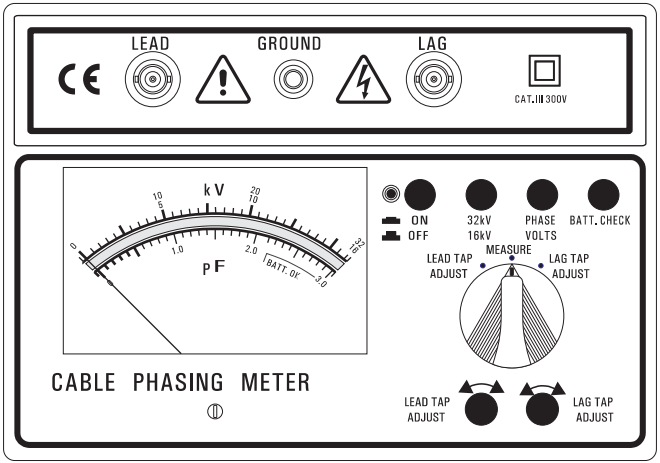
CABLE PHASING TESTER



INSTRUCTION MANUAL

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1. Introduction

Theory of Operation

Most manufacturers of high voltage cable terminations incorporate capacitive test point into their elbow connectors. These test points can be used for measuring cable voltage and other functions.

The Cable Phasing Meter is an instrument designed for use on underground distribution systems to offer a safe and quick method of measuring voltage determining phase rotation and phasing-out cables when the instrument is batter-powered and is supplied with a ground (earth) lead and two voltage measuring leads.

Besides its basic features for determining phase relationships and voltages of cable under test, the Cable Phasing Meter has a special feature which allows the operator to :

a. Adjust for different styles of elbow connector test point. (set capacitance value for the elbow).
b. Determine capacitance of the elbow test points. (When actual circuit voltage is know).
c. Adjust for differences in voltage between phases.

2. Specifications

- **Input**
  Four size AA, 1.5V batteries.
- **Measurements**
  a. Voltage Ranges :
  Two ranges; 0 to 16 kV, 0 to 32 kV.
  b. Accuracy :
  ±8% (exclusive of tap capacitance Variations).
  c. Tap Capacitance setting :
  0.4 to 3.0 pF continuous per channel.
  d. Frequency : 50 or 60 Hz.
- **Rated environmental conditions :**
  a. Indoor use.
  b. Installation Category III. 300V.
  c. Pollution Degree 2.
  d. Altitude up to 2000 meter.
  e. Relative Humidity 80% Max.
  f. Ambient Temperature 0°C~50°C.
- **Observe the international electrical symbols listed below.**


Meter is protected throughout by double insulation or reinforced insulation.


Warning! Risk of electric shock.


Caution! Refer to this manual before using the meter.


Alternating current.


Direct current.

3. Functions and Controls

- **Operation**
  a. Measure cable voltage.
  b. Test phase rotation.
  c. Compare phase relationship of two cables.

- **Controls**
  Three latching pushbuttons (press once to latch in the"down" position press again to release and return to the "up" position) to select :
  a. Instrument Power (ON / OFF) : Down position is ON up position is OFF.
  b. Voltage Range (16kV / 32kV) : Down position is 0 to 32 kV; up position is 0 to 16 kV.
  c. Function (PHASE / VOLTS) : Down position is PHASE up position is VOLTS.

- **One momentary pushbutton to select :**
  Batter Test (BATT): Press and hold ; battery condition is read in the green (BATT OK) Area located below the 12.5kV to 16kV section of the scale.

- **Selector Switch (LEAD - MEASURE - LAG) :**
  Three - position switch to select between tap capacitance adjustment for LEAD and LAG inputs, and the PHASE / VOLTS measurement mode.

  Tap capacitance Adjustments (LEAD TAP ADJUSTMENT / LAG TAP ADJUSTMENT) : When the selector Switch is in either the LEAD or LAG position, the instrument can be adjusted for the capacitance value of the test point the

corresponding test lead is connected to. See preparation for Operation and Test procedures sections for the specific applications of these controls.

4. Instrument Check - Voltage Testing Operation

Complete instrument operation, including test leads, can be verified in the shop by using this procedure and a grounded neutral power source not exceeding 320V line-to-ground. Verify voltage level before performing this test procedure (120 V will be used as an example.)

CAUTION

a. Connect the red test lead to the LEAD terminal, the black test lead to the LAG terminal and green test lead to the GROUND terminal of CPM. Connect the test clip of the GROUND lead to a good quality ground.

b. Set the ON / OFF pushbutton to ON ("down" Position).

c. Perform the Battery Check procedure.

d. Set the 16kV / 32kV pushbutton to the proper (16kV with the range button in the "down" position or 32kV with the range button "up") Use the 16kV range for test voltage up to 160V or the 32kV range for test voltage up to 320V.

e. Set the PHASE / VOLTS pushbutton to VOLTS ("up" Position).
f. Set LEAD - MEASURE - LAG switch to LEAD.
g. Adjust the LEAD potentiometer until the meter indicates 1 pF. (The bottom scale of the meter is calibrated in pF.)
h. Set LEAD - MEASURE - LAG switch to LAG.
i. Adjust the LAG potentiometer until the meter indicates 1 pF.
j. Set LEAD - MEASURE - LAG switch to MEASURE.
k. Apply 120V to the red lead. The meter should indicate 12kV. Remove the red lead from voltage source.
l. Apply 120V to the black lead. The meter should indicate 12kV Remove the black lead from voltage source.

NOTE

Voltage indicated is proportional to test voltage. If voltage indicated is incorrect, ensure that the proper range has been selected, recheck voltage value of the voltage source, and check the quality of the neutral circuit.

INSTRUMENT CHECK-PHASE TESTING OPERATION

For this procedure, a four - wire, three - phase with grounded neutral of known phase relationship (LEAD or LAG status) with a line - to - line voltage not exceeding 320V is required.

CAUTION

NEVER apply instrument leads directly to a voltage exceeding 320 volts.

a. If not already connect the test leads to the appropriate terminals of the Cable Phasing Meter. Connect the test clip of the GROUND lead to a good quality ground or neutral (as appropriate).

b. Set the ON / OFF pushbutton to NO.

c. Perform the battery check procedure.

d. Set the 16kV / 32kV pushbutton to the proper range. Use the range appropriate for the expected phase - to - phase test voltage.

e. If the instrument Check - voltage testing procedure was not performed prior to this procedure, perform steps 5 -10 of that procedure. If that procedure has already been performed, go to step 6.

f. Set the PHASE / VOLTS pushbutton to PHASE.

g. Connect the red test lead to "A" phase.

h. The meter should indicate 12kV for 120V line - to ground (line - to - neutral) test voltage.

i. Connect the black test lead to "B" phase.

j. The meter should now indicate zero (or nearly zero) if "A" phase LEADS "B" phase. If not, reverse the red and black test lead connections and the meter should now indicate zero (or nearly zero), indicating that "A" phase LAGS "B" phase.

k. Remove the red and black test leads from the voltage source.

5. Adjustment Procedures

Adjusting the Cable Phasing Meter for Known System Voltage (Unknown Elbow Connector Test point Capacitance).

This adjustment is only used when the operator knows the system voltage and can therefore set the Cable Phasing Meter to read the correct voltage on both LEAD and LAG Inputs.

EXAMPLE :

Known system voltage : 14.4kV

a. If not already connected, connect the test leads to appropriate terminals of the Cable Phasing Meter. Connect the test clip of the GROUND lead to a good quality ground or neutral(as appropriate).
b. Set the ON/OFF pushbutton to ON.
c. Perform the Battery check procedure.
d. Set the 16kV / 32kV pushbutton to 16kV.
e. Set the PHASE / VOLTS pushbutton to VOLTS.
f. Set the LEAD - MEASURE - LAG switch to MEASURE.
g. Apply the red test lead (LEAD) to test point of Elbow No. 1.
h. Adjust the LEAD potentiometer until the mete ndicates 14.4kV (the system voltage).
i. Remove the red test lead from the test point.
j. Apply the black test point of Elbow NO. 2.
k. Adjust the LAG potentiometer until the meter indicates 14.4kV (the system voltage).

l. Remove the black test lead from the point. The Cable Phasing Meter has now been adjusted for these two elbow test points.

6. Adjusting Different Types of Capacitive Test Points

When testing elbow connectors produced by various manufacturers quite common for each manufacturer to have different tolerances for the value of the test point capacitance. If the value of the test point capacitance is known, this procedure can be followed in setting the Cable Phasing Meter to the exact value of each elbow capacitance. Refer to Operating Frequency section for a system frequency other than 60 Hz.

EXAMPLE :

Known Capacitance : Elbow NO.1 = 1.5pF
Elbow NO.2 = 1.9pF

a. If not already connected, connect the test leads to the appropriate terminals of the Cable Phasing Meter. Connect the test clip of the GROUND lead to a good quality ground or neutral (as appropriate).
b. Set the ON / OFF pushbutton to ON.
c. Perform the Battery Check procedure.
d. Set the 16kV / 32kV pushbutton to the range appropriate for the circuit voltage of the cable.

e. Set the PHASE / VOLTS pushbutton to volts.
f. Set the LEAD - MEASURE - LAG switch to LEAD.
g. Apply the red test probe to the test point of Elbow NO. 1.
h. Adjust the LEAD potentiometer until the meter indicates 1.5pF.
i. Remove the red test probe from the test point.
j. Set the LEAD - MEASURE - LAG switch to LAG.
k. Apply the black test probe to the test point of Elbow NO.2.
l. Adjust the LAG potentiometer until the meter indicates 1.9pF.
m. Remove the black test probe from the test point. The Cable Phasing Meter is now adjusted for test points of 1.5pF and 1.9pF.

To adjust for unknown test point values, do not connect the test probes to test points. Set the LEAD and LAG potentiometers to 1pF using only the LEAD -MEASURE - LAG switch.

7. Test Procedures

- **Determining Capacitance Value of Test Points (When System Voltage is Known)**

  This test will determine a value for the elbow test point capacitance if the circuit voltage of the cable is known. By knowing the capacitance, the operator can mark each elbow with the actual value of capacitance for his reference when performing future testing.

  a. Refer to the section on "Adjusting the Cable Phasing Meter for known system voltages" and perform steps 1 through 12.
  b. Set the LEAD - MEASURE - LAG switch to LEAD.
  c. Apply the red (LEAD) test probe to test point of Elbow NO. 1.
  d. Meter will now indicate capacitance of test point of Elbow NO 1.
  e. Remove the red test probe from the test point.
  f. If desired, mark the capacitance value in aq suitable location.
  g. Set LEAD - MEASURE - LAG switch to LAG.
  h. Apply the black (LAG) test probe to test point of Elbow NO. 2.
  i. Meter will now indicate capacitance of test point of Elbow NO. 2.
  j. Remove the black test probe from the test point.
  k. If desired, mark the capacitance value in a suitable llocation.

- **Cable Voltage Measurement - Line-to-Ground**

  If this procedure is used on a system with an ungrounded neutral, then the GROUND lead is connected to the neutral terminal and the voltage reading is line - to -Neutral (phase-to-neutral).

  a. If not already connected, connect the test leads to the appropriate terminals of the Cable Phasing Meter connect the test clip of the GROUND lead to a good quality ground or neutral (as appropriate).
  b. Set the ON/OFF pushbutton to ON.
  c. Perform the Battery check procedure.
  d. Set the 16kV / 32kV pushbutton to the proper range.
  e. Set the PHASE / VOLTS pushbutton to VOLTS.
  f. Set the LEAD - MEASURE - LAG switch to MEASURE.
  g. Apply either the red or black test probe to the capacitive test point of the elbow connector. The meter will indicate the line-to-ground (phase - to - ground) circuit voltage of the cable.
  h. Remove the test probe from the test point.

- **Cable Voltage Measurement - Line - to - line**
  a. If not already connected, connect the test leads to the appropriate terminals of the Cable Phasing Meter Connect the clip of the GROUND lead to a good quality Ground.
  b. Set the ON / OFF pushbutton to ON.
  c. Perform the Battery Check procedure.
  d. Set the 16kV / 32kV pushbutton the proper range.
  e. Set the PHASE / VOLTS pushbutton to VOLTS.
  f. Set the LEAD - MEASURE - LAG switch to MEASURE.
  g. Apply the red test probe to the test point of elbow connector and the black test probe to the point of the other elbow connector. The meter will indicate the line - to - line (cable - to - cable) voltage.
  h. Remove the test probes from the test points.

8. Cable Phase Comparison

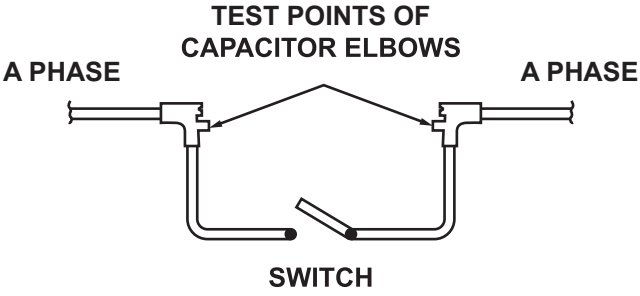
The phase comparison or "phasing" test determines if two cable are "in - phase" (i.e.,both are "A" phase as opposed to one "A" phase and one "B" phase). This will also determine if the two phases are similar voltages. Refer to FIGURE 1.

a. If not already connected, connect the test leads to the appropriate terminals of the Cable Phasing Meter connect the test clip of the GROUND lead to a good quality ground. For a system with an ungrounded neutral, the GROUND lead is connected to the neutral and the voltage reading is line - to - meutral (phase - to - neutral).
b. Set the ON / OFF pushbutton to ON.
c. Perform the Battery Check procedure.
d. Set the 16kV / 32kV pushbutton to the range appropriate for the cable voltage.
e. Set the PHASE / VOLTS pushbutton to VOLTS. For capacitive test points of different values and elbow of different makes, perform the "Adjusting the Cable Phasing Meter for Different Types of Capacitive Test Point" approximately 1pF, proceed to Step 6.
f. Set the LEAD - MEASURE - LAG switch to LEAD.
g. Adjust the LEAD potentiometer until the meter indicates 1 pF.
h. Set LEAD - MEASURE - LAG switch to LAG.
i. Adjust the lag potentiometer until the meter indicates 1 pF.
j. Set LEAD - MEASURE - LAG switch to MEASURE.
k. Apply the red test probe to the test point of one elbow. The meter should indicate the cable voltage.

l. With the red test probe still applied to the test point of one elbow, apply the black test probe to the test point of other elbow.

m. If the meter indicates zero (or nearly zero), this means that the two voltages are the same phase ("in phase") and approximately equal values. If a voltage is indicated, the two voltages are not in phase and/or are substantially different values.

n. Remove the red and black test leads from the test points.



9. Determining Phase Rotation

This test determines which phase leads or lags, and indicates rotational direction (ABC or CBA, RYB or BYR, RST or TSR).

a. If not already connected, connect the leads to the appropriate terminals of the Cable Phasing Meter connect the test clip of the GROUND lead to a good quality ground or neutral (as appropriate).

b. Set the ON / OFF pushbutton to ON.

c. Perform the Battery check procedure.

d. Set the 16kV / 32kV pushbutton to the range appropriate for the anticipated phase - to - phase cable voltage.
For capacitive test point of different values and elbows of different makes, perform the "Adjusting the Cable Phasing Meter for Different Types of Capacitive Test Points" procedure and go to step 10. For capacitive test point values of approximately 1 pF, proceed to step 5.

e. Set the PHASE / VOLTS pushbutton to VOLTS.

f. Set the LEAD - MEASURE - LAG switch to LEAD.

g. Adjust the LEAD potentiometer until the meter indicates 1 pF.

h. Set LEAD - MEASURE - LAG switch to LAG.

i. Adjust the LAG potentiometer until the meter indicates 1pF.

j. Set the PHASE / VOLTS pushbutton to PHASE.

k. Set LEAD - MEASURE - LAG switch to MEASURE.

l. Apply the red test probe to the test point of the elbow for phase The meter should indicate the voltage of Phase No. 1.

m. With the red test probe still applied to elbow test point of phase No. 1. Apply the black test probe to the probe to test point of the elbow for phase No. 2. The meter should indicate zero (or nearly zero). This means that Phase No. 1. Leads Phase No. 2.

n. Remove the red and black test probes from the elbow test points of phase No. 1 and Phase No. 2. Determining Phase Rotation (Continued).

o. Apply the red test probe to the test point of the elbow for Phase No. 2. The meter should indicate the voltage of Phase No. 2.

p. Remove the red and black test probes from the elbow test point No. 2. and Phase No. 3.
The results obtained indicate the voltages of cables 1, 2 and 3 are an "ABC" (RST or RYB) configuration.

10. Cleaning and Storage :

Periodically wipe the case with a damp cloth and detergent ; do not use abrasives or solvents. If the meter Is not to be used for periods of longer than 60 days remove the batteries and store them separately.