SERVICE WORK INSTRUCTION

SEAKEEPER MOTOR LEAD TESTING - 124

PRODUCT ALL SEAKEEPER MODELS

PURPOSE

This procedure provides guidance in performing the phase-to-phase resistance and motor potting (insulation) testing on all Seakeeper flywheel motors.

BACKGROUND

As in any motor, Seakeeper flywheel motor windings and cable insulation are susceptible to breakdown. Failure in a phase's insulation will cause slowing of the flywheel motor. Megohm testing is needed to accurately determine the need to replace a sphere. A time-resistance megohm test is provided because an instantaneous megohm reading does not ensure accuracy without historical values.

In factory testing, it has been found that arcing occurs when megohm testing is conducted in an enclosure at atmospheric pressure; an enclosure sphere vacuum ensures minimized arcing damage to motor windings.

TOOLS & SUPPLIES REQUIRED

- Megohm meter capable of maintaining a test voltage (1000 V for AC models / 500 V for Seakeeper 2 through 4 models / 250 V for Seakeeper 1) for one minute.
- Digital Multimeter
- Phillips #2 screwdriver [for AC motor drive box (MDB)]
- Torque wrench (inch-pounds/Nm)
- Phillips bit for torque wrench (for AC MDB)
- Sockets and ratchet wrench
- SAE and Metric combination wrench sets
- T15 Torx® key (for DC MDB cover screws)

REFERENCES:

SWI-129, Seakeeper Vacuum Gauge Operation

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PRECAUTIONS

1. PERSONNEL INJURY MAY RESULT if Seakeeper is NOT locked and at zero RPM before removing covers or accessing unit for service.
2. PERSONNEL INJURY MAY RESULT if attempting to perform maintenance on Seakeeper without removing flywheel motor power and applying lockouts due to remote start capabilities.
3. DAMAGE TO MOTOR WINDINGS MAY OCCUR if megohm testing between phases; Megohm tests are conducted from a phase lead to ground.
4. DAMAGE TO MOTOR WINDINGS MAY OCCUR if megohm testing is conducted on enclosure with no vacuum.

NOTES

1. Improper test results may occur if leads are not electrically isolated (in contact with metallic surfaces) during testing.
2. Seakeeper Product Support Team can better assist if all data and actions taken are recorded during testing and that information is immediately shared with Seakeeper.
3. For AC-powered models, use **Section 1**.
   For DC-powered models, use **Section 2**.

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PROCEDURE

Link to Testing DC-Powered Models

SECTION 1: TESTING AC-POWERED MODELS

1. **RECORD** all data taken during this procedure for submittal in communication.
2. **ENSURE** enclosure sphere of Seakeeper tested has vacuum (less than 100 torr):
   a. **IF** enclosure has no vacuum sensor,
   THEN DETERMINE enclosure pressure by SWI-129, Vacuum Gauge Operation.

> **WARNING!**
>
> PERSONNEL SHOCK HAZARD EXISTS WHEN FLYWHEEL ROTATING OR POWER ALIGNED TO SEAKEEPER.

3. **OPEN/TURN OFF** AC power breaker to Seakeeper.
4. **ENSURE** DC power aligned for brake override.
5. **ENSURE** flywheel RPM is zero.
6. **REMOVE** MDB cover.
7. **STORE** motor drive cover's ten M4 screws in safe place for re-use.

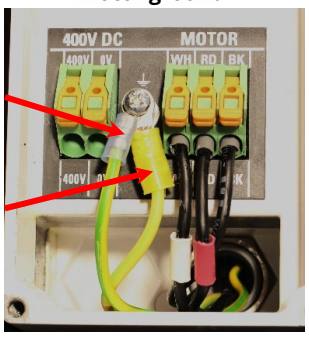
> **NOTE:**
>
> Some Seakeeper models have a motor ground and a shield ground at motor terminal.

8. **REMOVE** three phase leads, shield ground, and motor ground cable from "MOTOR" terminal.
   a. **IF** motor leads are not color-coded,
   THEN IDENTIFY each lead with a piece of tape as to location found (WH, RD, or BK).

Motor with shield and motor ground

Shield ground (16 AWG)

Motor ground (12 AWG)



Motor with just shield ground

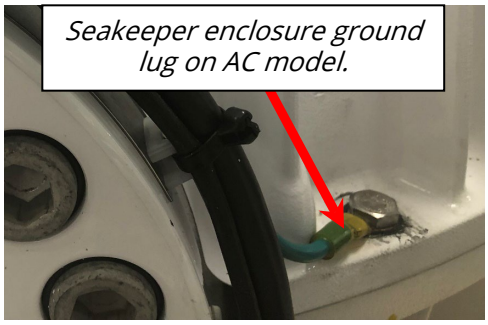
9. **ENSURE** leads are NOT in contact with each other or MDB frame.

10. **REMOVE** enclosure ground cable on enclosure near equator as shown.

11. **ENSURE** enclosure ground cable terminal is NOT in electrical contact with enclosure.

12. **ACTIVATE** brake override.

13. **PERFORM** thorough visual inspection of motor power cable from motor drive to feedthrough on enclosure.



Seakeeper enclosure ground lug on AC model.

    a. **IF** any cable or feedthrough damage found, **THEN PHOTOGRAPH** damage **AND SUBMIT** photos with data from tests.

SEAKEEPER MOTOR LEAD TESTING - 124

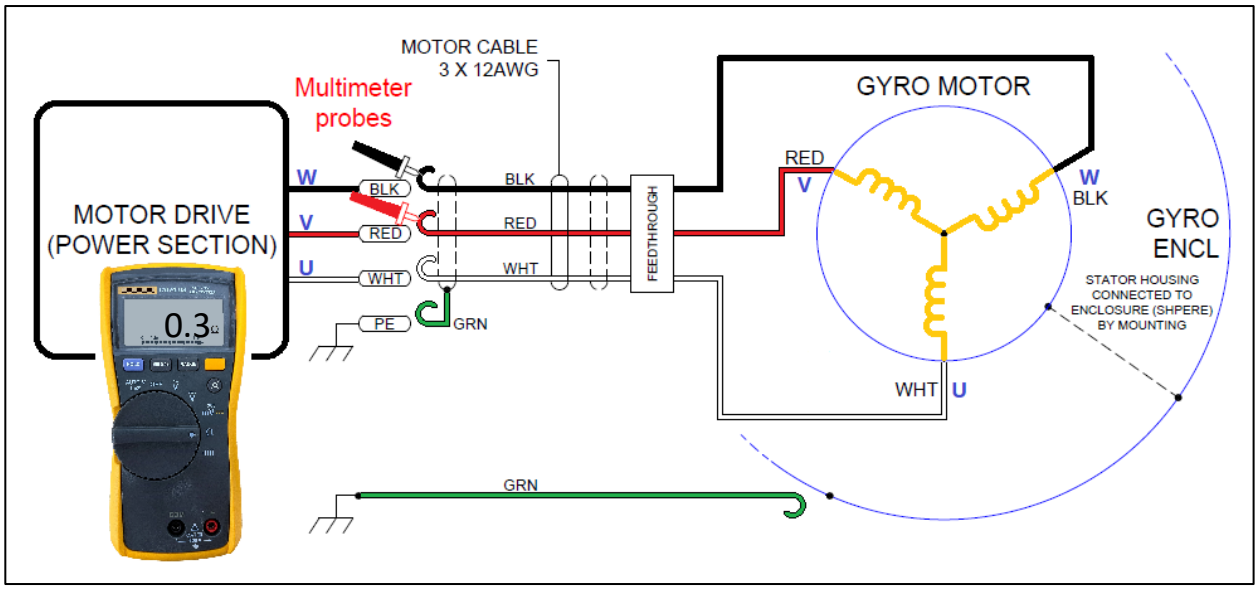
PRODUCT ALL SEAKEEPER MODELS

NOTE:

Intermittent opens or shorts may not be seen if cable is not manipulated to duplicate movement of precession.

14. With multimeter in resistance mode, **MEASURE AND RECORD** resistance between each motor phase wire end crimp to one decimal place.

Resistance (Ω) Between Phases	
Black (W) to White (U)	
White (U) to Red (V)	
Black (W) to Red (V)	



15. **PRECESS** enclosure sphere **AND REPEAT** resistance measurements.

CAUTION:

DAMAGE TO MOTOR MAY OCCUR IF TESTED
PHASE TO PHASE

WARNING!

SHOCK HAZARD EXISTS WITH CURRENT
& HIGH VOLTAGE TO MOTOR CABLE LEADS

16. **PERFORM** megohm testing on each phase, one at a time, as follows:

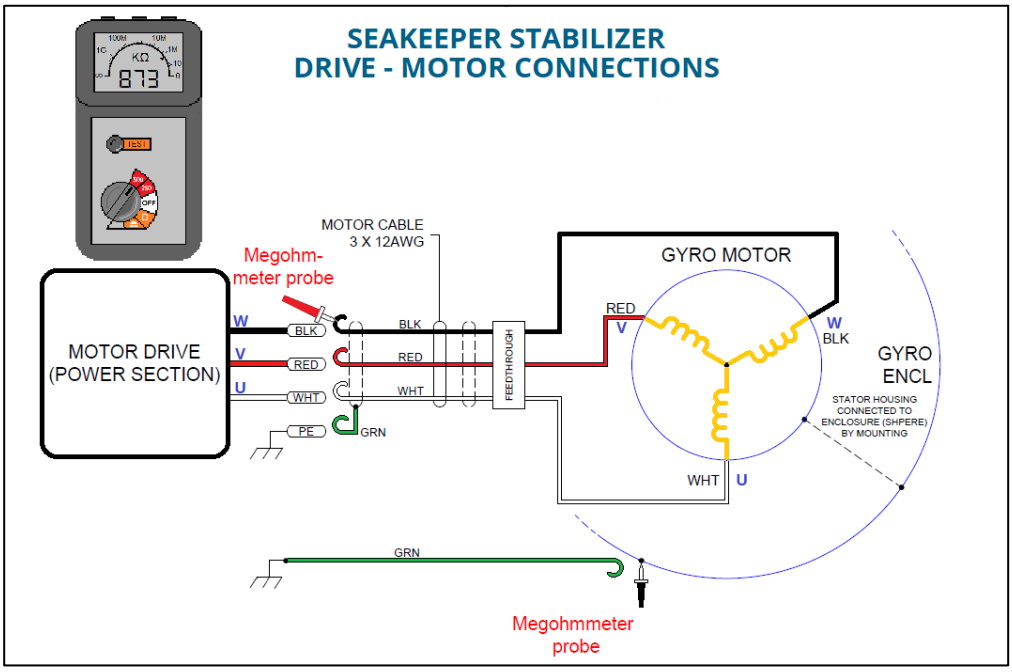
    a. **ATTACH** black megohm test lead to enclosure ground lug (near equator). [On Seakeeper 4.5, motor ground is 12 AWG green/yellow cable in motor drive]

    b. **ATTACH** red megohm test lead to phase in test.

CAUTION:

MOTOR DAMAGE MAY OCCUR IF TESTED AT A HIGHER VOLTAGE THAN SPECIFIED.

    c. **PLACE** megohmmeter on scale of **1000V**.



Seakeeper recommends a Time-Resistance megohm test because it is independent of temperature and can give conclusive evidence without recorded past tests. This method accounts for the absorption effect of good insulation compared to compromised insulation. Good insulation will show a continual rise in resistance over time. This rise is caused by the absorption of voltage in the stator windings. Degraded winding insulation will have a higher leakage current to keep resistance constant.

The time-resistance method is independent of meter quality or winding types or sizes between models. It provides a clearer understanding of insulation breakdown even when an instantaneous reading shows a high resistance.

A ratio between the 30-second and 60-second readings will provide a ratio helpful in evaluating the insulation breakdown in a motor. When customer time and expense are at stake, Seakeeper desires to eliminate all doubt when determining whether a sphere replacement is necessary.

17. With each phase (Red, White, and Black), **PRESS AND HOLD** megohmmeter's test button for 60 seconds.

    a. **RECORD** readings at 30 seconds and 60 seconds.

    White (U): **30 Seconds:** _____ **60 Seconds:** _____

    Red (V): **30 Seconds:** _____ **60 Seconds:** _____

    Black (W): **30 Seconds:** _____ **60 Seconds:** _____

18. **MANUALLY PRECESS** sphere enclosure full travel, forward and back.

19. **REPEAT** test momentarily to verify same initial resistance (it is NOT necessary to repeat 60 second test).

20. **CALCULATE** following:

    a. For each megohm test result, **DIVIDE** 60 second reading by 30 second reading to determine ratio.

> For example, say at 30 seconds one reads resistance of 110 Mohms. At 60 seconds, they read 600 Mohms. Determine ratio of 60 second reading divided by 30 second reading as follows:
>
> 600 Mohms ÷ 110 Mohms = **5.45** is ratio

WHITE (U): **(60 sec)** _____ **÷ (30 sec)** _____ **=** _____

RED (V): **(60 sec)** _____ **÷ (30 sec)** _____ **=** _____

BLACK (W): **(60 sec)** _____ **÷ (30 sec)** _____ **=** _____

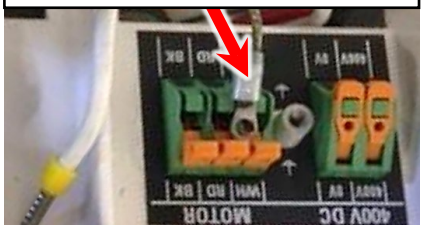
21. For minimum of 60 seconds, **MEASURE** megohm resistance of each phase to shield ground of motor drive cable at 1000V.

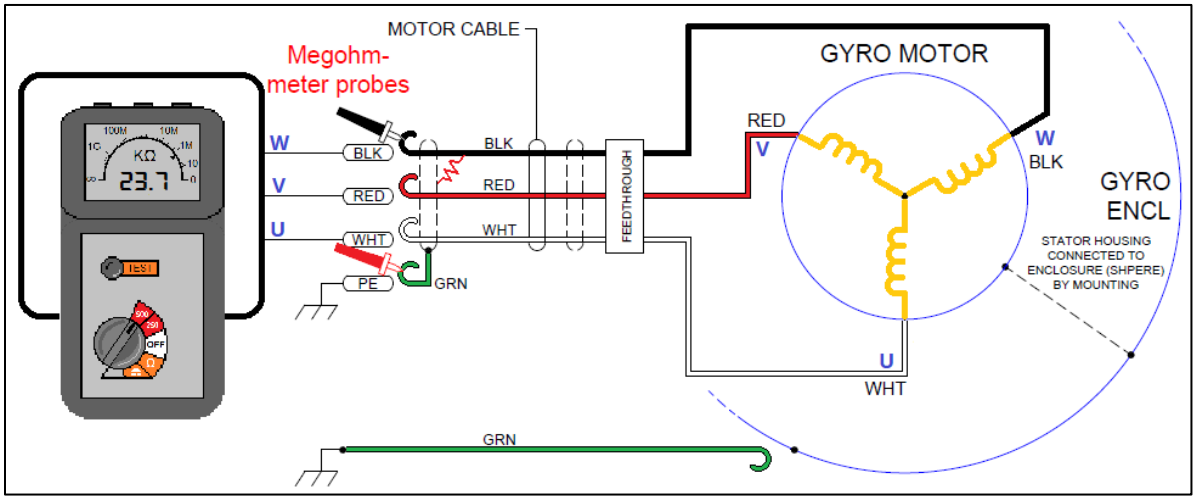
WHITE (U): _____,

RED (V): _____,

BLACK (W): _____

A motor power cable equipped with shield ground.





22. **DOCUMENT** any physical damage of motor power cable or leads with photograph.

23. **CONTACT** Seakeeper Product Support Team with ALL data taken for evaluation while still onsite. (Email support@seakeeper.com after hours)

    a. Americas Telephone: +1 (410) 326-1590
    b. EMEA Telephone: +39 0185 1897071

WARNING!

SHOCK HAZARD EXISTS DUE TO CAPACITANCE FROM MEGOHM TESTING

24. While holding ground wire insulation, **FASTEN AND TORQUE** enclosure ground cable onto enclosure ground lug per table below. **[N/A for Seakeeper 4.5 models]**

MODEL	TORQUE SPECIFICATION	NOTES
Seakeeper 5 (EM)	120 in-lbs	Use only internal tooth lock washer, 5/16" screws size. P/N: 60276.  Apply Loctite 243 to bolt threads.
Seakeeper 6/5	200 in-lbs	Use only internal tooth lock washer, 5/16" screws size. P/N: 60276
Seakeeper 9/7HD	120 in-lbs	No washer under bolt head. Use conductive paste under cable lug.
Seakeeper 16/12HD & 18	200 in-lbs	
Seakeeper 26/20HD		
Seakeeper 35/30HD/40		

25. **RE-ATTACH** all motor cable leads to their respective terminal.

26. **ENSURE** other leads within Motor Drive are attached properly.

27. **INSTALL** MDB cover with ten M4 screws.

28. **TORQUE** ten M4 screws of cover to **19 in-lbs** (**2.2 Nm**) to prevent moisture intrusion.

********** **END** **********

SECTION 2: TESTING DC-POWERED MODELS

1. **RECORD** all data taken during this procedure for submittal in communication.

2. **ENSURE** enclosure sphere of Seakeeper tested has vacuum (less than 100 torr):

   a. **IF** enclosure has no vacuum sensor,
   THEN DETERMINE enclosure pressure by SWI-129, Vacuum Gauge Operation.

> **WARNING!**
>
> PERSONNEL SHOCK HAZARD EXISTS WHEN FLYWHEEL ROTATING
> OR POWER ALIGNED TO SEAKEEPER.

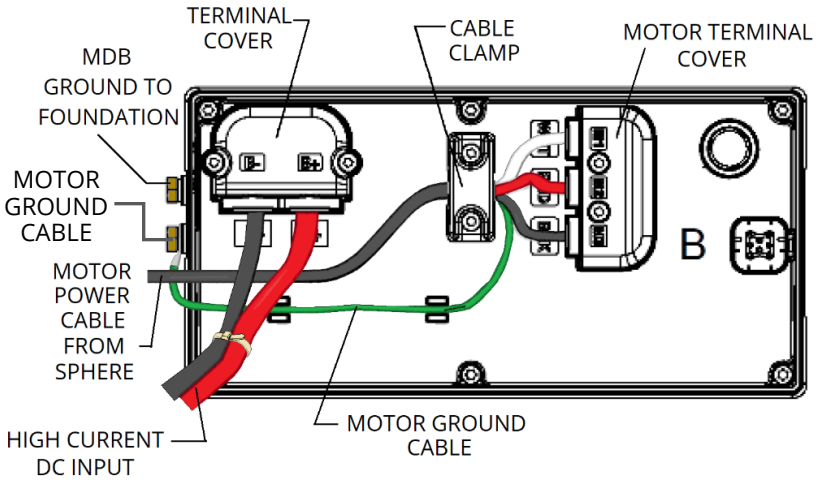
3. **ENSURE** low-current DC power aligned for brake override. **[N/A on Seakeeper 1]**

4. **DISCONNECT** motor power cable leads as follows:

   a. For Seakeeper 2, 3, and 4:

      i. **REMOVE** motor terminal cover with T15 Torx® key.

      ii. **REMOVE** cable clamp with T15 Torx® key.



      iii. **REMOVE** motor ground cable from MDB side lug with 10 mm socket.

      iv. **REMOVE** motor leads from motor terminal with 8 mm socket.

      v. **ENSURE** leads are electrically isolated (NOT in contact with other metal).

Section 2, Step 4 continued

b. For Seakeeper 1:

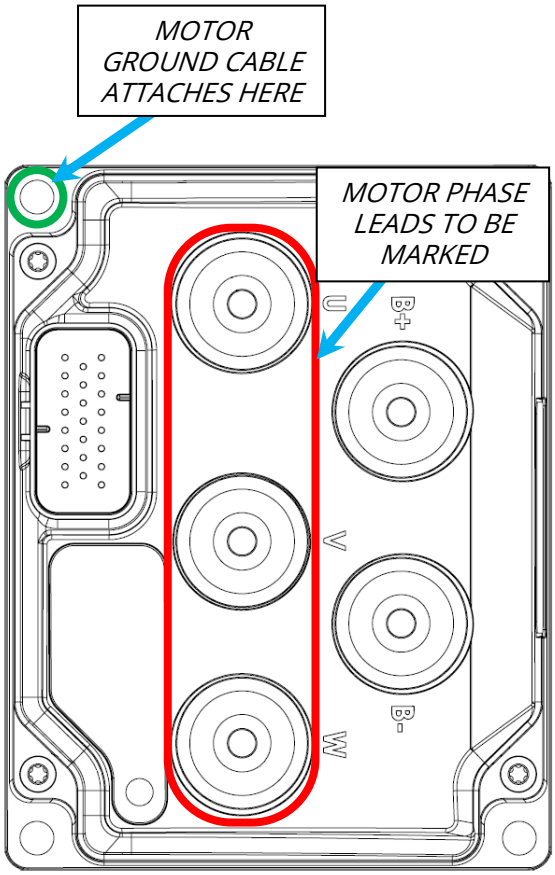
i. **REMOVE** clear gel coating of motor lead lugs.

ii. **IF** no label attached to each motor lead,
THEN LABEL each cable as U, V, or W based on their connection post designation.

iii. **REMOVE** motor leads from Curtis drive with 10 mm socket.

iv. **REMOVE** green/yellow motor ground cable with 10 mm socket.

v. **ENSURE** all leads are NOT in contact with each other or metal frame.



5. **ACTIVATE** brake override.

6. **PERFORM** visual inspection of motor power cable from motor drive to feedthrough on enclosure.

a. **IF** any cable or feedthrough damage found, **THEN**:

i. **PHOTOGRAPH** damage.

ii. **SUBMIT** photos with data from tests.

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NOTE:

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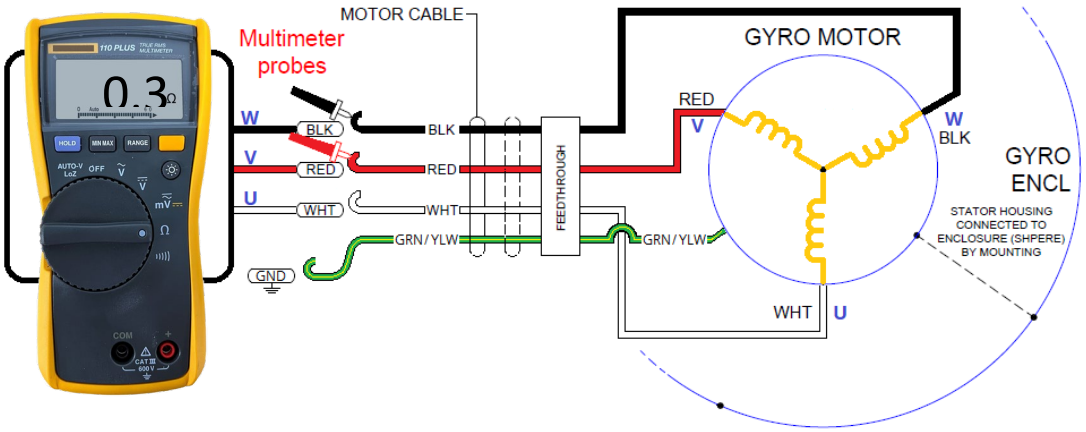


7. With a multimeter in resistance mode, **MEASURE <u>AND</u> RECORD** resistance between each phase wire end crimp to one decimal point.

Resistance (Ω) Between Phases	
Black (W) to **White (U)**	
White (U) to **Red (V)**	
Black (W) to **Red (V)**	

8. **MANUALLY PRECESS** sphere enclosure full forward and aft.

9. **REPEAT** resistance measurements.

10. **PERFORM** megohm testing on each phase, one at a time, as follows:

    a. **ENSURE** any motor phase leads NOT in test is electrically isolated (NOT touching metal).

    b. **ATTACH** black megohm test lead to motor ground lead.

    c. **ATTACH** red megohm test lead to phase in test.

CAUTION:

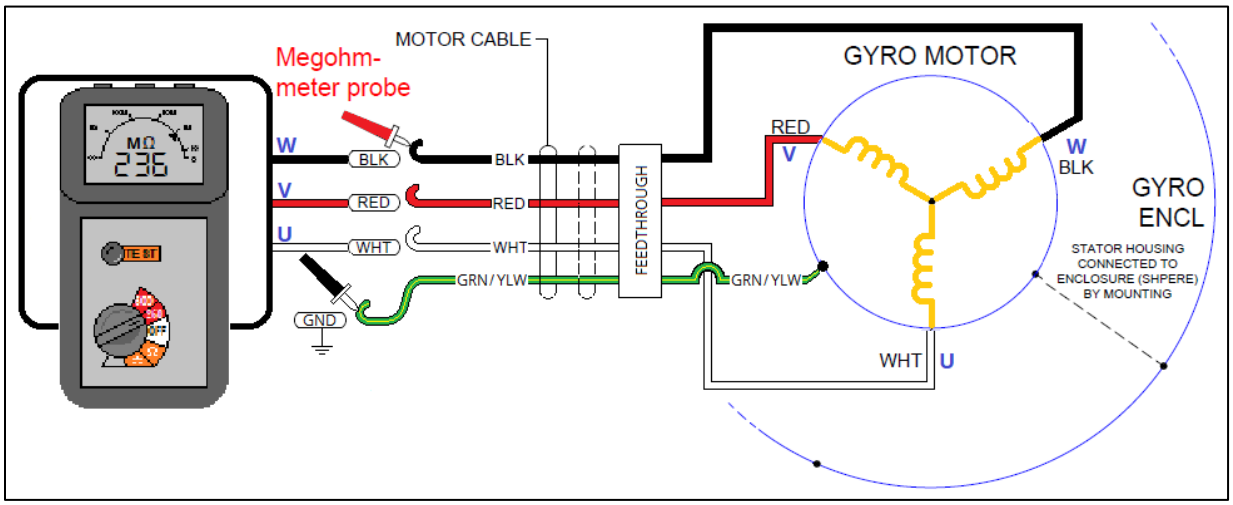
MOTOR DAMAGE MAY occur IF TESTED AT A HIGHER VOLTAGE THAN SPECIFIED.

    d. **PLACE** megohmmeter on correct scale:

        i. For Seakeeper 2, 3, and 4: **500 V**

        ii. For Seakeeper 1: **250V**

Seakeeper 1, 2, 3, and 4



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CAUTION:

DAMAGE TO MOTOR MAY OCCUR IF TESTED
PHASE TO PHASE

WARNING!

SHOCK HAZARD EXISTS WITH CURRENT
& HIGH VOLTAGE TO MOTOR CABLE LEADS

11. **PRESS AND HOLD** megohmmeter's test button for 60 seconds.

    a. **RECORD** resistance readings of each lead at 30 seconds and 60 seconds.

White (U):	**30 Seconds:** _____	**60 Seconds:** _____
Red (V):	**30 Seconds:** _____	**60 Seconds:** _____
Black (W):	**30 Seconds:** _____	**60 Seconds:** _____

12. **MANUALLY PRECESS** sphere enclosure full forward and aft.

13. **REPEAT** test momentarily to verify same initial resistance (it is NOT necessary to repeat 60 second test).

14. **CALCULATE** following:

    a. For each megohm test result, **DIVIDE** 60 second reading by 30 second reading to determine ratio.

> For example, say at 30 seconds one reads resistance of 110 Mohms. At 60 seconds, they read 600 Mohms. Determine ratio of 60 second reading divided by 30 second reading as follows:
>
> 600 Mohms **÷** 110 Mohms = **5.45** is ratio

WHITE (U): **(60 sec)** _____ **÷ (30 sec)** _____ **=** _____

RED (V): **(60 sec)** _____ **÷ (30 sec)** _____ **=** _____

BLACK (W): **(60 sec)** _____ **÷ (30 sec)** _____ **=** _____

15. **DOCUMENT** any physical damage with photograph.

16. **CONTACT** Seakeeper Product Support Team with ALL data while still onsite if possible. (Email support@seakeeper.com after hours)

    a. Americas Telephone: +1 (410) 326-1590
    b. EMEA Telephone: +39 0185 1897071

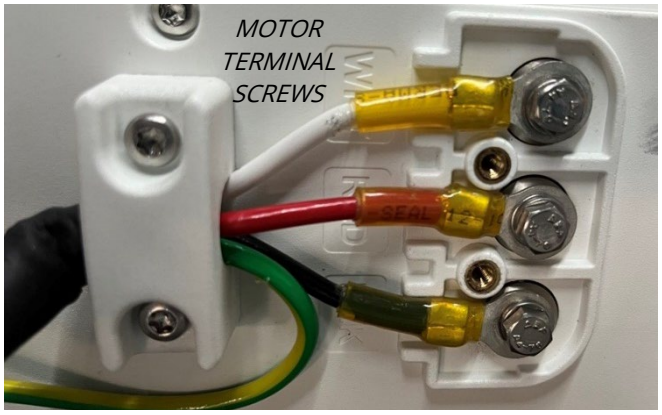
17. **RE-ATTACH** all motor leads and ground to their respective terminals at MDB/Curtis drive controller.

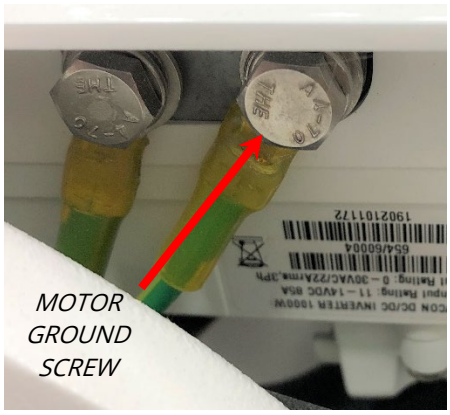
18. **TORQUE** motor leads as follows:

    a. For Seakeeper 2, 3, and 4:

        i. **TORQUE** motor terminal screws to **30 in-lbs** (**3.3 Nm**) with 8 mm socket.

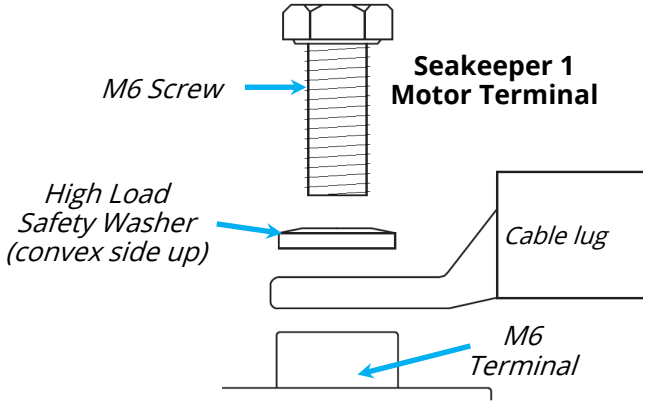
        ii. **TORQUE** motor ground screw to **40 in-lbs** (**4.5 Nm**) with 10 mm socket.





        iii. **INSTALL** remaining terminal cover and cable clamp.

    b. For Seakeeper 1, **TORQUE** motor terminal screws to **90 in-lbs** (**10.2 Nm**).



********** END **********

Revision	Description	Approval	Date
7	Lowered Seakeeper 1 test voltage to 250 V per specifications. Specified U, V, or W for Seakeeper 1 motor leads. Minor edits.	A Patricio	19JUL2024
8	Changed descriptions on image on p. 3 for AC motor power cable and terminals.	A Patricio	26MAR2025