ELECTROM INSTRUMENTS

TIG Winding Analyzer
Accessory Instruction Manual

RTR-03	**Rotor Bar Adaptor**
TAP-01	**Temperature Probe**
ATF-10, 11	**Armature Test Fixtures**
CFS-05	**Calibration / Fault Simulator**

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ADDENDUM

May 1, 1995

TIG Accessory Instruction Manual
Models RTR-03 & TAP-03

The following sections of the TIG Accessories Manual have been changed to reflect the recent hardware changes in the TIG Winding Analyzer.

RTR-03, Rotor Bar Test Accessory;
The basic operation of the RTR-03 has not changed from the instruction manual or the software instructions. However, these two tips will help identify rotor problems much more clearly.

1. To display the rotor waveform on the TIG Winding Analyzer, adjust the sweep control to **200us** (2ms on the crt) **instead** of 6 clicks CCW of 500us as described in the software. This setting should display just over 1/2 of a full sine wave on the crt.

2. Immediately after the first waveform is saved on computer, press SAVE and RECALL on the TIG. Next, clear the HOLD light and observe the difference between the two waveforms while holding the SURGE switch ON. When the separation is the greatest, release the SURGE switch. The remaining software prompts can now be followed to complete the data collection.

TAP-03, Infrared Temperature Probe;
The temperature probe has been changed from a contact type to a non contact type.

1. This probe works best when the sweep is set to **1ms** (1 click CCW of 500us), and the volts per division is set to **0.2 volts** (4 clicks CW of 250).

2. The probe is set up to read in degrees F. ANA 3.1 will then correct the megohm value to degrees C if it is selected in the motor nameplate menu - AFTER the test has been performed in Fahrenheit.

Dear Customer,
Thank you for your purchase of a TIG Winding Analyzer Test Accessory.

Electrom Corporation has shipped the model of the TIG Winding Analyzer Accessories indicated below.

Model:
- RTR-03 ☐
- TAP-01 ☐
- ATF-10 ☐
- ATF-11 ☐
- CFS-05 ☐

CAUTION:
Before attempting to use the TIG Winding Analyzer or any accessory, all users must thoroughly read the TIG Instruction Manual and the applicable portion(s) of this manual to familiarize themselves with the unit's proper setup and operation.

CAUTION!

READ THE FOLLOWING SAFETY PRECAUTIONS BEFORE OPERATING.

THIS EQUIPMENT PRODUCES HIGH VOLTAGE. USE EXTREME CAUTION WHEN HANDLING AND OPERATING ANY HIGH VOLTAGE DEVICE.

Always follow these safety procedures and precautions:

- Never operate the tester in any manner other than indicated in this manual. Do not apply the tester to any device other than those recommended by the manufacturer. Electrom Corporation is not responsible for injury and/or damage resulting from the misuse of its products or failure to follow proper procedures.

- Use High Voltage rated Safety Gloves when handling test leads or test accessories.

- Never handle the test leads or any part of the winding when performing a test.

- Never use tester in a volatile, or explosive atmosphere. Possible arcing between leads or within the winding may provide a source of ignition.

- Do not change positions on the Lead Selector while the test voltage is being applied to the winding.

- After the dc hipot test, Always discharge, to ground, any residual charge on a winding for a minimum of 60 seconds. See the DC Hipot Test Procedure for discharge method.

- Always remove, from the test circuit, any line conditioning devices (i.e. surge arrestors) or start-up capacitors.

Failure to follow these precautions may result in severe injury or death or damage to equipment due to electrical shock.

Service and Shipping Instructions

- For Servicing, Calibration, or Warranty Repairs call Electrom's Service Department at 1-800-833-1881. Be prepared to give the Model Number and Serial Number of your unit. These numbers are located on labels inside the front lid of the T.I.G. unit.

- A Customer Return Authorization (CRA) number is required for all repairs. Please include this CRA number on your shipping label.

- All equipment returned to Electrom should be shipped in its original carton. If the shipping container is not adequate for return shipment, Electrom will provide a new shipping carton at a cost to the customer.

- Include a shipping location address. Pickup and Delivery cannot be made to a Post Office Box.

- Please include a description of symptoms or required repairs and note all items shipped (i.e. power cord, waveform card, RS-232 cable, etc.).

- Additional shipping costs for faster delivery methods requested by the customer, such as overnight or second day delivery, will be charged to the customer.

For non-warranty repairs:

Electrom's Service Department will provide a repair cost estimate to be approved by the customer prior to servicing. If a repair estimate is refused, the customer must accept the estimate fee and all shipping costs before the equipment will be returned. A Purchase Order number is required for any chargeable repairs, estimates, and shipping before the equipment will be returned.

WARRANTY

Electrom products are warranted to be free of defects in materials or workmanship. Each TIG Winding Analyzer Accessory is warranted for a period of one year from the date of purchase. Electrom's obligation under this warranty is limited to repairing or replacing, at its sole option, any defective components or products.

This warranty does not apply to equipment which has been damaged by accident, improper customer packing or mishandling during shipping, negligence, misapplication or uses other than those described in the product manual, or modifications made to the product in any way. Products damaged during shipping must be reported IMMEDIATELY to the shipping company and Electrom. Unauthorized repairs made by someone other than factory authorized personnel will also void the warranty.

The user must comply with all warnings and operating procedures explained in the product manual.

Warranty repairs will be made ONLY after the Electrom Customer Service Representative has been contacted to verify a defect, approve the return of the product, and assign a CRA number. Returned equipment MUST be shipped in the original shipping carton for proper protection during transit.

This Warranty applies only to the original purchaser who must have properly registered the product within 10 days of delivery, or by retaining a copy of the original invoice.

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1 INTRODUCTION

This manual is designed to cover the functions of some of the accessories available for use in onjunction with the Electrom Instruments T.I.G. model Winding Analyzers. Each accessory is designed to enhance the TIG's capabilities and is not recommended for use with other types of test equipment.

WARNING: Before using any of the test or support accessories herein, the operator must have read and understood the Set-up instructions, Megohmmeter, Hipot, and Surge Comparison Test procedures and all precautions pertaining to the type and size of T.I.G. Winding Analyzer used. The T.I.G. Winding Analyzer is a High Voltage Test Device. Misuse or failure to properly operate the Winding Analyzer and all test accessories may result in serious injury or death.

The TIG Winding Analyzer is a multi-function test device. It's principal function is testing the windings in AC and DC electric motors. In order to do this, the TIG operates as a:

- DC megohmmeter
- DC hipot
- Surge tester
- Comparison tester

Using these functions, the TIG performs high voltage non-destructive tests. These tests assure high quality insulating systems in any device containing electric coils, e.g. motor windings, generators, transformers, or wound inductive coils.

Each TIG accessory performs one of the following functions:

1. Supports the TIG in performing a test not provided for in the base unit;
2. S p lies data input for the supporting software via the TIG unit;
3. Improves the portability of the TIG base unit and additional Power Pack;

4. Provides a means of support for training purposes.

2 RTR-03 Rotor Bar Adaptor (for use with T.I.G. D models only)

The RTR-03 Rotor Bar Adaptor is a clamp-on current transformer specifically designed to monitor the 50 / 60 hertz signal on one phase of an induction motor. Its purpose is to detect a fluctuation in the sine wave that would indicate the presence of an open or broken bar in the rotor.

This test is made possible by the use of a dual-channel digital storage oscilloscope such as that used in Electrom's T.I.G. D model Winding Analyzers.

2.1 Set-up

1. Follow the Set-up procedures for the T.I.G. Winding Analyzer.
2. Rotate the VOLTAGE OUTPUT control knob to the fully counter-clockwise or MIN position. The FUNCTION switch must be in the center or OFF position.
3. Make sure the red HOLD light is OFF. If not, toggle the FUNCTION switch to HIPOT then OFF to reset the HOLD feature.
4. Using the verticle position knob for Channel A, move the trace corresponding to Channel A to the center of the oscilloscope screen. Move the Channel B trace off the screen.
5. Connect the RTR-03 cable end to the Channel A, BNC connector.
6. Follow the Test Procedures as outlined in the next section.

2.2 Test Procedure

1. After completing the set-up, clamp the probe around any one of the phase leads on the motor.

NOTE: Do not clamp it around more than one lead. This will give an improper waveform.

2. With the motor running, adjust the VOLTS/DIV knob clockwise from the 250V position and use the Range Selector on the RTR-03 to get a sine waveform about 3 divisions high on the oscilloscope screen.

3. Adjust the SWEEP control 2 to 4 clicks counter-clockwise from the 500us position (G), to get the horizontal peak-to-peak separation spread over a few divisions. About 3 or 4 full cycles should be displayed on the screen.

4. After the waveform is properly established on the screen, toggle the FUNCTION switch to SURGE then OFF. The red HOLD light should be ON. This captures the waveform on the screen for visual comparison or downloading to software.

5. Save the waveform in scope memory by pressing the SAVE button below the oscilloscope screen. Press RECALL to display the "saved" waveform.

6. Toggle the FUNCTION switch to SURGE then OFF to reset the HOLD function, returning the scope to the sampling mode. With the RECALL on, the "active" waveform is superimposed over the stored pattern.

7. Toggling the FUNCTION switch again will capture a different time frame of the same waveform for a "stop" comparison.

8. Observe the superimposed waveforms for any differences or separation. Refer to Section 2.3 for waveform analysis. Figure 1, shows the typical pattern displayed on the CRT for the rotor test.

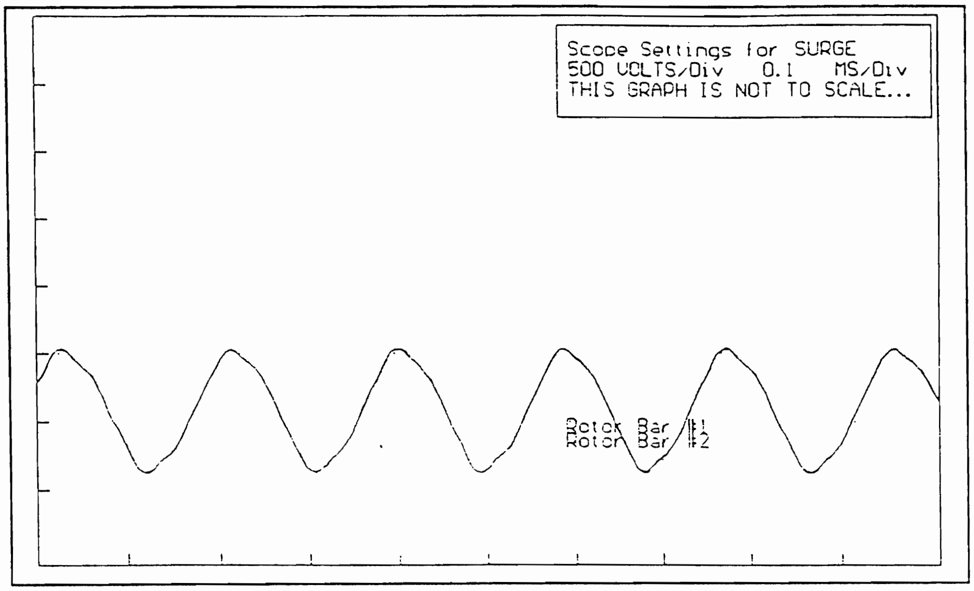

Figure 1. Typical Rotor Test Pattern

2.3 Waveform Analysis

The storage mode of the Winding Analyzer is used to display a sample sine wave from phase 'A' of the motor as it is running and under load. The real-time mode is then used to display Channel A again for comparison to the stored waveform of the same phase. Any "dynamic" differences would indicate an imbalance in stator / rotor interaction caused by a broken or open bar.

The waveform can be analyzed using two methods:

The first is to display an 'active' waveform on the CRT to visually observe the changes over time. If the full waveform moves back and forth on the CRT with a periodic change in its shape or if smaller peaks or notches move through the base waveform, a rotor fault is indicated.

The second method requires the use of the digital oscilloscope functions on the Winding Analyzer. An on-screen comparison is made by:

1. capturing the waveform;
2. storing it in scope memory;

3. recalling it to the screen; and
4. capturing another time frame of the same waveform on the screen to make a comparison (steps 6 & 7 above).

Figures 1, 2, and 3 show the saved patterns superimposed for documentation. In either case a dynamic change in the waveform, displayed as real-time motion in the first case, or separations of superimposed patterns in the second, indicates a faulted rotor.

With the T.I.G. D model Winding Analyzer and ANA-3.1 Direct Download Software, two waveforms are saved and superimposed for printed reports or for future reference.

Figure 2, next page, shows two current samples from the same motor phase. The separation represents a change in the waveshape in real time. This change in shape is caused by an induced change in phase current from the rotor, when the motor is running. This comparison displays the maximum differential in current as the open rotor bar passes through the phase under test.

Figure 3 shows the rotor test patterns along with a power quality comparison between each motor phase. The upper three waveforms (all 3 phases) indicate an difference in the peak current from one phase to another. This is most likely caused by unbalanced line voltages or high resistive connections. This test is recorded by sampling each separate phase pattern in the separate SURGE Test fields provided by the ANA-3.1 software.

The bottom two waveforms (same phase) indicate an amplitude change caused by the unbalanced or fluctuating line voltages. The lack of frequency change suggests that the rotor bars are not the cause.

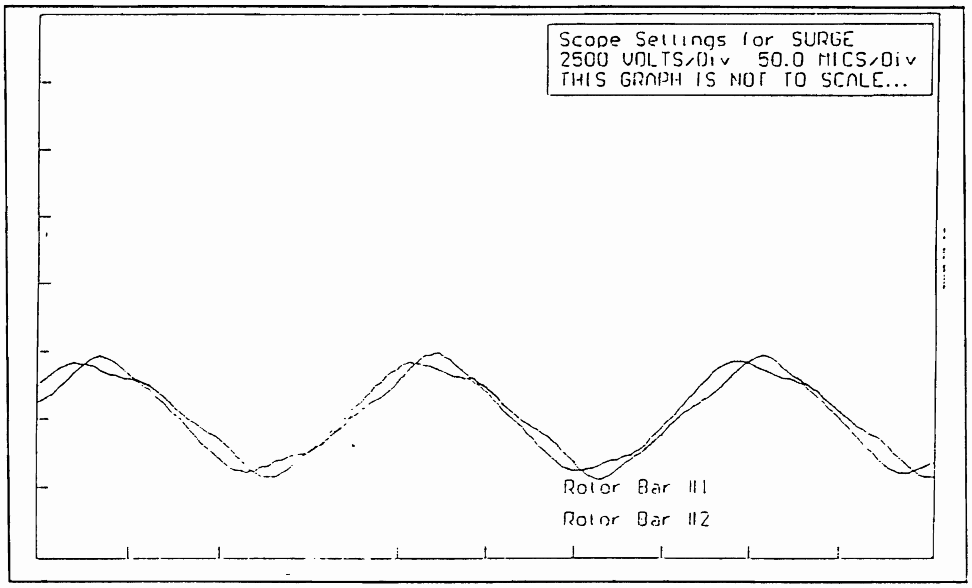

Figure 2. Faulted Rotor Indicated by Separated Waveforms

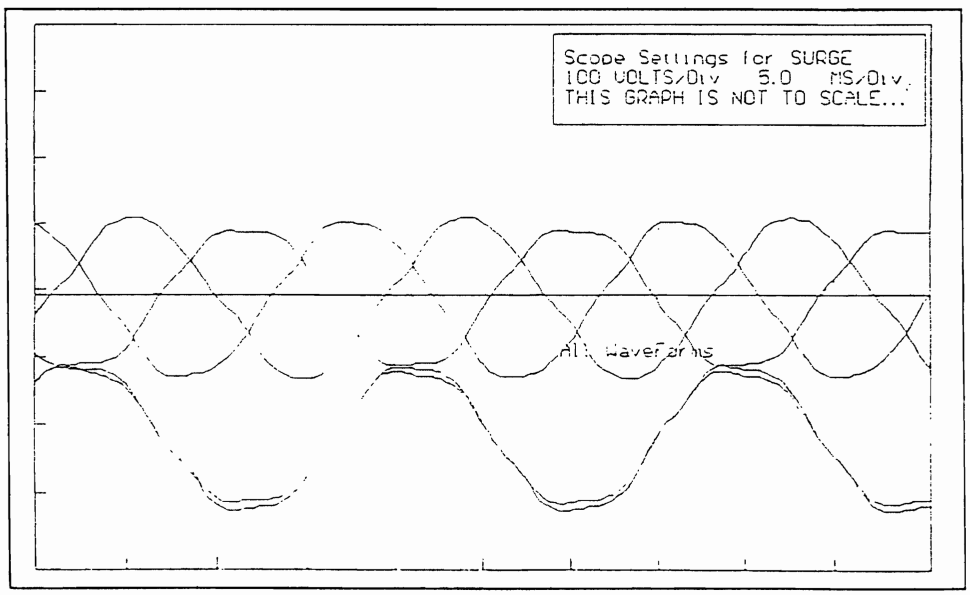

Figure 3. Power Quality & Rotor Bar Analysis

3 TAP-01 Temperature Probe

(for use with T.I.G. D models only) The resistance of the ground or winding to frame insulation is temperature dependant. Therefore Megohm readings require a correction for changes in temperature from a standard of 68°F or 20°C.

The TAP-01 optional Temperature Probe samples the temperature of a coil or motor winding. The obtained temperature values are used to compensate the Megohmmeter test results for changes in temperature. A measurement of both ambient and winding temperatures are made for comparison to the standard temperature.

The TAP-01 option requires the use of Electrom's T.I.G. D model Winding Analyzer and ANA-3.1 download software. Fahrenheit or Celsius scales can be selected by the user when entering the motor or winding information in ANA-3.1.

Direct measurement is necessary when the motor or winding has been in operation prior to the Megohm test or when the winding temperature is noticeably different from the ambient air temperature. If the motor or winding has been allowed to equalize to the ambient air temperature, the user can manually enter the ambient air temperature reading from a room thermometer. This is in the winding information portion of the of the ANA-3.1 software - select #3 in the Main Menu.

3.1 Set-up

Follow the setup procedures for the T.I.G. D model Winding Analyzer.

The TAP-01 should not be connected to the Winding Analyzer until required, during the test procedures.

NOTE: The TAP-01 Temperature Probe uses only the Oscilloscope functions of the Winding

Analyzer. The High Voltage Output control on the Winding Analyzer should remain at MIN or fully counterclockwise when using the temperature probe.

3.2 Test Procedure

The test procedures outlined below can also be found in the ANA-3.1 Direct Download Software. In ANA-3.1, select the Megohm/ Hipot Test Menu from the Main Menu and follow the prompts for the Ambient and Winding Temperature tests.

The following procedure lists the steps found in ANA-3.1 with a more detailed description of the test.

1. Ensure that the High Voltage Output control knob is in the MIN or fully counterclockwise position. The high voltage will not be applied for this test.

2. Set the Channel B Volts/ Div knob to a point 3 clicks clockwise from the 250 Volts/ Div position. The oscilloscope display will show the Volts/ Div at 50mV.

3. Set the Sweep Control knob to the 50µs position.

4. Plug the TAP-01 BNC connector into the Channel B BNC input on the front panel of the Winding Analyzer.

5. Set the FAHR / CELS switch on the TAP-01 to the required scale position.

6. Set the TAP-01 power switch to the OFF position.

7. Using the VERTICLE position knobs on the Winding Analyzer, set **both** traces to the 0% line (one division up from the bottom of the CRT).

8. Set the TAP-01 power switch to the ON position.

9. For a Ambient temperature test, leave hold the probe tip away from any heat source to measure only the ambient air temperature in the surrounding environment of the motor or winding.

   For a Winding temperature test, contact the probe tip to the winding or frame as close to the ground or frame insulating system as possible.

10. Allow one minute for the temperature probe to settle to the proper temperature. The ANA-3.1 software uses a convenient timer to prompt the operator when one minute has passed.

11. Toggle the FUNCTION switch on the T.I.G. to the SURGE ON position and then OFF to capture the trace position on the oscilloscope.

12. The ANA-3.1 Software will then sample the captured trace information and convert it to a temperature value. The software automatically corrects the Megohm value to compensate for the temperature change.

4 ATF-10, 11 Armature Test Fixtures

4.1 ATF-10

The ATF-10 Armature Test Fixture is a hand-held unit that attaches directly to the test leads of any T.I.G. model Winding Analyzer to allow direct Surge and Comparison testing of DC motor armatures. It provides a quick, relatively easy to use method of testing the coil-to-coil and interturn insulation for shorts and weaknesses.

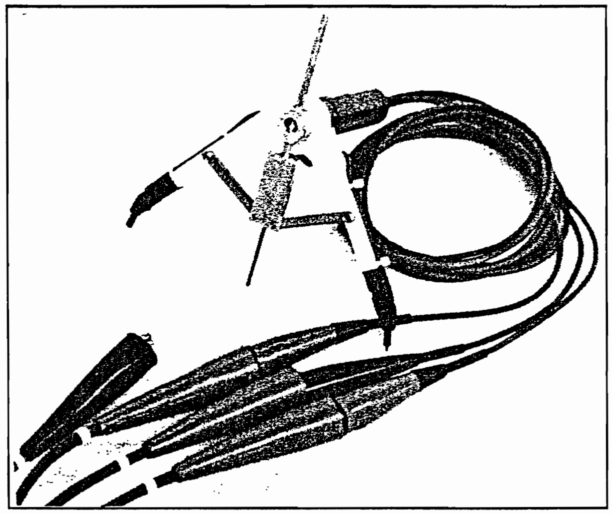

Figure 4. ATF-10 Armature Test Fixture

4.1.1 Set-up

1. Follow set-up procedures for the T.I.G. Winding Analyzer.

2. With Output Control at MIN and Function Switch in the OFF position, connect leads 1 and 2 to the two red leads of the ATF-10 fixture and lead 3 to the black lead of the ATF.

3. Place the LEAD Selector knob on the TIG to the 1-2 position. It should remain in this position for the entire test.

4. Connect the Black Ground lead from the TIG to the shaft of the armature.

5. Follow the Test Procedures outlined below.

4.1.2 Test Procedure

1. Loosen the outer arms of the ATF by turning the handle counter-clockwise. Open the arms to span an even number of bars as needed (about 6-8 bars between center pin to either outer pin). Turn the handle clockwise to lock the arms in place.

   NOTE: The two determining factors for the number of bars spanned are the amount of inductance between bars and the presence of shorting jumpers or equalizers within the armature. If a single pattern cannot be found, for example, at a 10 bar span, it may be that the pins have to be placed at a 6 bar span.

   When the inductance or impedance of the bars on either side of the center pin are equal, one pattern should appear. Read the waveform analysis section for important details about patterns on random wound armatures that display small separations.

2. Place the pins of the ATF on the commutator so that each pin keeps positive contact with only a single bar. Figure 5 shows the correct test fixture placement.

   NOTE: For best results, wrap the commutator with masking tape to prevent the brass pins from slipping off narrow bars.

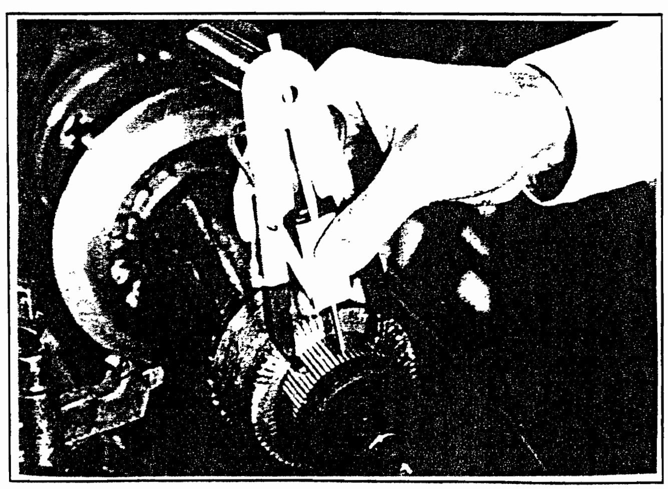

Figure 5. ATF-10 Placement on Commutator

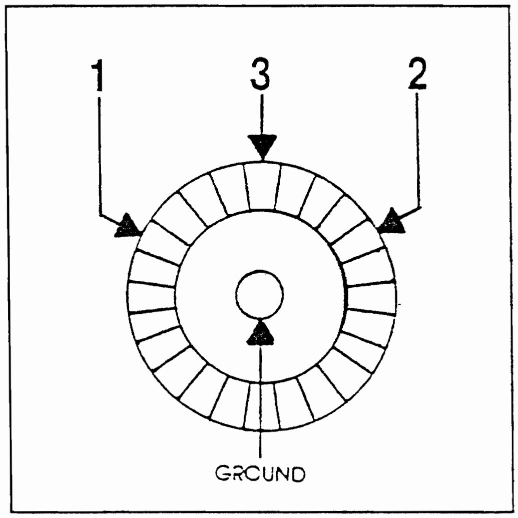

Figure 6. Connections for Span Test

3. With the fixture held in place, use the footswitch to energize the tester.

4. Slowly rotate the HIGH VOLTAGE OUTPUT control to about 1000 volts or use a recommended bar-to-bar voltage multiplied by the number of bars spanned (i.e. 150v/bar x 8bars = 1200v). Adjust the focus, intensity, volts per division, and sweep, if needed, at this time.

5. Observe the waveforms displayed on the oscilloscope screen.

6. Without changing the output voltage, release the footswitch and move the ATF to the next position on the commutator.

   NOTE: The ATF can be moved a single bar at a time if desired. However, to save time and retain test accuracy, mark the center pin starting position with chalk and move either side pin position to that previously occupied by the center pin. Maintain the same span and same direction of movement around the commutator.

7. Observe the waveforms on the screen for each test position and refer to Section 4.1.3 for waveform analysis.

4.1.3 Waveform Analysis

NOTE: Make sure the commutator is free of debris. Carbon dust and metal particles left between the bars on the commutator may cause shorting or arcing that affects test results.

NOTE: Do not test an armature while it is lying on a bench made of metal or other conductive material. Even some rubber bench pads may be made contain embedded conductive materials. These conditions may affect the test results. Use a stable support to hold the armature whenever possible.

While using the ATF-10, the waveforms displayed on the oscilloscope may exhibit some separation, even when used on a "known good" armature. Particularly on random wound armatures, the coil turn lengths may vary due to coil overlap. This condition changes the capacitive and inductive characteristics of some of the coils only slightly. Thus small separations in the peaks of the waveforms with a slight frequency shift are acceptable as long as the waveforms remain stable and they appear very similar without becoming completely out of phase.

The most significant item to remember is that the characteristic shape of the waveform is not important in determining armature winding condition. When the coils are free of defects, the winding will hold the test voltage, and the waveforms will be stable and appear very similar as shown in Figures 7a, 7b. Weak insulation results in an unstable or flickering pattern, Figure 7c, while a solid short results in an electrical imbalance (out-of-phase condition) between the two windings, Figure 7d.

If the waveforms display some separation leading to questionable results of the winding condition, the operator can simulate the waveform for a shorted winding by randomly shorting together two bars on the commutator with an insulated screwdriver.

NOTE: Some armatures may not contain enough turns of wire to produce an adequate waveform on the CRT. Some armatures use coils with very few turns, giving them very low inductive qualities. These armatures will show few, if any, peaks in the waveform past the initial peak, even with the sweep set at the fastest rate. In this case, a special high frequency coil tester or adapter may be required.

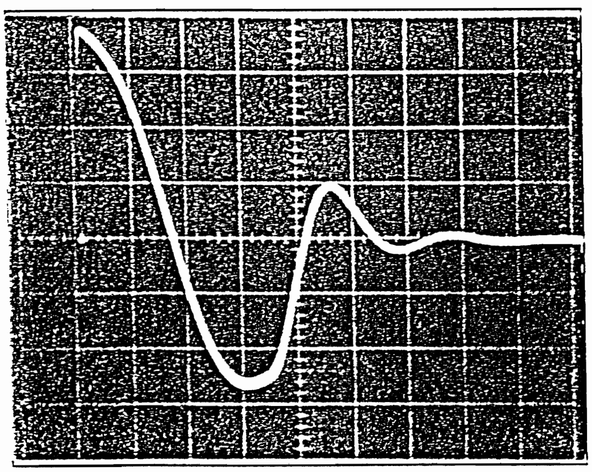

Figure 7a. Balanced Waveforms

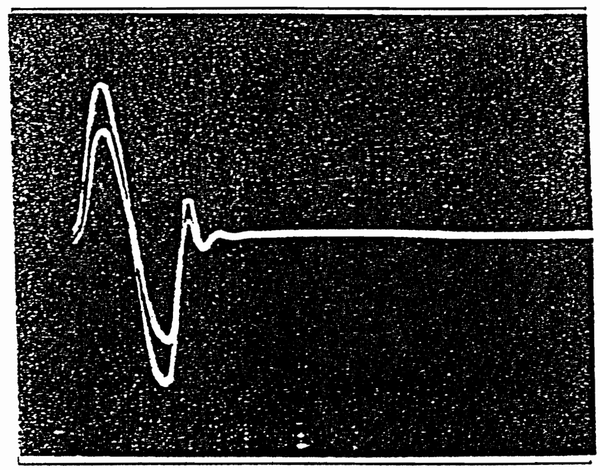

Figure 7b. Good Pattern (no phase shift)

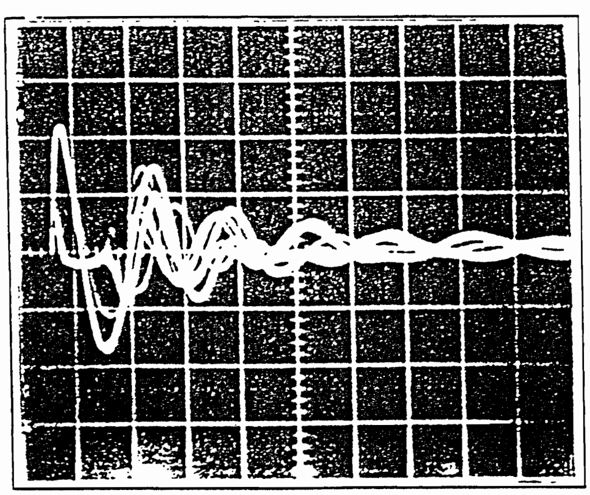

Figure 7c. Surge Breakdown

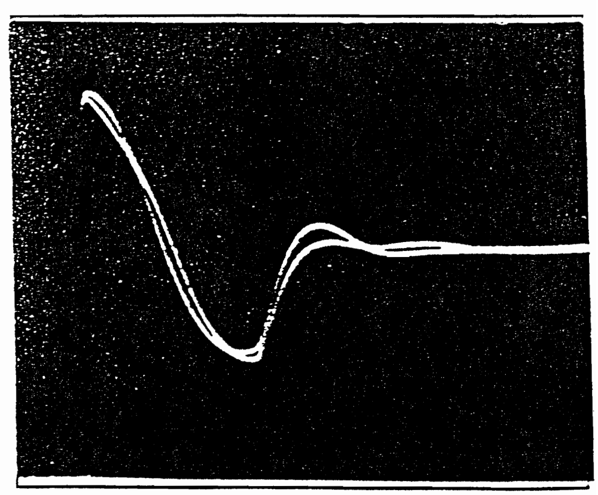

Figure 7d. Shorted Coils

4.2 ATF-11

The ATF-11 Armature Test Fixture is used in the same manner as the ATF-10, described in the previous section. The ATF-11 is used primarily with a T.I.G. Digital Winding Analyzer with the on-screen capture and hold features.

The ATF-11 unit uses only two side contact pins rather than the three on the ATF-10. This provides the same path from high voltage side to grounded side. Both traces on the CRT represent the applied voltage through the same coil in the same direction. Therefore, the CRT displays the same single span on both traces.

The digital feature allows the first span to be captured and redisplayed for comparison to all subsequent positions of the ATF-11. This method produces more accurate results for comparison.

4.2.1 Set-up

1. Follow set-up procedures for T.I.G. Winding Analyzer.

2. With Output Control at MIN and Function Switch in the OFF position, connect leads 1 and 2 together to the one red lead of the ATF-11 fixture and lead 3 to the black lead of the ATF.

3. Place the LEAD Selector knob on the TIG to the 1-2 position. It should remain in this position for the entire test.

4. Connect the Black Ground lead from the TIG to the shaft of the armature.

5. Follow the Test Procedures outlined below.

4.2.2 Test Procedure

1. Loosen the outer arms of the ATF by turning the handle counter-clockwise. Open the arms to span as many bars as needed (about 8-10

bars between the pins). Turn the handle clockwise to lock the arms in place.

NOTE: The two determining factors for the number of bars spanned are the amount of inductance between bars and the presence of shorting jumpers or equalizers within the armature. If a single pattern cannot be found, for example, at a 10 bar span, it may be that the pins have to be placed at a 6 bar span.

2. Place the pins of the ATF on the commutator so that each pin keeps positive contact with only a single bar.

NOTE: For best results, wrap the commutator with masking tape to prevent the brass pins from slipping off narrow bars.

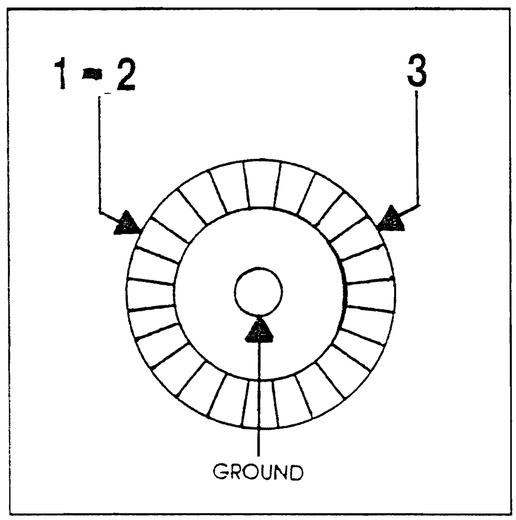

Figure 8. Connections for Span Test

3. With the fixture held in place, use the footswitch to energize the tester.

4. Slowly rotate the HIGH VOLTAGE OUTPUT control to about 1000 volts or use a recommended bar-to-bar voltage multiplied by the number of bars spanned (i.e. 150v/bar x 8bars = 1200v). Adjust the

focus, volts per division, and sweep, if needed, at this time.

5. Observe the waveforms displayed on the oscilloscope screen.

   NOTE: Both traces represent the same set of windings being surged by two high voltage leads at the same time. On some high frequency armatures, "doubling the leads" may cause feedback effects on one of the waveforms. If the patterns on the screen do not match, adjust the verticle position to remove the "worst" waveform from the oscilloscope CRT. That is, use the better defined waveform with the highest peaks.

6. Without changing the output voltage, release the footswitch. The digital CRT will be in the HOLD mode (red HOLD light ON). Press the SAVE button under the CRT, then press the RECALL button. The waveform(s) will be stored and held in continuous display on the CRT.

7. Move the ATF to the next position on the commutator. Press and release the footswitch to reset the HOLD mode on the oscilloscope to the "Sampling" mode (red HOLD light OFF).

   NOTE: The ATF can be moved a single bar at a time if desired. However, to save time and retain test accuracy, mark both of the pin starting positions with chalk and move that pin to the position of the other pin.

8. Press the footswitch to energize the winding and observe the patterns. The "active" waveform will be superimposed atop the "saved" waveform.

9. Release the footswitch and without pressing the SAVE or RECALL buttons, move the ATF to

the next position on the commutator. Maintain the same span and same direction of movement around the commutator.

10. Surge each set of bars and compare that waveform to stored pattern from the first span tested. Refer to Section 4.2.3 for waveform analysis.

4.2.3 Waveform Analysis

NOTE: Make sure the commutator is free of debris. Carbon dust and metal particles left between the bars on the commutator may cause shorting or arcing that affects test results.

NOTE: Do not test an armature while it is lying on a bench made of metal or other conductive material. Even some rubber bench pads may be made contain embedded conductive materials. These conditions may affect the test results. Use a stable support to hold the armature whenever possible.

While using the ATF-11, the superimposed waveforms from separate spans, displayed on the oscilloscope, may exhibit some separation, even when used on a "known good" armature. Particularly on random wound armatures, the coil turn lengths may vary due to coil overlap. This condition changes the capacitive and inductive characteristics of some of the coils only slightly. Thus small separations in the peaks of the waveforms with a slight frequency shift are acceptable as long as the waveforms remain stable and they appear very similar without becoming completely out of phase.

The most significant item to remember is that the characteristic shape of the waveform is not important in determining armature winding condition. When the coils are free of defects, the winding will hold the test voltage, and the waveforms will be stable and appear very similar as shown in Figure 7a, 7b. Weak insulation results in an unstable or flickering pattern, Figure 7c, while a solid short results in an electrical imbalance (out-of-phase condition) between the two windings, Figure 7d.

If the waveforms display some separation leading to questionable results of the winding condition, the operator can simulate the waveform for a shorted winding by randomly shorting together two bars on the commutator with an insulated screwdriver. Do this only after capturing a "reference" waveform so that the good and bad patterns can be compared at the same time.

NOTE: Some armatures may not contain enough turns of wire to produce an adequate waveform on the CRT. Some armatures use coils with very few turns, giving them very low inductive qualities. These armatures will show few, if any, peaks in the waveform past the initial peak, even with the sweep set at the fastest rate. In this case, a special high frequency coil tester or adapter may be required.

5 CFS-05 Calibration/Fault Simulator

The CFS-05, Figure 9, incorporates a specially designed winding used for checking the accuracy and calibration of all Electrom T.I.G Winding Analyzers. It will confirm that a Winding Analyzer is in proper working condition, and that the instrument is within calibration limits.

The CFS-05 is also intended as a training aid, to display faulted ground and winding insulation conditions on the Winding Analyzer.

The CFS-05 has two *replaceable* calibrated vacuum spark gaps rated at 1500 volts DC. A maximum test voltage of 3000 volts DC is recommended for the nonfaulted phases 1 and 2, where the spark gaps are not used.

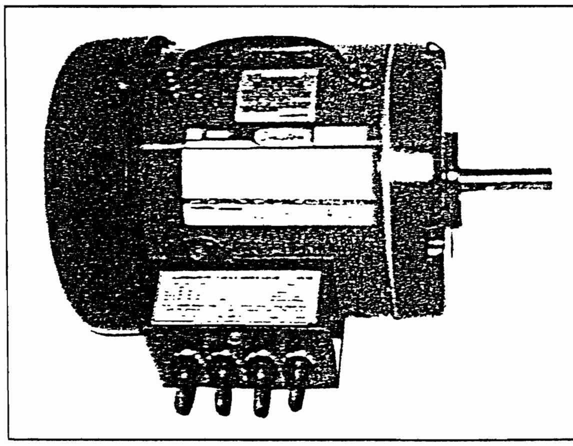

Figure 9.CFS-05 Calibrated Fault Simulator

5.1 Megohmmeter Test

Resistance from the windings to earth ground (motor frame) is in the form of a fixed resistor value of 50 megohms. This resistance may be read with an output of 250 to 1000 volts DC. The leakage Current meter should display 20μA at a voltage of 1000 volts DC, ± 0.6μA (3%).

5.1.1 Test Procedure

1. Connect lead #1 of the Winding Analyzer to all motor leads.

2. Connect the black ground lead from to the motor frame.

3. Apply 1000 volts DC to the windings as shown on the oscilloscope CRT.

4. Observe the leakage reading on the LED meter.

5. Divide the applied voltage by the current leakage to find the resistance in Megohms.

6. Turn the output control knob to MIN.

7. Discharge the windings to ground for at least 60 seconds by turning the lead selector to the 2-3 position before removing the test leads.

CAUTION: **DO NOT** apply more than 3000 volts DC to the windings!

5.2 DC Hipot Test

The output voltage and 'trip-out' circuit of the Winding Analyzer are checked by increasing the DC output voltage across the ground insulation to about 1500 volts. The Hipot should trip-out within ± 50 volts (3%).

5.2.1 Test Procedure

1. Connect lead #1 from the Winding Analyzer to all motor leads.

2. Connect the black ground lead to the motor frame.

3. Slowly increase the output voltage to 1500 volts as shown on the oscilloscope CRT.

4. Trip-out should occur at or near 1500 volts indicated by a change from the ding-dong type alarm to a screeching alarm and shut-off of the LEAD ENERGIZED light.

NOTE: If trip-out does not occur, return the high voltage output to MIN and recheck lead connections and retest. If the Hipot still does not trip-out increase the voltage to no more than 1800 volts to check for an out of calibration condition. Observe the trip-out voltage.

5. Once trip-out occurs, return the high voltage output control to MIN.

6. Discharge the winding for at least 60 seconds by turning the LEAD SELECTOR to the 2-3 position. A rule of thumb is to discharge the winding for a period ten times the test duration.

CAUTION: **DO NOT** apply more than 3000 volts DC to the winding!

5.3 Surge Comparison Test

The CFS-05 incorporates a 'flash-over' feature which is observed during the Surge Comparison test. Although the waveforms will appear stable in the 2-3 and 1-3 positions of the LEAD SELECTOR switch at low voltages, the pattern will become unstable and flicker at about 1500 volts ± 50 volts. The pattern should be stable up to the 3000 volt maximum while testing in the 1-2 position of the LEAD SELECTOR switch.

Four toggle switches on the CFS-05 allow the user to select four different types of solid short conditions:

1. All switches down: Balanced phases;
2. Far left switch up: turn-to-turn short;
3. Two left switches up: coil-to-coil short;
4. Three left switches up: phase-to-phase short;
5. All down except far right: Reversed coil connection.

The winding will exhibit 'flash-over' at 1500 volts in any of the faulted positions while testing phases 1 & 3 and 2 & 3, as in Figure 10 below.

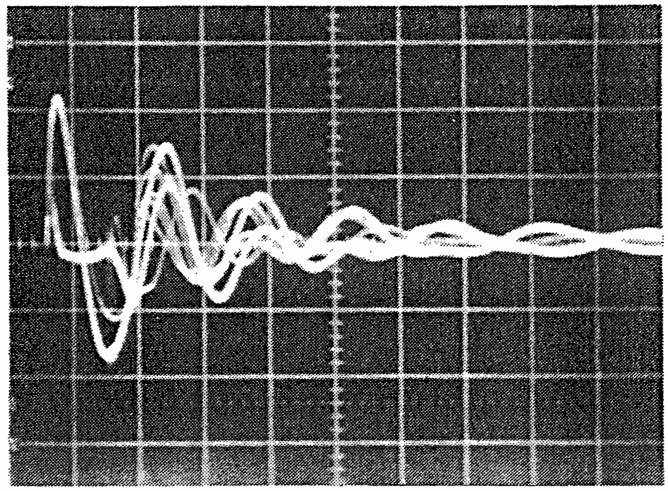

Figure 10. Surge Breakdown (Flashover)

5.3.1 Test Procedure

1. Match and connect the numbered test leads on the Winding Analyzer to the numbered leads on the CFS-05.

2. Connect the black ground lead to the motor frame.

3. Place the simulator switches to the desired position.

4. Perform the Surge and Comparison tests as described in the T.I.G. Winding Analyzer Instruction Manual.

CAUTION: **DO NOT** apply more than 3000 volts DC to the winding.

5.4 The Rotor

Rotors often cause a damping effect on the Surge Comparison test waveforms of assembled motors. In some cases a 'rotor coupling' effect causes separation in the waveforms that appear much like solid turn-to-turn or coil-to-coil faults. However, the rotor does not affect the identification of true faults in the winding as demonstrated with the CFS-05.

To eliminate the rotor coupling effect slowly turn the rotor while performing the Surge Comparison test. For balanced or nonfaulted phases, the superimposed waveforms displayed on the CRT will match at some point as the rotor is turned. If the waveforms do not properly match at any rotor position through a complete 360° revolution, a fault is indicated. In this case the rotor must be removed to test the stator directly to find the exact nature of the fault.

5.4.1 Removing The Rotor

The rotor of the CFS-05 can be easily removed by tapping on the rotor **OPPOSITE** the long shaft end. There are no screws to remove to disengage to rotor. The rotor and endbell are removed as one assembly and should not be separated. Figure 11, below, shows the CFS-05 with the rotor removed.

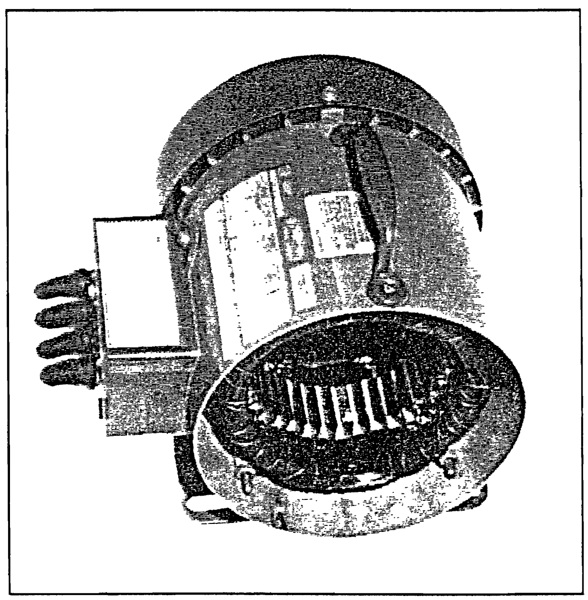

Figure 11. CFS-05 Without Rotor