

Electrical Instruments and Tools for Servo Motor Repair

Brushless servo motors ARE motors, therefore many of the tools needed to repair these motors are already available in an electric motor repair facility. I have listed here by priority, some instruments that are basic tools you will need to service servo motors.

Priority 1 – Necessary



Multi-meters as the name implies are used to make multiple measurements of voltage, current, and resistance. A good quality multi-meter is a basic requirement in servo repair. This may be either analog or digital but should of dependable quality. Preferably, both analog and digital would be available. The pictured multi-meter is an Extech Multimaster 560.



Meg-ohm meter will be used for testing the quality of insulation and is used the same as it would be used in the repair of other electric motors. Care must be exercised that electronic circuits are not contacted during meggar testing of the windings. The test instrument would preferably have selectable voltages available for testing. The voltage used for testing should be near the rated voltage that the motor will see when in service. The pictured unit is an Amprobe AMB-4D with 250, 500, and 1000 volts selectable output voltage.



Oscilloscopes are used to observe waveforms and timing differences of these waveforms. A good quality oscilloscope with storage and printout capability is one of the most used tools in the repair of servo motors. It should have a minimum of two channels. An oscilloscope with two isolated channels is very useful in testing circuits that do not have a common reference point. The unit pictured is a Fluke 196 digital scopemeter.



Encoder / Resolver test equipment is used for pulse counts on encoder output and testing of pulse width and the relationships of these pulses to each other. The testing of serial encoder signals requires special decoding equipment to be able to read these signals. The angular position of a resolver may be determined at ninety degree increments with an oscilloscope. However, resolver to digital interface equipment will allow the angular position to be determined

for all positions of the resolver. Pictured here is the Mitchell Electronics TI-5000R test unit.



Servo motor drive amplifiers for test running of motors after repairs. The ability to test run a motor up to operating speed is useful to checkout the dynamic operation of the motor. Bearings, vibration, noise, rubs, and overall operating condition of the motor may be checked. Shown here is the Mitchell Electronics TI-3000R test unit that will test run many different servo motors by processing the commutation signals and converting them to match a standard amplifier.



Signal breakout boxes for looking at various feedback and counter generated voltages. The use of a signal break out box will give quick, easy and safe availability to the voltages and feedback signals with an oscilloscope. This may be done with test points brought out from a common connection point that is used for connection to the motor.

Breakout boxes eliminate falling leads that can result in damage to the feedback components. The unit pictured is the Mitchell Electronics TI-5250.



Variable regulated voltage supplies are used for supplying power to the auxiliary devices during test, and for such other applications as releasing magnetic brakes. A variable supply for lock-up of the rotor is also needed. The pictured unit is a Spence Tek Model 6306A. This is a triple output supply for 5.0 volts and two variable outputs 0-30 volts at 6 amps each.



Variable speed motor test stand to back drive the motor being repaired. A variable speed test stand for back driving the servo motor is necessary for working on brushless units. The permanent magnet rotors that are used in these motors cause the motors to become generators when they are driven. This counter generated voltage will be equivalent to the applied voltage when the motor is running. The alignment of the commutation, voltage level of the counter voltage, and waveform all are important to be able to verify. This test stand is used for these purposes.

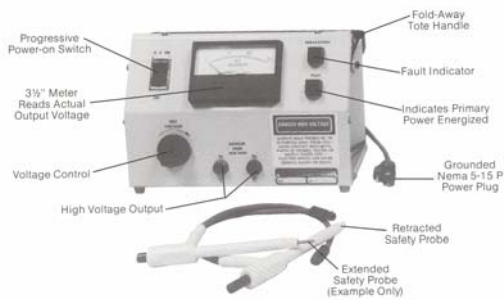


A shop built dual unregulated variable voltage DC power supply. This supply was built from two 0 to 90 VDC power supplies that were designed to supply power for permanent magnet DC motors with a 90 volt armature circuit. This makes available a variable DC voltage of 0 – 90 volts at 10 amps. Power supplies for releasing brakes up to 90 VDC. Second supply is for locking-up the rotor for alignment checks.

Priority 2 – Very useful



Signal generators are used in the test out of auxiliary devices such as resolvers. You will need the ability to generate a variable frequency sine wave for testing of resolvers. The frequency range would normally be from 1,000 Hz to 20,000 Hz with an adjustable output voltage from 2 volts to 10 volts. The unit pictured is a CSI/Speco Model SS-1.



Hipot tester is another test unit with which the motor repair technician is already familiar and is used in the same manner for over voltage testing of servo motor windings the same as it is used in testing standard induction motors. Features of the tester should include the ability to connect to the circuit being tested and then increase the test voltage to the desired test level. A unit that will test up to 3000 volts would be sufficient. Pictured is a Slaughter model 306-3.0 AC Hipot.

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Surge tester is used to test a servo motor winding in the same manner as it is used on a standard induction motor. All circuits not being tested should be isolated and grounded.

Surge test should not be performed with the rotor inside the stator. Cutting oils, dirt, and contamination are common for the machining applications using servo motors. One weakness of design is the laminations

extending to the outside, letting oils wick down into the windings. Surge testing will show weak insulation caused by this contamination. Damage caused by loose windings that have suffered damage due to wire vibration may be found with the surge test. Shown is the Baker ST-103A.

Priority 3 – Somewhat useful



Flux meters are used for measuring flux densities. Since permanent magnets are present in servo motors, the ability to measure and compare flux densities is very useful. The flux density in the air gap is difficult to measure because of accessibility. Unless you are involved in the design or redesign of a motor measuring the air gap flux density is not necessary. The measuring of torque, BEMF voltage, and waveform will give better information about the magnets. However the ability

to measure the flux balance between poles when a motor is disassembled will sometimes be helpful. The flux meter shown is an F. W. Bell Model 5080 Gauss/Teslameter.



Resistance Bridge is used for testing the resistance of windings and other low resistance circuits. Many manufacturers will specify the winding resistance of their units. Testing the resistance will indicate if the winding has been changed. Resistance measurement of the winding will also indicate unbalance that could be due to wrong connection, open, or shorted winding. The temperature of the windings at the time of the test is important for consistent readings. The winding resistance will vary with changes in temperature. If the winding temperature is at a

temperature that is different than normal ambient, then the winding resistance will be affected. This should be accounted for when comparing the winding resistance of similar motors. Shown is a Yokogawa Model 2769 double bridge.



Other Instruments and Tools will be needed. The above outline of instruments and tools is not all-inclusive and does not include all facilities and equipment that may be needed in the repair of servo motors. Physical location, electrical power, compressed air, and amount of floor space will all need to be determined.

Tools such as those pictured here of a tachometer and torque wrench are normal tools that will be used in the repair of servo motors.

Additional equipment such as vibration analysis instruments for testing vibration, and temperature measurement tools for testing of bearing temperature are at least priority 2.

Dynamometer for testing of servo motors under load, and magnetizing equipment for re-magnetizing of the permanent magnets are all equipment that may be very useful in the repair of these motors. However, many successful servo motor repairs may also be performed without the use of this equipment