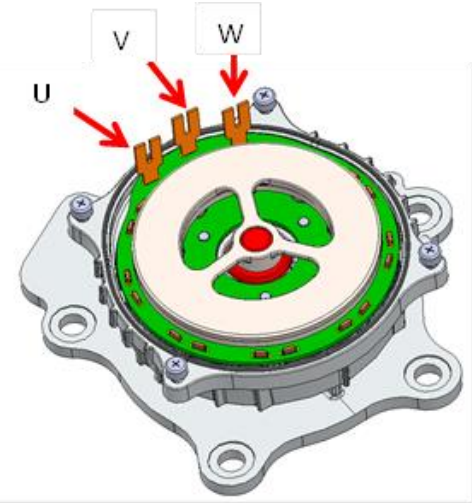
TEST AND EVALUATION PROCEDURES

1. TEST AND EVALUATION PROCEDURES – INLINE ELECTRICAL TESTS



EQUIPMENT

B&K Precision 891 LCR Meter
B&K Precision 9115 80V 60A 1200W Power Supply
NI cDAQ9188 chassis
cDAQ Modules:
NI 9229 AI +/- 60V 4CH
(2 ea) NI 9246 AI 20Arms, 3CH
NI 9361 SE/Diff counter input, 8CH
NI 9263 AO +/- 10V, 8 CH
NI 9375 DO/DI 24V sink/source, 32CH
Non conductive workbench
No metallic objects within 50cm of the DUT
TBD Gates provided hardware

1.1. PHASE RESISTANCE

1.1.1. PURPOSE

Confirm acceptable phase resistance on sub-assembly

1.1.2. PROCEDURE

1. Initialize LCR Meter

2. Prompt Operator to connect the U, V and W terminals to U, V, W connectors on fixture.
3. Set LCR Meter to read R-X in milliohms.
4. Zero the LCR Meter
5. Prompt Operator to Start Test.
6. The software will measure R with the LCR meter across motor U & V terminals
    a. Connect Relays U – V (relays TBD)
    b. The software will measure R with the LCR meter and save data
    c. Disconnect U – V relays
7. The software will measure R with the LCR meter across motor U & W
    a. Select Relays U-W (TBD)
    b. The software will measure R with the LCR meter and save data
    c. Disconnect U-W relays
8. The software will measure R with the LCR meter across motor V & W
    a. Select Relays V-W (TBD)
    b. The software will measure R with the LCR meter and save data
    c. Disconnect V-W relays

9. Resistance measurement data must meet the value on the applicable assembly drawing.
    a. TBD: where are these values going to be saved? INI file? CSV?
10. The software shall indicate all values passed or failed. TBD: Failed units will abort test?
11. Compliant samples may proceed to the next production station. Failures shall be routed into the reject bin for examination. Failures may be retested if results or procedure seems questionable

1.2. DIFFERENCE IN PHASE RESISTANCE

1.2.1. PURPOSE

Calculate balance of phase resistances between the UV, UW and VW phases

1.2.2. PROCEDURE

1. The software will calculate the phase resistances difference between UV – UW and save data
2. The software will calculate the phase resistances difference between UV – VW and save data
3. The software will calculate the phase resistances difference between VW – UW and save data

3.2.2 The software shall indicate the test passed or failed. TBD: Failed units will abort test?

1.3. PHASE INDUCTANCE

1.3.1. PROCEDURE

12. Initialize LCR Meter
13. Set LCR Meter to read Ls-(TBD) in uH
14. Zero the LCR Meter
15. Prompt Operator to Start Test.

16. Measure inductance across motor U & V terminals
    a. Connect Relays U – V (relays TBD)
    b. The software will measure L with the LCR meter and save data
    c. Disconnect U – V relays
17. Measure inductance across motor U & W
    a. Select Relays U-W (TBD)
    b. The software will measure L with the LCR meter and save data
    c. Disconnect U-W relays
18. Measure inductance across motor V & W
    a. Select Relays V-W (TBD)
    b. The software will measure L with the LCR meter and save data
    c. Disconnect V-W relays

3.4. DIFFERENCE IN PHASE INDUCTANCE

3.4.1. PURPOSE

Calculate balance of phase inductance between the UV, UW and VW phases

3.4.2. PROCEDURE

4. The software will calculate the phase inductance difference between UV – UW and save data
5. The software will calculate the phase inductance difference between UV – VW and save data
6. The software will calculate the phase inductance difference between VW – UW and save data

3.4.3 The software shall indicate the test passed or failed. TBD: Failed units will abort test?

6.4. BACK EMF TBD: Needs clarification and documentation/wiring of Gates Hardware

6.4.1. PURPOSE

Verify acceptable BEMF levels at defined speeds

BACK EMF – POWERED ROTOR / PWM CONTROLLED

EQUIPMEMENT

1. Power supply capable of providing 20.0 ±0.1 VDC
2. cDAQ Analog In (TBD) precise to 2 or more decimal places
3. cDAQ PWM (TBD)

4.5.2.2. PROCEDURE

1. Zero the meter
2. Connect the 3 phase test leads from the controller to the housing sub-assembly
3. Apply 12.5 VDC power and appropriate command signal to the test stand control board
4. Begin the test on the computer by hitting button
5. the computer will send a PWM command to the controller to spin the rotor at preprogrammed speeds (shown on drawing)
6. Equipment will automatically increase speed to next test step and repeat step 5 until test is completed
7. BEMF measurement data must meet the value on the applicable assembly drawing
8. Disconnect leads from the U, V and W phases

9. BEMF data must meet the values on the applicable assembly drawing
10. Compliant samples may proceed to the next production station. Failures shall be routed into the reject bin for QC examination. Failures may be retested if results or procedure seems questionable.

4.6. DIFFERENCE IN BACK EMF

4.6.1. PURPOSE

Verify the balance of BEMF measurements across the 3 phases

4.6.2. EQUIPMENT

1. Computer will automatically calculate the differences between phases

6.5. TEST AND EVALUATION PROCEDURES – EOL MOTOR AND CONTROLLER TESTS TBD: Needs clarification and documentation/wiring of Gates Hardware

5.

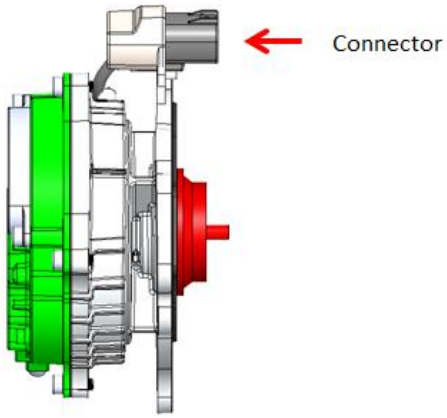
5.1. MOTOR RESPONSE CHECK

5.1.1.1. PURPOSE

Check motor response to the software speed commanded by the controller board when the motor is not loaded

5.1.1.2. EQUIPMENT

- Power source capable of providing minimum 20.0 ±0.1 VDC
- PCB controller PWM input command
- PCB controller output PWM analyzer
- DMM capable of measuring voltage



5.1.1.3. PROCEDURE

1. Power the EWP with 13.5 VDC
2. Start test by pushing start button on computer screen
3. The computer will command the pump assembly to run at the lowest speed

4. Measure the pump controller PWM output (amplitude and frequency, input voltage and current.
5. Equipment will automatically increase speed to next test step and repeat step 4
6. Measurement data must meet the values on the applicable assembly drawing
7. Repeat steps 2-6 at 9.0VDC
8. Repeat steps 2-6 at 16.0VDC
9. Compliant samples proceed to the next production station. Failures shall be routed into the reject bin for QC examination. Failures may be retested if results or procedure seems questionable.

Document Revision History

Revision	Date	Revision Notes	Author
A	3/31/2021	Initial Release	Paul Gaier
B	4/7/2021		Paul Gaier