REPAIR INSTRUCTIONS

General Notes
**Mechanical and Electrical Instructions**

**Visual Check**

Product should be disassembled, cleaned and checked to determine the full extent of repair required.

MECHANICAL PARTS — including gears, spindles, bearings and housings inspected for wear or damage.

ELECTRICAL COMPONENTS — including switches, cords, armatures, fields and carbon brushes thoroughly inspected and tested.

CORDS / PLUGS — all unsafe, damaged or modified 2 & 3 wire cords and plugs ARE replaced with an approved cord and plug to comply with MILWAUKEE’S Safety Policy and Federal regulations.

LUBRICANTS / GREASE — replaced as needed.

Upon COMPLETION tool is completely tested to assure its being restored both mechanically and electrically to a like new condition. Tool receives a 5 point check to insure safety... - check cord & plug condition; check ground continuity [for 3-wire – grounded tools only]; - "proof-test" - ‘dielectric/hypot test’ the entire tool against grounds or shorts which at the least might cause an inconvenience and at the most can cause a ‘shock’ or death; - check running current draw to insure gear train & mechanical components are not binding or applying an excessive torque requirement of the motor; - check all safety guard[s] for condition & operation.

Care has to be taken that insures essential elements for safety of the tool are neither visibly damaged nor obviously unsuitable for the tool. This applies especially to insulations and insulated elements, which become visible when repairing. It applies not only to the electrical but also to mechanical safety of the product.

**Tests**

When servicing a portable electric power tool, operator safety is imperative and tests that assure the electrical safety of the repair performed, by application of basic industry test standards are recommended.

The check and verification of the continuity & quality of the ground circuit, dielectric (insulation breakdown) and the current draw of repaired product protect from liabilities that may arise from the service/repair work performed.

A firm who services portable electric power tools must be aware of their responsibility to ensure the proper operation of all safety features on each product and the need/requirement to perform electrical & mechanical safety test & checks on each product they repair.
Electrical Instructions

There are two types of tests that are required on portable electric power tools to insure its electrical safety.

1.) Quality & Continuity of the Ground Wire / Ground Circuit

Quality & Continuity of the Ground Wire / Ground Circuit of three-wire grounded tools. The nameplate of the tool will read ‘grounding required’ and the tool will be equipped with a three-wire cord set, with a three prong ‘dead-front’ plug. ‘Dead front’ plug is one, which is constructed so that there are no exposed current carrying parts except the prongs, blades or pins. All wiring is completely enclosed in its own separate cell, and is partitioned off from the other cells; no wiring can come loose and contact a wire in another cell.

The continuity/quality test is performed to verify the presence and quality of the ground circuit in the power tool. In the ground wire of a portable electric power tool no current / no electricity passes through the wire during the normal operation of the product. The ground wire / ground circuit is provided as a means or path for an electrical fault / electrical current (short circuit or ground condition) to earth ground. The ground wire / ground circuit is there to ensure that a tool case (exposed metal surfaces) are at the same voltage potential as earth ground, eliminating the chance for a person to get a shock.

In the past, Underwriters Laboratories (UL) Standard 45 required only that the continuity of a tool be verified using any indicating (light, buzzer, or combination of both) device. Current UL Standard’s 745, paragraph 25.5, requires the test to be performed with a test current / electricity of 25 amperes at 12 VoltsAC, and measuring the resistance of the circuit. The maximum allowable resistance is 0.1 ohms. Product and/or cordsets that can not pass this test would be considered faulty and need further repair to correct the problem.

2.) Dielectric (High Voltage Insulation Breakdown) Testing

Dielectric (insulation breakdown) testing is performed to verify the quality of the tool’s ability to withstand an over-voltage, greatly in excess of normal - 120VoltsAC potential, protecting against defects in the workmanship or components used in a product repair.

The idea behind a Dielectric Test is to detect either an existing or potential electrical shock hazard(s) before repaired product reaches the end-user.

This is accomplished by subjecting the product to abnormally high voltage between the products current carrying circuits and dead - exposed metal (ground), while measuring for excessive leakage current or insulation breakdown. By applying high voltage between ‘live’ parts and the exposed metal of a portable electric power tool (screws, motor housings, gear case) we test the entire tool against ground or shorts which have the potential to cause bodily harm or death. Underwriters Laboratories (UL) incorporates the high voltage Dielectric Test on all ‘new’ products that bear their monogram. Product that can not pass this test would be considered faulty and need further repair to correct the problem.
Electrical Instructions

Dielectric Test Equipment

The dielectric test equipment shall:

- Be supplied by a voltage source that will not vary more than ±5% about the nominal 120v, 60hz value.
- Be protected in such a manner that no transient voltages in excess of 125% of the peak value of the test voltage is applied to the product under test.
- Require no more than 15 amperes input current.
- Be equipped with an isolation type output transformer with a 50va rating.
- Maintain the required test potential to +10% -0% at 5.0ma (milliamperes) minimum leakage current.
- Produce an output potential that has:
  1) a sinusoidal waveform.
  2) a frequency within the range of 40-70hz.
  3) a peak value of the waveform that is not less than 1.3 and not more than 1.5 times the ‘rms’ value.
- Be provided with both a visual and auditory means of indicating a failure that commands the attention of the operator. Failure is defined as a leakage of 5.0ma (milliamperes) or greater.
- Be equipped with a device that automatically shuts down the application of the dielectric potential when failure is indicated, while maintaining the audio and visual indications. It must require manual reset to continue testing.

Indicate an unacceptable performance within 0.5 seconds.

Be guarded and interlocked in a manner that prevents the operator from exposure to dielectric potential or other electrical hazards.

Complete Tool

The following dielectric voltage values are nominal values to be applied, at the locations indicated, to corded repaired product or components to assure the electrical safety:

With the switch secured in the ‘on’ position, dielectric voltage is to be applied, at the same time, between both current carrying blades of the plug cap and exposed metal surface of the tool. Exposed metal includes a screw(s) in plastic/nylon parts (ie. Handles, motor housings) if the screw(s) do not contact an exposed metal part, such as a gear case or motor housing. Voltage levels are to be at the following specified value for the classification of tool under test; leakage current in excess of 5.0ma constitutes a failure or breakdown of the products insulation.

Classifications:
- **GROUNDED** DEFINES PRODUCT MARKED ‘GROUNDING REQUIRED’ and/or EQUIPPED WITH A THREE (3) WIRE CORD AND PLUG.
- **DOUBLE INSULATED** DEFINES PRODUCT MARKED WITH THE WORDS ‘DOUBLE INSULATED’ AND EQUIPPED WITH A TWO (2) WIRE CORD OR PLUG.

**TEST VOLTAGES**
- GROUNDED - 1200VAC FOR ONE (1) SECOND MINIMUM.
- DOUBLE INSULATED - 3000VAC FOR ONE (1) SECOND MINIMUM

* Because of the poor conductivity of powder coated castings, oxide screws and anodized saw shoes, caution is recommended when dielectric testing of both grounded and double insulated tools is being performed, to insure test probes contact a ‘clean’ conductive surface.
Electrical Instructions

Motor Components

Dielectric voltages are to be applied to the following components, between the points indicated, for a minimum of one (1) second. Voltage levels are to be at the specified value to the component under test; leakage current in excess of 5.0ma constitutes a failure or breakdown of the components insulation.

Classifications:

**GROUNDED** DEFINES PRODUCT MARKED ‘GROUNDING REQUIRED’ and/or EQUIPPED WITH A THREE (3) WIRE CORD AND PLUG.

**DOUBLE INSULATED** DEFINES PRODUCT MARKED WITH THE WORDS ‘DOUBLE INSULATED’ AND EQUIPPED WITH A TWO (2) WIRE CORD OR PLUG.

TEST VOLTAGES

**FIELD COILS** - 1200VAC FOR ONE (1) SECOND MINIMUM BETWEEN EACH LEAD WIRE AND THE STEEL LAMINATIONS.

**ARMATURE** -

**GROUNDED** -

(1) 1200VAC FOR ONE (1) SECOND MINIMUM BETWEEN COMMUTATOR BARS AND PINION SHAFT

**DOUBLE INSULATED** -

**IMPORTANT!** -

(1) 3000VAC FOR ONE (1) SECOND MINIMUM OR 2500VAC FOR ONE (1) MINUTE BETWEEN COMMUTATOR BARS AND PINION SHAFT

(2) 1200VAC FOR ONE (1) SECOND MINIMUM BETWEEN COMMUTATOR BARS AND STEEL LAMINATIONS

(3) 1500VAC FOR ONE (1) SECOND MINIMUM BETWEEN STEEL LAMINATIONS AND PINION SHAFT

Field Coils

Dielectric Testing

**FIELD COIL** Grounded or Double Insulated – 1200VAC for one (1) second minimum between each lead wire or terminal and the steel laminations.

* Because of the poor conductivity of powder coated castings, oxide screws and anodized saw shoes, caution is recommended when dielectric testing of both grounded and double insulated tools is being performed, to insure test probes contact a ‘clean’ conductive surface.
**Electrical Instructions**

**Armature Dielectric Testing**

**ARMATURE - 3-WIRE GROUNDED TOOL**

A - Armature commutator bars and steel pinion shaft  
1200VAC

**ARMATURE - 2-WIRE DOUBLE INSULATED TOOL**

A - Armature commutator bars and steel pinion shaft  
3000VAC

B - Armature commutator bars to steel laminations  
1200VAC

C - Armature steel laminations to steel pinion shaft  
1500VAC
Electrical Instructions

Current draw of product under test

The amount of electricity flowing in the tools circuitry indicates the current draw in amperes (AMPS) of the tool under test at no load or load conditions to verify how hard the motor is working. The more torque applied to the motor the higher the current draw.

Under a no load condition the current draw will normally be about 1/3-1/2 of the nameplate rating shown on the tool.

Two important things to watch for when monitoring current draw, are;

1). the amount of the current draw
2). the stability of the reading.

1). Amount of current draw, if excessive indicates there is something stopping the armature from rotating freely. A dry ball bearing, a bound gear or mechanism part, or an electrical short in the motor. Any of these conditions will cause the motor to draw excessive current, which is displaced as ‘heat’ in the motor windings, and will damage or significantly shorten the life of the tool. Product with excessive current draw would be considered faulty and need further repair to correct the problem.

2). If the current draw is un-stable and the ammeter needle fluctuates, it is an indication that an armature maybe out of balance, the carbon brushes not making proper contact with the commutator, or a faulty armature. Again, product with a fluctuating current draw would be considered faulty and need further repair to correct the problem.
Safety Policy

Milwaukee’s Safety Policy

un-repaired portable electric power tools...
because serious injury or death can occur from mechanical component failure or from an electrical shock hazard present in an un-repaired power tool, it is Milwaukee’s policy to return all un-repaired tools disassembled. If assembled, unrepaired tools are UNSAFE and potentially dangerous.

portable electric power tools with a damaged power cord or plug...
because serious injury or death can occur from an electrical shock hazard present in a damaged power cord or plug, Milwaukee’s policy is required replacement. If the power cord on your tool has any of the following conditions, we WILL replace it:

- a cut through its outer jacket
- damaged inner conductor or insulation
- plug head has separated from the cord jacket
- plug with missing or damaged ground prong

portable electric power tools with damaged or missing safety guard...
because a serious injury hazard is present when a tool’s safety guard(s) is damaged or missing, Milwaukee’s policy is required replacement. If the tool brought to us for repair is missing a safety guard, our service personnel will advise you to bring in the guard to have it installed before returning the tool to you. If the guard has been lost or damaged, our policy REQUIRES that we replace it.

Grinder’s require proper guarding during use; a guard must be installed when using a grinding wheel to provide maximum protection for the operator if the grinding wheel should break.

Milwaukee believes it is in the best interest of your personal safety that we have adopted this corporate SAFETY POLICY… any inconvenience with the return of disassembled un-repaired tools or the cost associated with replacement of a cord, plug or guard is minimal when a person’s safety is involved.

If you have any question or comments regarding the Milwaukee SAFETY POLICY, please contact Milwaukee After-Sales Service Staff at 1.800.729.3878