

■ GROUND FLEX® ADAPTER

6474



ENGLISH

User Manual



3.610.7664

 www.calcert.com

sales@calcert.com

Statement of Compliance

Chauvin Arnoux®, Inc. d.b.a. AEMC® Instruments certifies that this instrument has been calibrated using standards and instruments traceable to international standards.

We guarantee that at the time of shipping your instrument has met its published specifications.

NIST traceable calibration is only possible when the Model 6474 is connected to the Ground Tester Model 6472.

To obtain NIST calibration (for a nominal charge), the instrument would need to be returned to our facility, along with your Ground Tester Model 6472.

The recommended calibration interval is 12 months and begins on the date of receipt by the customer.

Serial #: _____

Catalog #: _____

Model #: 6474

Please fill in the appropriate date as indicated:

Date Received: _____

Date Calibration Due: _____



Chauvin Arnoux®, Inc.
d.b.a AEMC® Instruments

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INTRODUCTION



These safety warnings are provided to ensure the safety of personnel. Please **read** and **comply** with these precautions:

- This instrument is protected from accidental voltages of not more than 50V with respect to earth in measurement CAT IV. The guaranteed level of protection of this equipment may be compromised if used in a manner not specified by the manufacturer.
- Safety is the responsibility of the operator.
- All metal objects or wires connected to the electrical system should be assumed to be lethal until tested. Grounding systems are no exception.
- Never exceed the maximum rated voltage and current, and the measurement category.
- Never exceed the protection limits, and always comply with the conditions and place of use, indicated in the specifications.
- Do not use the instrument or its accessories if they appear damaged.
- Use accessories that have overvoltage category and service voltages greater than or equal to those of the instrument (CAT IV 50V). Use only accessories that comply with safety standards (IEC 61010-2-031 & 32).
- Wear the appropriate protective gear (insulating boots and gloves).
- Check that no terminal is connected and the switch is set to OFF before opening the device.
- Use only the charging unit supplied with the instrument to recharge the battery.
- Troubleshooting and metrological verification procedures must only be performed by qualified, approved personnel, or the factory.
- **NOTE:** The potentials on the various rods used for an earth measurement may be different if a nearby electrical installation is defective or certain weather conditions prevail (thunderstorms). It is up to the operator to decide whether to continue or postpone measurements in these situations.

1.1 International Electrical Symbols

	Signifies that the instrument is protected by double or reinforced insulation.
	This symbol on the instrument indicates a WARNING that the operator must refer to the user manual for instructions before operating the instrument. In this manual, the symbol preceding instructions indicates that if the instructions are not followed, bodily injury, installation/sample and/or product damage may result.
	Risk of electric shock. The voltage at the parts marked with this symbol may be dangerous.
	Ground/Earth symbol
	In conformity with WEEE 2002/96/EC

1.2 Definition of Measurement Categories

CAT II: For measurements performed on circuits directly connected to the electrical distribution system. Examples are measurements on household appliances or portable tools.

CAT III: For measurements performed in the building installation at the distribution level such as on hardwired equipment in fixed installation and circuit breakers.

CAT IV: For measurements performed at the primary electrical supply (<1000V) such as on primary overcurrent protection devices, ripple control units, or meters.

1.3 Receiving Your Shipment

Upon receiving your shipment, make sure that the contents are consistent with the packing list. Notify your distributor of any missing items. If the equipment appears to be damaged, file a claim immediately with the carrier and notify your distributor at once, giving a detailed description of any damage. Save the damaged packing container to substantiate your claim.

1.4 Ordering Information

NOTE: The GroundFlex® Adapter Model 6474 only operates in combination with the Ground Tester Model 6472 Kit - 500ft.

GroundFlex® Adapter Model 6474 Cat. #2136.01
Includes the GroundFlex® Adapter Model 6474, four GroundFlex® sensors (5m/16ft) with twelve color-coded rings, carrying case for meter, connection lead, two extension leads on H reel (black/green) with color-coded alligator clips, six BNC extension leads, calibration loop, three C-clamps, and a user manual.

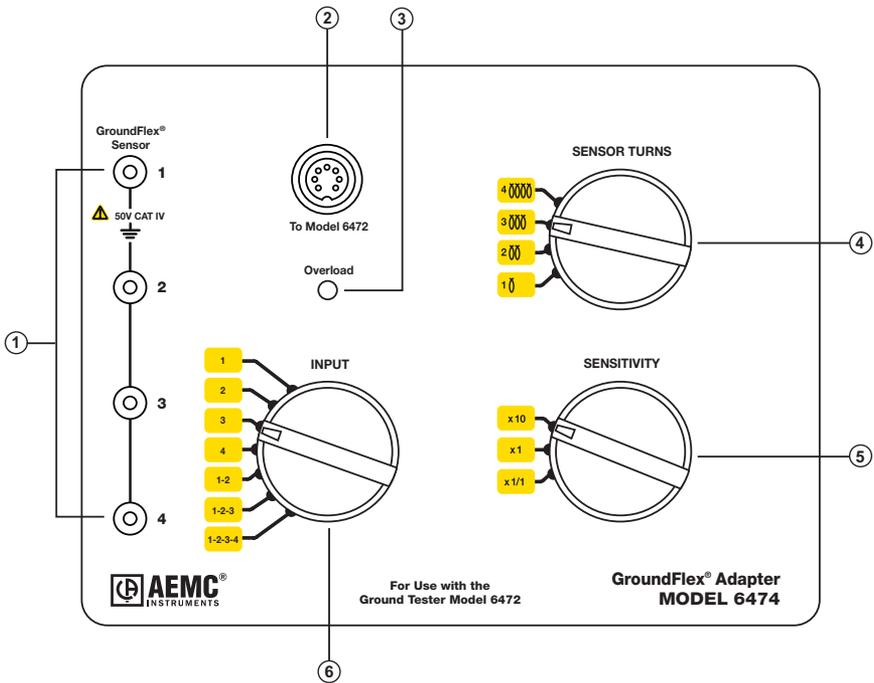
GroundFlex® Field Kit (Model 6472 and 6474) Cat. #2136.03
Includes the GroundFlex® Adapter Model 6474, Ground Resistance Tester Model 6472, carrying bag for meter, carrying bag for kit, hard carrying case, optical USB cable, power adapter 110/240V with power cord 115V US, two 500ft color-coded leads on spools (red/blue), two 100ft color-coded leads (hand-tied, green/black), one 30ft lead (green), four T-shaped auxiliary ground electrodes, set of five spaded lugs, one 100ft AEMC® tape measure, rechargeable NiMH batteries, and a USB stick with DataView® software, ground tester workbook and user manual.

1.4.1 Accessories and Replacement Parts

Bag #6 - Carrying Bag for Ground Kits.....	Cat. #2119.82
Tape Measure - AEMC® (100 ft)	Cat. #2130.60
Set of two, 14.5" T-shaped Auxiliary Ground Electrodes.....	Cat. #2135.39
Optical USB Cable.....	Cat. #2135.41
Replacement - One GroundFlex® (5m/16ft) Sensor.....	Cat. #2135.73
Replacement - Connection Lead for Model 6472/6474.....	Cat. #2135.75
Replacement - One BNC (15m/50ft) Extension Lead.....	Cat. #2135.76
Replacement - Set of 12, GroundFlex® Rings (red, yellow, brown, orange).....	Cat. #2135.77
Replacement - Green Extension Lead	Cat. #2135.78
Replacement - Black Extension Lead.....	Cat. #2135.79
Replacement - Set of 3, C-clamps.....	Cat. #2135.80
Replacement - Calibration Loop.....	Cat. #2135.82
Replacement - Carrying Case	Cat. #2135.83
Replacement - Safety Alligator Clip (black).....	Cat. #2140.53
Replacement - Safety Alligator Clip (green).....	Cat. #2140.69

GROUND FLEX® ADAPTER

2.1 Control Features



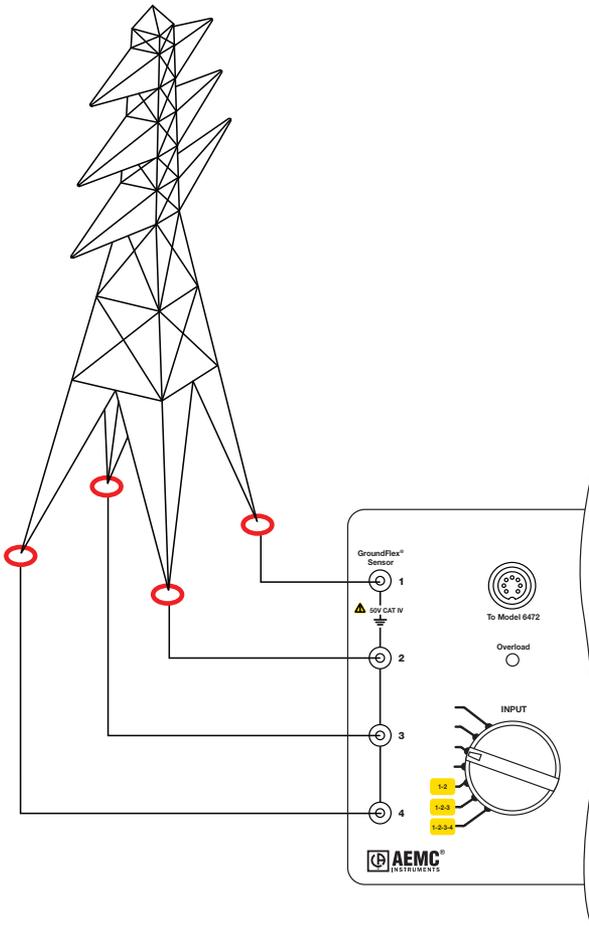
1. Inputs 1 through 4 for GroundFlex® sensors
2. Connector for connection lead to the Ground Tester Model 6472
3. OVERLOAD indicator
4. SENSOR TURNS selector: 1, 2, 3 or 4
5. SENSITIVITY selector: x10, x1 or x1/10
6. INPUT SELECTION: 1, 2, 3, 4, 1-2, 1-3 or 1-4

2.2 GroundFlex® Sensor

The GroundFlex® sensors are placed around a conductor (tower leg or pole) and closed using a screw connector, which is part of the sensor. This closed loop is then used to make a contact-free measurement of the current flowing in the conductor (leg) it is wrapped around.

These sensors are current measurement clamps but are able to enclose objects that are much larger.

GroundFlex® sensors are available in lengths of up to approx 24ft (8m) and can be placed around objects (such as tower legs) up to in approx 8ft diameter (2.7m).



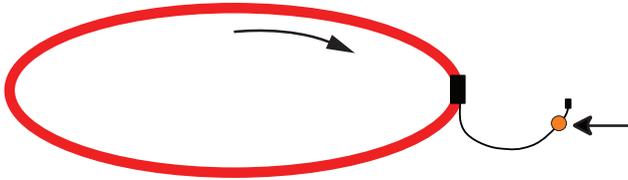
2.2.1 Calibration of GroundFlex® Sensors

Calibration is necessary for a new sensor, one that is no longer identified when a sensor has been replaced, or more than 2 lengths of extension cable is used. The calibration coefficients are then stored in the Model 6474.

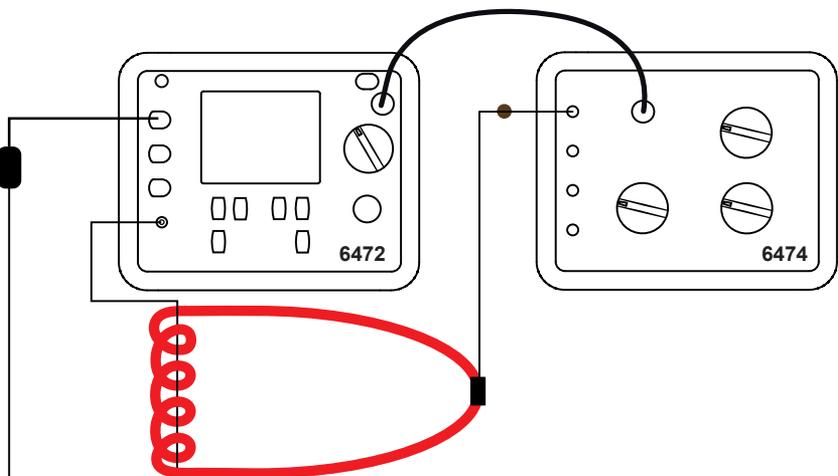


NOTE: Do not move or touch the GroundFlex® sensor or the calibration loop during the calibration. This could cause errors.

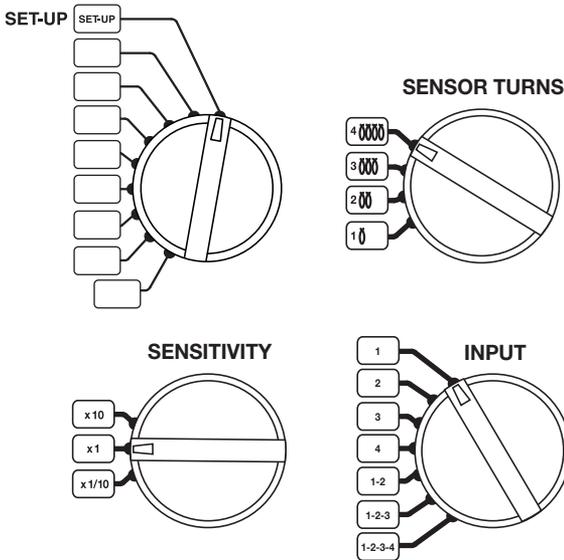
Start by identifying each sensor using the identification rings that are supplied with the Model 6474: (1) Brown (2) Red (3) Orange (4) Yellow



- Connect the calibration loop between terminals H and E of the Model 6472.
- Connect the Model 6472 and 6474 together using the connection cable.
- Connect the GroundFlex® sensor with the Brown ring to Input 1 of the Model 6474, the one with the Red ring to Input 2, the one with the Orange ring to Input 3, and the one with the Yellow ring to Input 4.
- Coil the GroundFlex® sensor four times around in the calibration loop and close it using its screw connector. Place the connector as far as possible from the calibration device.

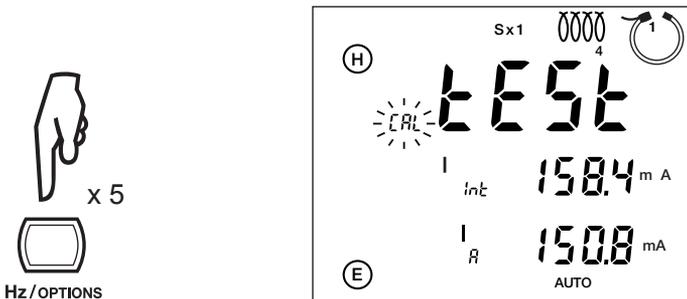


1. Set the switch of the 6472 to **SET-UP**.
2. Set the **SENSOR TURNS** switch to 4.
3. Set the **SENSITIVITY** switch to x1.
4. Set the **INPUT SELECTION** switch to 1.



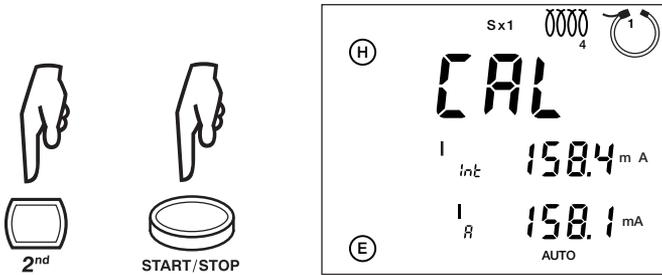
5. Press the **HZ/OPTIONS** button 5 times.

The device starts by comparing the current I_{int} injected by the device into the calibration loop to the current I_A measured by the GroundFlex[®] sensor. If they are different, the "CAL" symbol blinks to recommend a calibration.



NOTE: To avoid measurement errors, do not touch the GroundFlex[®] sensor or the calibration loop during the calibration.

6. To start the calibration, press **2nd + START**.
7. The device calculates and stores a calibration coefficient for the GroundFlex® sensor connected to channel 1.



This operation must be repeated for channels 2, 3 and 4; the **INPUT SELECTION** switch must be set to the corresponding position each time.

The calibration values are now stored into memory.

After calibration, the GroundFlex® sensors must always be connected to their respective channels.



NOTE: Always connect the same sensor to the same input.

2.3 Measurements in AUTO Mode

2.3.1 Preparation of the GroundFlex® Adapter

The GroundFlex® Adapter Model 6474 is designed to be used only with the Model 6472 device. The two instruments must be connected using the special connection cable supplied. The Model 6474 has no ON/OFF button, and is powered only by the Model 6472, via this connection cable.

The Model 6474 is intended primarily to measure the current that flows through a high-voltage tower to the ground. You can wrap up to 4 legs of the towers each with a GroundFlex® sensor and measure the current flowing to earth through each of the legs or through several legs.

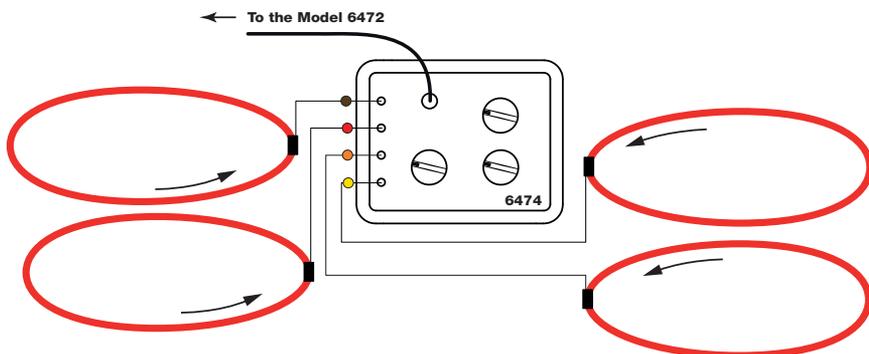
1. Set the rotary function switch to GroundFlex® on the Model 6472.

When you connect the GroundFlex® Adapter Model 6474 to the 6472, a self-test will begin. During this test, the OVERLOAD check light on the 6474 is lit.

2. Connect the required number of sensors to channels 1, 2, 3, and/or 4.



- NOTE:**
- The sensors have arrows to indicate a direction.
 - All sensors should face the same direction. (clockwise or counter-clockwise around the tower legs)
 - All sensors should have the same number of wraps.
 - Sensors should encircle both leg AND ground system.



3. On the Model 6474, set the **INPUT** selection switch accordingly. You can measure the current flowing through one GroundFlex® sensor (1, 2, 3, or 4), or through several sensors (1, 2 or 1, 2, 3), or through all of the sensors (1, 2, 3, 4).
4. Select how many times the sensor is wrapped around the conductor to be measured (from 1 to 4 turns) using the **SENSOR TURNS** selection switch.



NOTE: To increase measurement sensitivity, we recommend when possible, wrapping a maximum number of turns (up to 4) around the structure.

5. Set the **SENSITIVITY** switch to the desired sensitivity: x1/10, x1, or x10. The choice of sensitivity depends on the expected current value. As a precaution, always start with the lowest sensitivity, x1/10, and increase it as needed.

2.3.2 Making a Measurement (Resistance of Legs)

1. Place auxiliary electrodes **H (Z)** and **S (Y)** on opposite sides of the tower, as far away as possible (100-150 ft) and, if possible, perpendicular to the high-voltage line (depth is not important). This will eliminate interference with the measurement by stray voltages or currents induced under the high-voltage line.

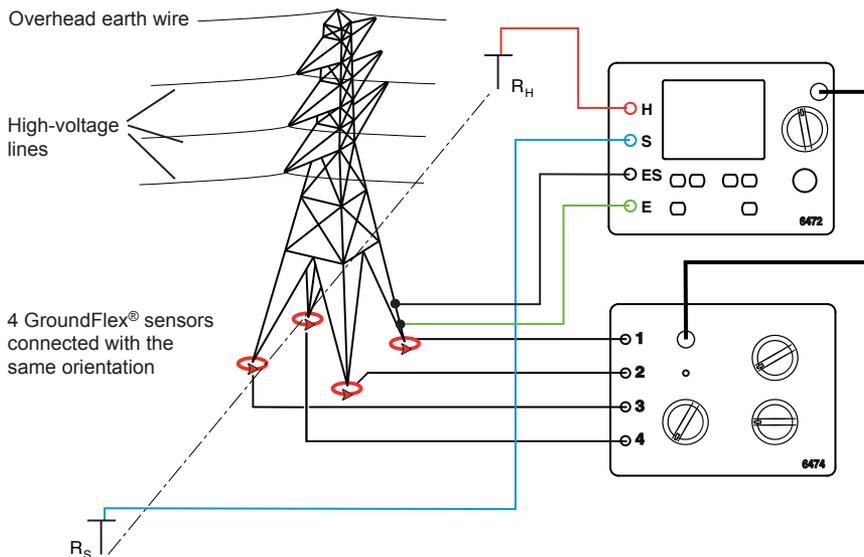


NOTE: The **H (Z)** and **S (Y)** electrodes can be placed in the same direction if necessary. In this case, the **S (Y)** electrode should be placed at 62% the distance of **H (Z)**.

2. In order to avoid electromagnetic interference, it is best to unwind the full length of each cable from the reel, to keep the cables as far apart as possible on the ground, taking care not to form loops, and to avoid placing the cables near or parallel to metallic conductors (cables, rails, fences, etc.). Effects of interference are measured in milli-ohms.
3. Connect these auxiliary electrodes to the terminals **H (Z)** and **S (Y)** on the Model 6472's front panel.
4. **Important:** The terminals **ES (Xv)** and **E (X)** must be connected to a conducting metallic part of the tower located **above** the GroundFlex® sensors. This ensures measurement of the current flowing **downward** and towards the earth (otherwise, you would measure the current flowing upward, from the earth to the top of the tower).
This will tell the condition of the overhead ground conductor.
5. Connect the required number of GroundFlex® sensors to channels 1, 2, 3, and/or 4 (the channels for which they are calibrated) and place the GroundFlex® sensors around the legs of the tower.

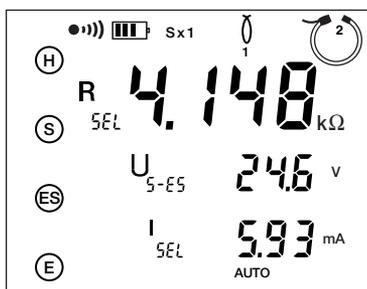


NOTE: The direction of coiling of the sensors around tower legs have no effect on the measurement, but **all** of the GroundFlex® sensors must be coiled in the **same direction** and have the same orientation (check arrow direction on the sensor) and they must **all** have the **same number of turns**. Sensors should encircle both leg **AND** ground system.



WARNING: If the GroundFlex® Adapter Model 6474 is connected to the earth tester, the earth potential connected to the terminals **E (X)** and **ES (Xv)** will also be present at the BNC connectors of the GroundFlex® sensors and at the connecting cable between the adapter and tester. Whenever any doubt exists about this earth potential, the user should proceed to a voltage measurement using the **S (Y)** and **ES (Xv)** terminals of the tester.

1. Set the 3 switches (Inputs, Turns and Sensitivity) of the GroundFlex® Adapter according to the connection made.
2. Start the measurement by pressing the **START/STOP** button.



To display the measurement parameters, press **DISPLAY** several times.

The device displays the following parameters:

R_{SEL} , U_{S-ES} and its frequency, I_{SEL} , R-Act (R_{PASS}), U-Act (U_{S-ES} and its frequency, U_{H-E} and its frequency), I-Act (I_{SEL} and its frequency).

To measure the resistances of electrodes **H (Z)** and **S (Y)**, or if the resistance of the electrodes is too high, start the measurement by a long press (approx 2 sec) of the **START/STOP** button (you will hear a 2nd beep).

R_H , R_S , U_{H-E} , I_{H-E} will be displayed.

2.3.3 Other Measurements

As explained in Step 4 on the previous page, terminals **ES (Xv)** and **E (X)** must be connected to a metallic part of the tower above the GroundFlex® sensor in order to measure the current flowing ISEL downward through the sensor towards the earth to measure ground resistance of the leg.

If connections **ES (Xv)** and **E (X)** are placed below the GroundFlex® sensor, the latter measures the current flowing towards the top of the tower via the overhead ground conductor at its top, and you can in this way evaluate the quality of this overhead ground conductor.

You can even make this measurement without moving the contacts of **ES (Xv)** and **E (X)** on the tower by simply passing the 2 connecting cables through the GroundFlex® sensor. The current in connecting cable **E (X)** and the current through the leg of the tower then cancel each other out.

You can also measure any leakage currents (I-Act) flowing through each leg of the tower in normal operation of the high-voltage line. If you find different leakage currents in each leg, but they cancel out when added together, you can conclude that these currents, induced by the rotating field of the high-voltage lines, indicate an earthing fault of the tower via the overhead ground wire at the tip of the mast.

2.4 MANUAL Mode and SWEEP Mode

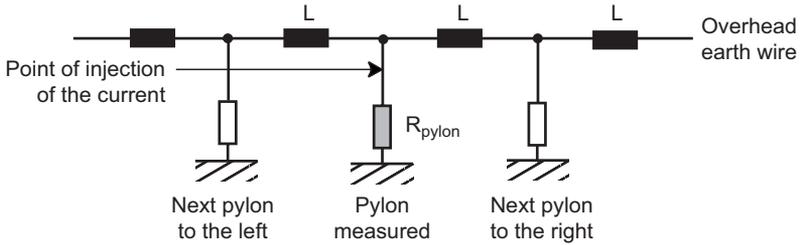
Use the **HZ/OPTIONS** button and ► button to change to **MANUAL** mode. The following parameters can be modified:

- 128Hz blinks → Change the test frequency
- Test voltage blinks → Switch between 16 and 32V

You can also perform a frequency sweep and a smoothing.

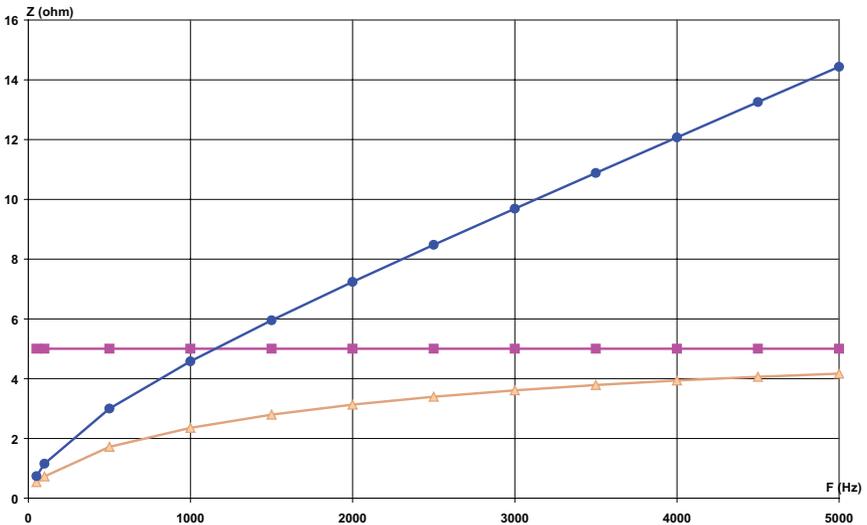
In the sweep mode, the measurements can be made at frequencies up to 5kHz. On a single tower, frequencies in the order of 5kHz do not always entail inductive effects, but the "current loops" formed by the adjacent towers and the return channel through the ground may result in inductances that can be detected only at high frequencies.

An equivalent diagram of the components forming this circuit is as follows:



A measurement in sweep mode (SWEEP) of an installation like this having 10 towers gives the following results assuming an earth resistance R_{pylon} of 10Ω for each tower and an inductance L of $550\mu H$ for the link via the overhead ground conductor at the tip of the towers:

Impedance of the towers



- Measurement of a tower earth impedance with GroundFlex® sensors
- ▲ Conventional 4 pole measurement
- Measurement into the top of a tower (iterative network impedance)

SPECIFICATIONS

3.1 Electrical

Measuring Method:

Voltage/Current measurement with a rectangular AC signal

Short Circuit Current: > 200mA_{AC}

Noise Suppression: > 80 dB at frequencies differing by 20% or more from the test frequency

Max. Overload: 250V_{rms}

Max. Value for R_H & R_S: 100kΩ

Measuring Time: **Short push on START:** approx. 7 s for first value of R_E at 128Hz, then 3 measurements per s.

Long push on START: approx. 15 s for first value of R_E at 128Hz, then 3 measurements per s.

Pylon Measurement with GroundFlex®

Measurement Range	0.067 to 9.999Ω	10.00 to 99.99Ω	100.0 to 999.9Ω	1.000 to 9.999kΩ	10.00 to 99.99kΩ
Resolution	0.001Ω	0.01Ω	0.1Ω	1Ω	10Ω
Test Voltage	16 or 32V user selectable				
Frequency	From 41 to 128Hz selectable				
Resistance Measurement Frequency	From 41 to 5078Hz selectable				
Accuracy	±5% of Reading + 1ct @ 128Hz				

The intrinsic error specified refers to reference conditions with a test voltage of 32V, test frequency of 128Hz, R_H, and R_S = 1kΩ, no external voltage.

The operating error for measurements of R_H, R_S and R_E is the same as that specified for 4-Pole earth resistance measurement.

The operating error of AC resistance measurements can be less than that specified for voltage or current because frequency characteristics of the voltage channel are matched to those of the current channel.

For test frequencies between 41 and 5087Hz, between 1 and 4 turns of the GroundFlex® sensor, and a selection of 1 to 4 measurement channels, the operating accuracies are the following:

SENSITIVITY and minimum I_{SEL} minimal		Operating accuracy for R_{S-ES}
S x 1/10	$I_{SEL} > 10mA$	$\pm (10\% + 4cts)$
S x 1	$I_{SEL} > 5mA$	$\pm (5\% + 4cts)$
S x 10	$I_{SEL} > 5mA$	$\pm (5\% + 4cts)$
	$5mA > I_{SEL} > 0.5mA$	$\pm (15\% + 10cts)$

Current Measurement with GroundFlex®

Measurement Range	0.0 to 99.9mA ⁽¹⁾	100 to 999mA	1.00 to 9.99A	10.0 to 99.9A
Resolution	0.1mA ⁽¹⁾	1mA	0.01A	0.1A
Frequency	16 to 400Hz			
Accuracy	<5% of Reading @ 50/60Hz			

(1): Valid only in the SENSITIVITY x 10 setting

The current measured depends on the number of turns of the GroundFlex® sensor around the conductor to be measured. (e.g. if the GroundFlex® sensor is wrapped 4 times around a conductor carrying a current of 1A, the input signal will be the same as if the GroundFlex® sensor were wrapped once around a conductor carrying a current of 4A. The operating error is therefore indicated for an input signal current in A.tr (Ampere.turns).

The minimum current measured depends on the setting of the SENSITIVITY switch as indicated by the table below:

SENSITIVITY	I_{MIN} (A.tr)	Points additional error (pt-er)
x 10	0.01	5
x 1	0.04	2
x 1/10	0.16	2

Accuracy

Current (A * turn)	16 to 49Hz	50 to 99Hz	100 to 400Hz
I_{MIN} to 0.399	$\pm (20\% + pt-er)$	$\pm (5\% + pt-er)$	$\pm (3\% + pt-er)$
0.4 to 39.9	$\pm (10\% + 2ct)$	$\pm (3\% + 2ct)$	$\pm (3\% + 2ct)$
40 to 99.9	$\pm (10\% + 2ct)$	$\pm (3\% + 2ct)$	$\pm (20\% + 2ct)$

3.2 Mechanical

Dimensions: 10.7 x 9.76 x 5.12" (272, 248 x 130mm)

Weight: 7 lbs (3.2kg) approx

Case Material: ULV0 Polypropylene

Terminals: 4mm recessed banana jacks

Case Protection: EN 60529 - IP53 (cover closed)

Drop Test: Per EN 61010-1

Vibration Test: Per EN 61557-1

3.3 Environmental

Operating Temperature: 32° to 113°F (0° to 45°C); 0 to 90% RH

Specified Operating Temperature⁽¹⁾: 0° to 95°F (0° to 35°C); 0 to 75% RH

Storage Temperature: -40° to 158°F (-40° to 70°C); 0 to 90% RH

Altitude: < 3000m

(1): This range corresponds to the one defined by standard EN 61557, for which an operating error including the quantities of influence is defined. When the device is used outside this range, 1.5%/10°C and 1.5% between 75 and 90% RH must be added to the operating error.

3.4 Safety

Electromagnetic Compatibility

This instrument satisfies the EMC and LVD directives required for the CE marking and product standard IEC 61326-1 (Ed. 97) + A1 (Ed. 98).

- Immunity in industrial environment
- Emissions in residential environment.

Electrical safety according to EN 61010-1 (Ed. 2 of 2001)

Measurement according to EN 61557 (Ed. 2 of 2007) parts 1, 4 and 5.

CAT IV, 50V

Pollution Degree 2

**Specifications are subject to change without notice*

MAINTENANCE

4.1 Maintenance



Please make sure that you have read and fully understand the **WARNING** section on page 3.

- To avoid electrical shock, do not attempt to perform any servicing unless you are qualified to do so.
- To avoid electrical shock and/or damage to the instrument, do not get water or other foreign agents into the case.
- Turn the instrument OFF and disconnect the unit from all circuits before opening the case.
- Use specified spare parts only.

4.2 Cleaning



Disconnect the instrument from any source of electricity.

Use a soft cloth lightly moistened with soapy water. Wipe with a moist cloth and then dry with a dry cloth. Never use alcohol, solvents or hydrocarbons.

Limited Warranty

The Model 6474 is warranted to the owner for a period of one year from the date of original purchase against defects in manufacture. This limited warranty is given by AEMC® Instruments, not by the distributor from whom it was purchased. This warranty is void if the unit has been tampered with, abused or if the defect is related to service not performed by AEMC® Instruments.

For full and detailed warranty coverage, please read the Warranty Coverage Information, which is attached to the Warranty Registration Card (if enclosed) or is available at www.aemc.com. Please keep the Warranty Coverage Information with your records.

What AEMC® Instruments will do:

If a malfunction occurs within the one-year period, you may return the instrument to us for repair, provided we have your warranty registration information on file or a proof of purchase. AEMC® Instruments will, at its option, repair or replace the faulty material.

**REGISTER ONLINE AT:
www.aemc.com**

Warranty Repairs

What you must do to return an Instrument for Warranty Repair:

First, request a Customer Service Authorization Number (CSA#) by phone or by fax from our Service Department (see address below), then return the instrument along with the signed CSA Form. Please write the CSA# on the outside of the shipping container. Return the instrument, postage or shipment pre-paid to:

Ship To: Chauvin Arnoux®, Inc. d.b.a. AEMC® Instruments
15 Faraday Drive • Dover, NH 03820 USA
Phone: (800) 945-2362 (Ext. 360)
(603) 749-6434 (Ext. 360)
Fax: (603) 742-2346 or (603) 749-6309
E-mail: repair@aemc.com

Caution: To protect yourself against in-transit loss, we recommend you insure your returned material.

NOTE: You must obtain a CSA# before returning any instrument.



10/15

99-MAN 100326 v5

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