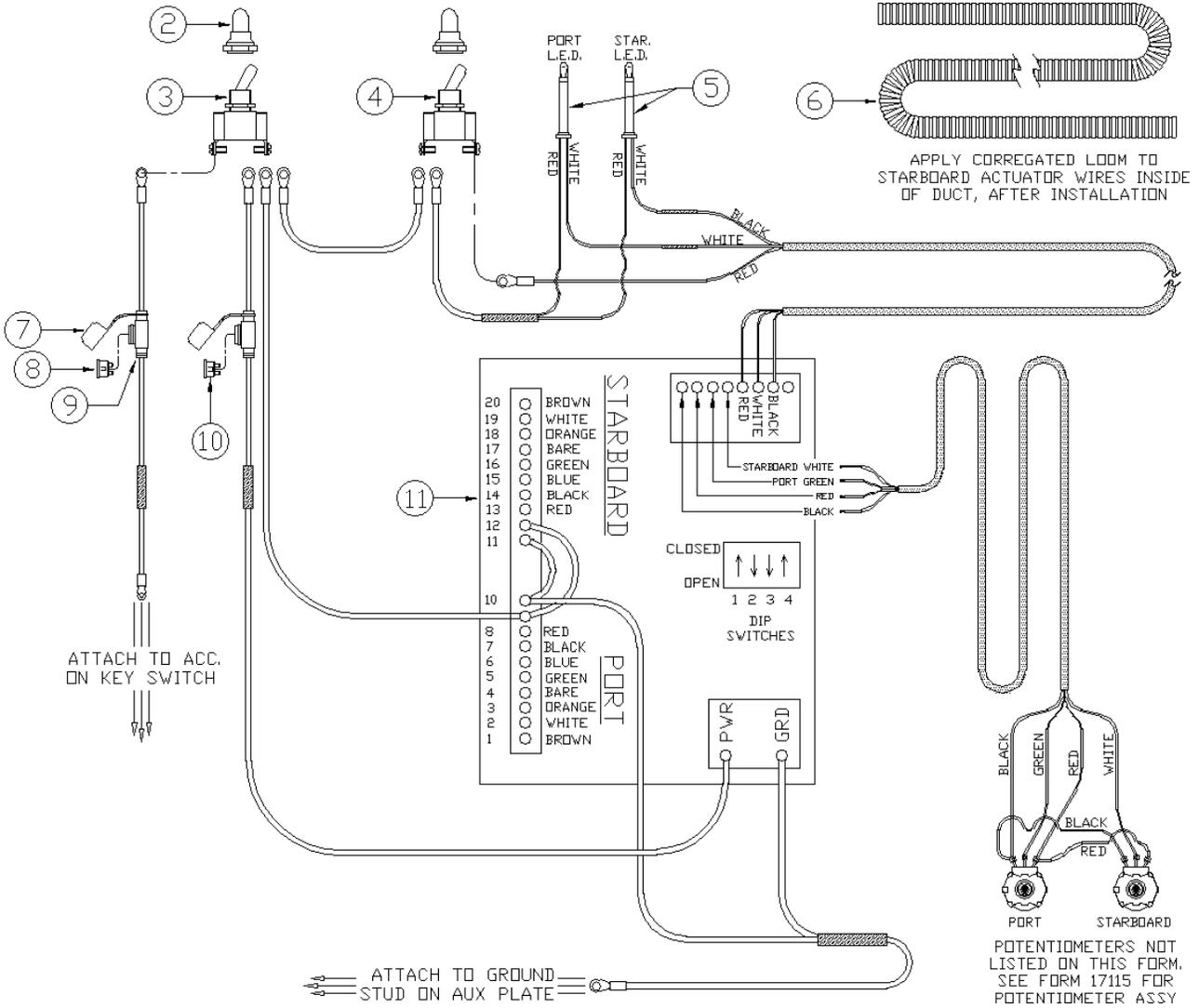
Fit potentiometer (pot.) to bracket with shaft pointing through the bottom of the bracket in the same direction as the welded ends.

Turn the pot. fully clockwise then back 10° and place the cable drum on the pot. shaft so that the slot is parallel with the edges of the bracket and the rounded sides of the slot are facing away from the side of the bracket through which the cable passes. The small set screw is now on the left side with the cable just passing over the top edge of the set screw. The top of the pot. shaft should line up with the bottom of the drum cable slot. Tighten 3/16 set screw.

Fit the brass end of the cable to the BMW control lever (take note of the arrangement of parts if you start this procedure by dismantling these controls). Fit the cable-housing end into the cable receptor on the bracket. Turn drum and pot. 10° or so counterclockwise. Wrap cable with loop end about 260° clockwise around drum; feed through slot so that the cable bend takes place in the carved out slot. Wrap remainder of cable, tighten about 280° clockwise around drum and fit spring through loop in cable. Stretch spring and hook its other end through the hole provided in the bracket. Fit 5/16 set screw and tighten down on cable with a pinching force. Operate BMW bucket levers while checking for proper rotation of pot. drum. If cable rubs against itself, rotate spring until rubbing stops. Drum must rotate a total of about 100°. Lubricate cable with SAE 30 oil.



REF.	PART NO.	DESCRIPTION
1	5704	MICROPROCESSOR ENCLOSURE, MODIFIED
2	1653	TOGGLE SWITCH BOOT
3	1652	TOGGLE SWITCH, ON/OFF
4	2431	TOGGLE SWITCH, MOMENTARY
5	5633	12V LED, GREEN
6	2422	7/16 CORRUGATED LOOM, BLACK
7	2683	MINI AUTOMOTIVE FUSE COVER
8	2685	MINI AUTOMOTIVE FUSE, 15A
9	2682	MINI AUTOMOTIVE FUSE HOLDER
10	2684	MINI AUTOMOTIVE FUSE, 5A
11	5622	HT REVERSE MICROPROCESSOR




**Neoteric Hovercraft Inc.**

1649 TIPPECANOE STREET  
 TERRE HAUTE, INDIANA, U.S.A. 47807-2394  
 TELEPHONE (812) 234-1120 FAX (812) 234-3217

DRAWN: C. STEIMEL	NAME: REVERSE MICROPROCESSOR ASSY
DATE: 20 JAN, 2009	FORM: 17103

### ***Testing actuator***

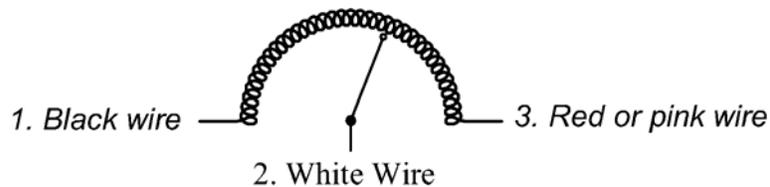
First, disconnect actuator cable from computer.

Connect 12 Vdc to the red and black actuator wires. Measure the current; this should be 0.6 amps. If not 0.6, actuator is faulty. Reverse the 12 Vdc to black and red wires and check for 0.6 amps.

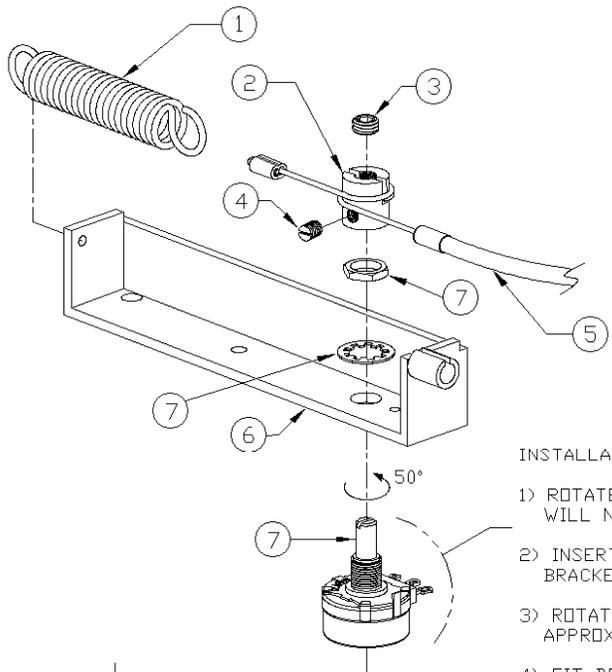
Connect 12 Vdc positive to blue and negative (ground) to green actuator wires. Clutch should engage and hold actuator rod from moving. If rod can be moved clutch is damaged.

Attach an ohmmeter to the brown and orange wires, which are connected to the potentiometer inside the actuator. A reading of 8 – 12 K ohms should be obtained otherwise internal potentiometer is defective.

Attach ohmmeter to brown and white wires. Move the actuator full stroke. The ohmmeter should read 0 – 10 K ohms. If the ohmmeter shows any discontinuity, peaks or 0 ohms during the stroke, the potentiometer is faulty.

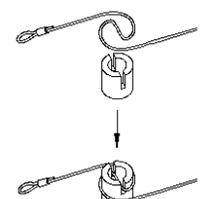


Hand control potentiometer: This should read 0 – 10 K ohms when tested.



BILL OF MATERIAL DESCRIPTION		
REF.	PART NO.	DESCRIPTION
1	2419	POTENTIOMETER CONTROL SPRING
2	3772	POTENTIOMETER CABLE DRUM
3	2464	Ø5/16-24 X 5/32 HOLLOW SET SCREW, HEX SOCKET SS
4	2465	#10-32 X 1/4 CUP POINT SET SCREW, SS
5	3954	POTENTIOMETER CONTROL CABLE, SXS
5	3520	POTENTIOMETER CONTROL CABLE, INLINE
6	3703	POTENTIOMETER CONTROL BRACKET ASSY
7	2970	POTENTIOMETER, 312 DEG
8	2397	#10-24 X 1-1/2 MACH SCREW, PHILLIPS ROUND HD SS
9	2070	1/4 X 5/8 X 1/16 WASHER, SS
10	2333	#10-24 HEX NUT, SS
11	2265	10-24 X 3/4 RD MACHINE Z SLT
12	2353	10 x 0.50 x 0.050 Z WASHER

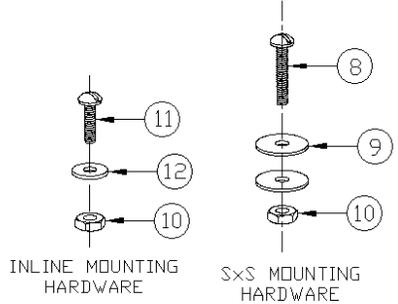
CABLE / DRUM INSTALLATION



THE CONTROL CABLE SHOULD BE INSTALLED ONTO THE DRUM AS SHOWN ABOVE

INSTALLATION NOTE:

- 1) ROTATE CLOCKWISE UNTIL DIAL WILL NO LONGER TURN
- 2) INSERT POTENTIOMETER INTO BRACKET AS SHOWN
- 3) ROTATE DIAL COUNTER-CLOCKWISE APPROX 50°
- 4) FIT DRUM WITH SLOT PARALLEL TO LONG SIDES OF BRACKET



POTENTIOMETER WIRING NOT SHOWN ON THIS FORM. SEE FORM 17103 FOR POTENTIOMETER WIRING.

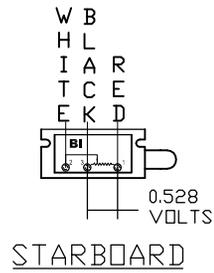
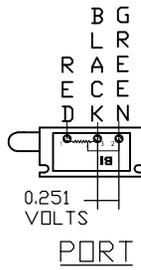

  
 1649 TIPPECANOE STREET  
 TERRE HAUTE, INDIANA, U.S.A. 47807-2394  
 TELEPHONE (812) 234-1120 FAX (812) 234-3217

DRAWN: C. STEIMEL	NAME: POTENTIOMETER CONTROL ASSY
DATE: 15 JULY, 2009	FORM: 17115

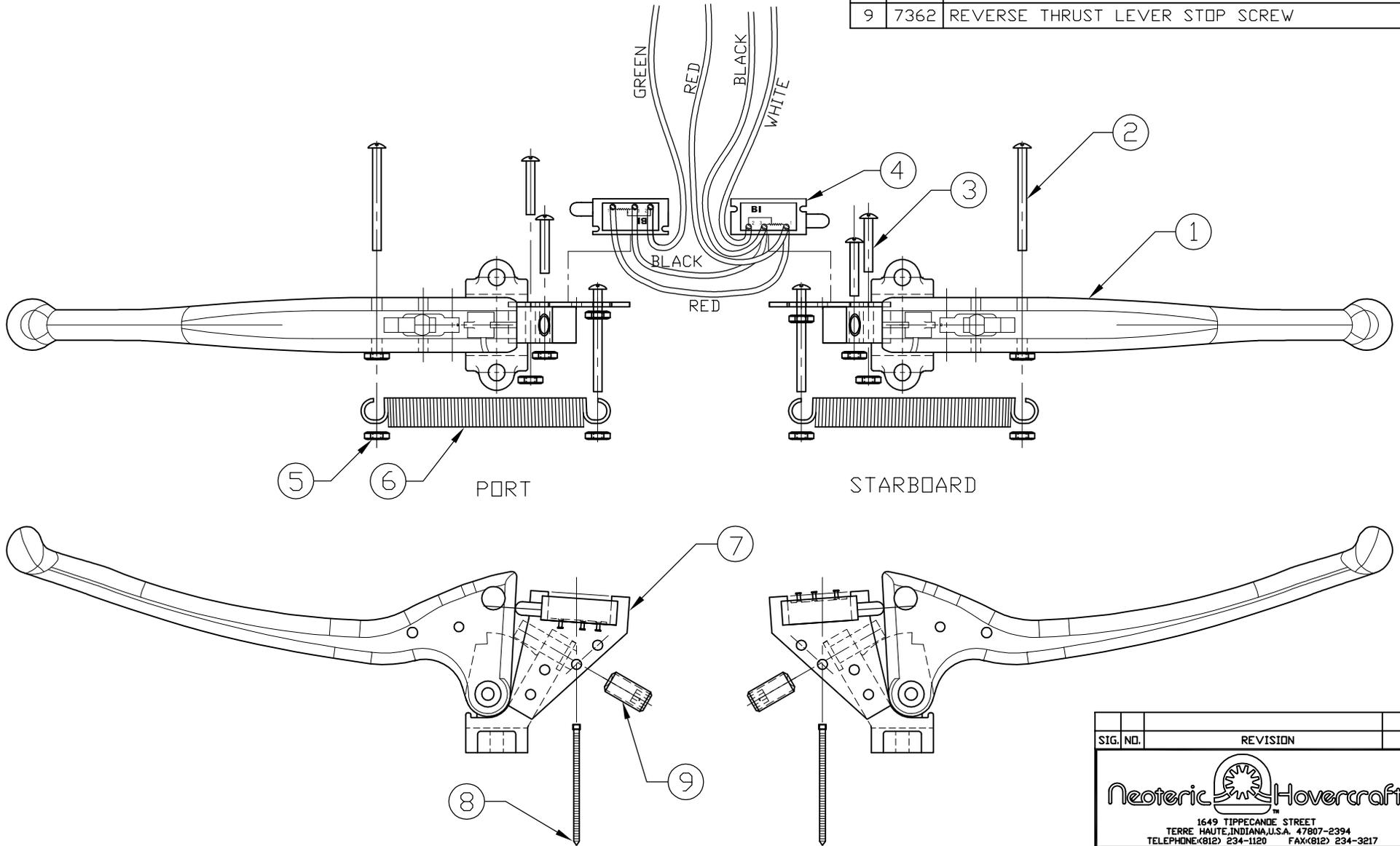
VOLTAGE MEASURED WHEN SYSTEM  
CORRECTLY SET

PORT: 0.251 VOLTS BETWEEN  
BLACK & GREEN

STARBOARD: 0.528 VOLTS  
BETWEEN BLACK & RED



BILL OF MATERIAL		
REF.	PART #	DESCRIPTION
1	9082	REVERSE THRUST CONTROL LEVER
2	7617	MACHINE SCREW
3	7577	MACHINE SCREW
4	7677	LINEAR PLUNGER POTENTIOMETER
5	7578	HEX NUT
6	7579	EXTENSION SPRING
7	7715	404 LINEAR POT MOUNT BRACKET
8	2372	WIRE TIE, BLACK
9	7362	REVERSE THRUST LEVER STOP SCREW



SIG. NO.	REVISION	DATE
 1649 TIPPECANOE STREET TERRE HAUTE, INDIANA, U.S.A. 47807-2394 TELEPHONE (812) 234-1120 FAX (812) 234-3217		
DRAWN: CJ POEHLEIN	NAME: NEW LINEAR POT SYSTEM	REV. 2
DATE: 27 MAY, 2015	NUMBER: 16649	

31<sup>st</sup> Jan 2020

## REVERSE THRUST COMPUTER BOARD TEST PROCEDURE

By Dave Xiang

### Nomenclature:

**Square wave:** Any signal on an oscilloscope that has a high for a certain time and low for a certain time. The duty cycle is not exactly 50% but pretty close to it.

**PWM:** Pulse Width Modulation (PWM) indicates a signal on an oscilloscope that has a high for a certain time and low for a certain time. The duty cycle is not 50%.

**Main chip:** The main chip is the largest chip on the computer board, it is the core chip on the board.

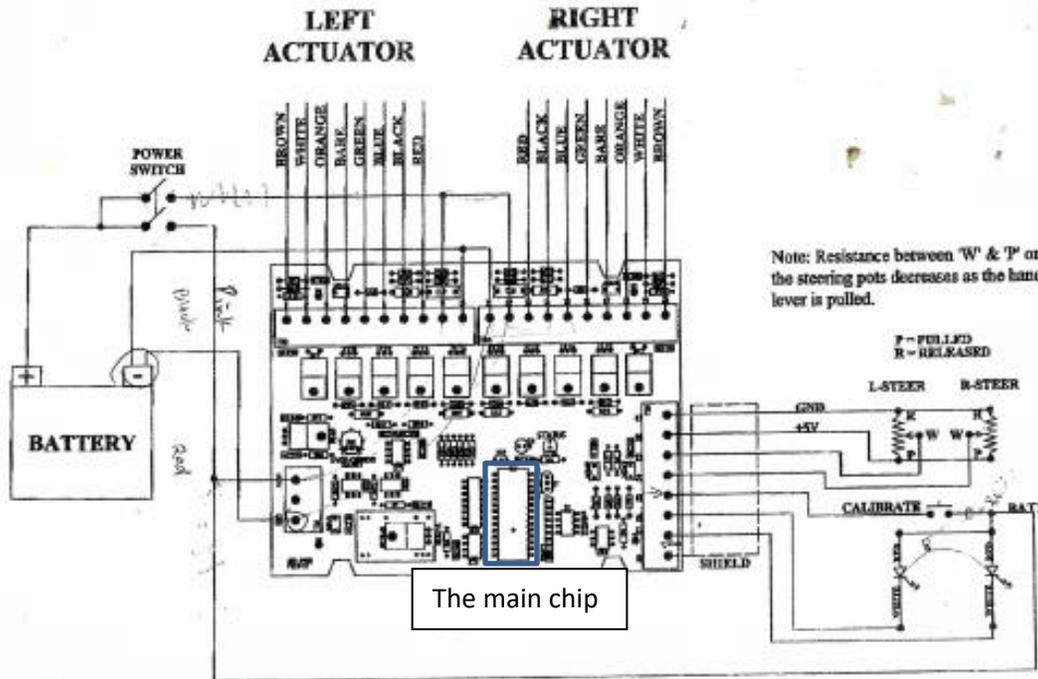
**Power switch:** Is an on/off switch on the instrument panel. Toggle the switch to ON position to give power to the reverse thrust computer board and actuators.

**Calibration switch:** Is a momentary switch on the instrument panel. Flipping the switch up within 30 seconds of system bootup will result in the system entering calibration mode. Calibration procedure is performed by turning the power switch on, followed by the calibration switch activation then hold the reverse handlevers 100% on for 3 seconds before releasing.



# Neoteric Hovercraft Inc.

1649 Tippecanoe Street • Terre Haute, Indiana, USA 47807-2394  
 TELEPHONE: 812-234-1120 • 800-285-3761 • FAX: 877-640-8507  
 EMAIL: Hovermail@NeotericHovercraft.com • WEB: NeotericHovercraft.com • RescueHovercraft.com



### Abstract:

The most common problem on the Neoteric reverse thrust computer is the failure of MOSFETs. In such situations, the actuator cannot work. Replacing a pair of MOSFETs usually solves the problem. Other problems include: unable to save calibration data, LED malfunctioning and unable to read potentiometer, replacing the related component can sometimes fix the problem.

### Equipment:

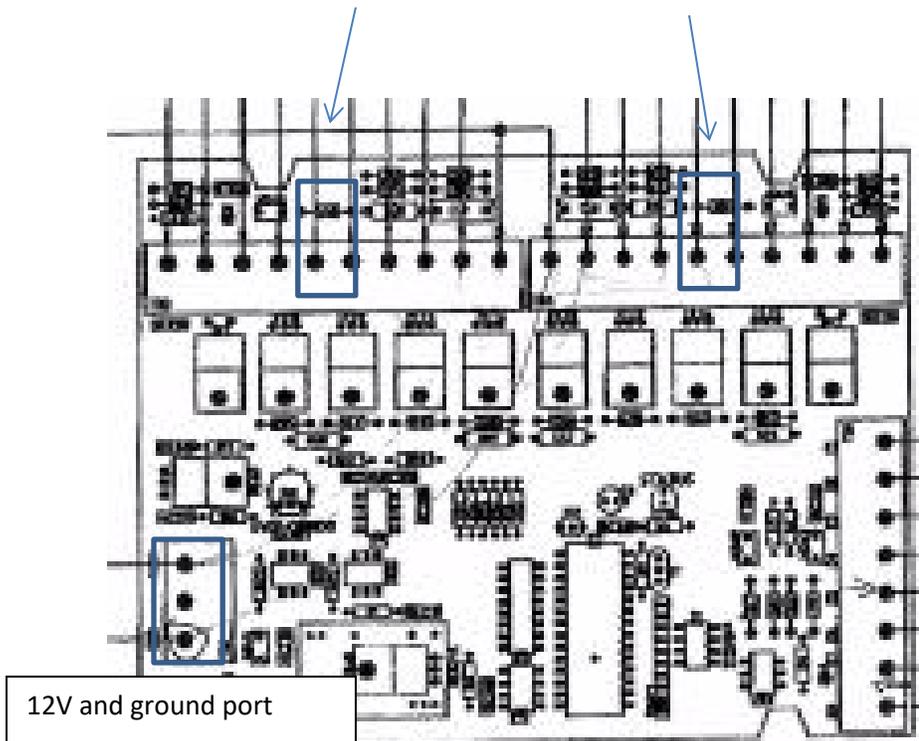
- 1: 12V power supply
- 2: Oscilloscope: Recommended an oscilloscope with at least 2 channels.
- 3: Digital multimeter: Usually used to test continuity. It could also be used to test input voltage.
- 4: Zip tags: zip tags can be useful when testing the handle bar potentiometers.

1649 Tippecanoe Street • Terre Haute, Indiana, USA 47807-2394  
TELEPHONE: 812-234-1120 • 800-285-3761 • FAX: 877-640-8507  
EMAIL: Hovermail@NeotericHovercraft.com • WEB: NeotericHovercraft.com • RescueHovercraft.com

**Procedure:**

1: The first step is to test the continuity between 12V input and ground(GND). Disconnect all the wires to the reverse computer board first and use the multimeter to measure the connectivity between 12V and ground on the computer board.

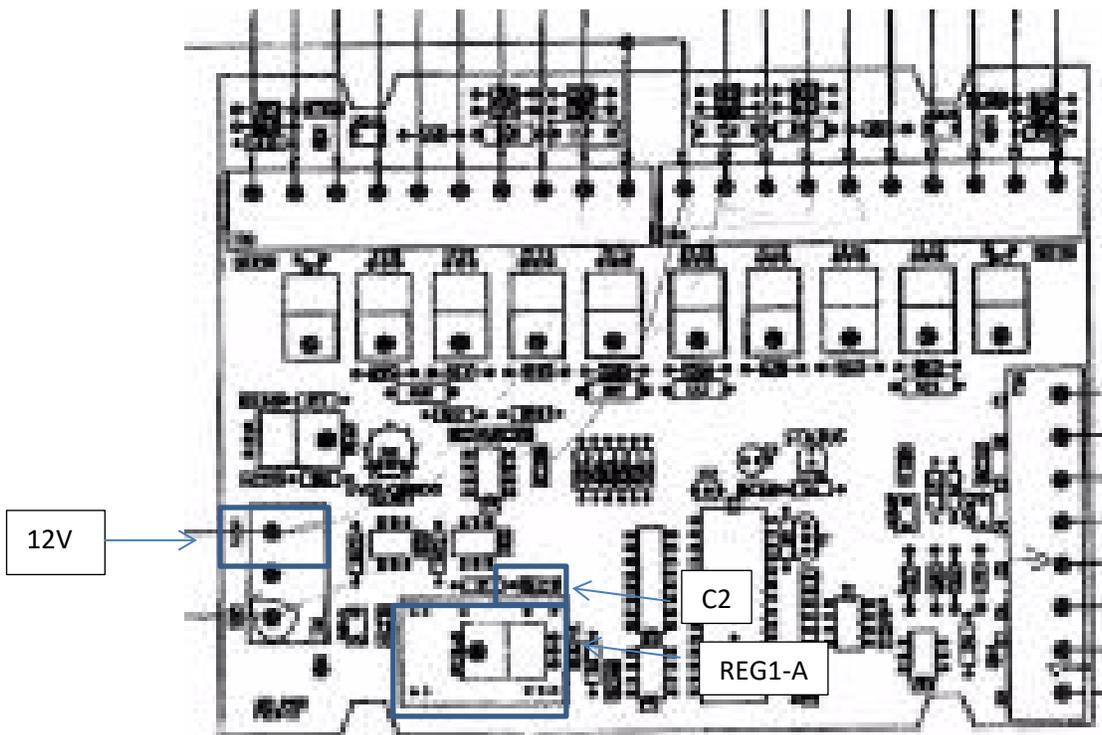
If the actuator is connected here, 12V and ground would read short because the clutch inside the actuator has a small resistance



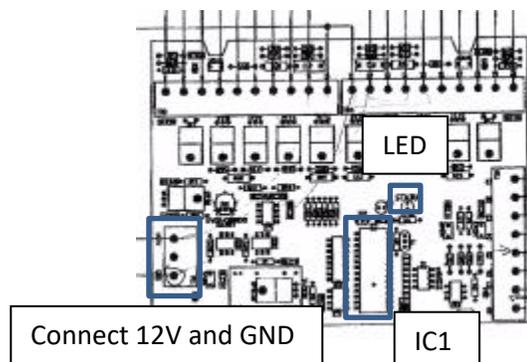
Make sure 12V and ground are not connected before proceeding.

1649 Tippecanoe Street • Terre Haute, Indiana, USA 47807-2394  
 TELEPHONE: 812-234-1120 • 800-285-3761 • FAX: 877-640-8507  
 EMAIL: Hovermail@NeotericHovercraft.com • WEB: NeotericHovercraft.com • RescueHovercraft.com

2: If 12V and ground are connected, check C1 and reg1-A. The problem could be in the DC to DC power converter. It may take several trials to verify un-connectivity because of the circuit protection. If 12V and ground are still connected after several trials, test reg1-A. To test reg1-A, measure the continuity using a multimeter between 12V, and plus side of C2. Normally, they would not be connected. They usually burn when failed. Replace reg1-A to solve the problem.



3: Test the board by connecting 12V and GND. Flip the power switch and see if the LED on the computer board is blinking. If not, measure output on the 24<sup>th</sup> pin on IC1 during calibration using an oscilloscope. If there is no square wave pattern, the main chip is gone. Replace the computer board.

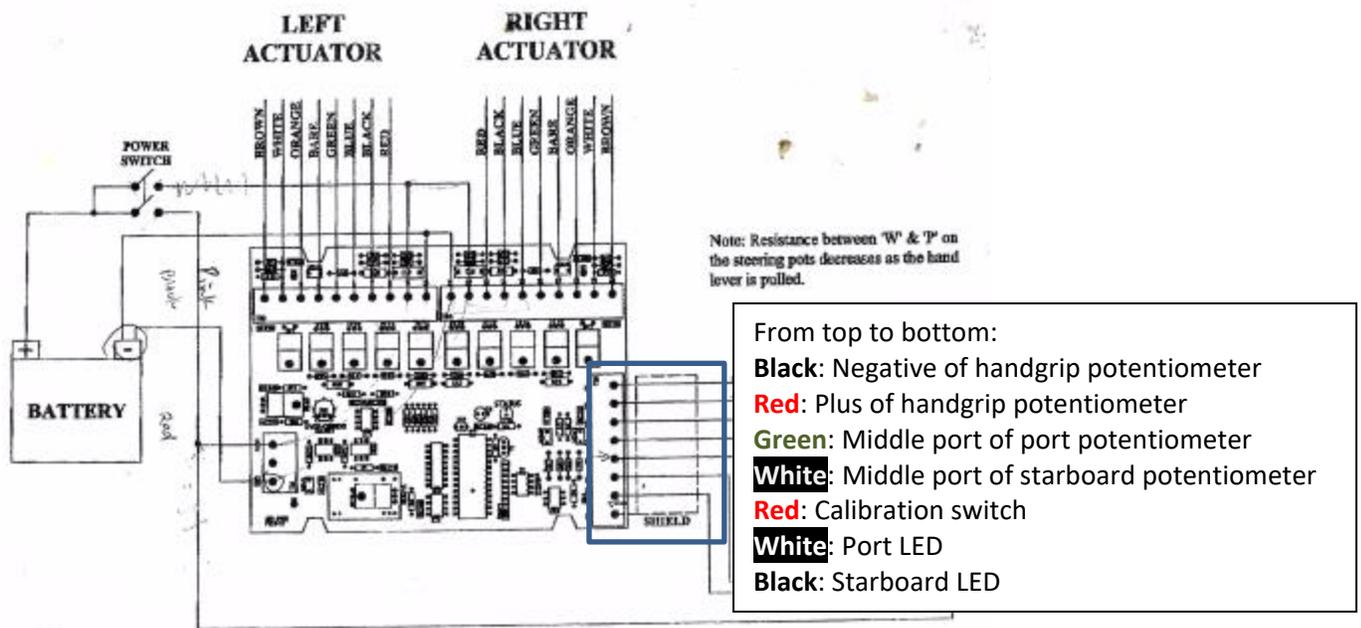




# Neoteric Hovercraft Inc.

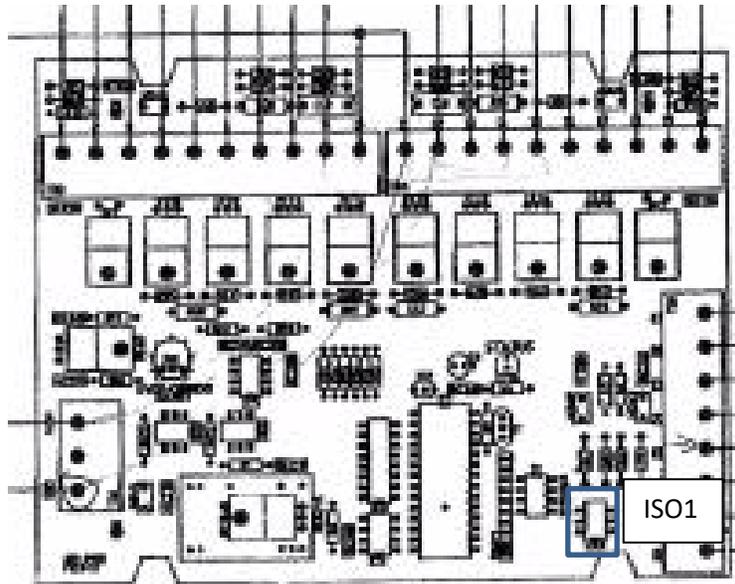
1649 Tippecanoe Street • Terre Haute, Indiana, USA 47807-2394  
 TELEPHONE: 812-234-1120 • 800-285-3761 • FAX: 877-640-8507  
 EMAIL: Hovermail@NeotericHovercraft.com • WEB: NeotericHovercraft.com • RescueHovercraft.com

4: Further, connect the wires on the 8 pin connector. The wire color for the bottom right section from TOP to BOTTOM should be black (Negative of handgrip potentiometer), red (plus of handgrip potentiometer), green (middle port of port potentiometer), white (middle port of starboard potentiometer), red (calibration switch), white (port LED), black (starboard LED). (Reverse in any of the wires may damage components on the computer board). Perform calibration. If the two LEDs on the instrument panel blink for a while then stop, go to step 7. If not blinking, first check LED(s) by measuring the voltage between the white wire (port LED) to GND and the black wire (starboard LED) to GND during calibration using a multimeter or oscilloscope. If you see a square wave on the oscilloscope or get a value between 12 and 0V on a multimeter, the LED is broken. Replace the related LED. If you do not see a square wave or the voltage is 0V, go to step 5.

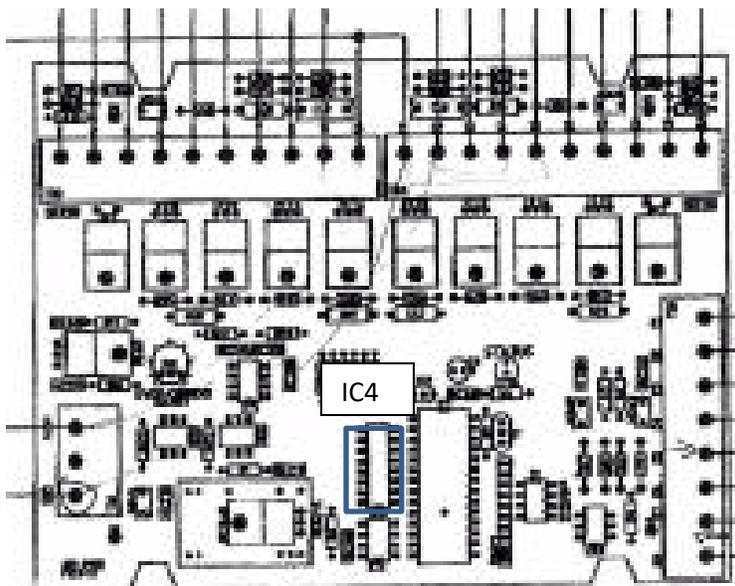


5: Check ISO1 (the white 6 pin chip), pin 1 of ISO 1 should be around 12V when calibration switch is held on, and pin 5 of ISO1 should be close to 5V. Use an oscilloscope in this test. ISO1 functions as a bridge that changes the 12V signal from the calibration switch to 5V going to the main chip. Replace the ISO1 when the voltage is not correct. The component name for ISO1 is 4N35. It could be found at Digikey and other places that sell electrical components. Notice that if any voltage higher than 7V on pin 5, the main chip may have failed.

1649 Tippecanoe Street • Terre Haute, Indiana, USA 47807-2394  
TELEPHONE: 812-234-1120 • 800-285-3761 • FAX: 877-640-8507  
EMAIL: Hovermail@NeotericHovercraft.com • WEB: NeotericHovercraft.com • RescueHovercraft.com



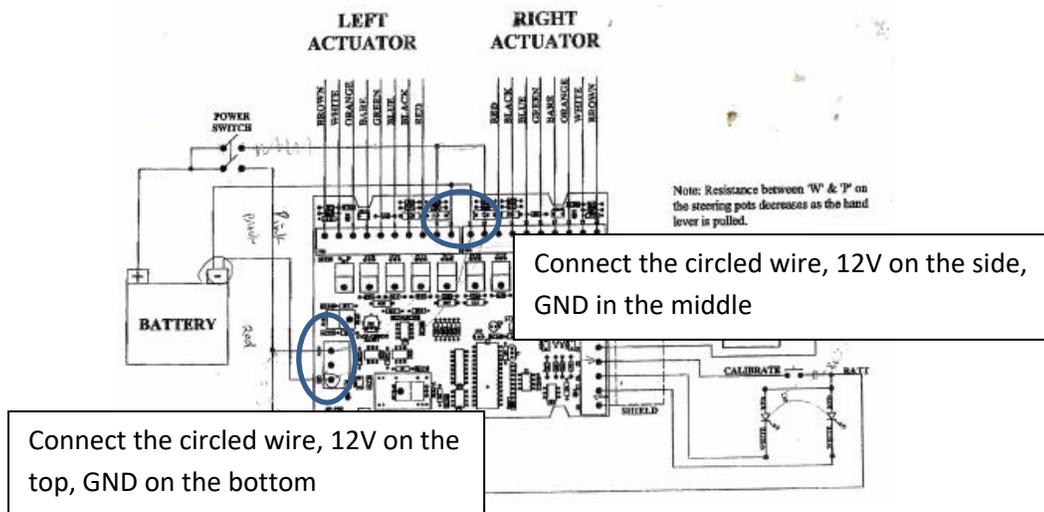
6: Check IC4 (black 16pin chip) use the following method: Check the connectivity between pin 1 and pin 8 using multimeter when both switches are off. They are usually connected when there is a problem. To continue checking, put two probes of oscilloscope on the following pair of pins (7&10, 8&11) while calibrating and look at the waveform. It should show an opposite wave form (if one voltage is high, another should be low at the same time). If the waveform is not present in pin 10 & 11, IC4 has a problem, replace IC4 (It is a ULN2003A chip). If No wave form on both sides, the main chip is gone. Replace the computer board.



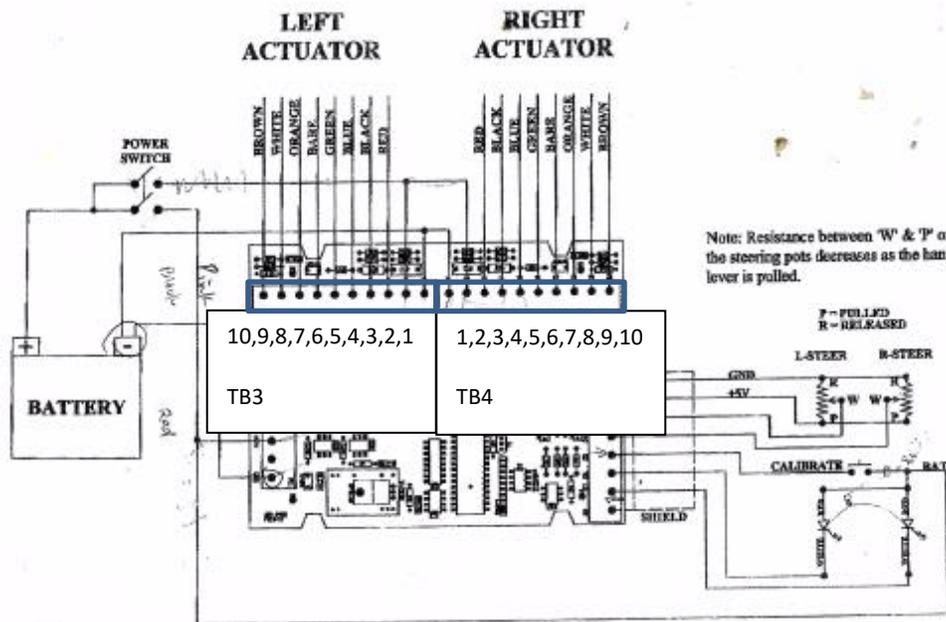
# Neoteric Hovercraft Inc.

1649 Tippecanoe Street • Terre Haute, Indiana, USA 47807-2394  
 TELEPHONE: 812-234-1120 • 800-285-3761 • FAX: 877-640-8507  
 EMAIL: Hovermail@NeotericHovercraft.com • WEB: NeotericHovercraft.com • RescueHovercraft.com

7: To test the actuator driver, connect 12V and GND to the terminal circled on the next figure. Ground is in the middle and 12V is on the side. Leave the actuator disconnected. Measure the connectivity of 12V and ground using a multimeter. If there is continuity, at least one pair of the MOSFET has failed, go to step 11. If they are not connected, go to step 8

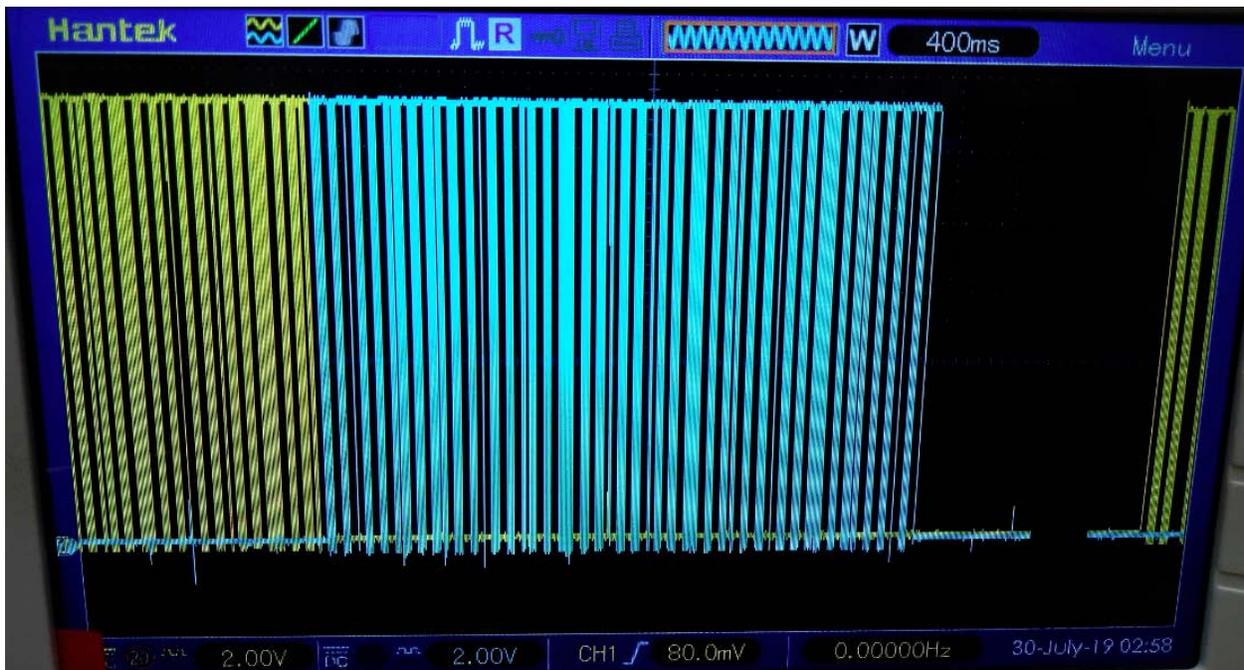


8: Flip the power on. Measure the following voltage of each port in TB3 and TB4. An oscilloscope is preferred in this test. Pin 5 (blue) should be 12V, Pin 6 & 7 (green and bare) should be ground. Pin 8 (orange) should be 5V and Pin 10 (brown) should be ground. If any of the voltage is not seen, first check if there are any broken traces on the circuit computer board. Then go back to step 2. REG-1A may have to be replaced.



1649 Tippecanoe Street • Terre Haute, Indiana, USA 47807-2394  
TELEPHONE: 812-234-1120 • 800-285-3761 • FAX: 877-640-8507  
EMAIL: Hovermail@NeotericHovercraft.com • WEB: NeotericHovercraft.com • RescueHovercraft.com

9: Put one oscilloscope probe on Pin 3 (red) and one on Pin 4 (black), perform calibration. Wait for a short period, two Pulse Width Modulation waveform (PWM) should appear on the oscilloscope. As indicated by the following picture. If any one of the signals is not present, check IC4 (in step 6) and MOSFETs (step 10). Otherwise, go to step 12



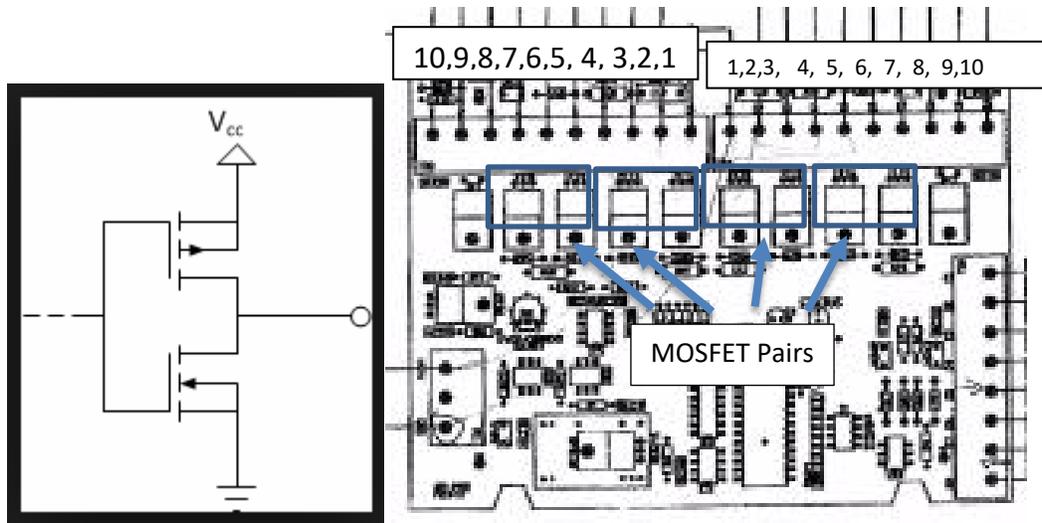
(image achieved by attached channel 1 to Pin 3 of TB3 channel 2 to Pin 4 of TB3)

This step could also be done by using two multimeters. Switch them to measure 20V DC. Put the black lead on multimeter on any of the ground Pin 1 on TB3 or TB4. Put one of the red lead multimeters on Pin 3, and one on Pin 4. You should see one of the multimeters go high (larger than 8V) and then low (less than 5V), as one multimeter goes low, the other multimeter should go high. If any one of the signals is not presented, check IC4 (in step 6) and MOSFETs (step 10). Otherwise, go to step 11.

1649 Tippecanoe Street • Terre Haute, Indiana, USA 47807-2394  
 TELEPHONE: 812-234-1120 • 800-285-3761 • FAX: 877-640-8507

EMAIL: Hovermail@NeotericHovercraft.com • WEB: NeotericHovercraft.com • RescueHovercraft.com

10: Check MOSFETs: There are four pairs of MOSFETs on the reverse computer board. Each pair consist of an N-channel and a P-channel MOSFET. It is a H bridge motor drive with some circuit protection. The simplified structure is the following:



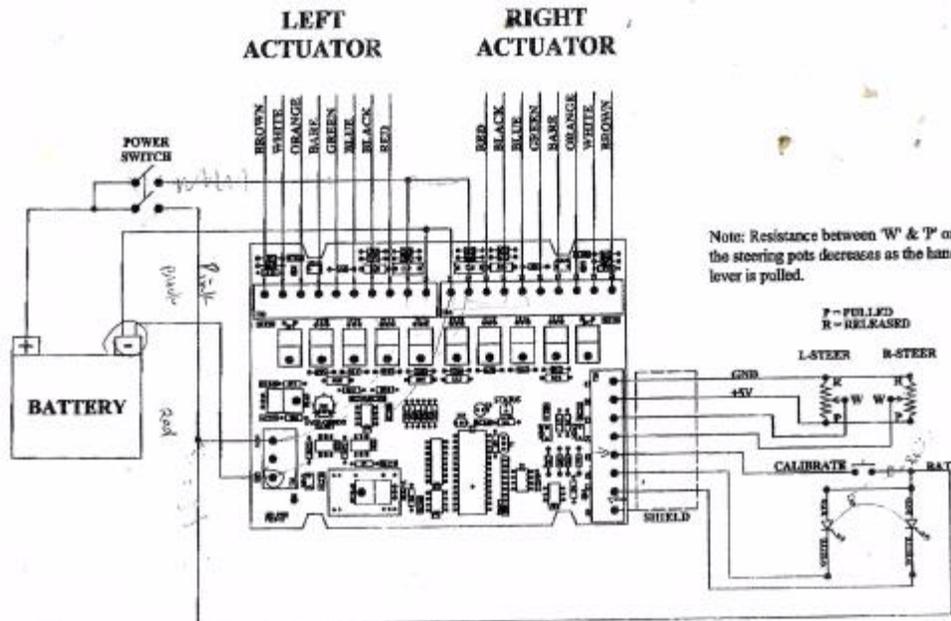
Usually, the bad pair of MOSFET would not give the waveform as indicated in the oscilloscope figure. Check if there are any burn marks or black traces around MOSFET(s) to locate the problem. Use a multimeter to measure the connectivity to trace which pair of MOSFETs has failed. If any MOSFET goes wrong, two of three legs would be connected. MOSFET 1,2 are a pair, MOSFET 3,4 are a pair, MOSFET 5,6 are a pair, MOSFET 7,8 are a pair. When replacing MOSFETs, **it is IMPORTANT to replace both**. Do NOT replace one in the pair, because the broken one can break the other. Those MOSFETs are P-channel **IRF9540N** and N-channel **IRF540N**. Those two MOSFETs have exactly the same appearance, **READ THE MOSFET NAME TO MAKE SURE WHICH IS WHICH**. Reversing the order would burn both MOSFETs.

11: If there is no problem in the pervious steps, connect the actuator. Connect both actuators on the computer board and start testing the whole system. Turn the power on to see LED on the computer board is blinking. Flip the calibration switch, and hold the handlevers for 3 seconds. See rods on actuator extended to the maximum and then to the minimum. Then go roughly to the middle according to the position of the two handlevers. After that, the two actuators can be controled by using the two handlevers.

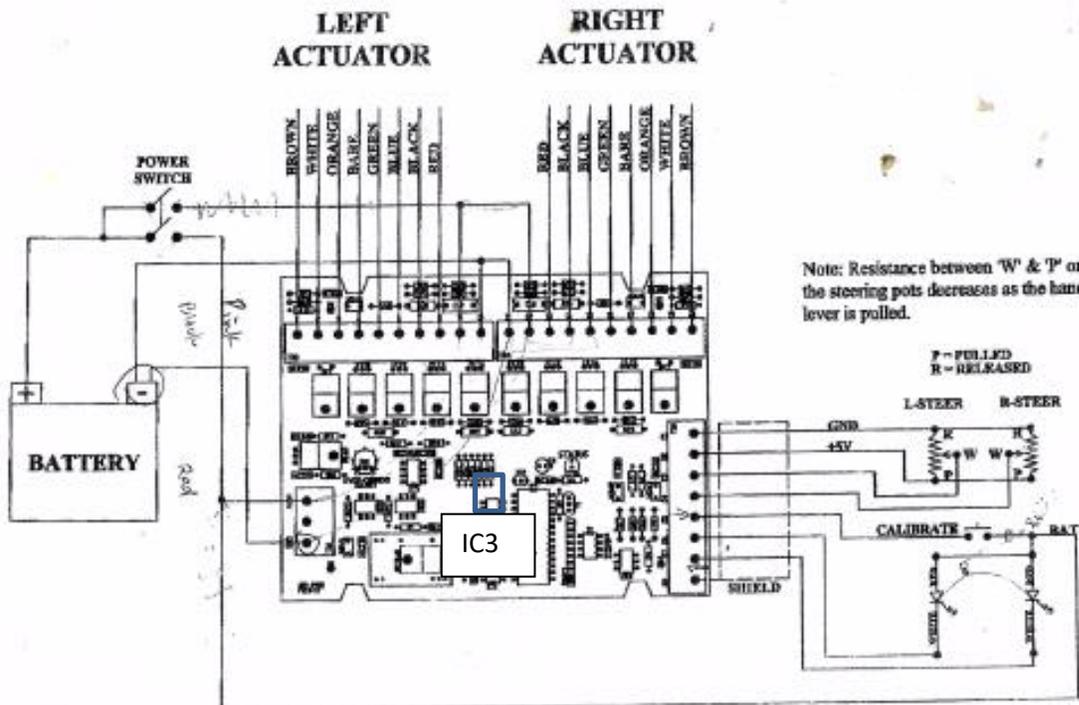


# Neoteric Hovercraft Inc.

1649 Tippecanoe Street • Terre Haute, Indiana, USA 47807-2394  
 TELEPHONE: 812-234-1120 • 800-285-3761 • FAX: 877-640-8507  
 EMAIL: Hovermail@NeotericHovercraft.com • WEB: NeotericHovercraft.com • RescueHovercraft.com



12: Finally, turn off the power switch and wait for 3 seconds. Then turn it on. Now actuator can be controlled without recalibration. If that is not happening and error code 6 appears, something is wrong with IC3 (black 8pin chip). The IC3 is in charge of storing calibration data when the power is off. If that happens, replace the IC3. It is an EEPROM named AT93C46D. Replacing IC3 will solve the problem.



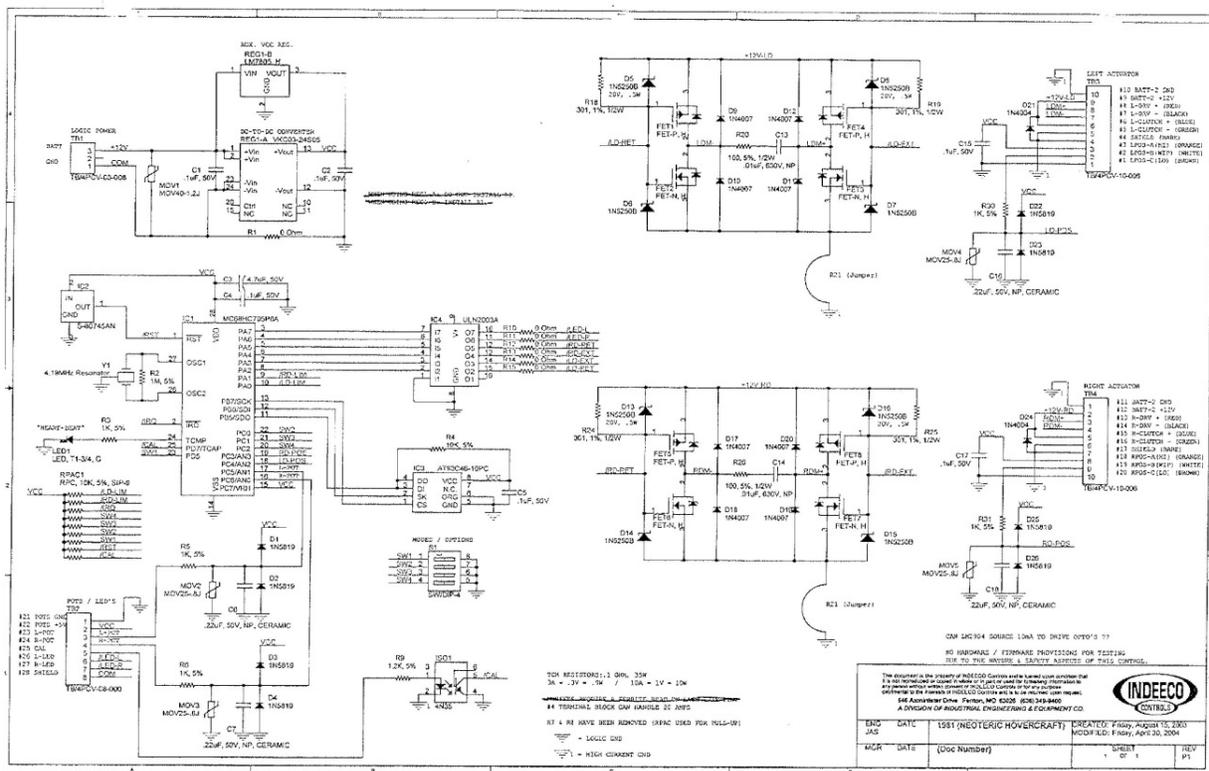
1649 Tippecanoe Street • Terre Haute, Indiana, USA 47807-2394

TELEPHONE: 812-234-1120 • 800-285-3761 • FAX: 877-640-8507

EMAIL: Hovermail@NeotericHovercraft.com • WEB: NeotericHovercraft.com • RescueHovercraft.com

13: Reaching this step without finding any problem means the computer board is good.

Schematic of the reverse thrust computer board.



SCHEMATIC Pg 2 of 2

#5622